Hyperparameter-tuning Cookbook

A guide for scikit-learn, PyTorch, river, and spotPython

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2023-06-08

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Preface

The goal of hyperparameter tuning (or hyperparameter optimization) is to optimize the hyperparameters to improve the performance of the machine or deep learning model.

spotPython ("Sequential Parameter Optimization Toolbox in Python") is the Python version of the well-known hyperparameter tuner SPOT, which has been developed in the R programming environment for statistical analysis for over a decade. The related open-access book is available here: Hyperparameter Tuning for Machine and Deep Learning with R—A Practical Guide.

scikit-learn is a Python module for machine learning built on top of SciPy and is distributed under the 3-Clause BSD license. The project was started in 2007 by David Cournapeau as a Google Summer of Code project, and since then many volunteers have contributed.

PyTorch is an optimized tensor library for deep learning using GPUs and CPUs.

River is a Python library for online machine learning. It is designed to be used in real-world environments, where not all data is available at once, but streaming in.

> ❗ Important: This book is still under development.

Citation

If this document has been useful to you and you wish to cite it in a scientific publication, please refer to the following paper, which can be found on arXiv: https://arxiv.org/abs/2305.11930.

```
@ARTICLE{bart23earxiv,
       author = {{Bartz-Beielstein}, Thomas},
        title = "{PyTorch Hyperparameter Tuning -- A Tutorial for spotPython}",
      journal = {arXiv e-prints},
     keywords = {Computer Science - Machine Learning, Computer Science - Artificial Intell
         year = 2023,
        month = may,
          eid = {arXiv:2305.11930},
```

```
         pages = {arXiv:2305.11930},
           doi = {10.48550/arXiv.2305.11930},
 archivePrefix = {arXiv},
        eprint = {2305.11930},
  primaryClass = {cs.LG},
        adsurl = {https://ui.adsabs.harvard.edu/abs/2023arXiv230511930B},
       adsnote = {Provided by the SAO/NASA Astrophysics Data System}
}
```

1 Introduction: Hyperparameter Tuning

Hyperparameter tuning is an important, but often difficult and computationally intensive task. Changing the architecture of a neural network or the learning rate of an optimizer can have a significant impact on the performance.

The goal of hyperparameter tuning is to optimize the hyperparameters in a way that improves the performance of the machine learning or deep learning model. The simplest, but also most computationally expensive, approach uses manual search (or trial-and-error (Meignan et al. 2015)). Commonly encountered is simple random search, i.e., random and repeated selection of hyperparameters for evaluation, and lattice search ("grid search"). In addition, methods that perform directed search and other model-free algorithms, i.e., algorithms that do not explicitly rely on a model, e.g., evolution strategies (Bartz-Beielstein et al. 2014) or pattern search (Lewis, Torczon, and Trosset 2000) play an important role. Also, "hyperband", i.e., a multi-armed bandit strategy that dynamically allocates resources to a set of random configurations and uses successive bisections to stop configurations with poor performance (Li et al. 2016), is very common in hyperparameter tuning. The most sophisticated and efficient approaches are the Bayesian optimization and surrogate model based optimization methods, which are based on the optimization of cost functions determined by simulations or experiments.

We consider below a surrogate model based optimization-based hyperparameter tuning approach based on the Python version of the SPOT ("Sequential Parameter Optimization Toolbox") (Bartz-Beielstein, Lasarczyk, and Preuss 2005), which is suitable for situations where only limited resources are available. This may be due to limited availability and cost of hardware, or due to the fact that confidential data may only be processed locally, e.g., due to legal requirements. Furthermore, in our approach, the understanding of algorithms is seen as a key tool for enabling transparency and explainability. This can be enabled, for example, by quantifying the contribution of machine learning and deep learning components (nodes, layers, split decisions, activation functions, etc.). Understanding the importance of hyperparameters and the interactions between multiple hyperparameters plays a major role in the interpretability and explainability of machine learning models. SPOT provides statistical tools for understanding hyperparameters and their interactions. Last but not least, it should be noted that the SPOT software code is available in the open source `spotPython` package on github[1], allowing replicability of the results. This tutorial descries the Python variant of SPOT, which is called

[1] https://github.com/sequential-parameter-optimization

`spotPython`. The R implementation is described in Bartz et al. (2022). SPOT is an established open source software that has been maintained for more than 15 years (Bartz-Beielstein, Lasarczyk, and Preuss 2005) (Bartz et al. 2022).

This tutorial is structured as follows. The concept of the hyperparameter tuning software `spotPython` is described in Section 1.1. Chapter 20 describes the execution of the example from the tutorial "Hyperparameter Tuning with Ray Tune" (PyTorch 2023a). The integration of `spotPython` into the `PyTorch` training workflow is described in detail in the following sections. Section 20.1 describes the setup of the tuners. Section 20.3 describes the data loading. Section 25.4 describes the model to be tuned. The search space is introduced in Section 20.5. Optimizers are presented in Section 20.6. How to split the data in train, validation, and test sets is described in Section 20.7. The selection of the loss function and metrics is described in Section 20.8. Section 24.13 describes the preparation of the `spotPython` call. The objective function is described in Section 20.10. How to use results from previous runs and default hyperparameter configurations is described in Section 20.11. Starting the tuner is shown in Section 20.12. TensorBoard can be used to visualize the results as shown in Section 20.13. Results are discussed and explained in Section 20.14. Finally, Section 20.15 presents a summary and an outlook.

> **Note**
>
> The corresponding `.ipynb` notebook (Bartz-Beielstein 2023) is updated regularly and reflects updates and changes in the `spotPython` package. It can be downloaded from https://github.com/sequential-parameter-optimization/spotPython/blob/main/notebooks/14_spot_ray_hpt_torch_cifar10.ipynb.

1.1 The Hyperparameter Tuning Software SPOT

Surrogate model based optimization methods are common approaches in simulation and optimization. SPOT was developed because there is a great need for sound statistical analysis of simulation and optimization algorithms. SPOT includes methods for tuning based on classical regression and analysis of variance techniques. It presents tree-based models such as classification and regression trees and random forests as well as Bayesian optimization (Gaussian process models, also known as Kriging). Combinations of different meta-modeling approaches are possible. SPOT comes with a sophisticated surrogate model based optimization method, that can handle discrete and continuous inputs. Furthermore, any model implemented in `scikit-learn` can be used out-of-the-box as a surrogate in `spotPython`.

SPOT implements key techniques such as exploratory fitness landscape analysis and sensitivity analysis. It can be used to understand the performance of various algorithms, while simultaneously giving insights into their algorithmic behavior. In addition, SPOT can be used as an optimizer and for automatic and interactive tuning. Details on SPOT and its use in practice are given by Bartz et al. (2022).

A typical hyperparameter tuning process with `spotPython` consists of the following steps:

1. Loading the data (training and test datasets), see Section 20.3.
2. Specification of the preprocessing model, see Section 20.4.1. This model is called `prep_model` ("preparation" or pre-processing). The information required for the hyperparameter tuning is stored in the dictionary `fun_control`. Thus, the information needed for the execution of the hyperparameter tuning is available in a readable form.
3. Selection of the machine learning or deep learning model to be tuned, see Section 20.4.2. This is called the `core_model`. Once the `core_model` is defined, then the associated hyperparameters are stored in the `fun_control` dictionary. First, the hyperparameters of the `core_model` are initialized with the default values of the `core_model`. As default values we use the default values contained in the `spotPython` package for the algorithms of the `torch` package.
4. Modification of the default values for the hyperparameters used in `core_model`, see Section 20.5.3.1. This step is optional.
    1. numeric parameters are modified by changing the bounds.
    2. categorical parameters are modified by changing the categories ("levels").
5. Selection of target function (loss function) for the optimizer, see Section 20.8.
6. Calling SPOT with the corresponding parameters, see Section 20.12. The results are stored in a dictionary and are available for further analysis.
7. Presentation, visualization and interpretation of the results, see **?@sec-results**.

1.2 Spot as an Optimizer

The `spot` loop consists of the following steps:

1. Init: Build initial design X
2. Evaluate initial design on real objective f: $y = f(X)$
3. Build surrogate: $S = S(X, y)$
4. Optimize on surrogate: $X_0 = \text{optimize}(S)$
5. Evaluate on real objective: $y_0 = f(X_0)$
6. Impute (Infill) new points: $X = X \cup X_0$, $y = y \cup y_0$.
7. Got 3.

Central Idea: Evaluation of the surrogate model `S` is much cheaper (or / and much faster) than running the real-world experiment f. We start with a small example.

1.3 Example: `Spot` and the Sphere Function

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
```

1.3.1 The Objective Function: Sphere

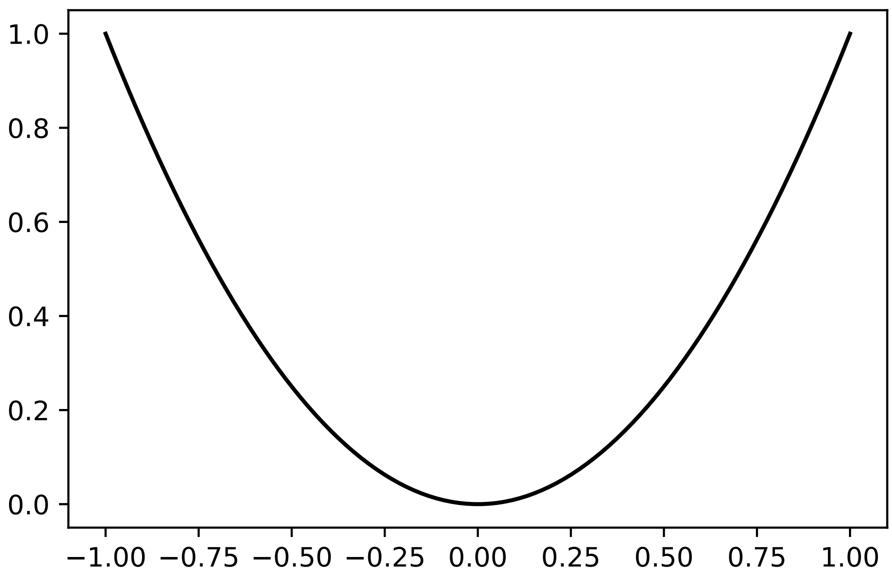
The `spotPython` package provides several classes of objective functions. We will use an analytical objective function, i.e., a function that can be described by a (closed) formula:

$$f(x) = x^2$$

```
fun = analytical().fun_sphere
```

We can apply the function `fun` to input values and plot the result:

```
x = np.linspace(-1,1,100).reshape(-1,1)
y = fun(x)
plt.figure()
plt.plot(x, y, "k")
plt.show()
```



```python
spot_0 = spot.Spot(fun=fun,
                   lower = np.array([-1]),
                   upper = np.array([1]))
```

```python
spot_0.run()
```

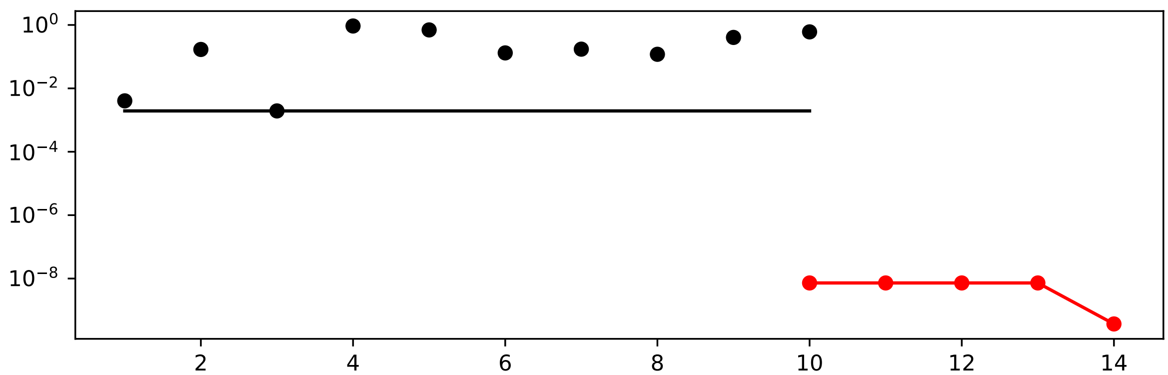
```
<spotPython.spot.spot.Spot at 0x16c1f9630>
```

```python
spot_0.print_results()
```

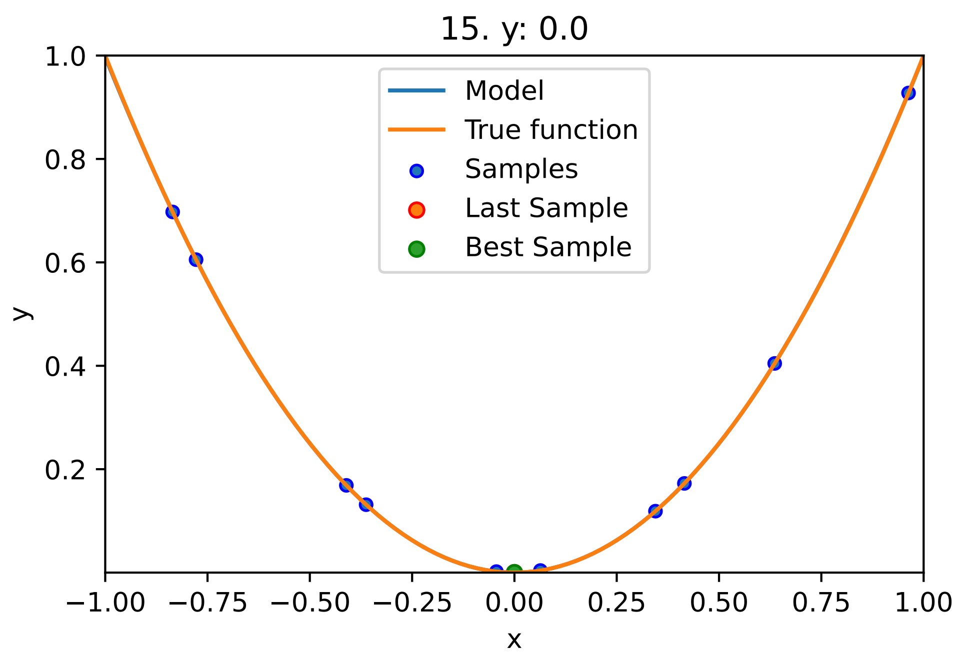
```
min y: 3.696886711914087e-10
x0: 1.922728975158508e-05
```

```
[['x0', 1.922728975158508e-05]]
```

```python
spot_0.plot_progress(log_y=True)
```




```
spot_0.plot_model()
```



1.4 Spot Parameters: `fun_evals`, `init_size` and `show_models`

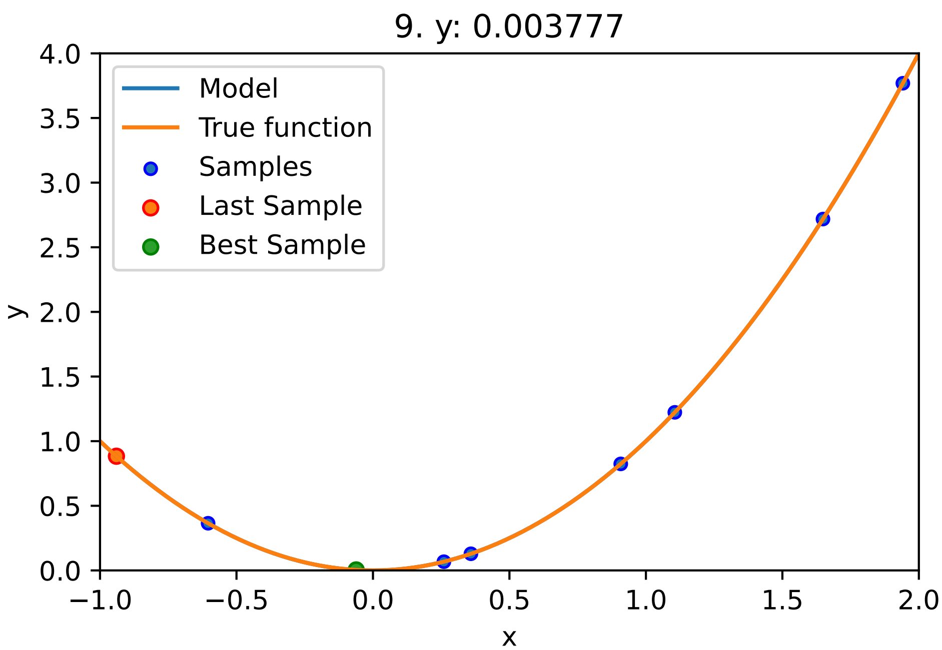
We will modify three parameters:

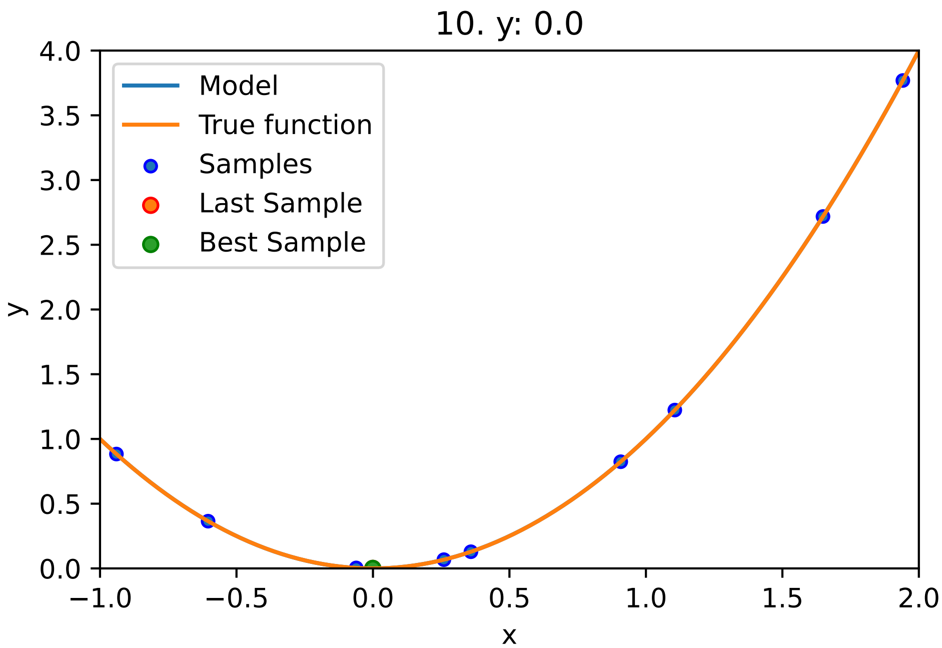
1. The number of function evaluations (`fun_evals`)
2. The size of the initial design (`init_size`)

3. The parameter `show_models`, which visualizes the search process for 1-dim functions.

The full list of the `Spot` parameters is shown in the Help System and in the notebook `spot_doc.ipynb`.

```
spot_1 = spot.Spot(fun=fun,
                   lower = np.array([-1]),
                   upper = np.array([2]),
                   fun_evals= 10,
                   seed=123,
                   show_models=True,
                   design_control={"init_size": 9})
spot_1.run()
```






```
<spotPython.spot.spot.Spot at 0x16ce9eef0>
```

1.5 Print the Results

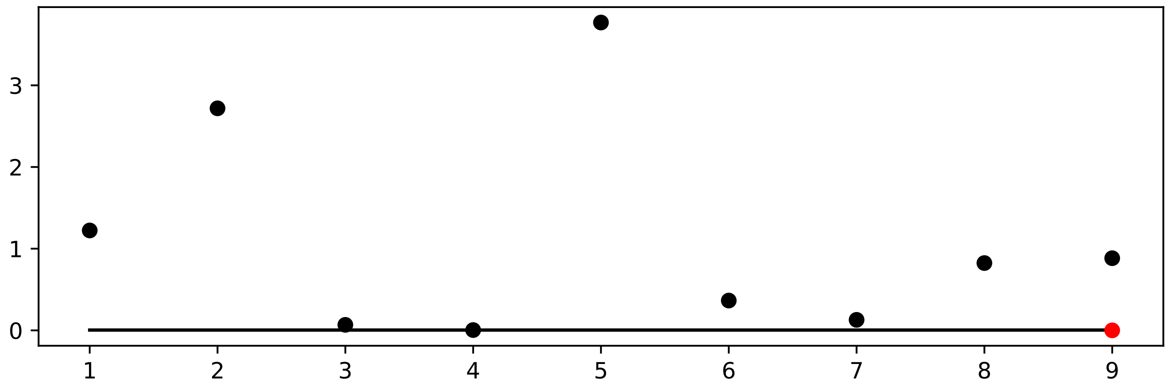
```
spot_1.print_results()
```

```
min y: 3.6779240309761575e-07
x0: -0.0006064589047063418
```

```
[['x0', -0.0006064589047063418]]
```

1.6 Show the Progress

```
spot_1.plot_progress()
```



3
2
1
0
1
2
3
4
5
6
7
8
9

2 Multi-dimensional Functions

This notebook illustrates how high-dimensional functions can be analyzed.

2.1 Example: `Spot` and the 3-dim Sphere Function

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
import pylab
from numpy import append, ndarray, multiply, isinf, linspace, meshgrid, ravel
from numpy import array
```

2.1.1 The Objective Function: 3-dim Sphere

- The `spotPython` package provides several classes of objective functions.
- We will use an analytical objective function, i.e., a function that can be described by a (closed) formula:

$$f(x) = \sum_i^n x_i^2$$

- Here we will use $n = 3$.

```
fun = analytical().fun_sphere
```

- The size of the `lower` bound vector determines the problem dimension.
- Here we will use `np.array([-1, -1, -1])`, i.e., a three-dim function.

- We will use three different `theta` values (one for each dimension), i.e., we set `surrogate_control={"n_theta": 3}`.

```
spot_3 = spot.Spot(fun=fun,
                   lower = -1.0*np.ones(3),
                   upper = np.ones(3),
                   var_name=["Pressure", "Temp", "Lambda"],
                   show_progress=True,
                   surrogate_control={"n_theta": 3})

spot_3.run()
```

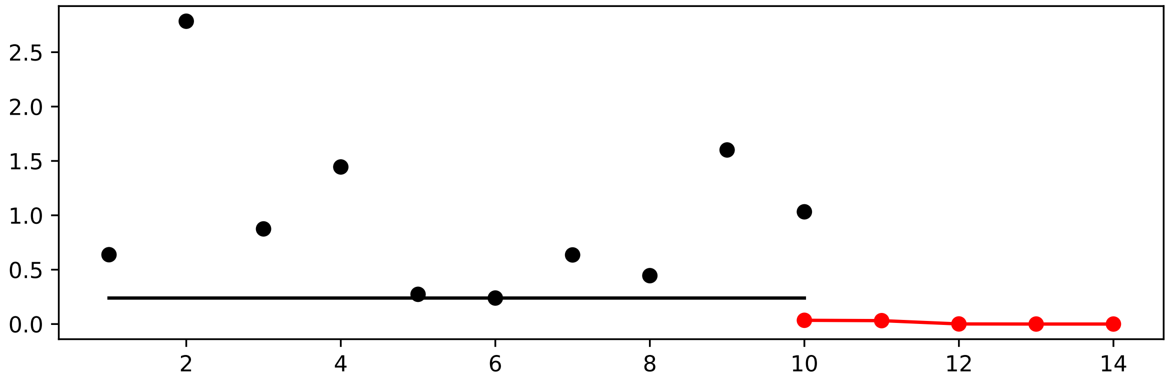
```
spotPython tuning: 0.03443344056467332 [#######---] 73.33%

spotPython tuning: 0.03134865993507926 [########--] 80.00%

spotPython tuning: 0.0009629342967936851 [#########-] 86.67%

spotPython tuning: 8.541951463966474e-05 [#########-] 93.33%

spotPython tuning: 6.285135731399678e-05 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x14ff67a90>
```

2.1.2 Results

```
spot_3.print_results()
```

```
min y: 6.285135731399678e-05
Pressure: 0.005236109709736696
Temp: 0.0019572552655686714
Lambda: 0.005621713639718905

[['Pressure', 0.005236109709736696],
 ['Temp', 0.0019572552655686714],
 ['Lambda', 0.005621713639718905]]
```

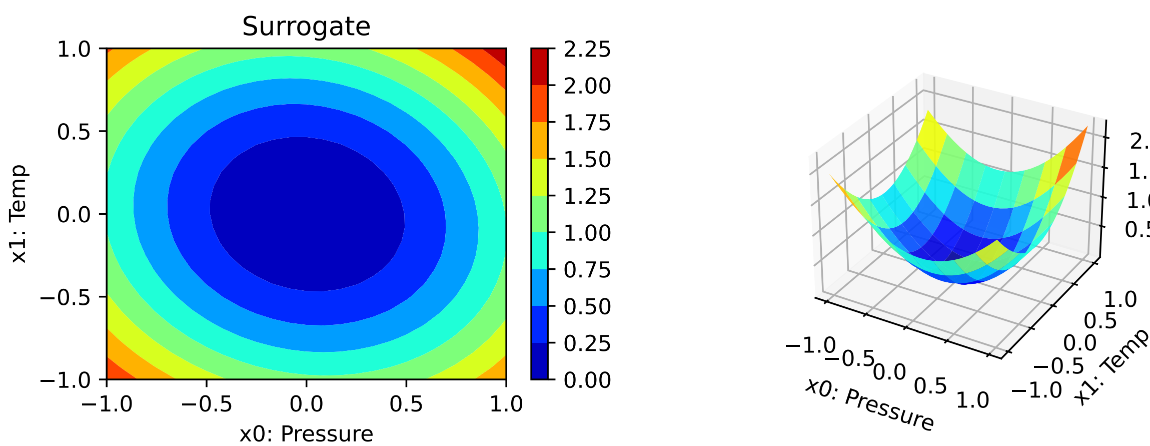
```python
spot_3.plot_progress()
```



2.1.3 A Contour Plot

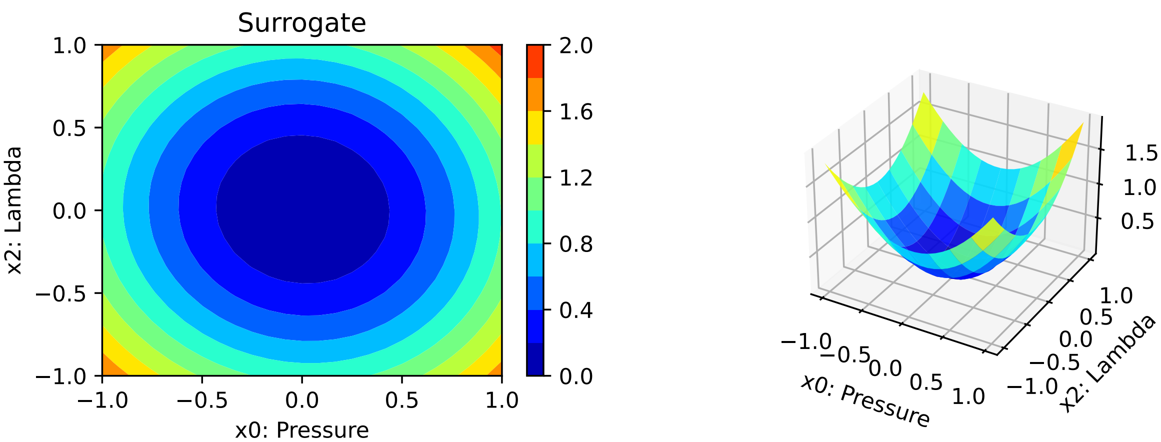
- We can select two dimensions, say $i = 0$ and $j = 1$, and generate a contour plot as follows.
  - Note: We have specified identical `min_z` and `max_z` values to generate comparable plots!

```python
spot_3.plot_contour(i=0, j=1, min_z=0, max_z=2.25)
```



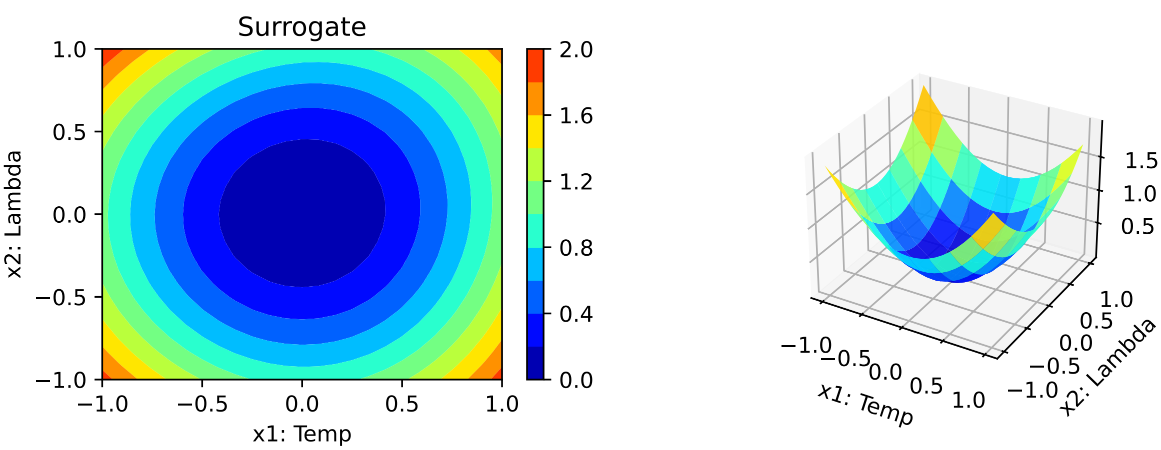
- In a similar manner, we can plot dimension $i = 0$ and $j = 2$:

```
spot_3.plot_contour(i=0, j=2, min_z=0, max_z=2.25)
```



- The final combination is $i = 1$ and $j = 2$:

```
spot_3.plot_contour(i=1, j=2, min_z=0, max_z=2.25)
```



- The three plots look very similar, because the `fun_sphere` is symmetric.
- This can also be seen from the variable importance:

```
spot_3.print_importance()
```

```
Pressure:  99.35185545837122
Temp:  99.99999999999999
```

```
Lambda:  94.31627052007231
```

```
[['Pressure', 99.35185545837122],
 ['Temp', 99.99999999999999],
 ['Lambda', 94.31627052007231]]
```

2.2 Conclusion

Based on this quick analysis, we can conclude that all three dimensions are equally important (as expected, because the analytical function is known).

2.3 Exercises

- Important:
  - Results from these exercises should be added to this document, i.e., you should submit an updated version of this notebook.
  - Please combine your results using this notebook.
  - Only one notebook from each group!
  - Presentation is based on this notebook. No addtional slides are required!
  - spotPython version `0.16.11` (or greater) is required

2.3.1 The Three Dimensional `fun_cubed`

- The input dimension is `3`. The search range is $-1 \leq x \leq 1$ for all dimensions.
- Generate contour plots
- Calculate the variable importance.
- Discuss the variable importance:
  - Are all variables equally important?
  - If not:
    - Which is the most important variable?
    - Which is the least important variable?

2.3.2 The Ten Dimensional `fun_wing_wt`

- The input dimension is `10`. The search range is $0 \leq x \leq 1$ for all dimensions.
- Calculate the variable importance.
- Discuss the variable importance:
  - Are all variables equally important?
  - If not:
    - Which is the most important variable?
    - Which is the least important variable?
  - Generate contour plots for the three most important variables. Do they confirm your selection?

2.3.3 The Three Dimensional `fun_runge`

- The input dimension is `3`. The search range is $-5 \leq x \leq 5$ for all dimensions.
- Generate contour plots
- Calculate the variable importance.
- Discuss the variable importance:
  - Are all variables equally important?
  - If not:
    - Which is the most important variable?
    - Which is the least important variable?

2.3.4 The Three Dimensional `fun_linear`

- The input dimension is `3`. The search range is $-5 \leq x \leq 5$ for all dimensions.
- Generate contour plots
- Calculate the variable importance.
- Discuss the variable importance:
  - Are all variables equally important?
  - If not:
    - Which is the most important variable?
    - Which is the least important variable?

3 Isotropic and Anisotropic Kriging

3.1 Example: Isotropic `Spot` Surrogate and the 2-dim Sphere Function

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
```

3.1.1 The Objective Function: 2-dim Sphere

- The `spotPython` package provides several classes of objective functions.
- We will use an analytical objective function, i.e., a function that can be described by a (closed) formula:

$$f(x, y) = x^2 + y^2$$

```
fun = analytical().fun_sphere
fun_control = {"sigma": 0,
               "seed": 123}
```

- The size of the `lower` bound vector determines the problem dimension.
- Here we will use `np.array([-1, -1])`, i.e., a two-dim function.

```
spot_2 = spot.Spot(fun=fun,
                   lower = np.array([-1, -1]),
                   upper = np.array([1, 1]))

spot_2.run()
```

<spotPython.spot.spot.Spot at 0x15f9d7c10>

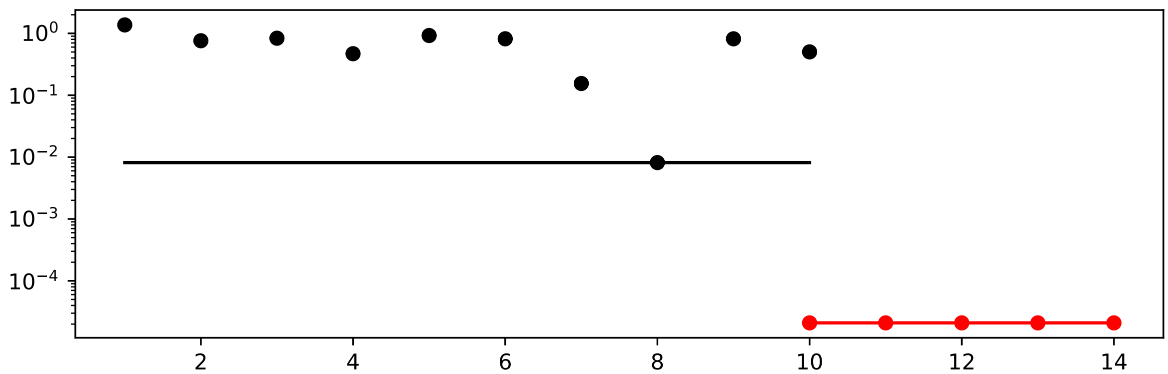
3.1.2 Results

```
spot_2.print_results()
```

```
min y: 2.093282610941807e-05
x0: 0.0016055267473267492
x1: 0.00428428640184529
```

```
[['x0', 0.0016055267473267492], ['x1', 0.00428428640184529]]
```

```
spot_2.plot_progress(log_y=True)
```



3.2 Example With Anisotropic Kriging

- The default parameter setting of `spotPython`'s Kriging surrogate uses the same `theta` value for every dimension.
- This is referred to as "using an isotropic kernel".
- If different `theta` values are used for each dimension, then an anisotropic kernel is used
- To enable anisotropic models in `spotPython`, the number of `theta` values should be larger than one.
- We can use `surrogate_control={"n_theta": 2}` to enable this behavior (`2` is the problem dimension).

```
spot_2_anisotropic = spot.Spot(fun=fun,
                    lower = np.array([-1, -1]),
                    upper = np.array([1, 1]),
                    surrogate_control={"n_theta": 2})
spot_2_anisotropic.run()
```

```
<spotPython.spot.spot.Spot at 0x16e4af190>
```

3.2.1 Taking a Look at the theta Values

- We can check, whether one or several `theta` values were used.
- The `theta` values from the surrogate can be printed as follows:

```
spot_2_anisotropic.surrogate.theta
```

```
array([0.19447342, 0.30813872])
```

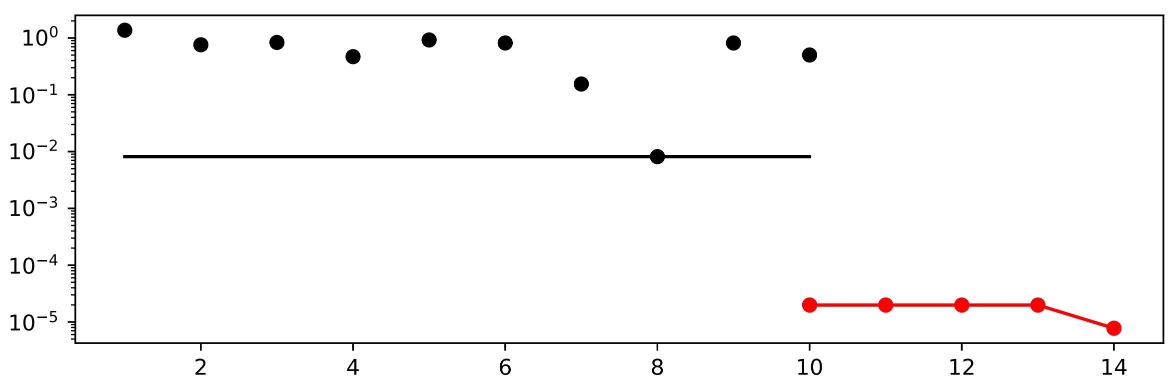
- Since the surrogate from the isotropic setting was stored as `spot_2`, we can also take a look at the `theta` value from this model:

```
spot_2.surrogate.theta
```

```
array([0.26287447])
```

- Next, the search progress of the optimization with the anisotropic model can be visualized:

```
spot_2_anisotropic.plot_progress(log_y=True)
```

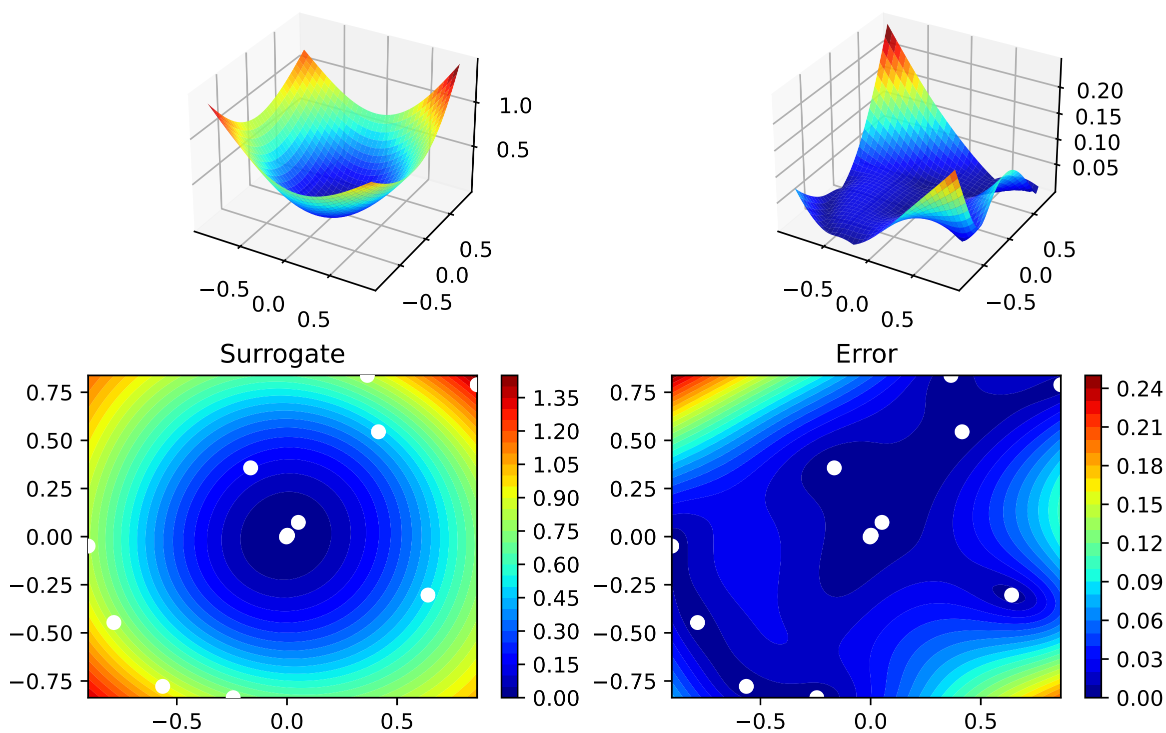


```
spot_2_anisotropic.print_results()
```

```
min y: 7.77061191821505e-06
x0: -0.0024488252797500764
x1: -0.0013318658594137815
```

```
[['x0', -0.0024488252797500764], ['x1', -0.0013318658594137815]]
```

```
spot_2_anisotropic.surrogate.plot()
```



4 Exercises

4.1 `fun_branin`

- Describe the function.
  - The input dimension is `2`. The search range is $-5 \leq x_1 \leq 10$ and $0 \leq x_2 \leq 15$.
- Compare the results from `spotPython` run a) with isotropic and b) anisotropic surrogate models.
- Modify the termination criterion: instead of the number of evaluations (which is specified via `fun_evals`), the time should be used as the termination criterion. This can be done as follows (`max_time=1` specifies a run time of one minute):

```
fun_evals=inf,
max_time=1,
```

4.2 `fun_sin_cos`

- Describe the function.
  - The input dimension is `2`. The search range is $-2\pi \leq x_1 \leq 2\pi$ and $-2\pi \leq x_2 \leq 2\pi$.
- Compare the results from `spotPython` run a) with isotropic and b) anisotropic surrogate models.
- Modify the termination criterion (`max_time` instead of `fun_evals`) as described for `fun_branin`.

4.3 `fun_runge`

- Describe the function.
  - The input dimension is `2`. The search range is $-5 \leq x_1 \leq 5$ and $-5 \leq x_2 \leq 5$.
- Compare the results from `spotPython` run a) with isotropic and b) anisotropic surrogate models.

- Modify the termination criterion (`max_time` instead of `fun_evals`) as described for `fun_branin`.

4.4 fun_wingwt

- Describe the function.
  - The input dimension is `10`. The search ranges are between 0 and 1 (values are mapped internally to their natural bounds).
- Compare the results from `spotPython` run a) with isotropic and b) anisotropic surrogate models.
- Modify the termination criterion (`max_time` instead of `fun_evals`) as described for `fun_branin`.

5 Using `sklearn` Surrogates in `spotPython`

This notebook explains how different surrogate models from `scikit-learn` can be used as surrogates in `spotPython` optimization runs.

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
```

5.1 Example: Branin Function with `spotPython`'s Internal Kriging Surrogate

5.1.1 The Objective Function Branin

- The `spotPython` package provides several classes of objective functions.
- We will use an analytical objective function, i.e., a function that can be described by a (closed) formula.
- Here we will use the Branin function:

```
y = a * (x2 - b * x1**2 + c * x1 - r) ** 2 + s * (1 - t) * np.cos(x1) + s,
where values of a, b, c, r, s and t are: a = 1, b = 5.1 / (4*pi**2),
c = 5 / pi, r = 6, s = 10 and t = 1 / (8*pi).
```

- It has three global minima:

```
f(x) = 0.397887 at (-pi, 12.275), (pi, 2.275), and (9.42478, 2.475).
```

```
from spotPython.fun.objectivefunctions import analytical
lower = np.array([-5,-0])
```

```
upper = np.array([10,15])
```

```
fun = analytical().fun_branin
```

5.1.2 Running the surrogate model based optimizer `Spot`:

```
spot_2 = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = 20,
                   max_time = inf,
                   seed=123,
                   design_control={"init_size": 10})
```

```
spot_2.run()
```

```
<spotPython.spot.spot.Spot at 0x105a6fdf0>
```

5.1.3 Print the Results

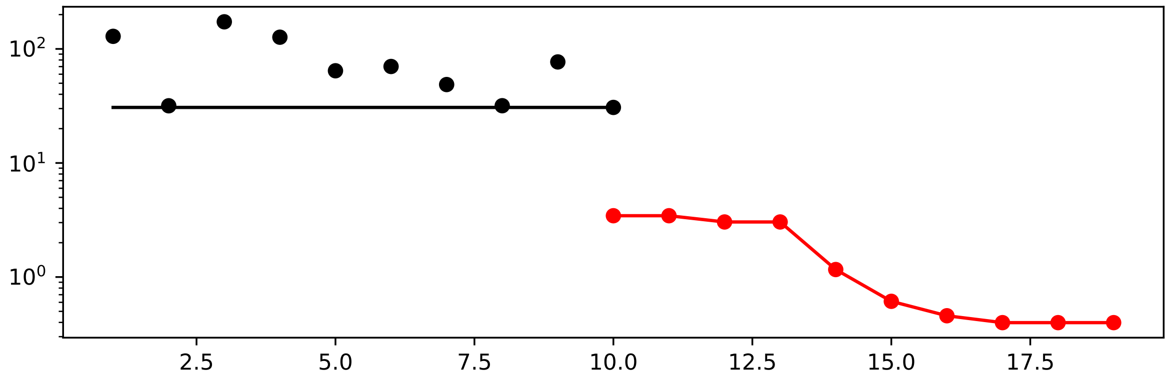
```
spot_2.print_results()
```

```
min y: 0.3982295132785083
x0: 3.135528626303215
x1: 2.2926027772585886
```

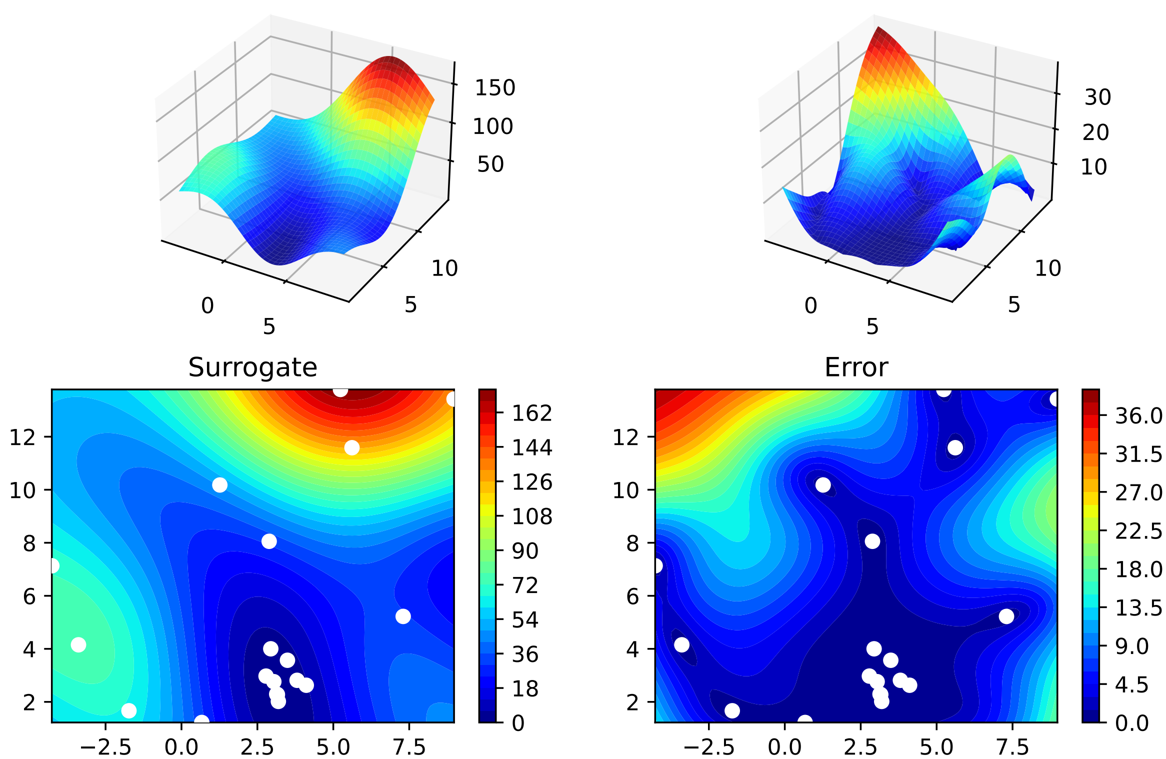
```
[['x0', 3.135528626303215], ['x1', 2.2926027772585886]]
```

5.1.4 Show the Progress and the Surrogate

```
spot_2.plot_progress(log_y=True)
```




```
spot_2.surrogate.plot()
```



5.2 Example: Using Surrogates From scikit-learn

- Default is the `spotPython` (i.e., the internal) `kriging` surrogate.

- It can be called explicitely and passed to `Spot`.

```
from spotPython.build.kriging import Kriging
S_0 = Kriging(name='kriging', seed=123)
```

- Alternatively, models from `scikit-learn` can be selected, e.g., Gaussian Process, RBFs, Regression Trees, etc.

```
# Needed for the sklearn surrogates:
from sklearn.gaussian_process import GaussianProcessRegressor
from sklearn.gaussian_process.kernels import RBF
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn import linear_model
from sklearn import tree
import pandas as pd
```

- Here are some additional models that might be useful later:

```
S_Tree = DecisionTreeRegressor(random_state=0)
S_LM = linear_model.LinearRegression()
S_Ridge = linear_model.Ridge()
S_RF = RandomForestRegressor(max_depth=2, random_state=0)
```

5.2.1 GaussianProcessRegressor as a Surrogate

- To use a Gaussian Process model from `sklearn`, that is similar to `spotPython`'s `Kriging`, we can proceed as follows:

```
kernel = 1 * RBF(length_scale=1.0, length_scale_bounds=(1e-2, 1e2))
S_GP = GaussianProcessRegressor(kernel=kernel, n_restarts_optimizer=9)
```

- The scikit-learn GP model `S_GP` is selected for `Spot` as follows:

  `surrogate = S_GP`

- We can check the kind of surogate model with the command `isinstance`:

```
isinstance(S_GP, GaussianProcessRegressor)
```

```
True
```

```
isinstance(S_0, Kriging)
```

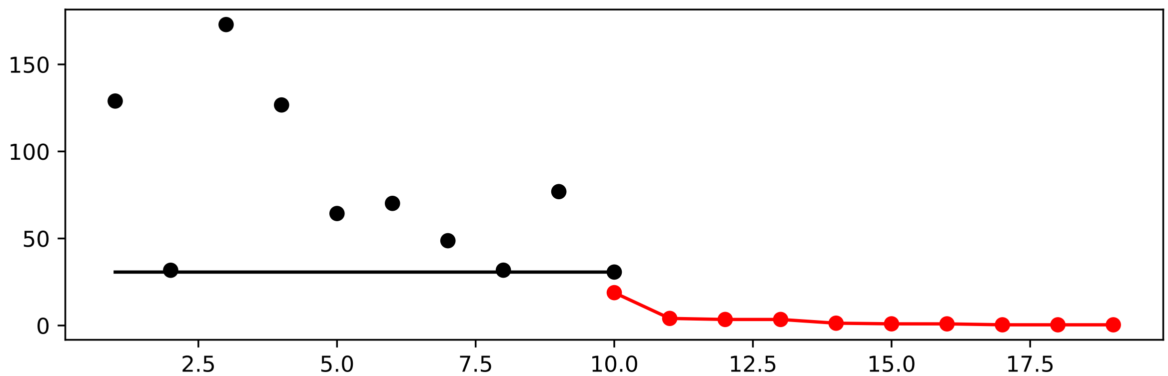
```
True
```

- Similar to the `Spot` run with the internal `Kriging` model, we can call the run with the `scikit-learn` surrogate:

```
fun = analytical(seed=123).fun_branin
spot_2_GP = spot.Spot(fun=fun,
                     lower = lower,
                     upper = upper,
                     fun_evals = 20,
                     seed=123,
                     design_control={"init_size": 10},
                     surrogate = S_GP)
spot_2_GP.run()
```

```
<spotPython.spot.spot.Spot at 0x29676b5b0>
```

```
spot_2_GP.plot_progress()
```




```
spot_2_GP.print_results()
```

```
min y: 0.3982220901970912
x0: 3.149885373838344
x1: 2.270679371556774
```

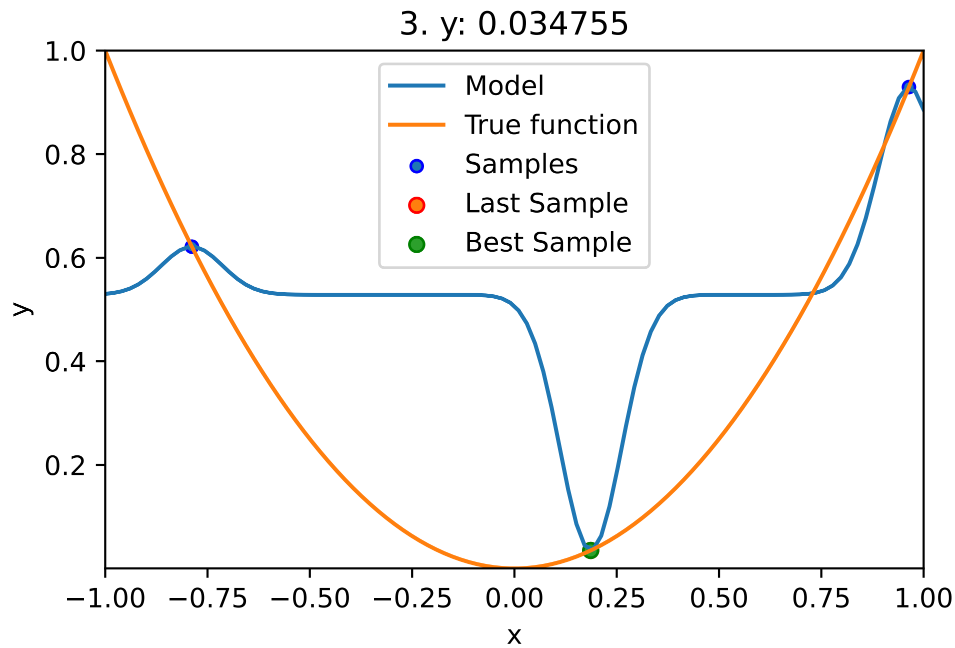
```
[['x0', 3.149885373838344], ['x1', 2.270679371556774]]
```

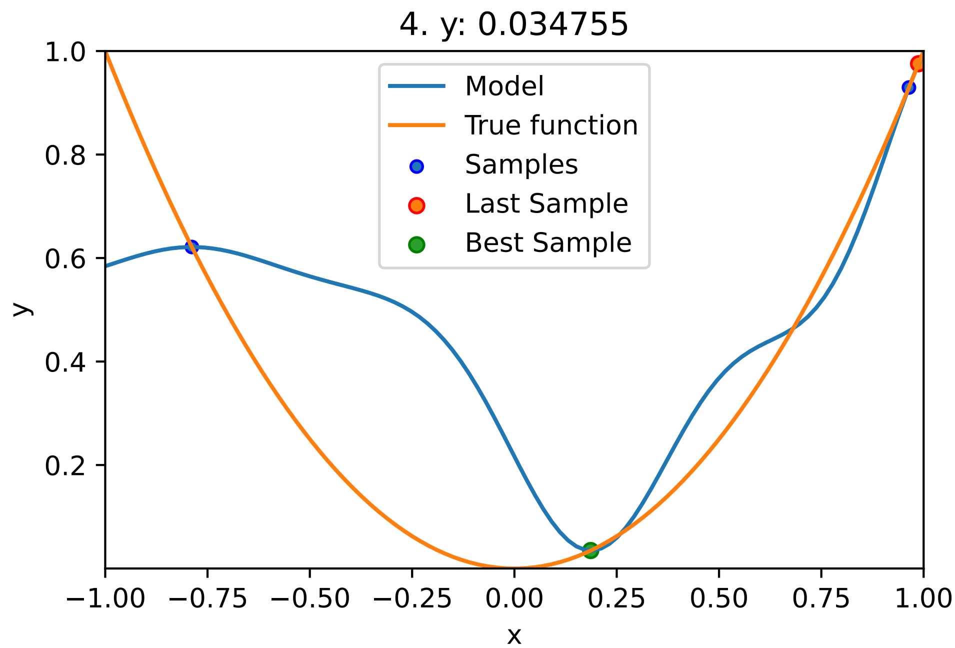
6 Example: One-dimensional Sphere Function With spotPython's Kriging

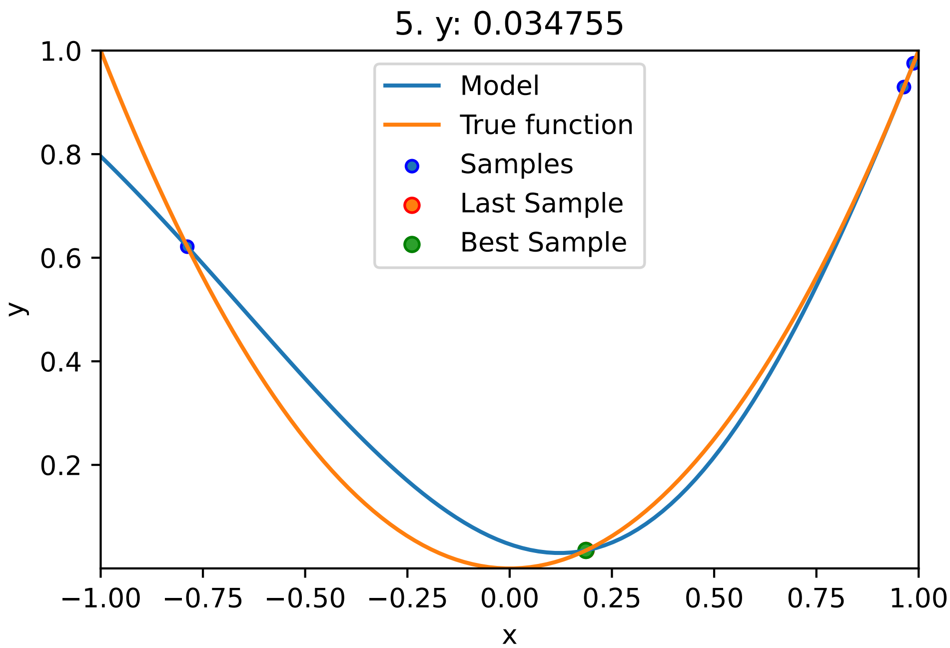
- In this example, we will use an one-dimensional function, which allows us to visualize the optimization process.
  - show_models= True is added to the argument list.

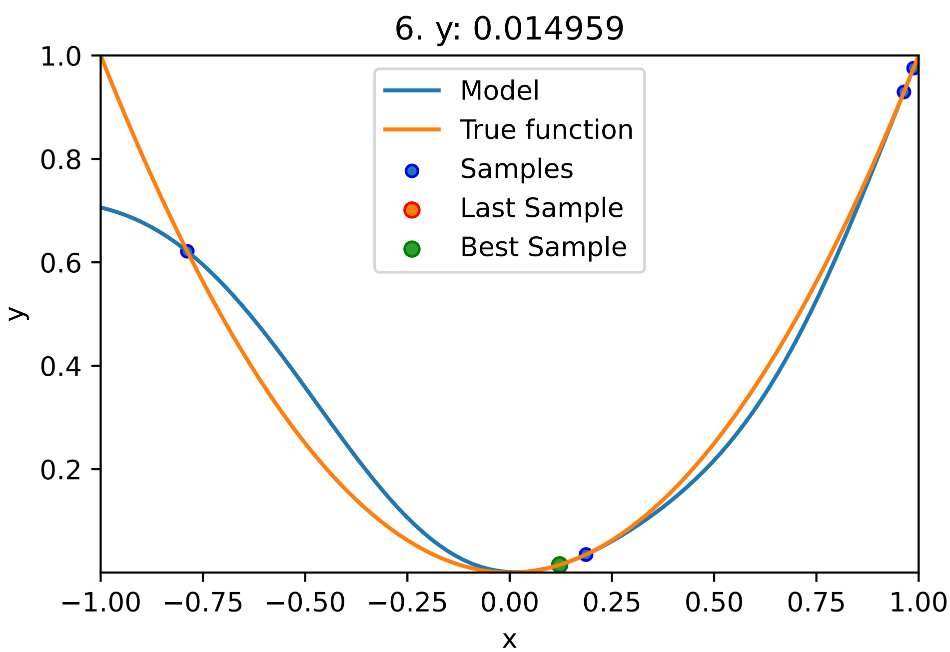
```
from spotPython.fun.objectivefunctions import analytical
lower = np.array([-1])
upper = np.array([1])
fun = analytical(seed=123).fun_sphere
```

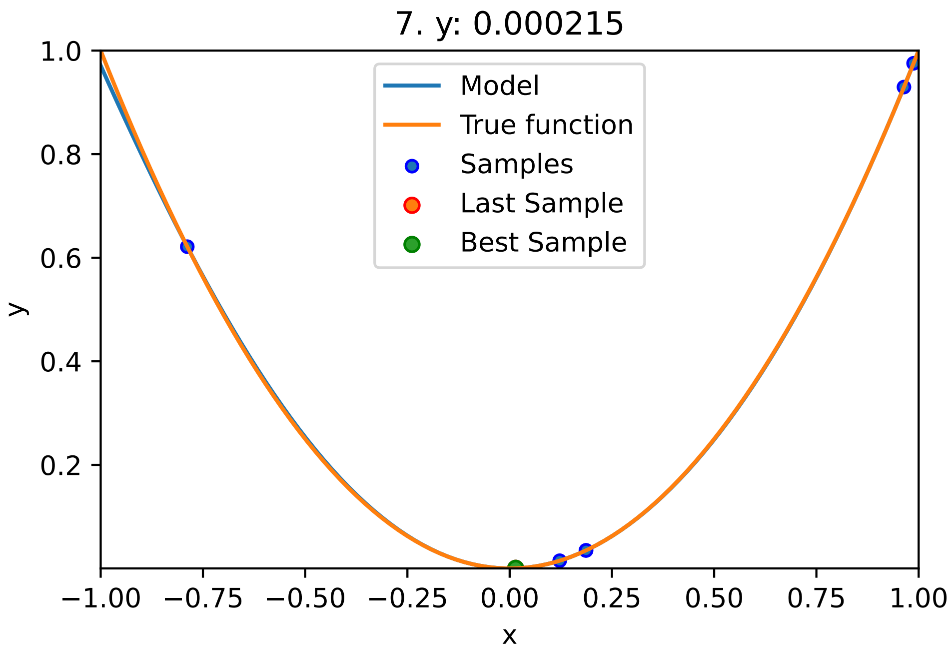
```
spot_1 = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = 10,
                   max_time = inf,
                   seed=123,
                   show_models= True,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   design_control={"init_size": 3},)
spot_1.run()
```

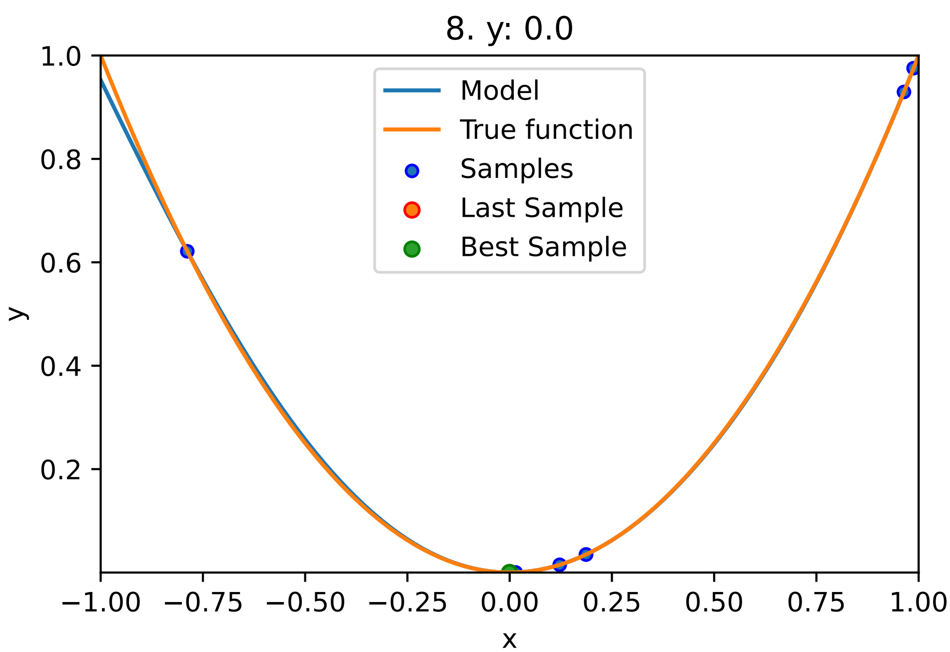

3. y: 0.034755
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

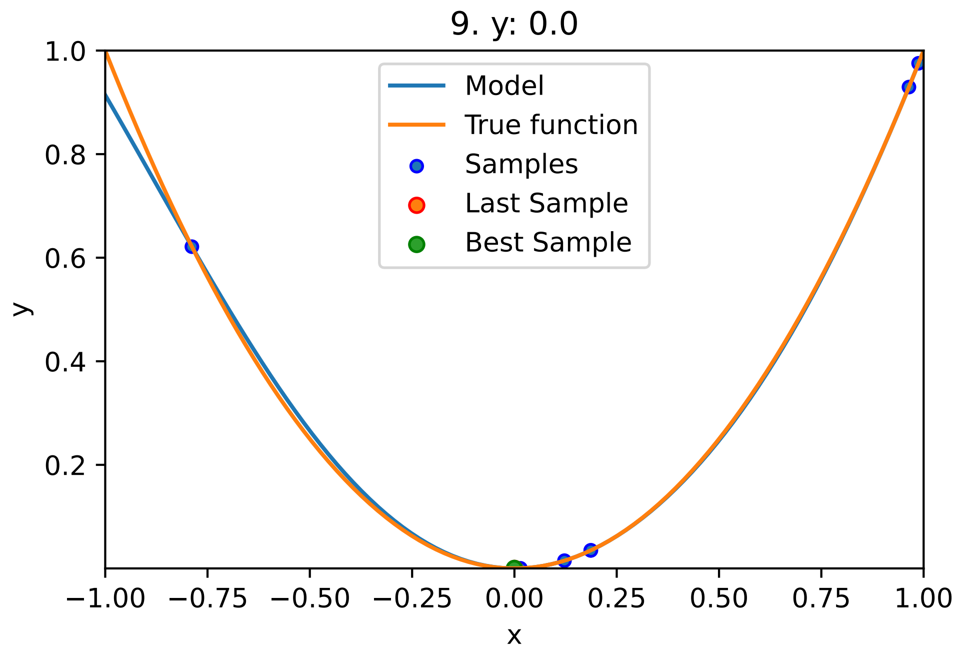

4. y: 0.034755
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

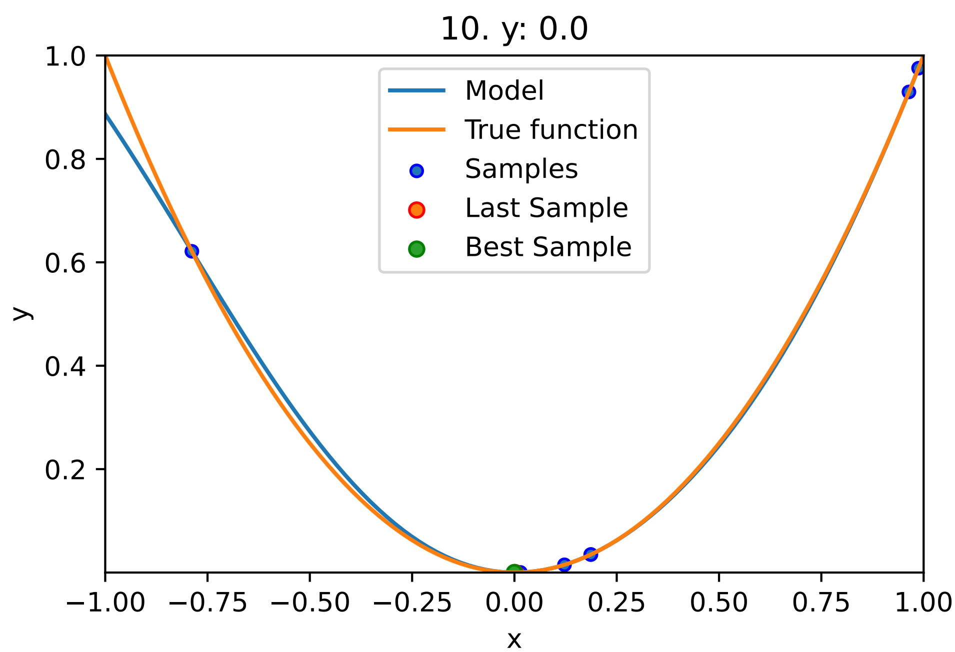

5. y: 0.034755
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


6. y: 0.014959
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


7. y: 0.000215
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


8. y: 0.0
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x






```
<spotPython.spot.spot.Spot at 0x29676a2f0>
```

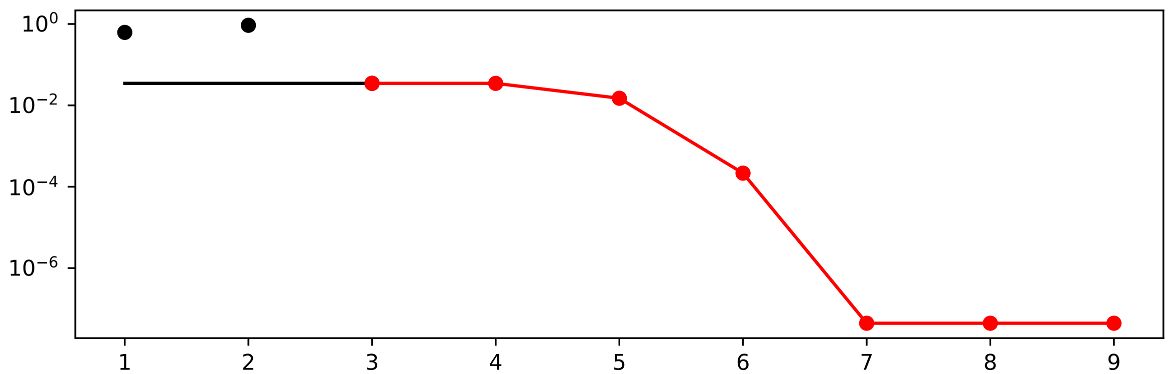
6.0.1 Results

```
spot_1.print_results()
```

```
min y: 4.41925228274096e-08
x0: -0.00021022017702259125
```

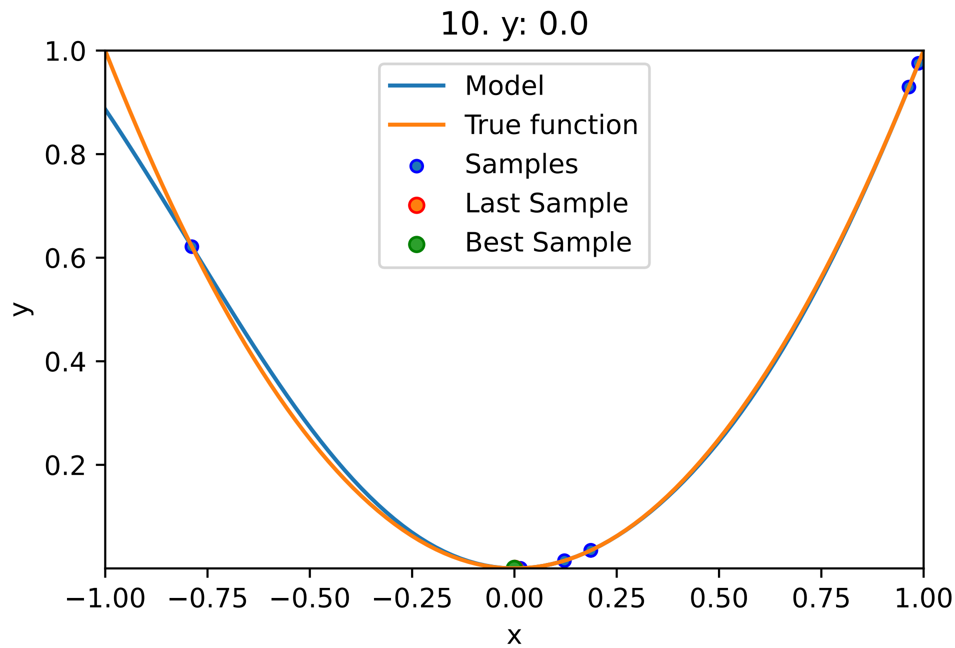
```
[['x0', -0.00021022017702259125]]
```

```
spot_1.plot_progress(log_y=True)
```



- The method `plot_model` plots the final surrogate:

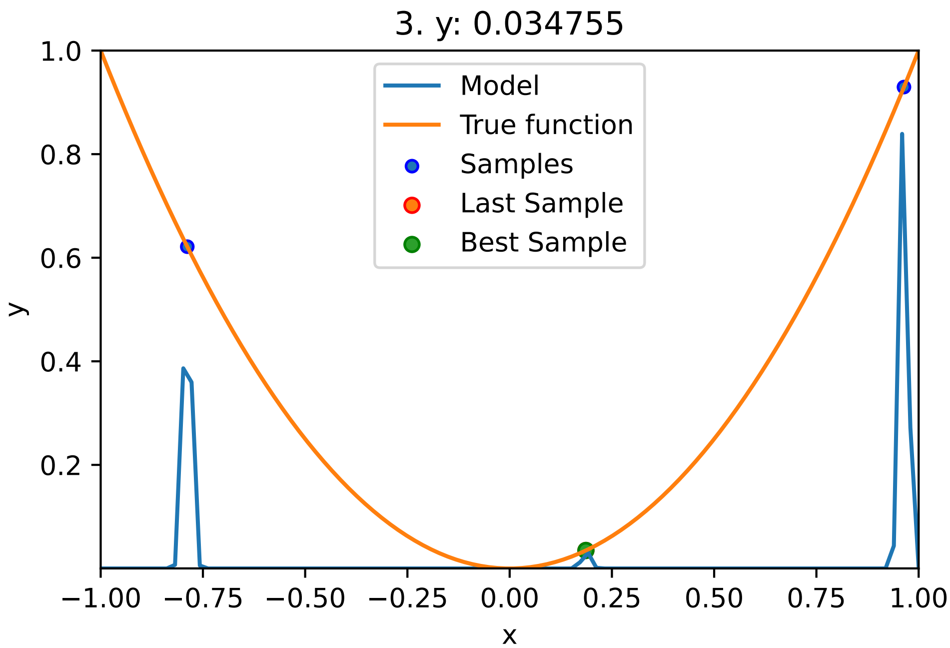
```
spot_1.plot_model()
```



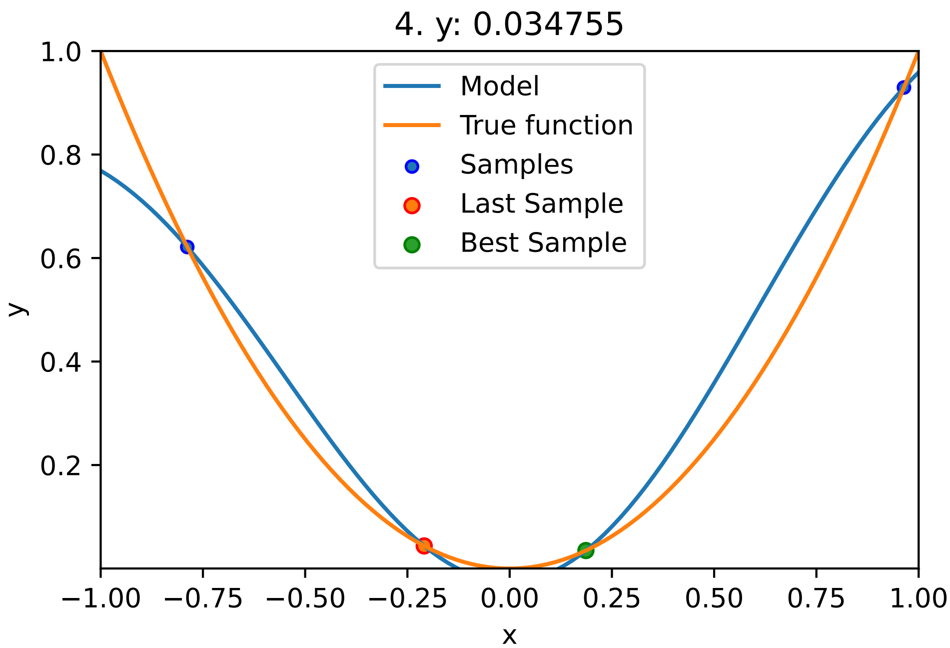
6.1 Example: `Sklearn` Model GaussianProcess

- This example visualizes the search process on the `GaussianProcessRegression` surrogate from `sklearn`.
- Therefore `surrogate = S_GP` is added to the argument list.

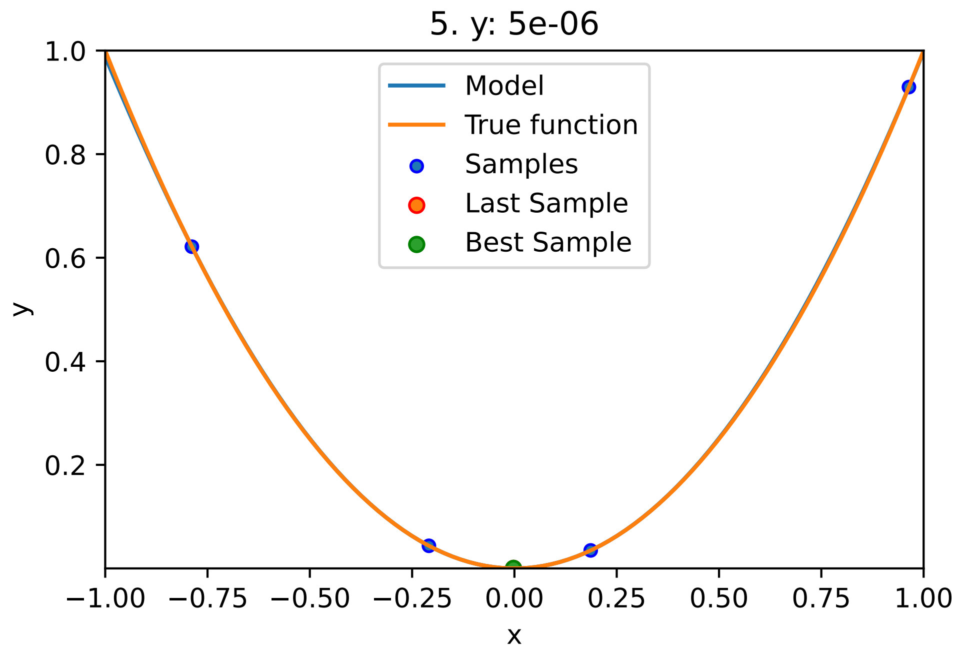
```
fun = analytical(seed=123).fun_sphere
spot_1_GP = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = 10,
                   max_time = inf,
                   seed=123,
                   show_models= True,
                   design_control={"init_size": 3},
                   surrogate = S_GP)
spot_1_GP.run()
```

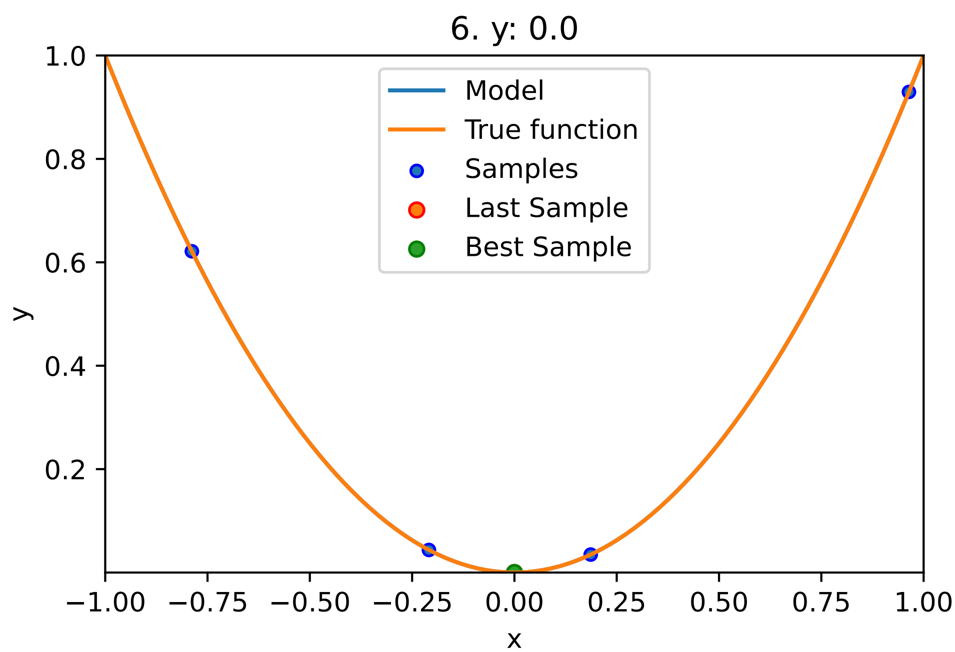


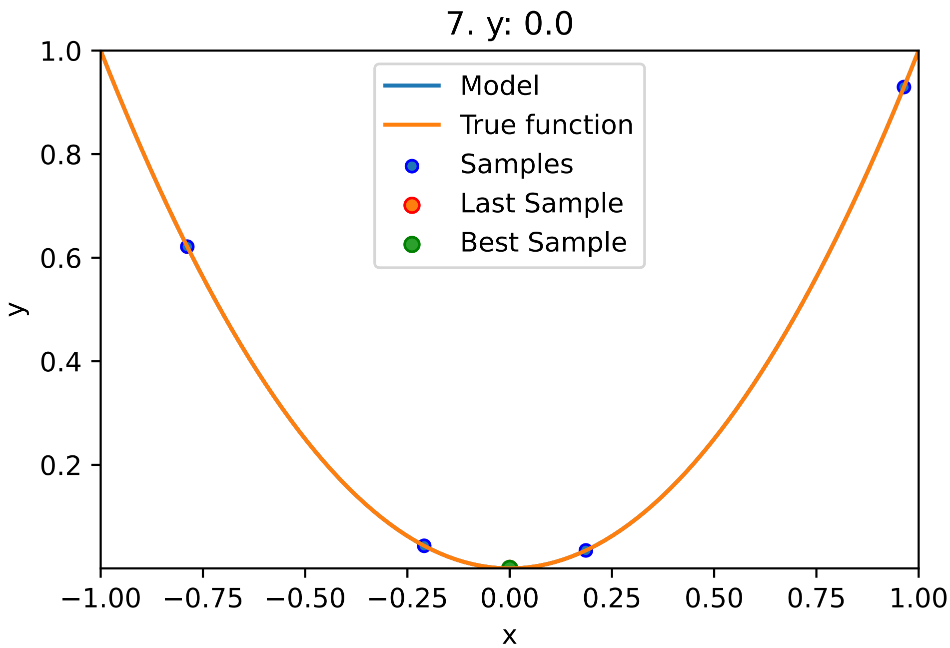
3. y: 0.034755
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

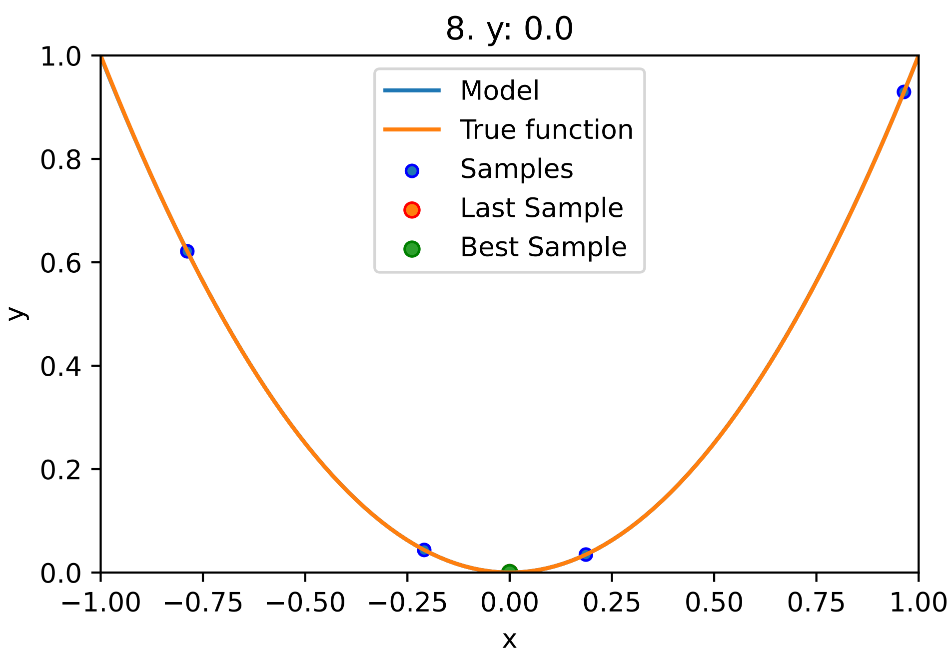


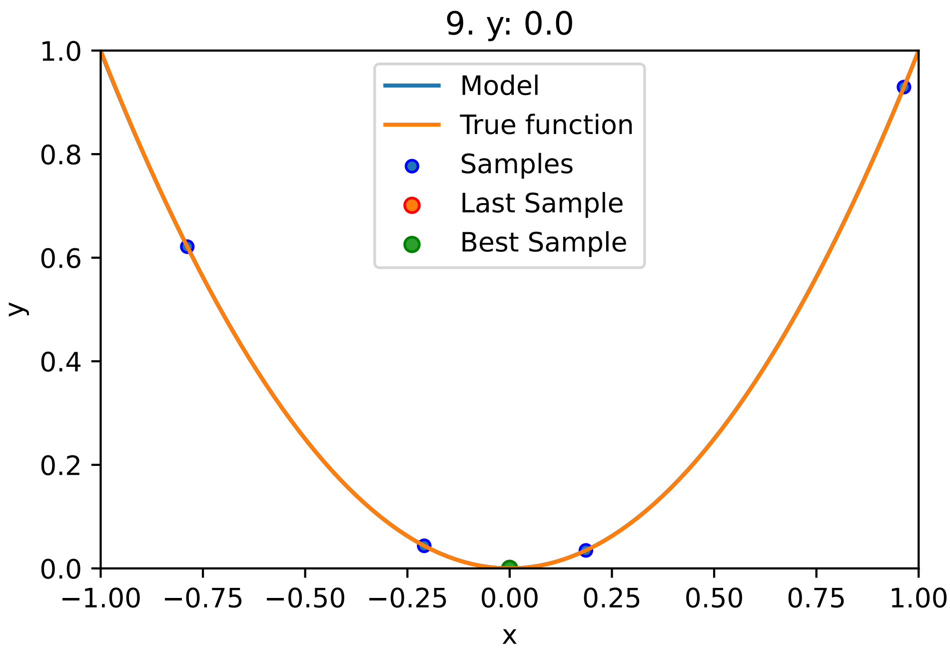
4. y: 0.034755
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

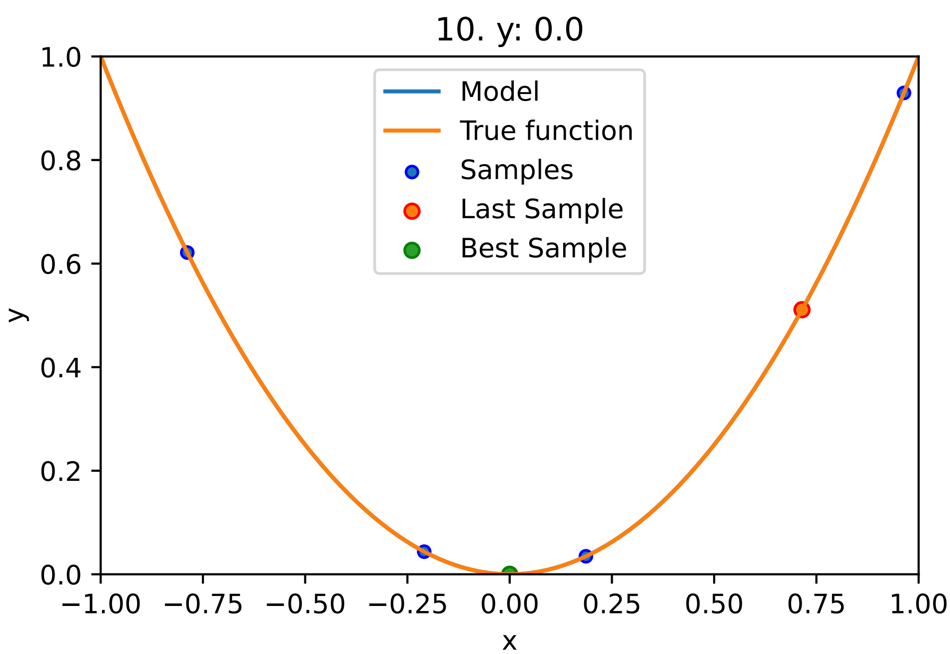

5. y: 5e-06
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


6. y: 0.0
Model
True function
Samples
Last Sample
Best Sample
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


7. y: 0.0
1.0
0.8
0.6
0.4
0.2
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x
Model
True function
Samples
Last Sample
Best Sample


8. y: 0.0
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x
Model
True function
Samples
Last Sample
Best Sample





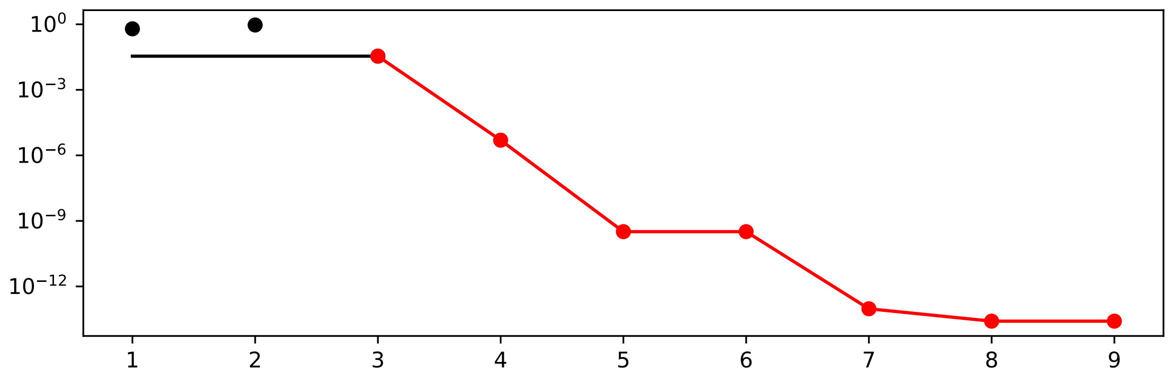

```
<spotPython.spot.spot.Spot at 0x2b096ba00>
```

```
spot_1_GP.print_results()
```

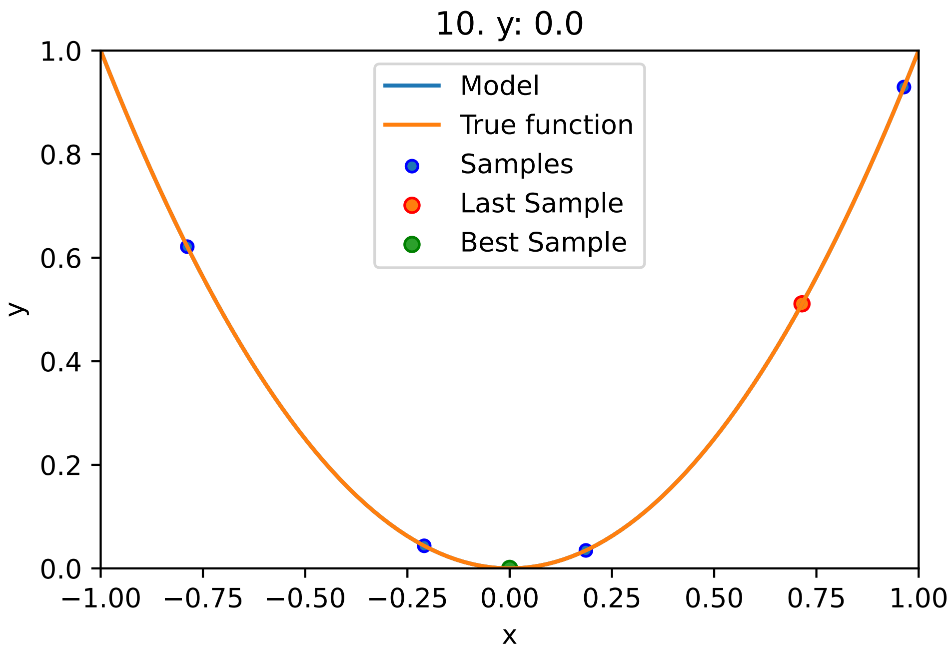
```
min y: 2.571685408635333e-14
x0: -1.6036475325442723e-07
```

```
[['x0', -1.6036475325442723e-07]]
```

```
spot_1_GP.plot_progress(log_y=True)
```




```
spot_1_GP.plot_model()
```



10. y: 0.0
Model
True function
Samples
Last Sample
Best Sample
y
x
1.0
0.8
0.6
0.4
0.2
0.0
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00

7 Exercises

- Important:
  - Results from these exercises should be added to this document, i.e., you should submit an updated version of this notebook.
  - Please combine your results using this notebook.
  - Only one notebook from each group!
  - Presentation is based on this notebook. No addtional slides are required!
  - spotPython version `0.16.11` (or greater) is required.

7.0.1 `DecisionTreeRegressor`

- Describe the surrogate model.
- Use the surrogate as the model for optimization.

7.0.2 `RandomForestRegressor`

- Describe the surrogate model.
- Use the surrogate as the model for optimization.

7.0.3 `linear_model.LinearRegression`

- Describe the surrogate model.
- Use the surrogate as the model for optimization.

7.0.4 `linear_model.Ridge`

- Describe the surrogate model.
- Use the surrogate as the model for optimization.

7.1 Exercise 2

- Compare the performance of the five different surrogates on both objective functions:
  - `spotPython`'s internal Kriging
  - `DecisionTreeRegressor`
  - `RandomForestRegressor`
  - `linear_model.LinearRegression`
  - `linear_model.Ridge`

8 Sequential Parameter Optimization: Using `scipy` Optimizers

This notebook describes how different optimizers form the `scipy optimize` package can be used on the surrogate. The optimization algorithms are available from https://docs.scipy.org/doc/scipy/reference/optimize.html

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
from scipy.optimize import dual_annealing
from scipy.optimize import basinhopping
import matplotlib.pyplot as plt
```

8.1 The Objective Function Branin

- The `spotPython` package provides several classes of objective functions.
- We will use an analytical objective function, i.e., a function that can be described by a (closed) formula.
- Here we will use the Branin function. The 2-dim Branin function is

$$y = a * (x2 - b * x1 * *2 + c * x1 - r) * *2 + s * (1 - t) * cos(x1) + s,$$

  where values of a, b, c, r, s and t are: $a = 1, b = 5.1/(4 * pi * *2), c = 5/pi, r = 6, s = 10$ and $t = 1/(8 * pi)$.

- It has three global minima:

  $f(x) = 0.397887$ at $(-\pi, 12.275)$, $(\pi, 2.275)$, and $(9.42478, 2.475)$.

- Input Domain: This function is usually evaluated on the square x1 in [-5, 10] x x2 in [0, 15].

```
from spotPython.fun.objectivefunctions import analytical
lower = np.array([-5,-0])
upper = np.array([10,15])
```

```
fun = analytical(seed=123).fun_branin
```

8.2 The Optimizer

- Differential Evalution from the `scikit.optimize` package, see https://docs.scipy.org/doc/scipy/reference/generated/scipy.optimize.differential_evolution.html#scipy.optimize.differential_evolution is the default optimizer for the search on the surrogate.
- Other optimiers that are available in `spotPython`:
  - `dual_annealing`
  - `direct`
  - `shgo`
  - `basinhopping`, see https://docs.scipy.org/doc/scipy/reference/optimize.html#global-optimization.
- These can be selected as follows:

  `surrogate_control = "model_optimizer": differential_evolution`
- We will use `differential_evolution`.
- The optimizer can use `1000` evaluations. This value will be passed to the `differential_evolution` method, which has the argument `maxiter` (int). It defines the maximum number of generations over which the entire differential evolution population is evolved, see https://docs.scipy.org/doc/scipy/reference/generated/scipy.optimize.differential_evolution.html#scipy.optimize.differential_evolution

```
spot_de = spot.Spot(fun=fun,
                    lower = lower,
                    upper = upper,
                    fun_evals = 20,
                    max_time = inf,
                    seed=125,
                    noise=False,
```

```
                        show_models= False,
                        design_control={"init_size": 10},
                        surrogate_control={"n_theta": 2,
                                           "model_optimizer": differential_evolution,
                                           "model_fun_evals": 1000,
                                           })
spot_de.run()
```

<spotPython.spot.spot.Spot at 0x15f83bbb0>

8.3 Print the Results

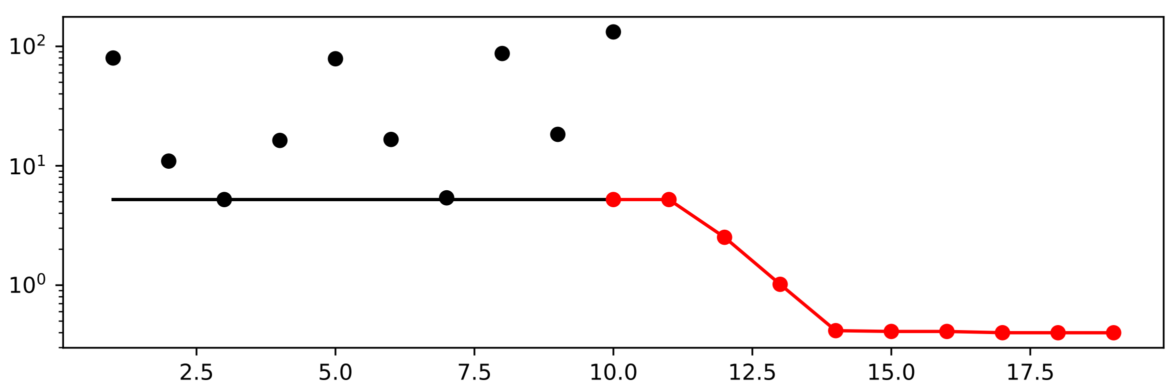
```
spot_de.print_results()
```

```
min y: 0.39951958110619046
x0: -3.1570201165683587
x1: 12.289980569430284
```

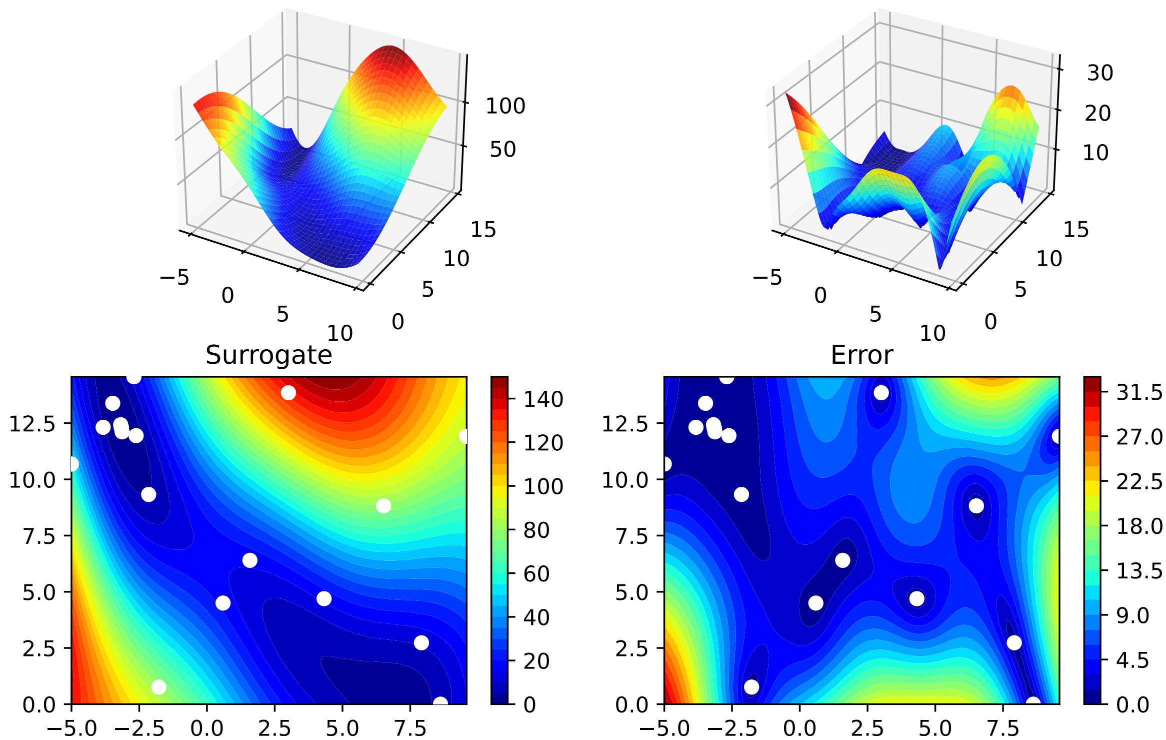
```
[['x0', -3.1570201165683587], ['x1', 12.289980569430284]]
```

8.4 Show the Progress

```
spot_de.plot_progress(log_y=True)
```



```
spot_de.surrogate.plot()
```



9 Exercises

9.1 `dual_annealing`

- Describe the optimization algorithm
- Use the algorithm as an optimizer on the surrogate

9.2 `direct`

- Describe the optimization algorithm
- Use the algorithm as an optimizer on the surrogate

9.3 `shgo`

- Describe the optimization algorithm
- Use the algorithm as an optimizer on the surrogate

9.4 `basinhopping`

- Describe the optimization algorithm
- Use the algorithm as an optimizer on the surrogate

9.5 Performance Comparison

Compare the performance and run time of the 5 different optimizers:

```
* `differential_evolution`
* `dual_annealing`
*  `direct`
* `shgo`
* `basinhopping`.
```

The Branin function has three global minima:

- $f(x) = 0.397887$ at
  - $(-\pi, 12.275)$,
  - $(\pi, 2.275)$, and
  - $(9.42478, 2.475)$.

- Which optima are found by the optimizers? Does the `seed` change this behavior?

10 Sequential Parameter Optimization: Gaussian Process Models

- This notebook analyzes differences between
  - the `Kriging` implementation in `spotPython` and
  - the `GaussianProcessRegressor` in `scikit-learn`.

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.design.spacefilling import spacefilling
from spotPython.spot import spot
from spotPython.build.kriging import Kriging
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
import math as m
from sklearn.gaussian_process import GaussianProcessRegressor
from sklearn.gaussian_process.kernels import RBF
```

10.1 Gaussian Processes Regression: Basic Introductory `scikit-learn` Example

- This is the example from scikit-learn: https://scikit-learn.org/stable/auto_examples/gaussian_process/pl
- After fitting our model, we see that the hyperparameters of the kernel have been optimized.
- Now, we will use our kernel to compute the mean prediction of the full dataset and plot the 95% confidence interval.

10.1.1 Train and Test Data

```
X = np.linspace(start=0, stop=10, num=1_000).reshape(-1, 1)
y = np.squeeze(X * np.sin(X))
rng = np.random.RandomState(1)
training_indices = rng.choice(np.arange(y.size), size=6, replace=False)
X_train, y_train = X[training_indices], y[training_indices]
```

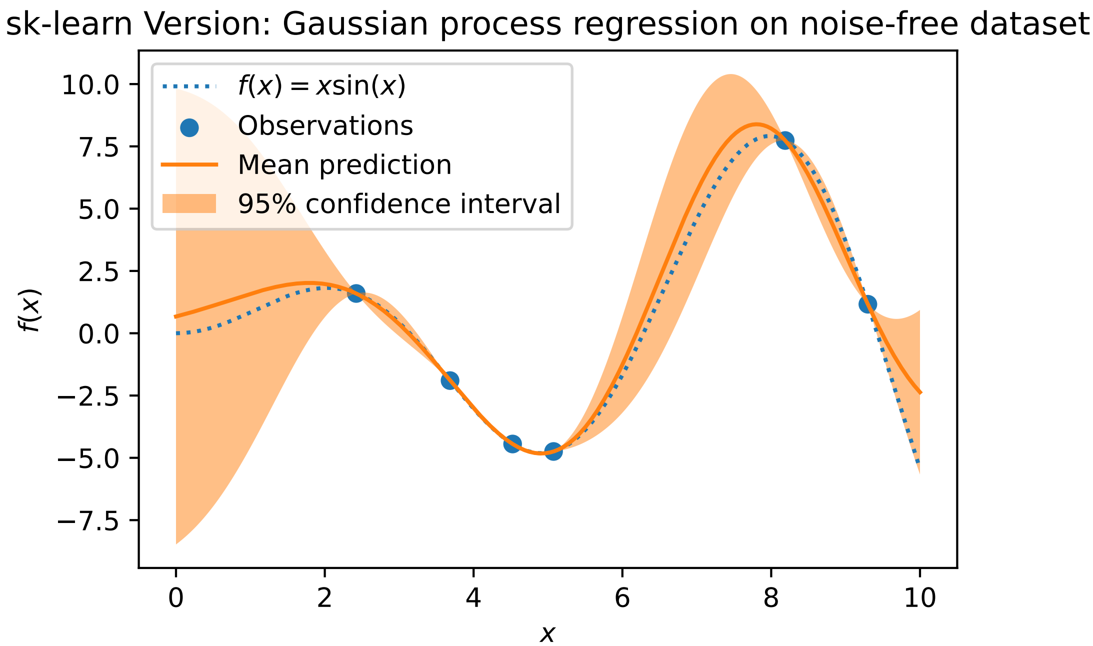
10.1.2 Building the Surrogate With `Sklearn`

- The model building with `sklearn` consisits of three steps:
    1. Instantiating the model, then
    2. fitting the model (using `fit`), and
    3. making predictions (using `predict`)

```
kernel = 1 * RBF(length_scale=1.0, length_scale_bounds=(1e-2, 1e2))
gaussian_process = GaussianProcessRegressor(kernel=kernel, n_restarts_optimizer=9)
gaussian_process.fit(X_train, y_train)
mean_prediction, std_prediction = gaussian_process.predict(X, return_std=True)
```

10.1.3 Plotting the `Sklearn`Model

```
plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, mean_prediction, label="Mean prediction")
plt.fill_between(
    X.ravel(),
    mean_prediction - 1.96 * std_prediction,
    mean_prediction + 1.96 * std_prediction,
    alpha=0.5,
    label=r"95% confidence interval",
)
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("sk-learn Version: Gaussian process regression on noise-free dataset")
```



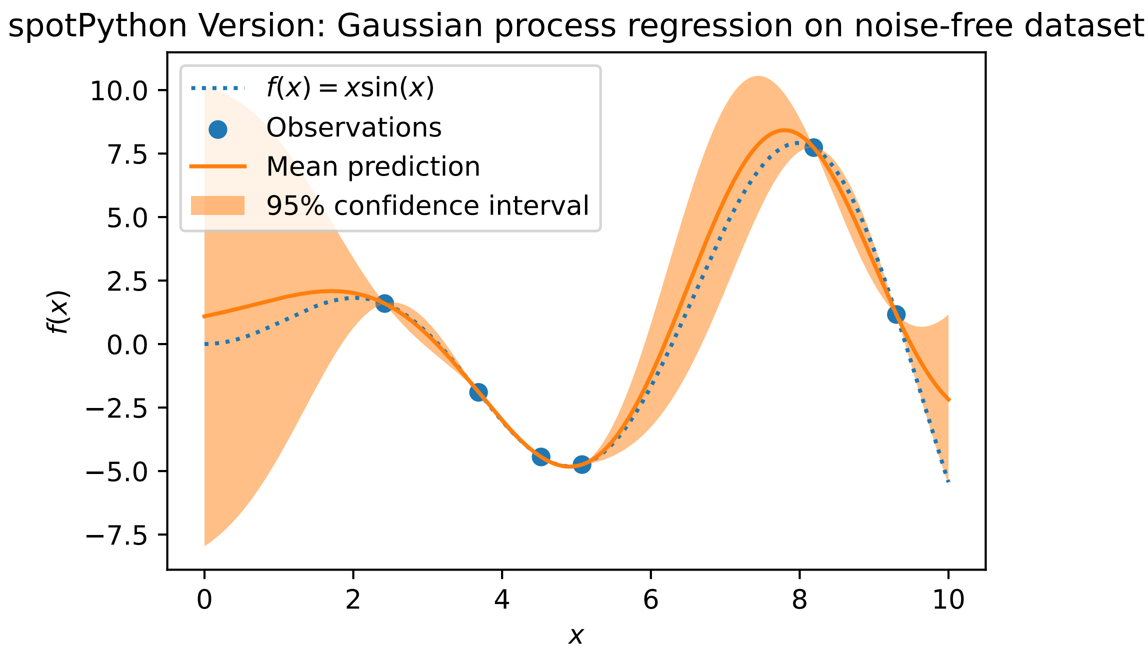
10.1.4 The `spotPython` Version

- The `spotPython` version is very similar:
  1. Instantiating the model, then
  2. fitting the model and
  3. making predictions (using `predict`).

```
S = Kriging(name='kriging',  seed=123, log_level=50, cod_type="norm")
S.fit(X_train, y_train)
S_mean_prediction, S_std_prediction, S_ei = S.predict(X, return_val="all")
```

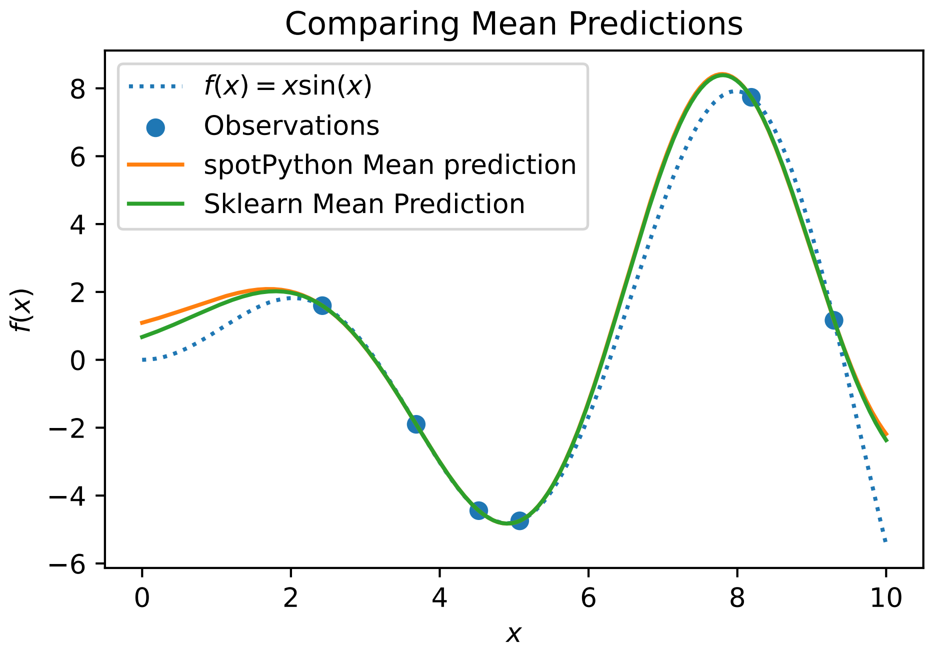
```
plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, S_mean_prediction, label="Mean prediction")
plt.fill_between(
    X.ravel(),
    S_mean_prediction - 1.96 * S_std_prediction,
    S_mean_prediction + 1.96 * S_std_prediction,
    alpha=0.5,
    label=r"95% confidence interval",
```

```
)
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("spotPython Version: Gaussian process regression on noise-free dataset")
```



10.1.5 Visualizing the Differences Between the `spotPython` and the `sklearn` Model Fits

```
plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, S_mean_prediction, label="spotPython Mean prediction")
plt.plot(X, mean_prediction, label="Sklearn Mean Prediction")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Comparing Mean Predictions")
```


Comparing Mean Predictions
$f(x) = x\sin(x)$
Observations
spotPython Mean prediction
Sklearn Mean Prediction
f(x)
x

11 Exercises

11.1 Schonlau Example Function

- The Schonlau Example Function is based on sample points only (there is no analytical function description available):

```
X = np.linspace(start=0, stop=13, num=1_000).reshape(-1, 1)
X_train = np.array([1., 2., 3., 4., 12.]).reshape(-1,1)
y_train = np.array([0., -1.75, -2, -0.5, 5.])
```

- Describe the function.
- Compare the two models that were build using the `spotPython` and the `sklearn` surrogate.
- Note: Since there is no analytical function available, you might be interested in adding some points and describe the effects.

11.2 Forrester Example Function

- The Forrester Example Function is defined as follows:

  `f(x) = (6x- 2)^2 sin(12x-4) for x in [0,1].`

- Data points are generated as follows:

```
X = np.linspace(start=-0.5, stop=1.5, num=1_000).reshape(-1, 1)
X_train = np.array([0.0, 0.175, 0.225, 0.3, 0.35, 0.375, 0.5,1]).reshape(-1,1)
fun = analytical().fun_forrester
fun_control = {"sigma": 0.1,
               "seed": 123}
y = fun(X, fun_control=fun_control)
y_train = fun(X_train, fun_control=fun_control)
```

- Describe the function.

- Compare the two models that were build using the `spotPython` and the `sklearn` surrogate.
- Note: Modify the noise level (`"sigma"`), e.g., use a value of `0.2`, and compare the two models.

```
fun_control = {"sigma": 0.2}
```

11.3 `fun_runge` Function (1-dim)

- The Runge function is defined as follows:

  `f(x) = 1/ (1 + sum(x_i))^2`

- Data points are generated as follows:

```
gen = spacefilling(1)
rng = np.random.RandomState(1)
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_runge
fun_control = {"sigma": 0.025,
               "seed": 123}
X_train = gen.scipy_lhd(10, lower=lower, upper = upper).reshape(-1,1)
y_train = fun(X, fun_control=fun_control)
X = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
y = fun(X, fun_control=fun_control)
```

- Describe the function.
- Compare the two models that were build using the `spotPython` and the `sklearn` surrogate.
- Note: Modify the noise level (`"sigma"`), e.g., use a value of `0.05`, and compare the two models.

```
fun_control = {"sigma": 0.5}
```

11.4 `fun_cubed` (1-dim)

- The Cubed function is defined as follows:

  `np.sum(X[i]** 3)`

- Data points are generated as follows:

```
gen = spacefilling(1)
rng = np.random.RandomState(1)
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_cubed
fun_control = {"sigma": 0.025,
               "seed": 123}
X_train = gen.scipy_lhd(10, lower=lower, upper = upper).reshape(-1,1)
y_train = fun(X, fun_control=fun_control)
X = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
y = fun(X, fun_control=fun_control)
```

- Describe the function.
- Compare the two models that were build using the `spotPython` and the `sklearn` surrogate.
- Note: Modify the noise level (`"sigma"`), e.g., use a value of `0.05`, and compare the two models.

```
fun_control = {"sigma": 0.05}
```

11.5 The Effect of Noise

How does the behavior of the `spotPython` fit changes when the argument `noise` is set to `True`, i.e.,

```
S = Kriging(name='kriging',  seed=123, n_theta=1, noise=True)
```

is used?

12 Expected Improvement

12.1 Example: `Spot` and the 1-dim Sphere Function

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
```

12.1.1 The Objective Function: 1-dim Sphere

- The `spotPython` package provides several classes of objective functions.
- We will use an analytical objective function, i.e., a function that can be described by a (closed) formula:

$$f(x) = x^2$$

```
fun = analytical().fun_sphere
```

```
fun = analytical().fun_sphere
fun_control = {"sigma": 0,
               "seed": 123}
```

- The size of the `lower` bound vector determines the problem dimension.
- Here we will use `np.array([-1])`, i.e., a one-dim function.

```
spot_1 = spot.Spot(fun=fun,
                   lower = np.array([-1]),
                   upper = np.array([1]))
```

```
spot_1.run()
```

<spotPython.spot.spot.Spot at 0x16a4afc10>

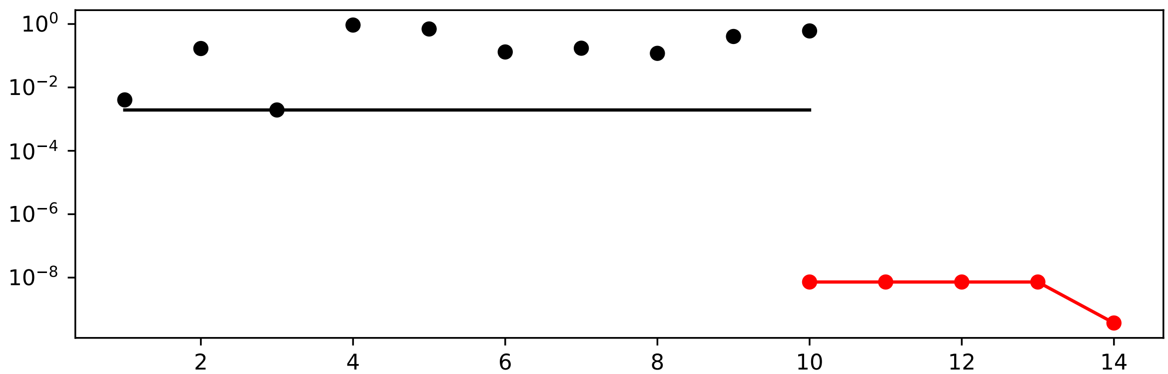
12.1.2 Results

```
spot_1.print_results()
```

```
min y: 3.696886711914087e-10
x0: 1.922728975158508e-05
```

```
[['x0', 1.922728975158508e-05]]
```

```
spot_1.plot_progress(log_y=True)
```

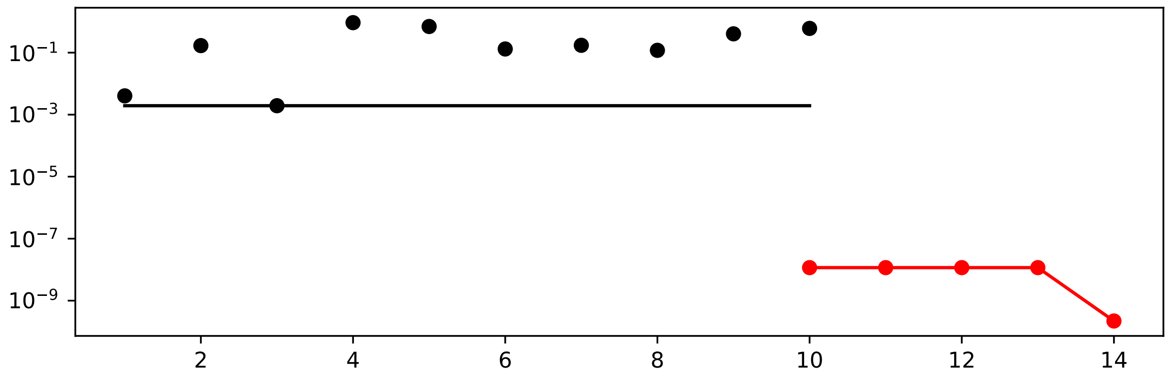


12.2 Same, but with EI as infill_criterion

```
spot_1_ei = spot.Spot(fun=fun,
                    lower = np.array([-1]),
                    upper = np.array([1]),
                    infill_criterion = "ei")
spot_1_ei.run()
```

<spotPython.spot.spot.Spot at 0x2abfb6290>

```
spot_1_ei.plot_progress(log_y=True)
```




```
spot_1_ei.print_results()
```

```
min y: 2.207887258868953e-10
x0: 1.4858961130809088e-05

[['x0', 1.4858961130809088e-05]]
```

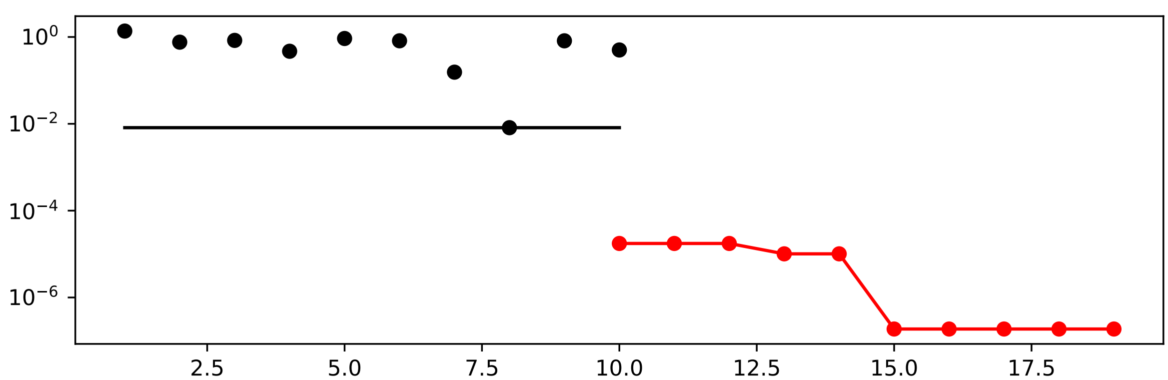
12.3 Non-isotropic Kriging

```
spot_2_ei_noniso = spot.Spot(fun=fun,
                   lower = np.array([-1, -1]),
                   upper = np.array([1, 1]),
                   fun_evals = 20,
                   fun_repeats = 1,
                   max_time = inf,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type=["num"],
                   infill_criterion = "ei",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models=True,
                   fun_control = fun_control,
```

```
                    design_control={"init_size": 10,
                                    "repeats": 1},
                    surrogate_control={"noise": False,
                                       "cod_type": "norm",
                                       "min_theta": -4,
                                       "max_theta": 3,
                                       "n_theta": 2,
                                       "model_optimizer": differential_evolution,
                                       "model_fun_evals": 1000,
                                       })
spot_2_ei_noniso.run()
```

```
<spotPython.spot.spot.Spot at 0x2ac10b340>
```

```
spot_2_ei_noniso.plot_progress(log_y=True)
```

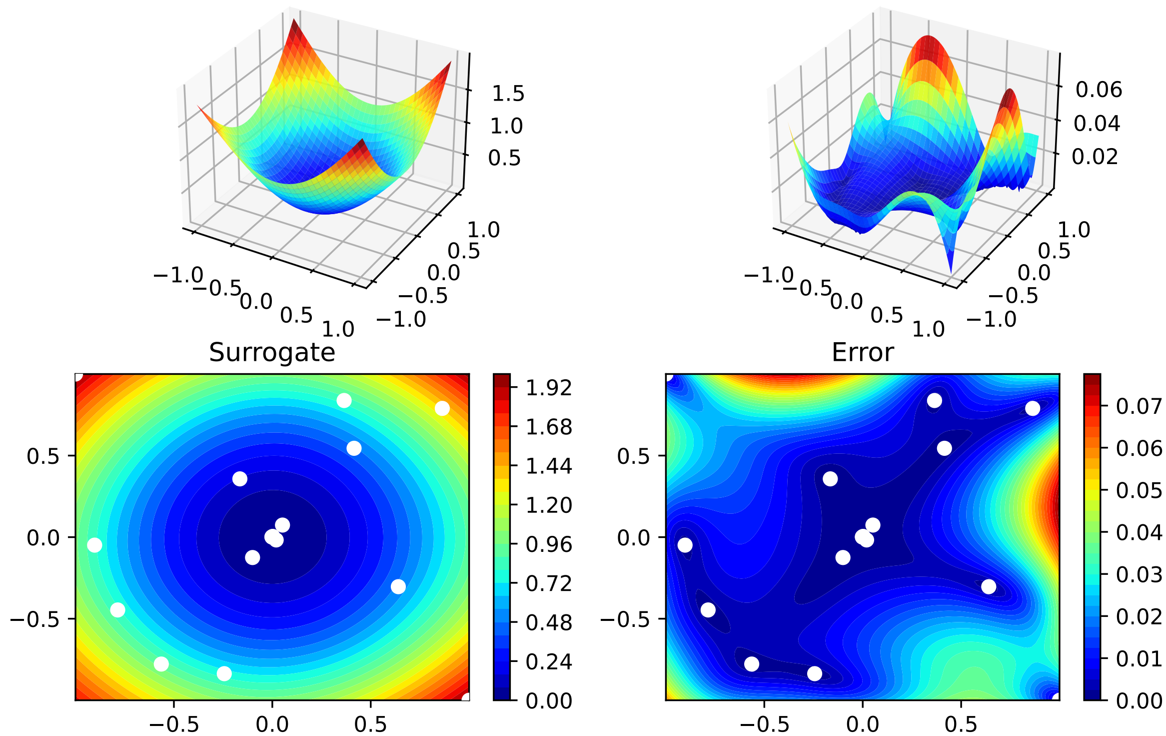



```
spot_2_ei_noniso.print_results()
```

```
min y: 1.8779971830281702e-07
x0: -0.0002783721390529846
x1: 0.0003321274913371111
```

```
[['x0', -0.0002783721390529846], ['x1', 0.0003321274913371111]]
```

```
spot_2_ei_noniso.surrogate.plot()
```



12.4 Using sklearn Surrogates

12.4.1 The spot Loop

The `spot` loop consists of the following steps:

1. Init: Build initial design X
2. Evaluate initial design on real objective f: $y = f(X)$
3. Build surrogate: $S = S(X, y)$
4. Optimize on surrogate: $X_0 = \text{optimize}(S)$
5. Evaluate on real objective: $y_0 = f(X_0)$
6. Impute (Infill) new points: $X = X \cup X_0$, $y = y \cup y_0$.
7. Got 3.

The `spot` loop is implemented in `R` as follows:

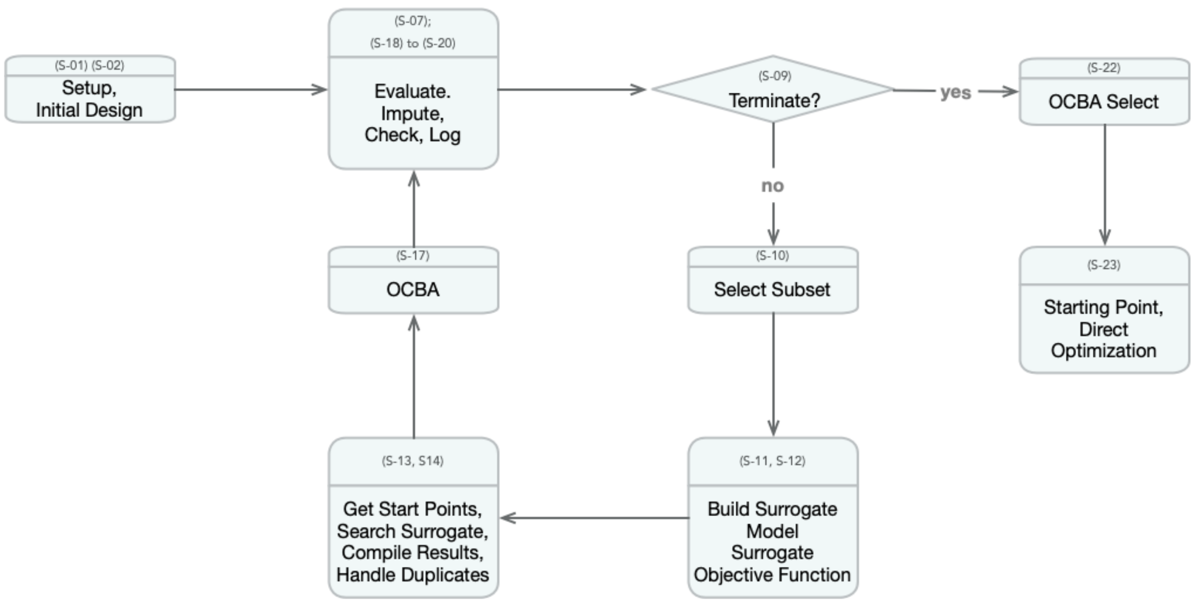


Figure 12.1: Visual representation of the model based search with SPOT. Taken from: Bartz-Beielstein, T., and Zaefferer, M. Hyperparameter tuning approaches. In Hyperparameter Tuning for Machine and Deep Learning with R - A Practical Guide, E. Bartz, T. Bartz-Beielstein, M. Zaefferer, and O. Mersmann, Eds. Springer, 2022, ch. 4, pp. 67–114.

12.4.2 spot: The Initial Model

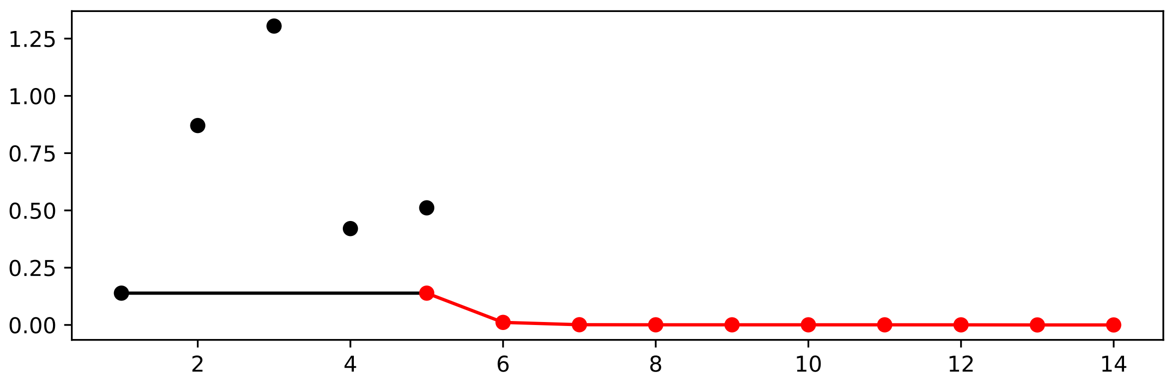
12.4.2.1 Example: Modifying the initial design size

This is the "Example: Modifying the initial design size" from Chapter 4.5.1 in [bart21i].

```
spot_ei = spot.Spot(fun=fun,
               lower = np.array([-1,-1]),
               upper= np.array([1,1]),
               design_control={"init_size": 5})
spot_ei.run()
```

<spotPython.spot.spot.Spot at 0x2ad510280>

```
spot_ei.plot_progress()
```




```
np.min(spot_1.y), np.min(spot_ei.y)
```

(3.696886711914087e-10, 1.7928640814182596e-05)

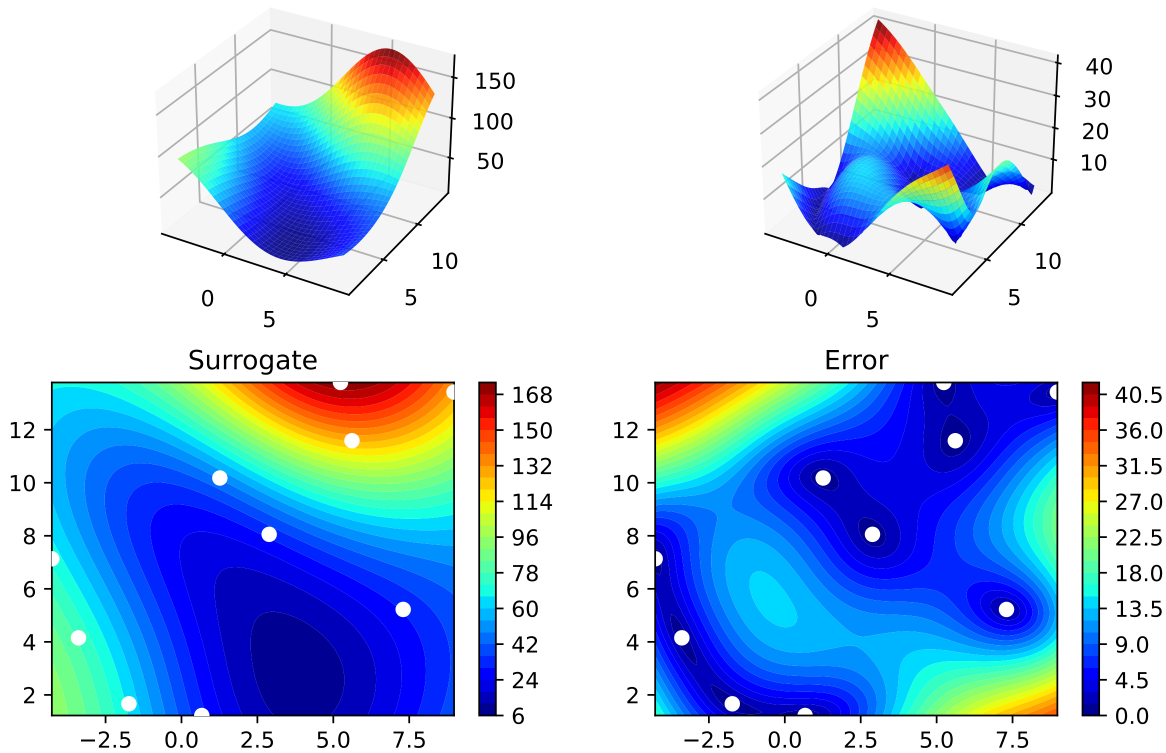
12.4.3 Init: Build Initial Design

```
from spotPython.design.spacefilling import spacefilling
from spotPython.build.kriging import Kriging
from spotPython.fun.objectivefunctions import analytical
gen = spacefilling(2)
```

```python
rng = np.random.RandomState(1)
lower = np.array([-5,-0])
upper = np.array([10,15])
fun = analytical().fun_branin
fun_control = {"sigma": 0,
               "seed": 123}

X = gen.scipy_lhd(10, lower=lower, upper = upper)
print(X)
y = fun(X, fun_control=fun_control)
print(y)
```

```
[[ 8.97647221 13.41926847]
 [ 0.66946019  1.22344228]
 [ 5.23614115 13.78185824]
 [ 5.6149825  11.5851384 ]
 [-1.72963184  1.66516096]
 [-4.26945568  7.1325531 ]
 [ 1.26363761 10.17935555]
 [ 2.88779942  8.05508969]
 [-3.39111089  4.15213772]
 [ 7.30131231  5.22275244]]
[128.95676449  31.73474356 172.89678121 126.71295908  64.34349975
  70.16178611  48.71407916  31.77322887  76.91788181  30.69410529]
```

```python
S = Kriging(name='kriging',  seed=123)
S.fit(X, y)
S.plot()
```




```
gen = spacefilling(2, seed=123)
X0 = gen.scipy_lhd(3)
gen = spacefilling(2, seed=345)
X1 = gen.scipy_lhd(3)
X2 = gen.scipy_lhd(3)
gen = spacefilling(2, seed=123)
X3 = gen.scipy_lhd(3)
X0, X1, X2, X3
```

```
(array([[0.77254938, 0.31539299],
        [0.59321338, 0.93854273],
        [0.27469803, 0.3959685 ]]),
 array([[0.78373509, 0.86811887],
        [0.06692621, 0.6058029 ],
        [0.41374778, 0.00525456]]),
 array([[0.121357  , 0.69043832],
        [0.41906219, 0.32838498],
        [0.86742658, 0.52910374]]),
```

```
array([[0.77254938, 0.31539299],
       [0.59321338, 0.93854273],
       [0.27469803, 0.3959685 ]]))
```

12.4.4 Evaluate

12.4.5 Build Surrogate

12.4.6 A Simple Predictor

The code below shows how to use a simple model for prediction.

- Assume that only two (very costly) measurements are available:
  1. f(0) = 0.5
  2. f(2) = 2.5
- We are interested in the value at $x_0 = 1$, i.e., $f(x_0 = 1)$, but cannot run an additional, third experiment.

```python
from sklearn import linear_model
X = np.array([[0], [2]])
y = np.array([0.5, 2.5])
S_lm = linear_model.LinearRegression()
S_lm = S_lm.fit(X, y)
X0 = np.array([[1]])
y0 = S_lm.predict(X0)
print(y0)
```

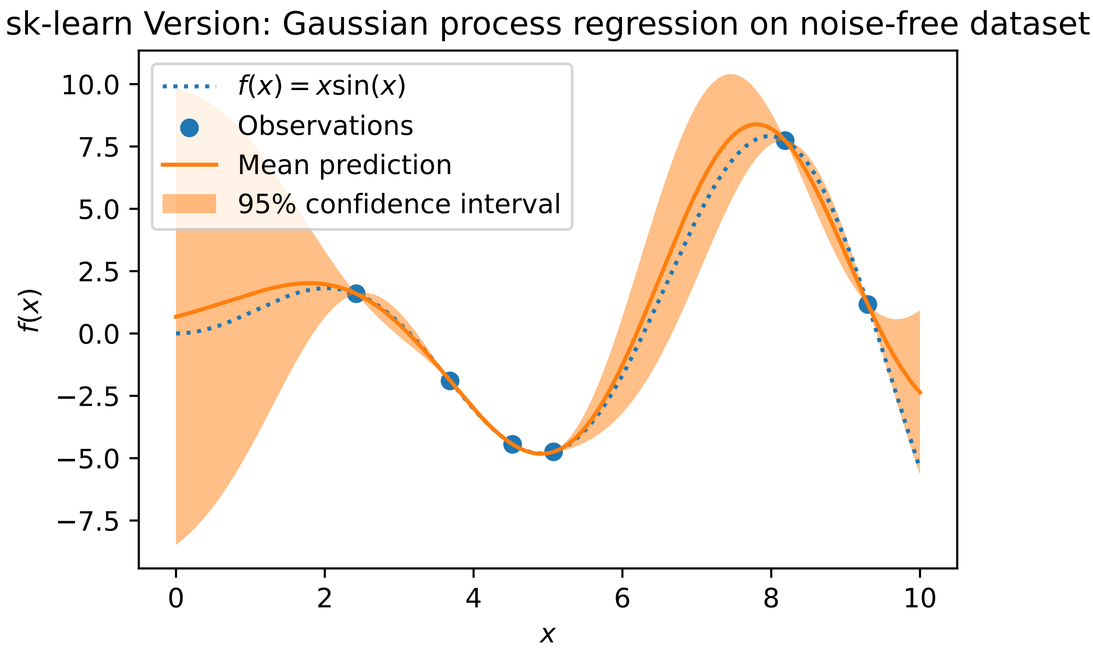
```
[1.5]
```

- Central Idea:
  - Evaluation of the surrogate model `S_lm` is much cheaper (or / and much faster) than running the real-world experiment f.

12.5 Gaussian Processes regression: basic introductory example

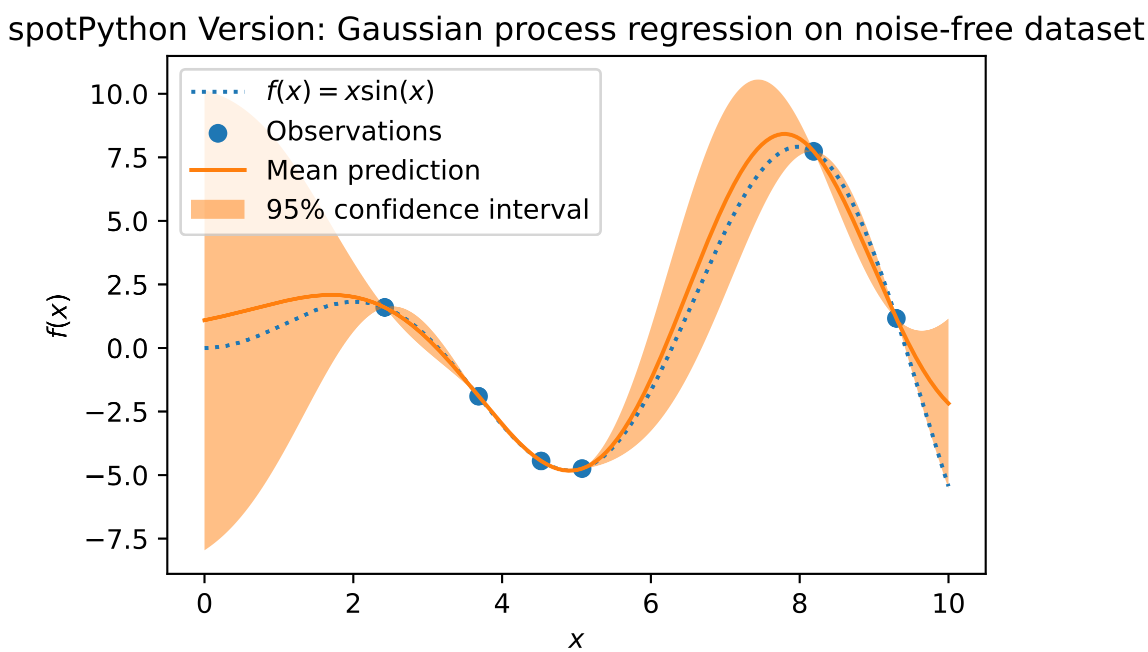
This example was taken from scikit-learn. After fitting our model, we see that the hyperparameters of the kernel have been optimized. Now, we will use our kernel to compute the mean prediction of the full dataset and plot the 95% confidence interval.

```python
import numpy as np
import matplotlib.pyplot as plt
import math as m
from sklearn.gaussian_process import GaussianProcessRegressor
from sklearn.gaussian_process.kernels import RBF

X = np.linspace(start=0, stop=10, num=1_000).reshape(-1, 1)
y = np.squeeze(X * np.sin(X))
rng = np.random.RandomState(1)
training_indices = rng.choice(np.arange(y.size), size=6, replace=False)
X_train, y_train = X[training_indices], y[training_indices]

kernel = 1 * RBF(length_scale=1.0, length_scale_bounds=(1e-2, 1e2))
gaussian_process = GaussianProcessRegressor(kernel=kernel, n_restarts_optimizer=9)
gaussian_process.fit(X_train, y_train)
gaussian_process.kernel_

mean_prediction, std_prediction = gaussian_process.predict(X, return_std=True)

plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, mean_prediction, label="Mean prediction")
plt.fill_between(
    X.ravel(),
    mean_prediction - 1.96 * std_prediction,
    mean_prediction + 1.96 * std_prediction,
    alpha=0.5,
    label=r"95% confidence interval",
)
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("sk-learn Version: Gaussian process regression on noise-free dataset")
```




```
from spotPython.build.kriging import Kriging
import numpy as np
import matplotlib.pyplot as plt
rng = np.random.RandomState(1)
X = np.linspace(start=0, stop=10, num=1_000).reshape(-1, 1)
y = np.squeeze(X * np.sin(X))
training_indices = rng.choice(np.arange(y.size), size=6, replace=False)
X_train, y_train = X[training_indices], y[training_indices]


S = Kriging(name='kriging',  seed=123, log_level=50, cod_type="norm")
S.fit(X_train, y_train)

mean_prediction, std_prediction, ei = S.predict(X, return_val="all")

std_prediction

plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, mean_prediction, label="Mean prediction")
plt.fill_between(
```

```
    X.ravel(),
    mean_prediction - 1.96 * std_prediction,
    mean_prediction + 1.96 * std_prediction,
    alpha=0.5,
    label=r"95% confidence interval",
)
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("spotPython Version: Gaussian process regression on noise-free dataset")
```



12.6 The Surrogate: Using scikit-learn models

Default is the internal `kriging` surrogate.

```
S_0 = Kriging(name='kriging', seed=123)
```

Models from `scikit-learn` can be selected, e.g., Gaussian Process:

```python
# Needed for the sklearn surrogates:
from sklearn.gaussian_process import GaussianProcessRegressor
from sklearn.gaussian_process.kernels import RBF
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn import linear_model
from sklearn import tree
import pandas as pd
```

```python
kernel = 1 * RBF(length_scale=1.0, length_scale_bounds=(1e-2, 1e2))
S_GP = GaussianProcessRegressor(kernel=kernel, n_restarts_optimizer=9)
```

- and many more:

```python
S_Tree = DecisionTreeRegressor(random_state=0)
S_LM = linear_model.LinearRegression()
S_Ridge = linear_model.Ridge()
S_RF = RandomForestRegressor(max_depth=2, random_state=0)
```

- The scikit-learn GP model `S_GP` is selected.

```python
S = S_GP
```

```python
isinstance(S, GaussianProcessRegressor)
```

```
True
```

```python
from spotPython.fun.objectivefunctions import analytical
fun = analytical().fun_branin
lower = np.array([-5,-0])
upper = np.array([10,15])
design_control={"init_size": 5}
surrogate_control={
            "infill_criterion": None,
            "n_points": 1,
        }
spot_GP = spot.Spot(fun=fun, lower = lower, upper= upper, surrogate=S,
                    fun_evals = 15, noise = False, log_level = 50,
                    design_control=design_control,
                    surrogate_control=surrogate_control)
```

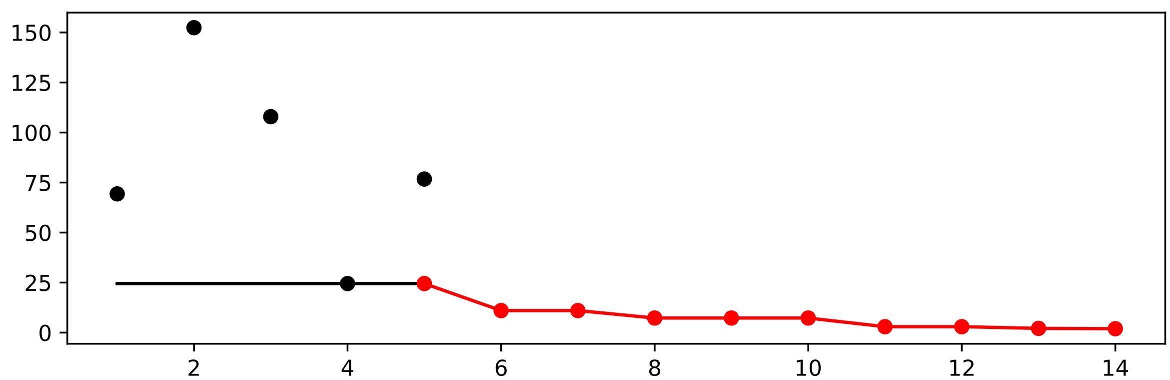
```
spot_GP.run()
```

```
<spotPython.spot.spot.Spot at 0x2aff6b880>
```

```
spot_GP.y
```

```
array([ 69.32459936, 152.38491454, 107.92560483,  24.51465459,
        76.73500031,  86.30425341,  11.00309802,  16.11743728,
         7.28138447,  21.82302535,  10.96088904,   2.95189876,
         3.02907337,   2.10497097,   1.94316204])
```

```
spot_GP.plot_progress()
```




```
spot_GP.print_results()
```

```
min y: 1.9431620431632464
x0: 10.0
x1: 2.998332724015279
```

```
[['x0', 10.0], ['x1', 2.998332724015279]]
```

12.7 Additional Examples

```python
# Needed for the sklearn surrogates:
from sklearn.gaussian_process import GaussianProcessRegressor
from sklearn.gaussian_process.kernels import RBF
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn import linear_model
from sklearn import tree
import pandas as pd
```

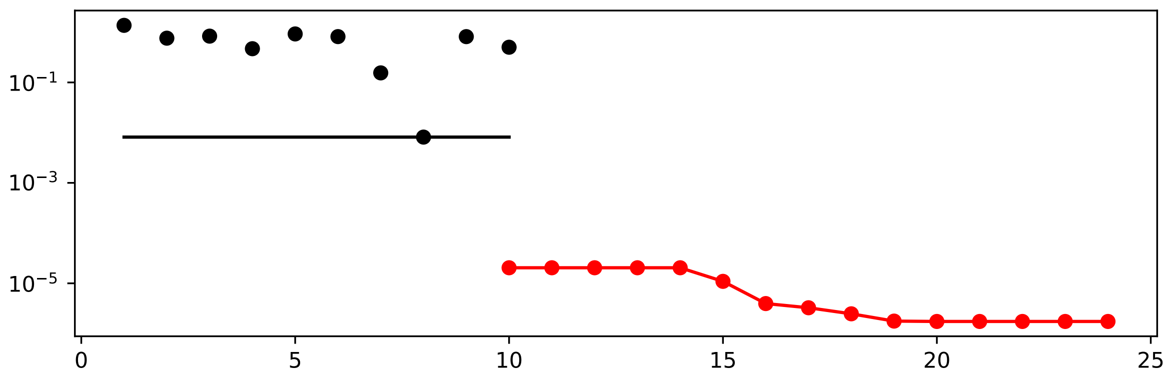
```python
kernel = 1 * RBF(length_scale=1.0, length_scale_bounds=(1e-2, 1e2))
S_GP = GaussianProcessRegressor(kernel=kernel, n_restarts_optimizer=9)
```

```python
from spotPython.build.kriging import Kriging
import numpy as np
import spotPython
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot

S_K = Kriging(name='kriging',
              seed=123,
              log_level=50,
              infill_criterion = "y",
              n_theta=1,
              noise=False,
              cod_type="norm")
fun = analytical().fun_sphere
lower = np.array([-1,-1])
upper = np.array([1,1])

design_control={"init_size": 10}
surrogate_control={
            "n_points": 1,
        }
spot_S_K = spot.Spot(fun=fun,
                     lower = lower,
                     upper= upper,
                     surrogate=S_K,
                     fun_evals = 25,
                     noise = False,
                     log_level = 50,
```

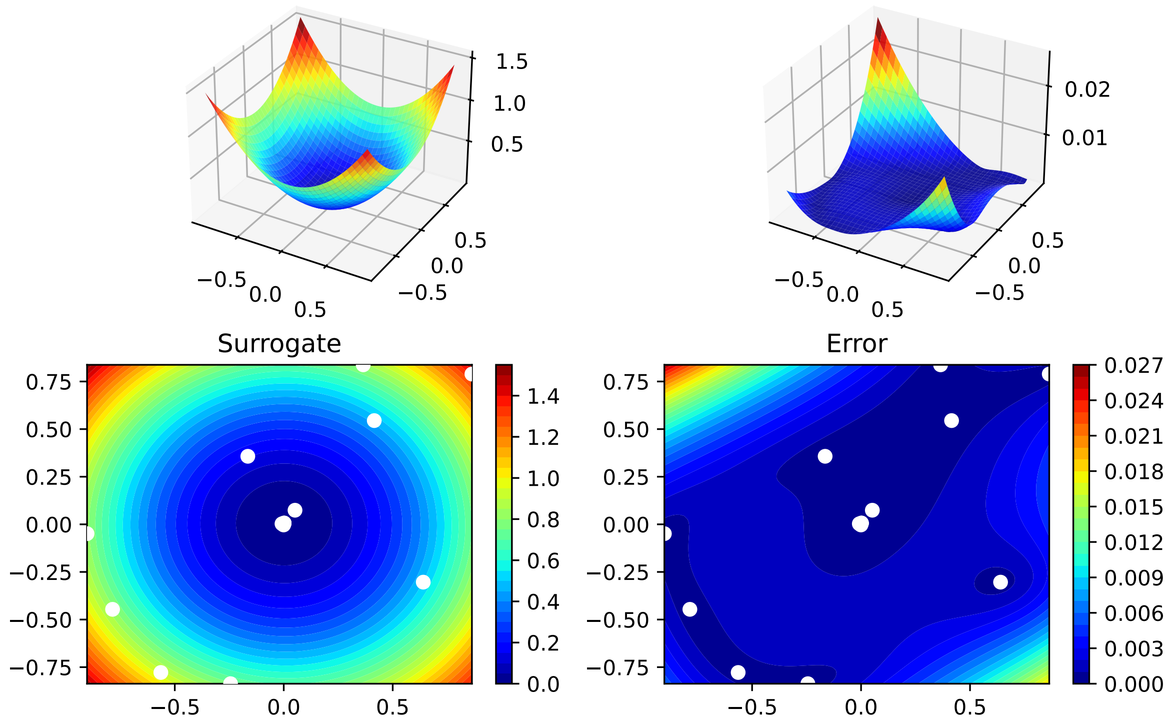
```
                                design_control=design_control,
                                surrogate_control=surrogate_control)

spot_S_K.run()
```

```
<spotPython.spot.spot.Spot at 0x2ad4d4df0>
```

```
spot_S_K.plot_progress(log_y=True)
```




```
spot_S_K.surrogate.plot()
```




```
spot_S_K.print_results()
```

```
min y: 1.7395335905335862e-06
x0: -0.0013044072412622557
x1: 0.0001950777780173277
```

```
[['x0', -0.0013044072412622557], ['x1', 0.0001950777780173277]]
```

12.7.1 Optimize on Surrogate

12.7.2 Evaluate on Real Objective

12.7.3 Impute / Infill new Points

12.8 Tests

```
import numpy as np
from spotPython.spot import spot
from spotPython.fun.objectivefunctions import analytical

fun_sphere = analytical().fun_sphere
spot_1 = spot.Spot(
    fun=fun_sphere,
    lower=np.array([-1, -1]),
    upper=np.array([1, 1]),
    n_points = 2
)

# (S-2) Initial Design:
spot_1.X = spot_1.design.scipy_lhd(
    spot_1.design_control["init_size"], lower=spot_1.lower, upper=spot_1.upper
)
print(spot_1.X)

# (S-3): Eval initial design:
spot_1.y = spot_1.fun(spot_1.X)
print(spot_1.y)

spot_1.surrogate.fit(spot_1.X, spot_1.y)
X0 = spot_1.suggest_new_X()
print(X0)
assert X0.size == spot_1.n_points * spot_1.k
```

```
[[ 0.86352963  0.7892358 ]
 [-0.24407197 -0.83687436]
 [ 0.36481882  0.8375811 ]
 [ 0.415331    0.54468512]
 [-0.56395091 -0.77797854]
 [-0.90259409 -0.04899292]
```

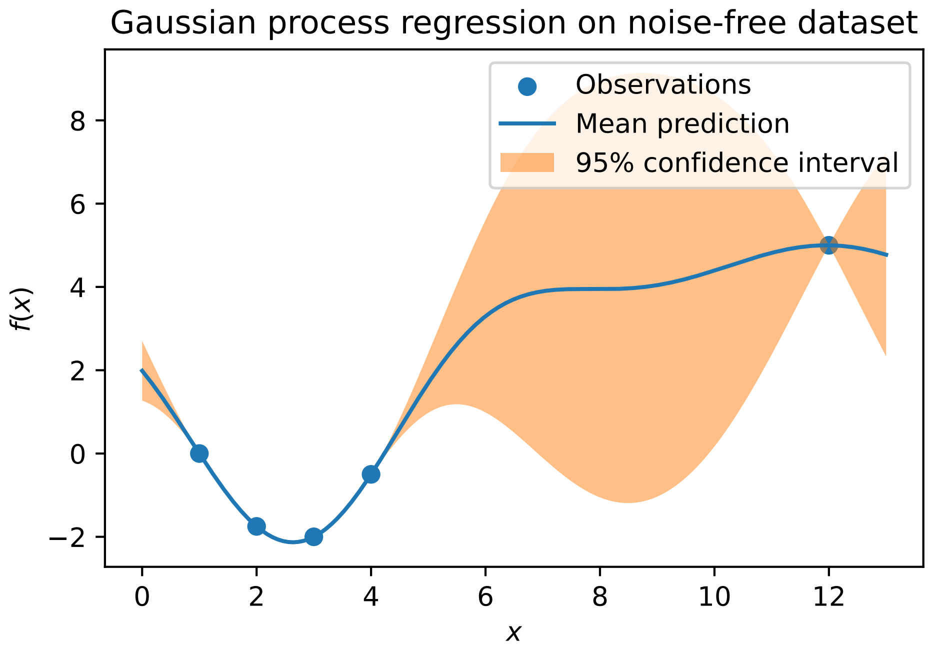
```
 [-0.16484832  0.35724741]
 [ 0.05170659  0.07401196]
 [-0.78548145 -0.44638164]
 [ 0.64017497 -0.30363301]]
[1.36857656 0.75992983 0.83463487 0.46918172 0.92329124 0.8170764
 0.15480068 0.00815134 0.81623768 0.502017  ]
[[0.00160553 0.00428429]
 [0.00160553 0.00428429]]
```

12.9 EI: The Famous Schonlau Example

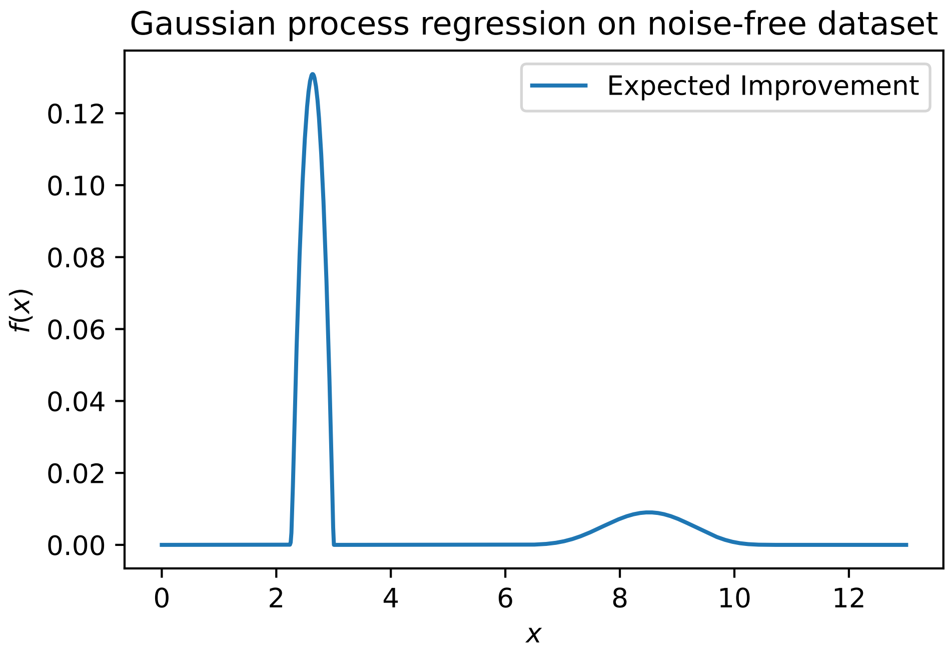
```
X_train0 = np.array([1, 2, 3, 4, 12]).reshape(-1,1)
X_train = np.linspace(start=0, stop=10, num=5).reshape(-1, 1)
```

```
from spotPython.build.kriging import Kriging
import numpy as np
import matplotlib.pyplot as plt

X_train = np.array([1., 2., 3., 4., 12.]).reshape(-1,1)
y_train = np.array([0., -1.75, -2, -0.5, 5.])

S = Kriging(name='kriging',  seed=123, log_level=50, n_theta=1, noise=False, cod_type="nor
S.fit(X_train, y_train)

X = np.linspace(start=0, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, mean_prediction, label="Mean prediction")
if True:
    plt.fill_between(
        X.ravel(),
        mean_prediction - 2 * std_prediction,
        mean_prediction + 2 * std_prediction,
        alpha=0.5,
        label=r"95% confidence interval",
    )
plt.legend()
plt.xlabel("$x$")
```

```
plt.ylabel("$f(x)$")
_ = plt.title("Gaussian process regression on noise-free dataset")
```




```
#plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
# plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, -ei, label="Expected Improvement")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Gaussian process regression on noise-free dataset")
```



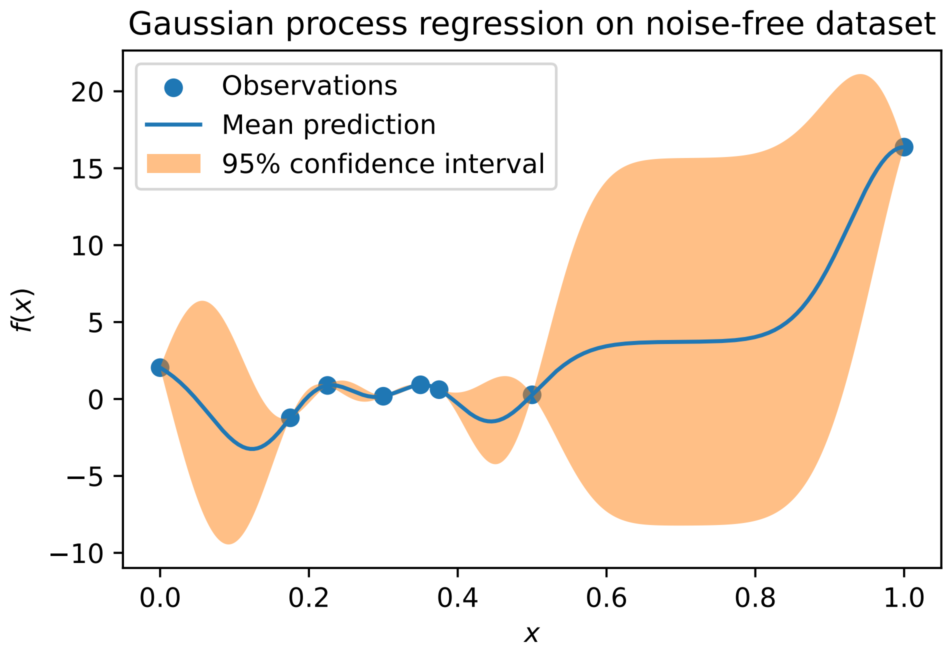

```
S.log
```

```
{'negLnLike': array([1.20788205]),
 'theta': array([1.09276]),
 'p': array([2.]),
 'Lambda': array([None], dtype=object)}
```

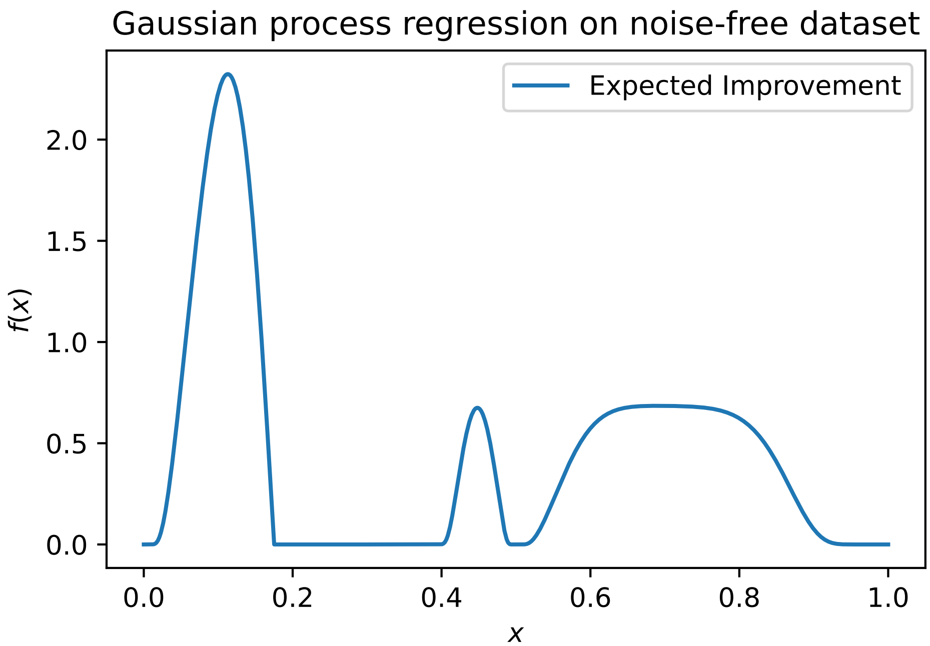
12.10 EI: The Forrester Example

```
from spotPython.build.kriging import Kriging
import numpy as np
import matplotlib.pyplot as plt
import spotPython
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot

# exact x locations are unknown:
X_train = np.array([0.0, 0.175, 0.225, 0.3, 0.35, 0.375, 0.5,1]).reshape(-1,1)
```

```
fun = analytical().fun_forrester
fun_control = {"sigma": 1.0,
               "seed": 123}
y_train = fun(X_train, fun_control=fun_control)

S = Kriging(name='kriging',  seed=123, log_level=50, n_theta=1, noise=False, cod_type="nor
S.fit(X_train, y_train)

X = np.linspace(start=0, stop=1, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, mean_prediction, label="Mean prediction")
if True:
    plt.fill_between(
        X.ravel(),
        mean_prediction - 2 * std_prediction,
        mean_prediction + 2 * std_prediction,
        alpha=0.5,
        label=r"95% confidence interval",
    )
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Gaussian process regression on noise-free dataset")
```




```
#plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
# plt.scatter(X_train, y_train, label="Observations")
plt.plot(X, -ei, label="Expected Improvement")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Gaussian process regression on noise-free dataset")
```

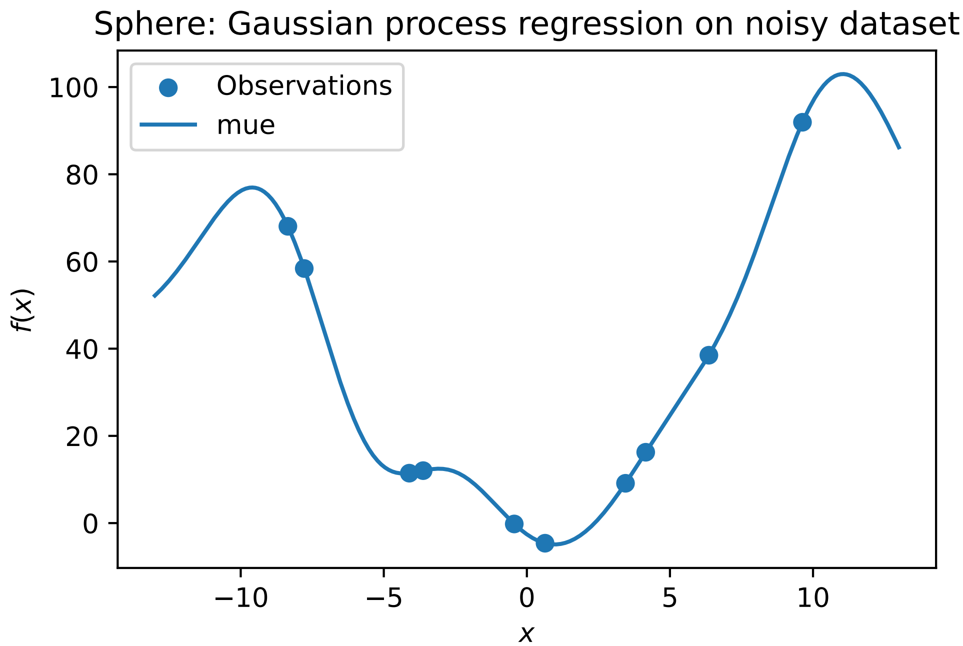


12.11 Noise

```
import numpy as np
import spotPython
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from spotPython.design.spacefilling import spacefilling
from spotPython.build.kriging import Kriging
import matplotlib.pyplot as plt

gen = spacefilling(1)
rng = np.random.RandomState(1)
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_sphere
fun_control = {"sigma": 2,
               "seed": 125}
X = gen.scipy_lhd(10, lower=lower, upper = upper)
print(X)
y = fun(X, fun_control=fun_control)
```

```python
print(y)
y.shape
X_train = X.reshape(-1,1)
y_train = y

S = Kriging(name='kriging',
            seed=123,
            log_level=50,
            n_theta=1,
            noise=False)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

#plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
plt.scatter(X_train, y_train, label="Observations")
#plt.plot(X, ei, label="Expected Improvement")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Sphere: Gaussian process regression on noisy dataset")
```

```
[[ 0.63529627]
 [-4.10764204]
 [-0.44071975]
 [ 9.63125638]
 [-8.3518118 ]
 [-3.62418901]
 [ 4.15331   ]
 [ 3.4468512 ]
 [ 6.36049088]
 [-7.77978539]]
[-4.61635371 11.44873209 -0.19988024 91.92791676 68.05926244 12.02926818
 16.2470957   9.12729929 38.4987029  58.38469104]
```

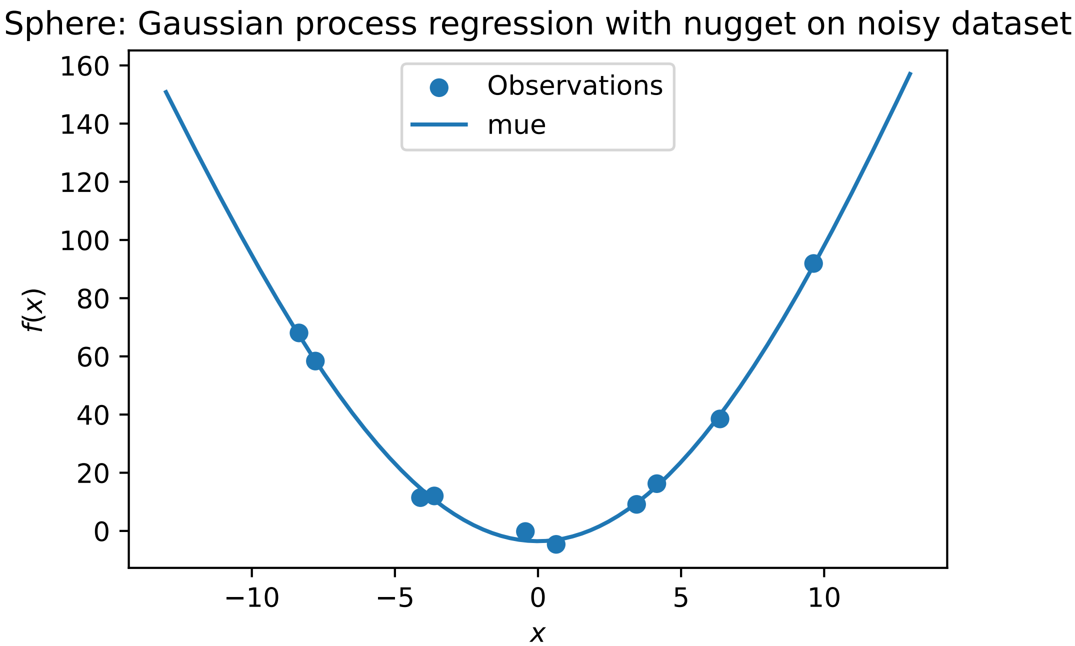



```
S.log
```

```
{'negLnLike': array([24.69806131]),
 'theta': array([1.31023943]),
 'p': array([2.]),
 'Lambda': array([None], dtype=object)}
```

```
S = Kriging(name='kriging',
            seed=123,
            log_level=50,
            n_theta=1,
            noise=True)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

#plt.plot(X, y, label=r"$f(x) = x \sin(x)$", linestyle="dotted")
plt.scatter(X_train, y_train, label="Observations")
#plt.plot(X, ei, label="Expected Improvement")
plt.plot(X_axis, mean_prediction, label="mue")
```

```
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Sphere: Gaussian process regression with nugget on noisy dataset")
```




```
S.log
```

```
{'negLnLike': array([22.14095646]),
 'theta': array([-0.32527397]),
 'p': array([2.]),
 'Lambda': array([9.08815007e-05])}
```

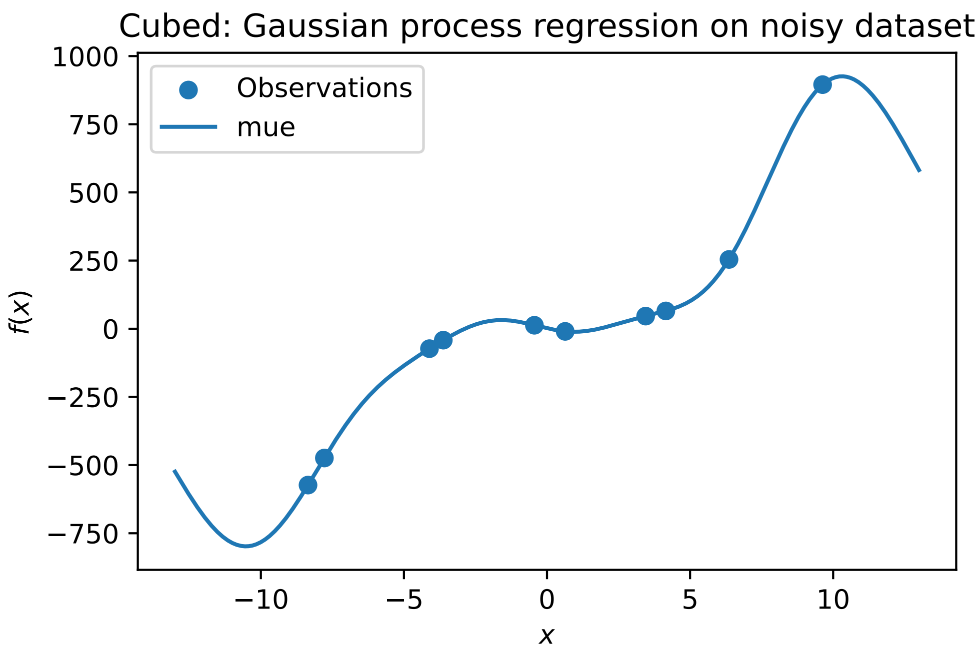
12.12 Cubic Function

```
import numpy as np
import spotPython
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from spotPython.design.spacefilling import spacefilling
```

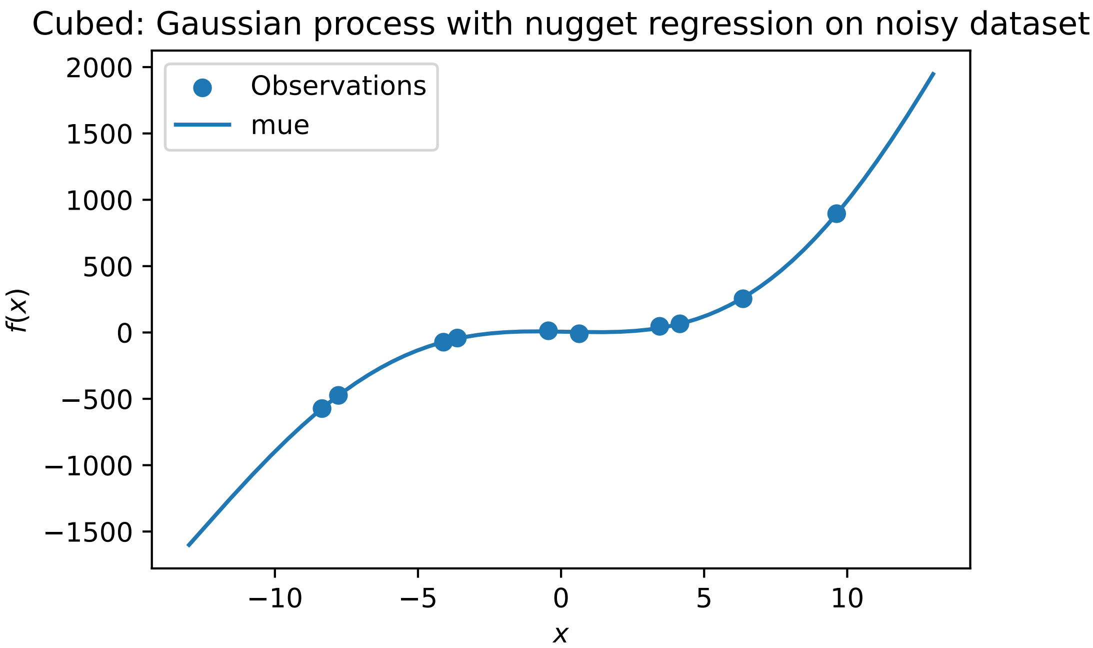
```python
from spotPython.build.kriging import Kriging
import matplotlib.pyplot as plt

gen = spacefilling(1)
rng = np.random.RandomState(1)
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_cubed
fun_control = {"sigma": 10,
               "seed": 123}

X = gen.scipy_lhd(10, lower=lower, upper = upper)
print(X)
y = fun(X, fun_control=fun_control)
print(y)
y.shape
X_train = X.reshape(-1,1)
y_train = y

S = Kriging(name='kriging',  seed=123, log_level=50, n_theta=1, noise=False)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
#plt.plot(X, ei, label="Expected Improvement")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Cubed: Gaussian process regression on noisy dataset")
```

```
[[ 0.63529627]
 [-4.10764204]
 [-0.44071975]
 [ 9.63125638]
 [-8.3518118 ]
 [-3.62418901]
 [ 4.15331   ]
 [ 3.4468512 ]
 [ 6.36049088]
```

```
 [-7.77978539]]
[  -9.63480707  -72.98497325   12.7936499   895.34567477 -573.35961837
  -41.83176425   65.27989461   46.37081417  254.1530734  -474.09587355]
```



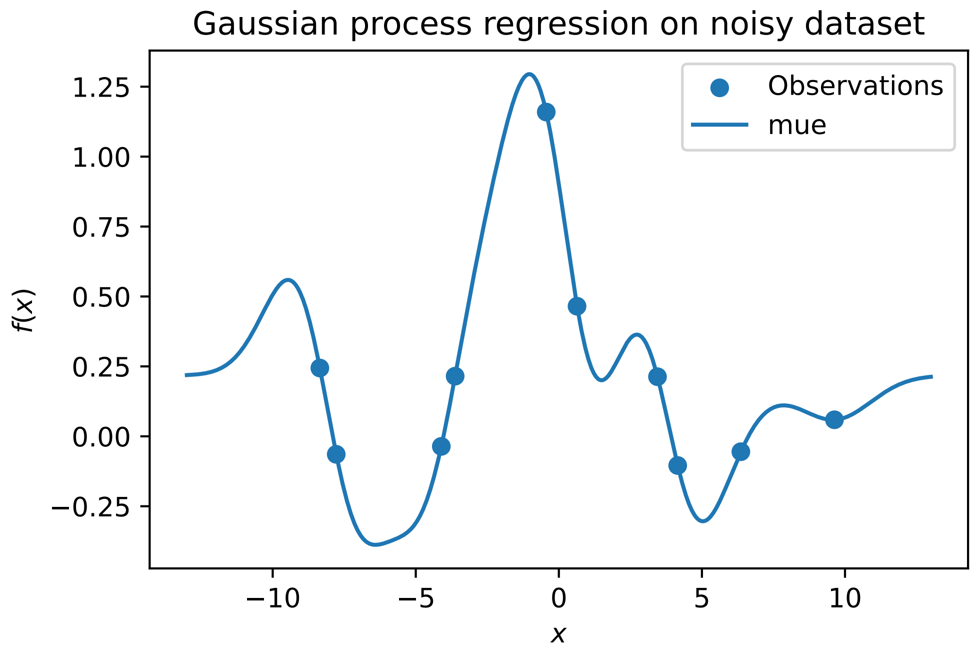

```
S = Kriging(name='kriging',  seed=123, log_level=0, n_theta=1, noise=True)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
#plt.plot(X, ei, label="Expected Improvement")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Cubed: Gaussian process with nugget regression on noisy dataset")
```



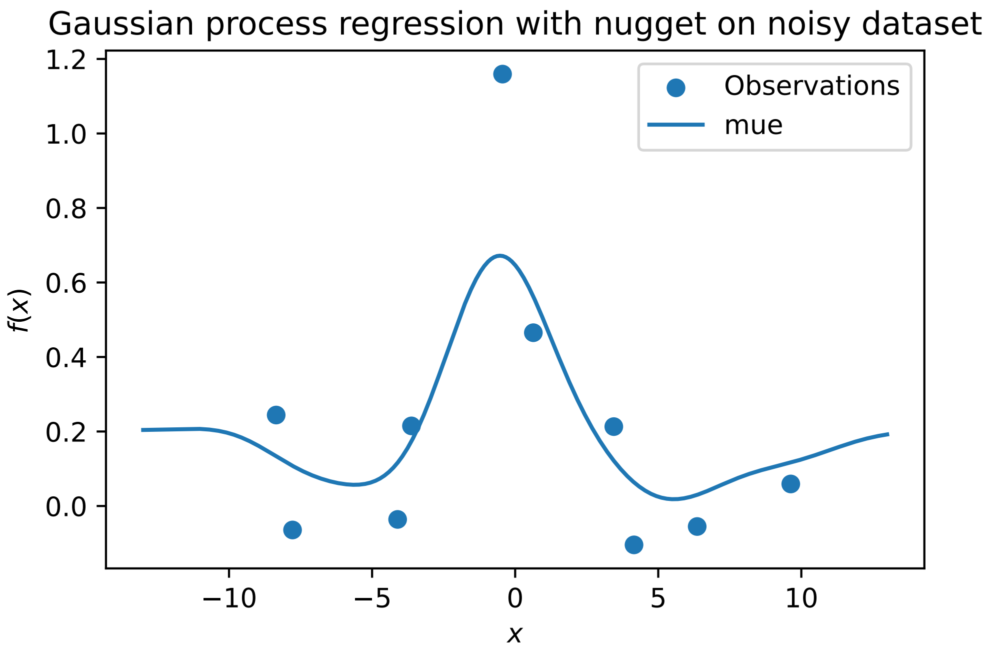

```
import numpy as np
import spotPython
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from spotPython.design.spacefilling import spacefilling
from spotPython.build.kriging import Kriging
import matplotlib.pyplot as plt

gen = spacefilling(1)
rng = np.random.RandomState(1)
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_runge
fun_control = {"sigma": 0.25,
               "seed": 123}

X = gen.scipy_lhd(10, lower=lower, upper = upper)
print(X)
y = fun(X, fun_control=fun_control)
print(y)
y.shape
```

```python
X_train = X.reshape(-1,1)
y_train = y

S = Kriging(name='kriging',  seed=123, log_level=50, n_theta=1, noise=False)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
#plt.plot(X, ei, label="Expected Improvement")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Gaussian process regression on noisy dataset")
```

```
[[ 0.63529627]
 [-4.10764204]
 [-0.44071975]
 [ 9.63125638]
 [-8.3518118 ]
 [-3.62418901]
 [ 4.15331   ]
 [ 3.4468512 ]
 [ 6.36049088]
 [-7.77978539]]
[ 0.46517267 -0.03599548  1.15933822  0.05915901  0.24419145  0.21502359
 -0.10432134  0.21312309 -0.05502681 -0.06434374]
```




```
S = Kriging(name='kriging',
            seed=123,
            log_level=50,
            n_theta=1,
            noise=True)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
#plt.plot(X, ei, label="Expected Improvement")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Gaussian process regression with nugget on noisy dataset")
```



12.13 Factors

```
["num"] * 3
```

```
['num', 'num', 'num']
```

```
from spotPython.design.spacefilling import spacefilling
from spotPython.build.kriging import Kriging
from spotPython.fun.objectivefunctions import analytical
import numpy as np
```

```
gen = spacefilling(2)
n = 30
rng = np.random.RandomState(1)
lower = np.array([-5,-0])
upper = np.array([10,15])
fun = analytical().fun_branin_factor
#fun = analytical(sigma=0).fun_sphere
```

```
X0 = gen.scipy_lhd(n, lower=lower, upper = upper)
X1 = np.random.randint(low=1, high=3, size=(n,))
X = np.c_[X0, X1]
y = fun(X)
S = Kriging(name='kriging',  seed=123, log_level=50, n_theta=3, noise=False, var_type=["nu
S.fit(X, y)
Sf = Kriging(name='kriging',  seed=123, log_level=50, n_theta=3, noise=False, var_type=["n
Sf.fit(X, y)
n = 50
X0 = gen.scipy_lhd(n, lower=lower, upper = upper)
X1 = np.random.randint(low=1, high=3, size=(n,))
X = np.c_[X0, X1]
y = fun(X)
s=np.sum(np.abs(S.predict(X)[0] - y))
sf=np.sum(np.abs(Sf.predict(X)[0] - y))
sf - s
```

```
105.42780173765641
```

```
# vars(S)
```

```
# vars(Sf)
```

13 Hyperparameter Tuning and Noise

This chapter demonstrates how noisy functions can be handled by `Spot`.

13.1 Example: `Spot` and the Noisy Sphere Function

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
```

```
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '10-sklearn' + "_" + HOSTNAME + "_" + str(start_time).split(".", 1)[0].r
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
10-sklearn_p040025_2023-06-16_20-17-35
```

13.1.1 The Objective Function: Noisy Sphere

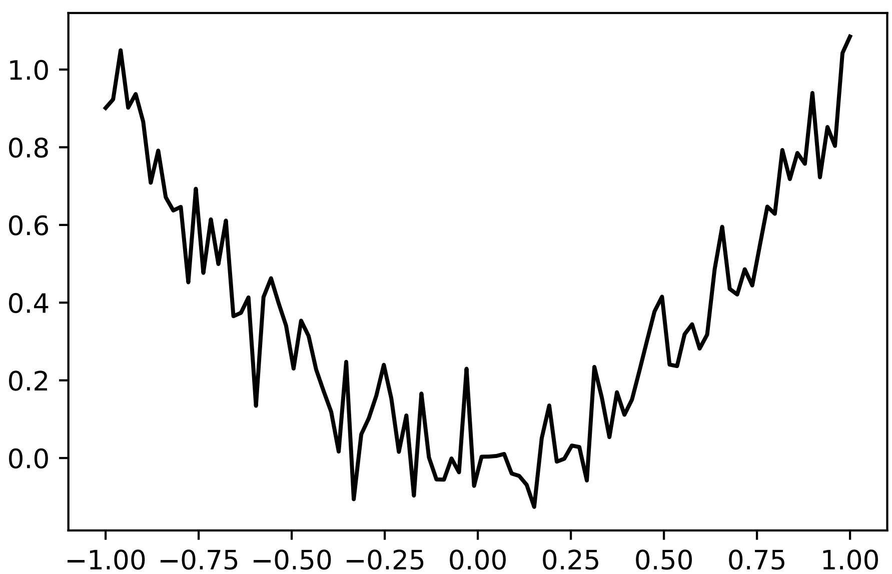
- The `spotPython` package provides several classes of objective functions.

- We will use an analytical objective function with noise, i.e., a function that can be described by a (closed) formula:
$$f(x) = x^2 + \epsilon$$
- Since `sigma` is set to `0.1`, noise is added to the function:

```
fun = analytical().fun_sphere
fun_control = {"sigma": 0.1,
               "seed": 123}
```

- A plot illustrates the noise:

```
x = np.linspace(-1,1,100).reshape(-1,1)
y = fun(x, fun_control=fun_control)
plt.figure()
plt.plot(x,y, "k")
plt.show()
```

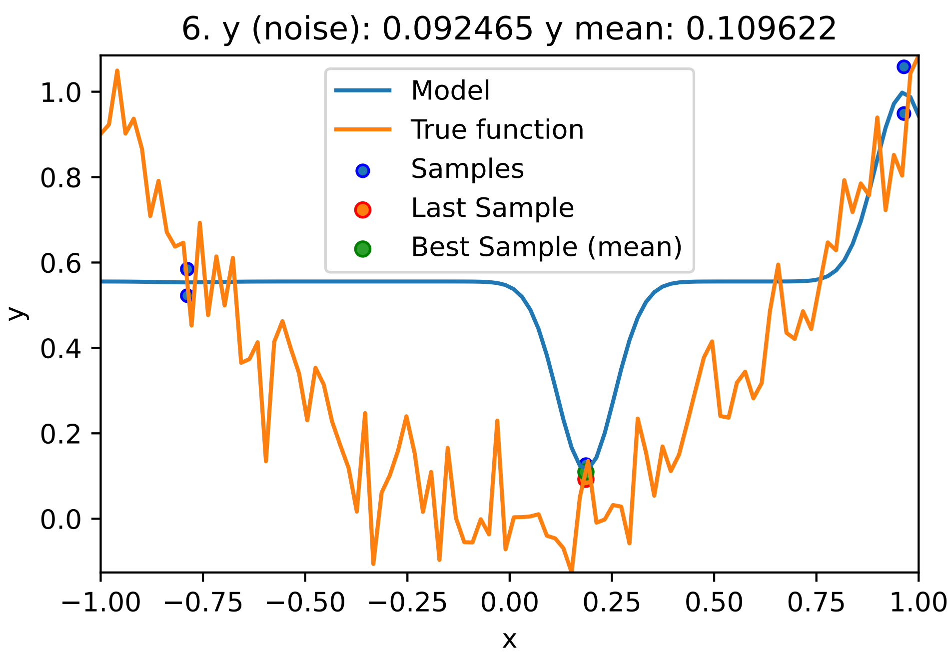


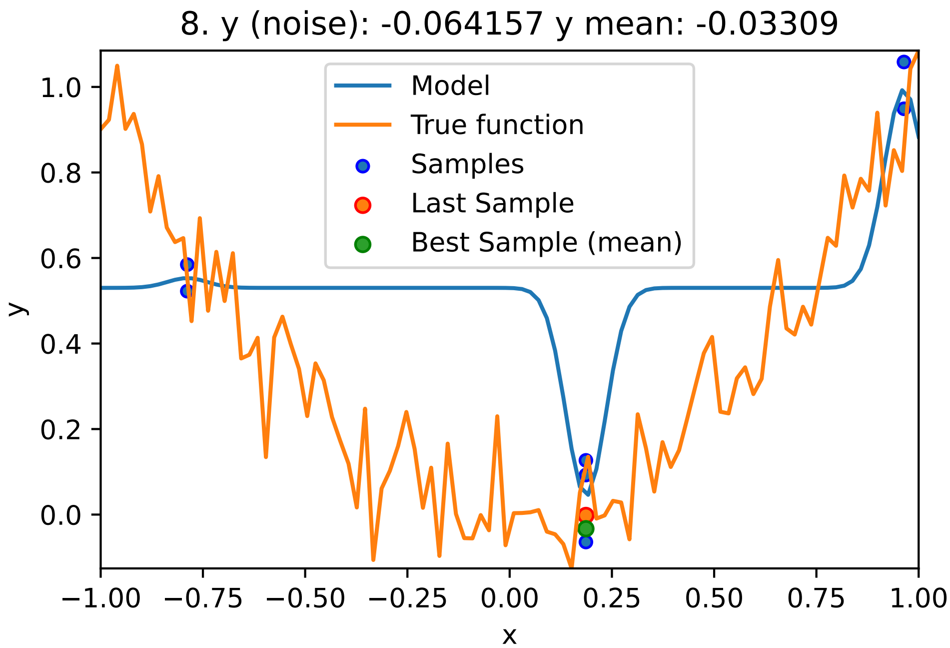
`Spot` is adopted as follows to cope with noisy functions:

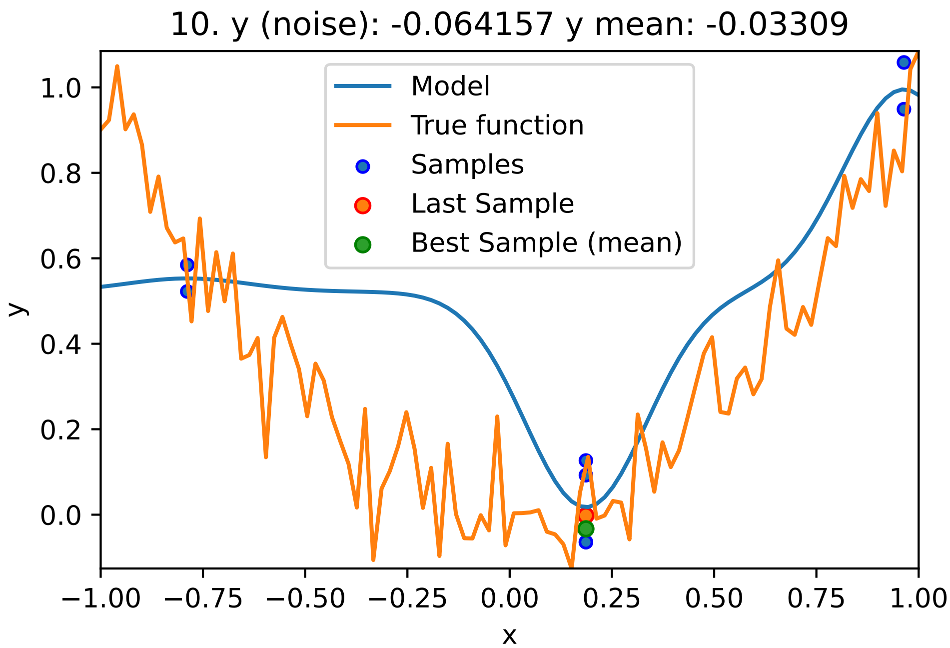
1. `fun_repeats` is set to a value larger than 1 (here: 2)
2. `noise` is set to `true`. Therefore, a nugget (`Lambda`) term is added to the correlation matrix
3. `init size` (of the `design_control` dictionary) is set to a value larger than 1 (here: 2)

```
spot_1_noisy = spot.Spot(fun=fun,
                   lower = np.array([-1]),
                   upper = np.array([1]),
                   fun_evals = 10,
                   fun_repeats = 2,
                   noise = True,
                   seed=123,
                   show_models=True,
                   fun_control = fun_control,
                   design_control={"init_size": 3,
                                   "repeats": 2},
                   surrogate_control={"noise": True})
```

```
spot_1_noisy.run()
```








```
<spotPython.spot.spot.Spot at 0x157beb700>
```

13.2 Print the Results

```
spot_1_noisy.print_results()
```

```
min y: -0.06415721594238855
x0: 0.18642671238960512
min mean y: -0.03309048099839016
x0: 0.18642671238960512
```

```
[['x0', 0.18642671238960512], ['x0', 0.18642671238960512]]
```

```
spot_1_noisy.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

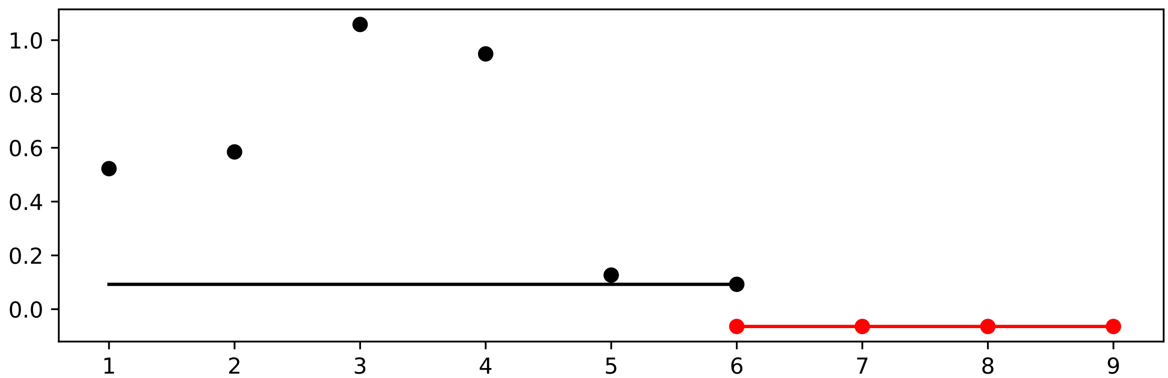


Figure 13.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

13.3 Noise and Surrogates: The Nugget Effect

13.3.1 The Noisy Sphere

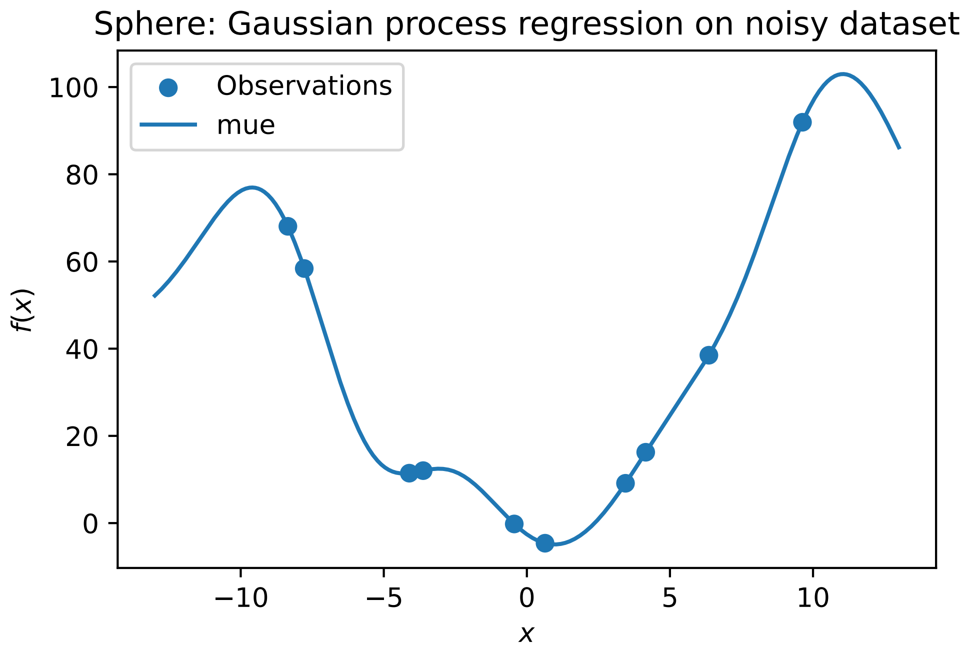
13.3.1.1 The Data

- We prepare some data first:

```python
import numpy as np
import spotPython
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from spotPython.design.spacefilling import spacefilling
from spotPython.build.kriging import Kriging
import matplotlib.pyplot as plt

gen = spacefilling(1)
rng = np.random.RandomState(1)
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_sphere
fun_control = {"sigma": 2,
               "seed": 125}
X = gen.scipy_lhd(10, lower=lower, upper = upper)
y = fun(X, fun_control=fun_control)
X_train = X.reshape(-1,1)
y_train = y
```

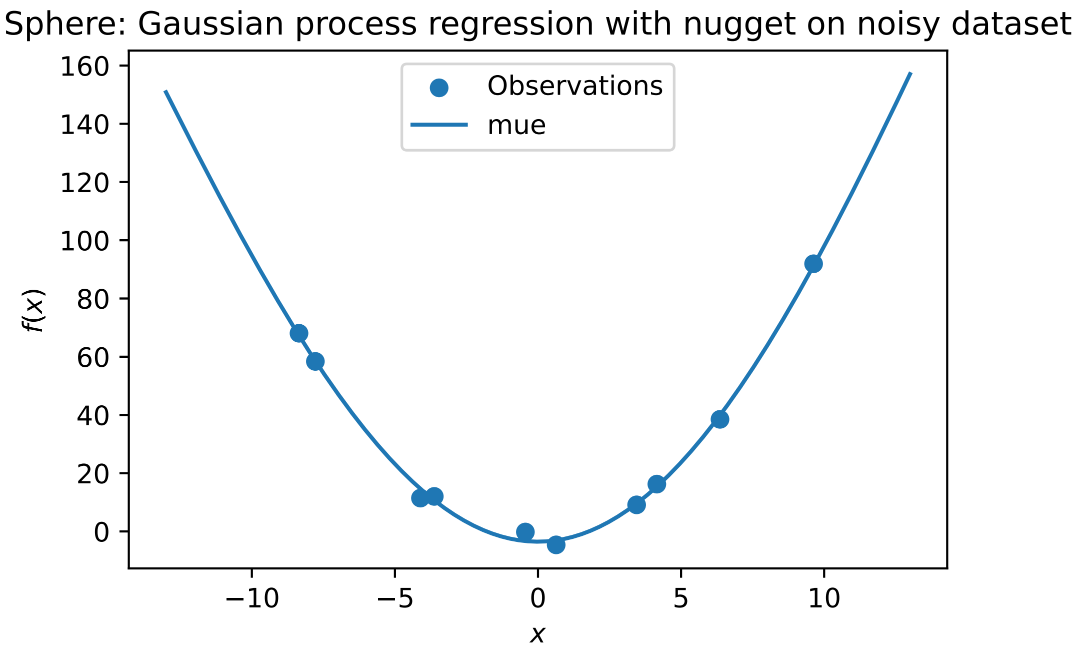
- A surrogate without nugget is fitted to these data:

```python
S = Kriging(name='kriging',
            seed=123,
            log_level=50,
            n_theta=1,
            noise=False)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Sphere: Gaussian process regression on noisy dataset")
```



- In comparison to the surrogate without nugget, we fit a surrogate with nugget to the data:

```
S_nug = Kriging(name='kriging',
            seed=123,
            log_level=50,
            n_theta=1,
            noise=True)
S_nug.fit(X_train, y_train)
X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S_nug.predict(X_axis, return_val="all")
plt.scatter(X_train, y_train, label="Observations")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Sphere: Gaussian process regression with nugget on noisy dataset")
```



- The value of the nugget term can be extracted from the model as follows:

```
S.Lambda
```

```
S_nug.Lambda
```

```
9.088150066416743e-05
```

- We see:
  - the first model `S` has no nugget,
  - whereas the second model has a nugget value (`Lambda`) larger than zero.

13.4 Exercises

13.4.1 Noisy `fun_cubed`

- Analyse the effect of noise on the `fun_cubed` function with the following settings:

```
fun = analytical().fun_cubed
fun_control = {"sigma": 10,
```

```
                 "seed": 123}
lower = np.array([-10])
upper = np.array([10])
```

13.4.2 fun_runge

- Analyse the effect of noise on the fun_runge function with the following settings:

```
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_runge
fun_control = {"sigma": 0.25,
               "seed": 123}
```

13.4.3 fun_forrester

- Analyse the effect of noise on the fun_forrester function with the following settings:

```
lower = np.array([0])
upper = np.array([1])
fun = analytical().fun_forrester
fun_control = {"sigma": 5,
               "seed": 123}
```

13.4.4 fun_xsin

- Analyse the effect of noise on the fun_xsin function with the following settings:

```
lower = np.array([-1.])
upper = np.array([1.])
fun = analytical().fun_xsin
fun_control = {"sigma": 0.5,
               "seed": 123}
```

14 Handling Noise: Optimal Computational Budget Allocation in `Spot`

This notebook demonstrates how noisy functions can be handled with OCBA by `Spot`.

14.1 Example: `Spot`, OCBA, and the Noisy Sphere Function

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
```

14.1.1 The Objective Function: Noisy Sphere

The `spotPython` package provides several classes of objective functions. We will use an analytical objective function with noise, i.e., a function that can be described by a (closed) formula:

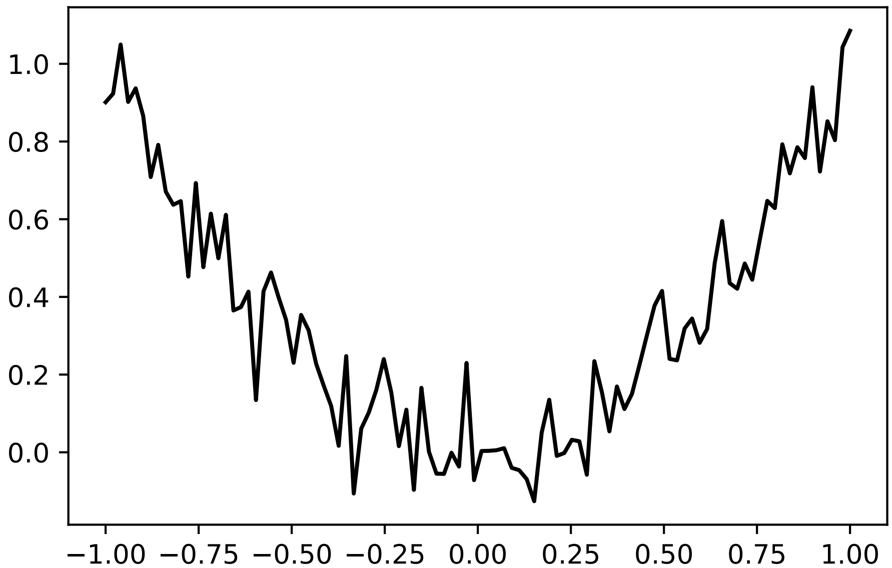
$$f(x) = x^2 + \epsilon$$

Since `sigma` is set to `0.1`, noise is added to the function:

```
fun = analytical().fun_sphere
fun_control = {"sigma": 0.1,
               "seed": 123}
```

A plot illustrates the noise:

```
x = np.linspace(-1,1,100).reshape(-1,1)
y = fun(x, fun_control=fun_control)
plt.figure()
plt.plot(x,y, "k")
plt.show()
```



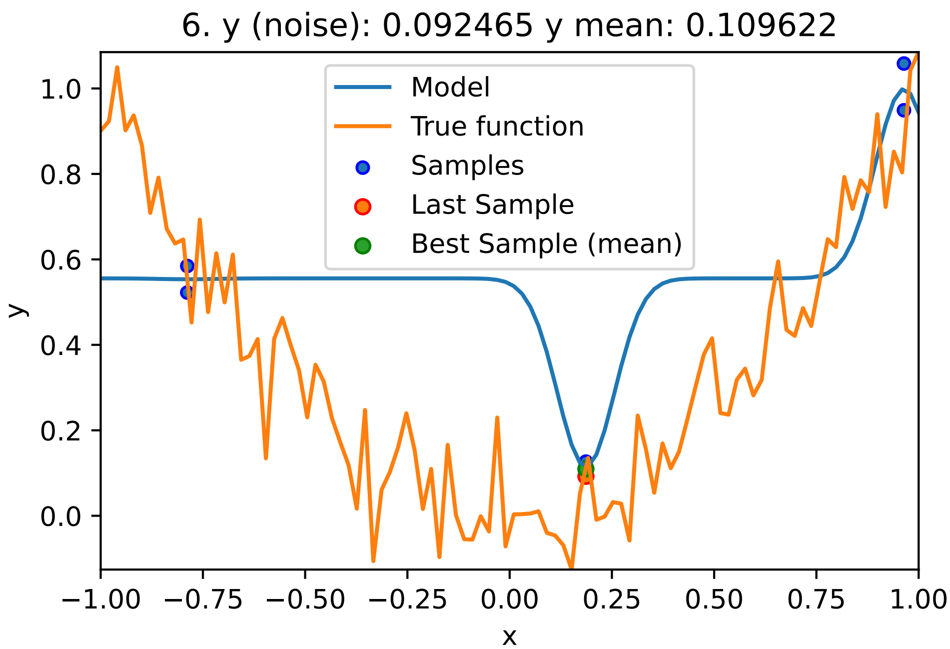
`Spot` is adopted as follows to cope with noisy functions:

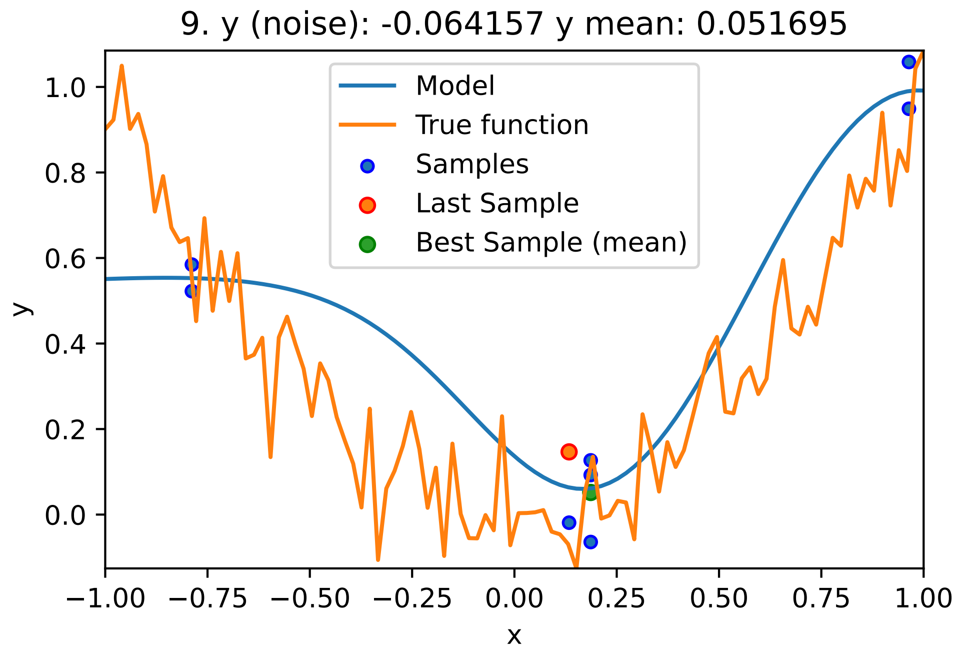
1. `fun_repeats` is set to a value larger than 1 (here: 2)
2. `noise` is set to `true`. Therefore, a nugget (`Lambda`) term is added to the correlation matrix
3. `init size` (of the `design_control` dictionary) is set to a value larger than 1 (here: 2)

```
spot_1_noisy = spot.Spot(fun=fun,
                   lower = np.array([-1]),
                   upper = np.array([1]),
                   fun_evals = 50,
                   fun_repeats = 2,
                   infill_criterion="ei",
                   noise = True,
                   tolerance_x=0.0,
                   ocba_delta = 1,
                   seed=123,
```

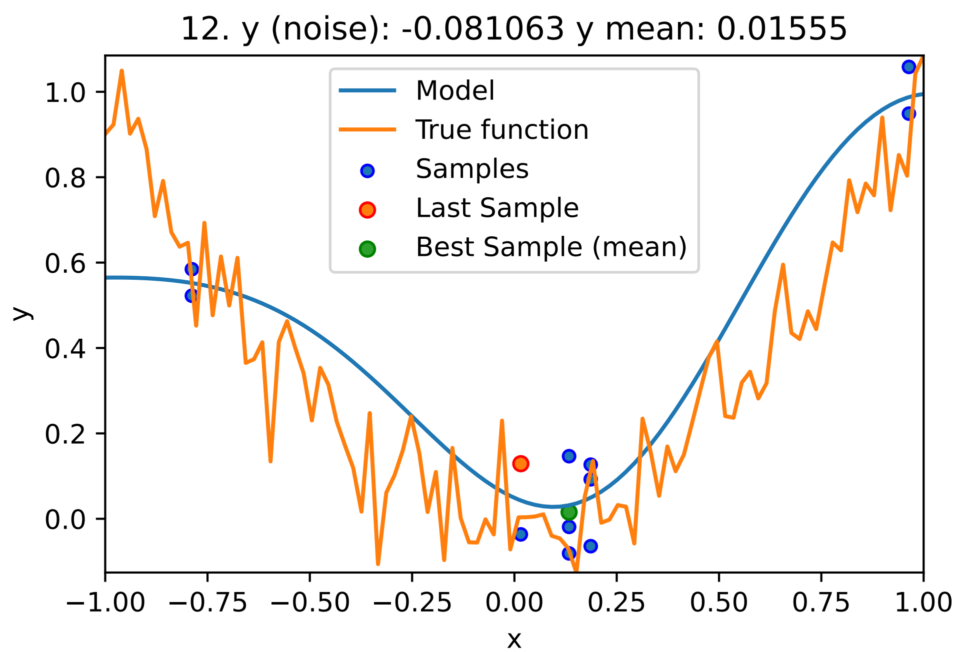
```
                    show_models=True,
                    fun_control = fun_control,
                    design_control={"init_size": 3,
                                    "repeats": 2},
                    surrogate_control={"noise": True})
```

```
spot_1_noisy.run()
```

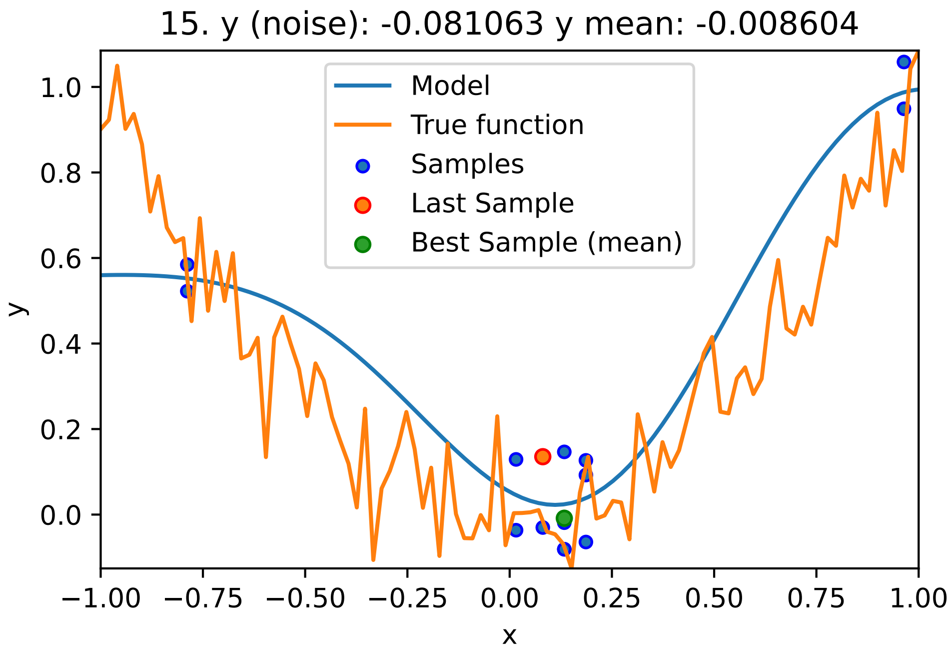


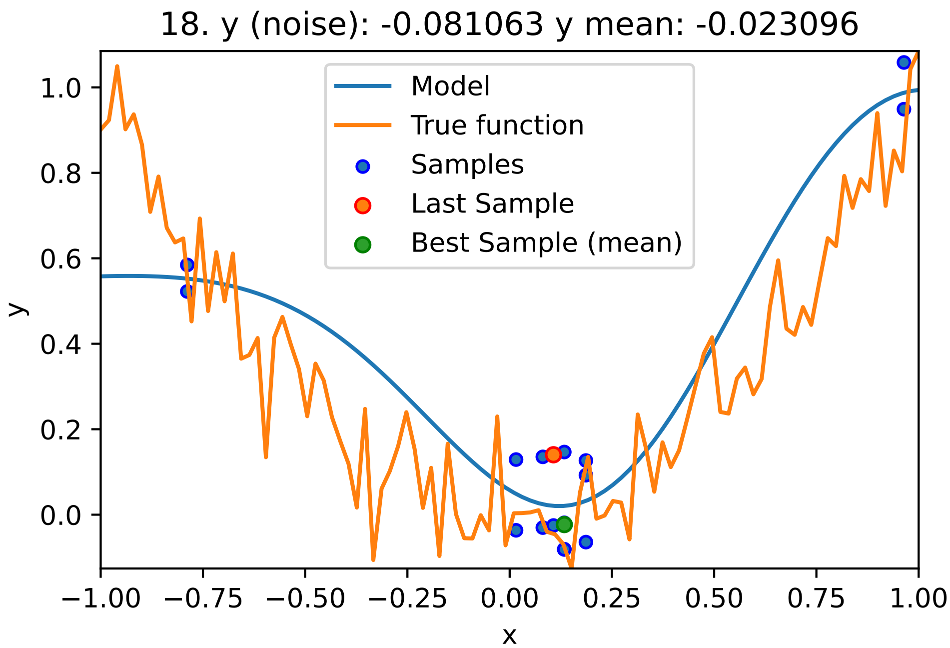


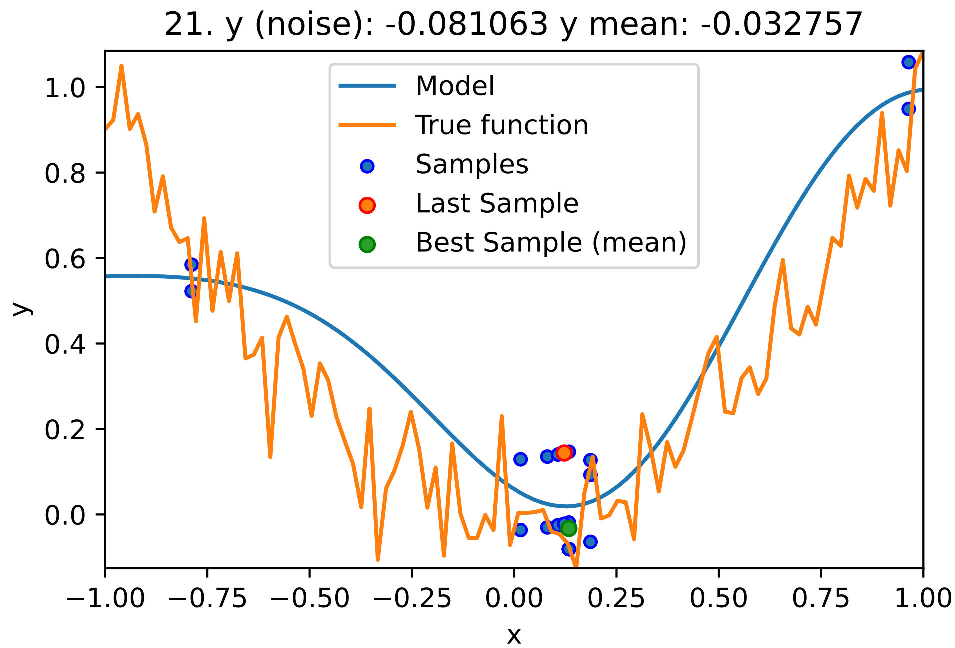
9. y (noise): -0.064157 y mean: 0.051695
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x



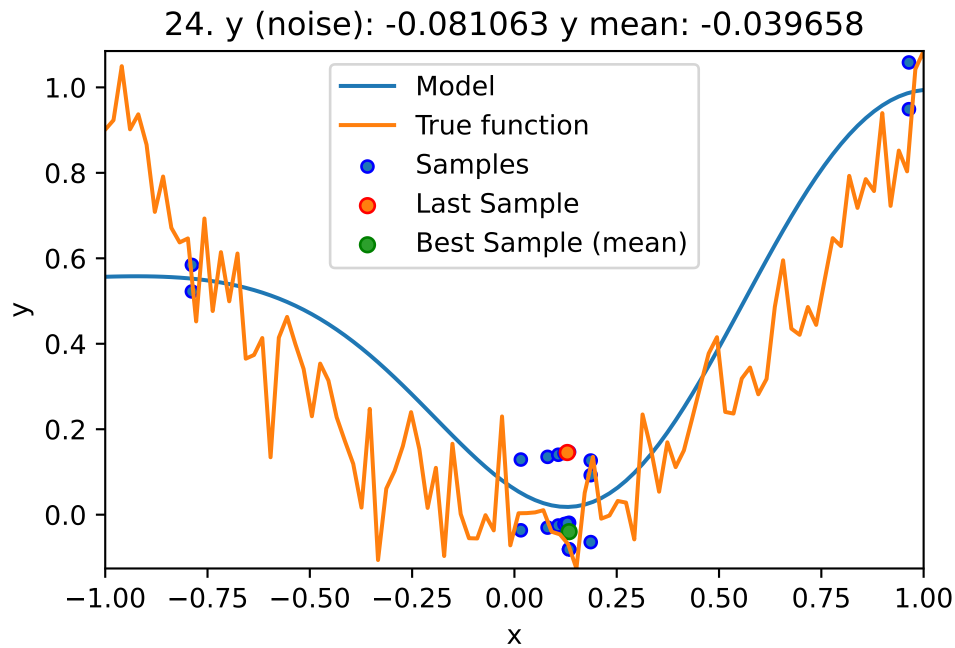
12. y (noise): -0.081063 y mean: 0.01555
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


15. y (noise): -0.081063 y mean: -0.008604
Model
True function
Samples
Last Sample
Best Sample (mean)
y
x
1.0
0.8
0.6
0.4
0.2
0.0
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00

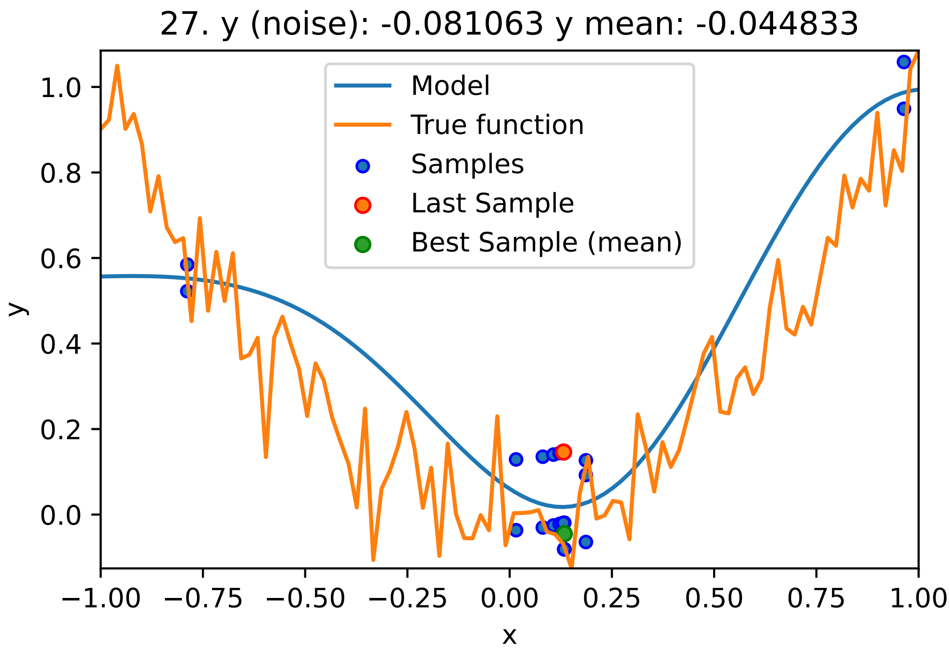

18. y (noise): -0.081063 y mean: -0.023096
Model
True function
Samples
Last Sample
Best Sample (mean)
y
x
1.0
0.8
0.6
0.4
0.2
0.0
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00

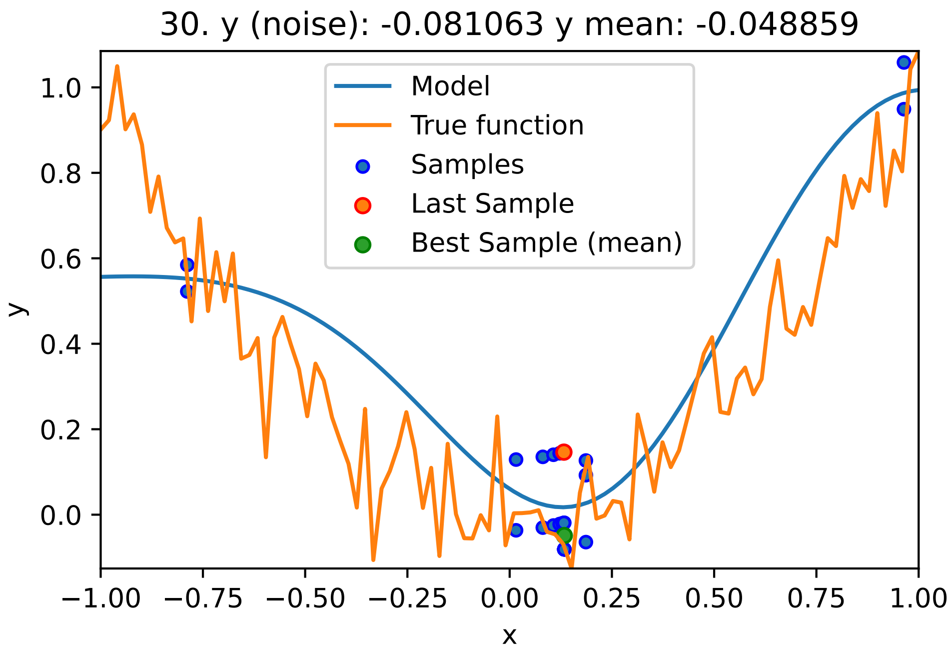


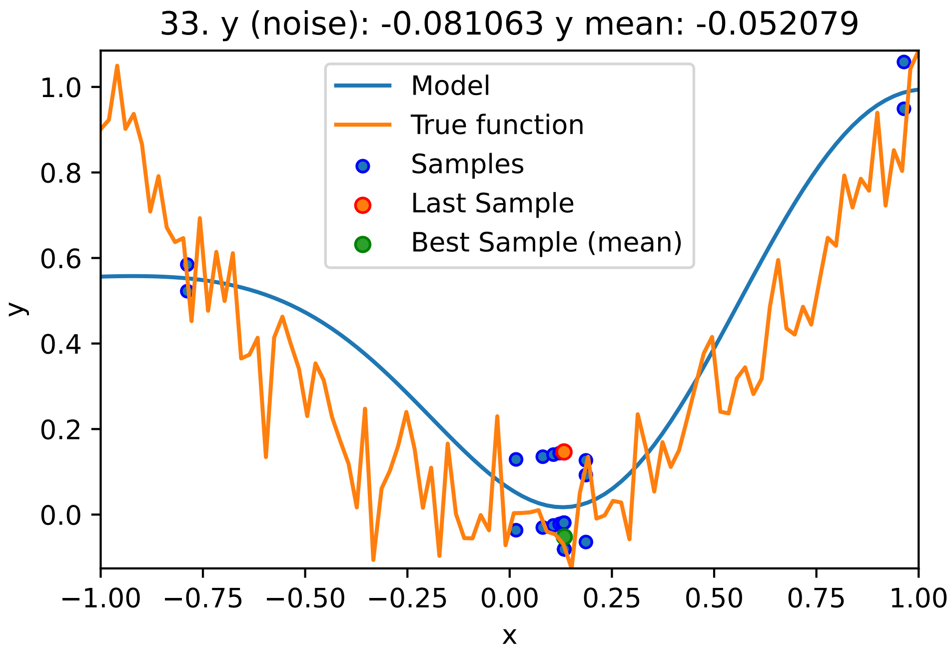
21. y (noise): -0.081063 y mean: -0.032757
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

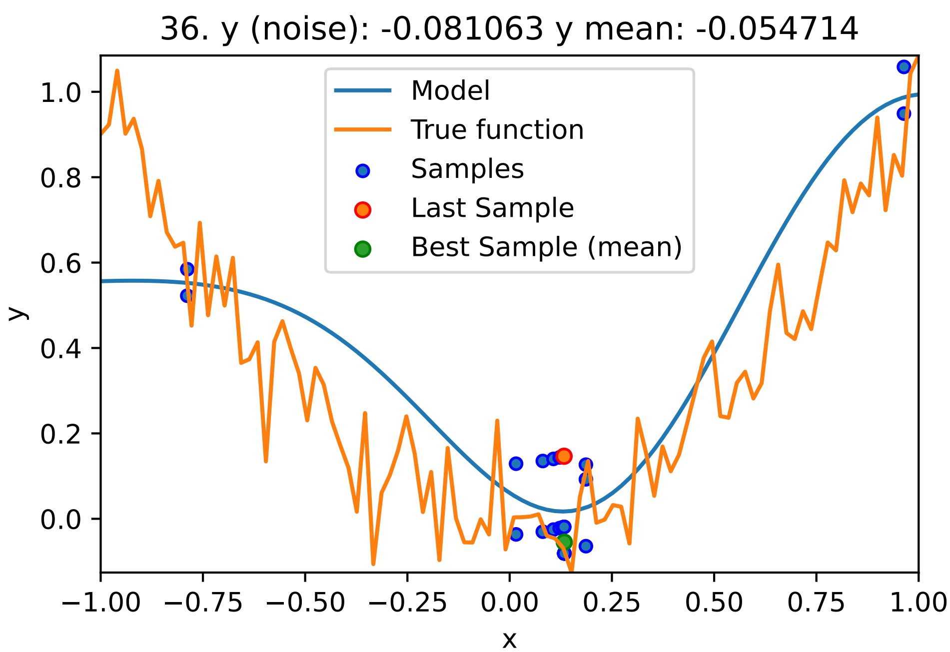


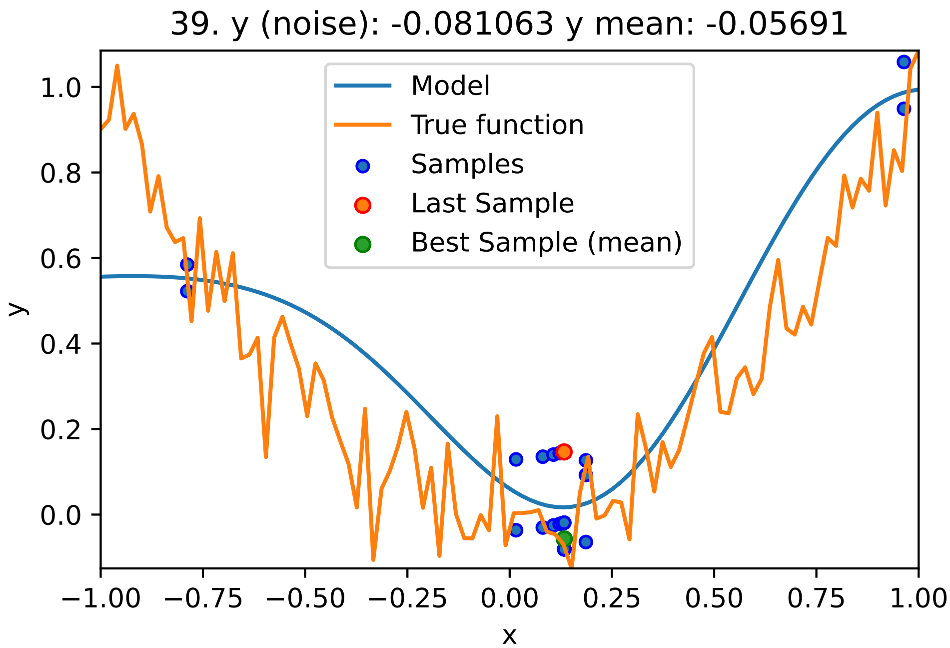
24. y (noise): -0.081063 y mean: -0.039658
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

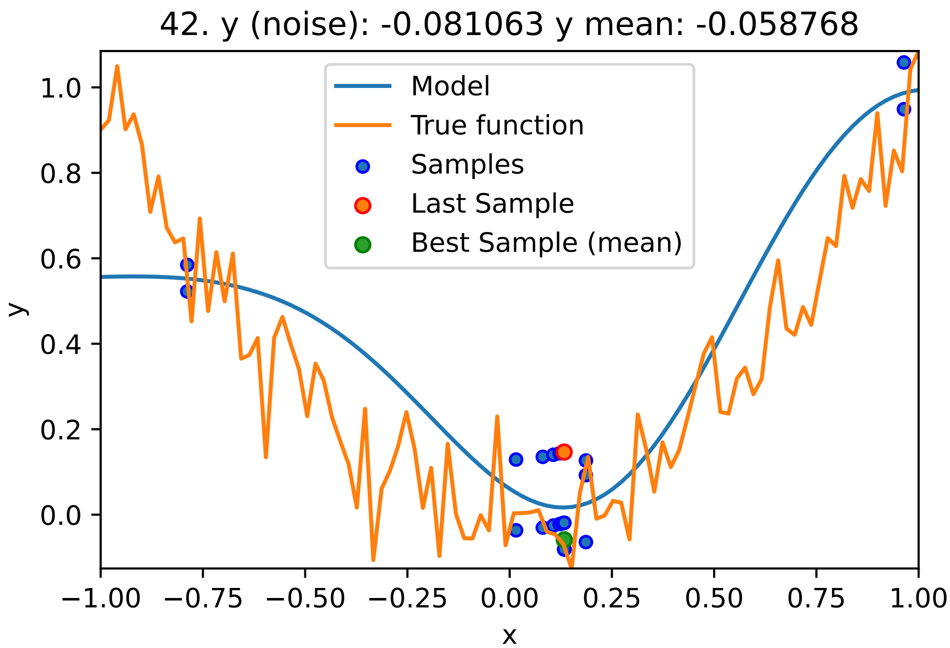

27. y (noise): -0.081063 y mean: -0.044833
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

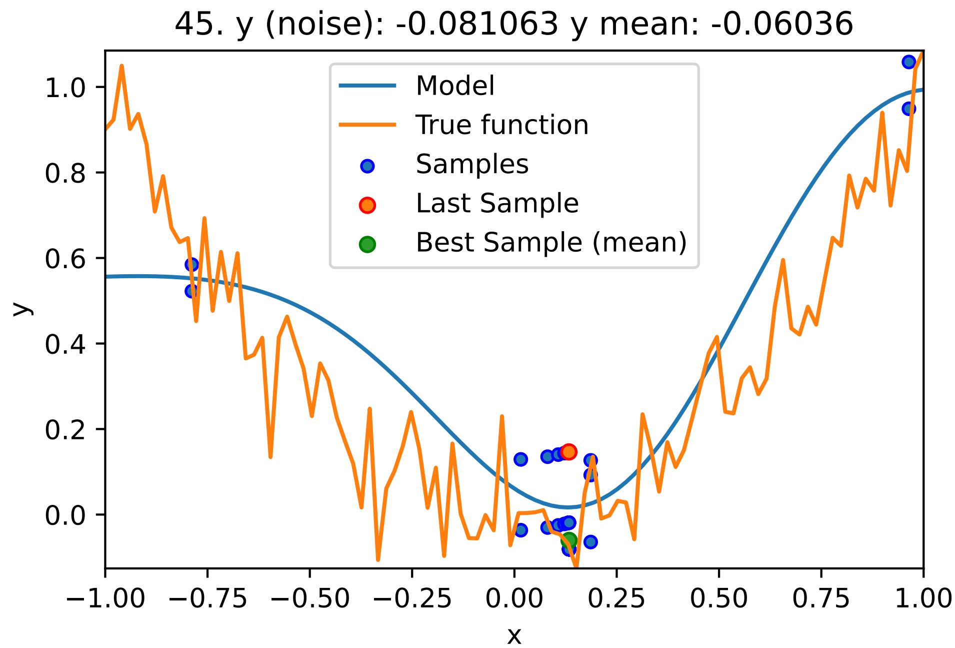

30. y (noise): -0.081063 y mean: -0.048859
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x

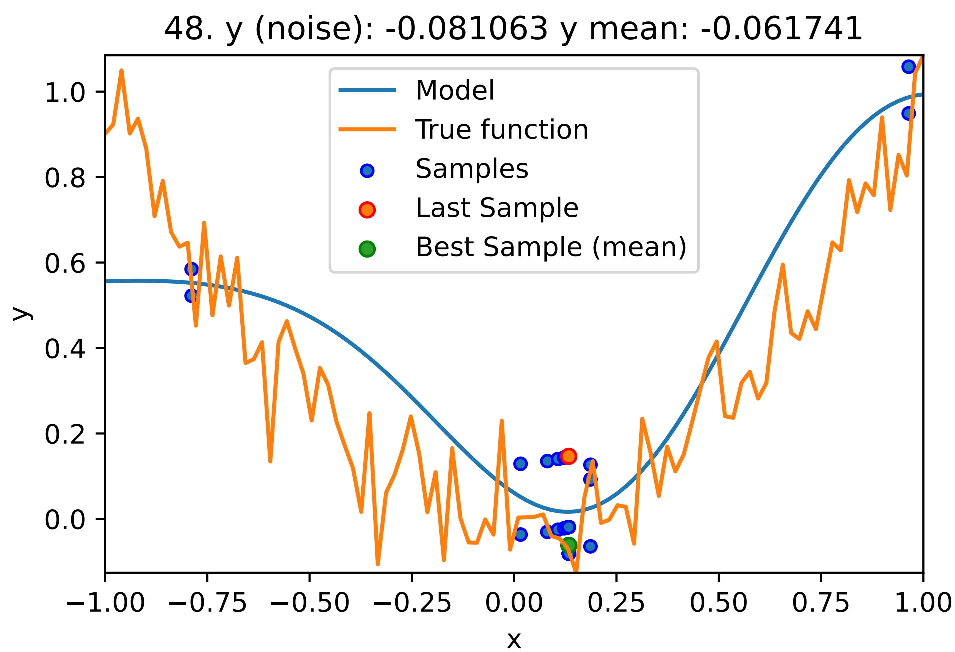

33. y (noise): -0.081063 y mean: -0.052079
Model
True function
Samples
Last Sample
Best Sample (mean)
y
x
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0.0
0.2
0.4
0.6
0.8
1.0

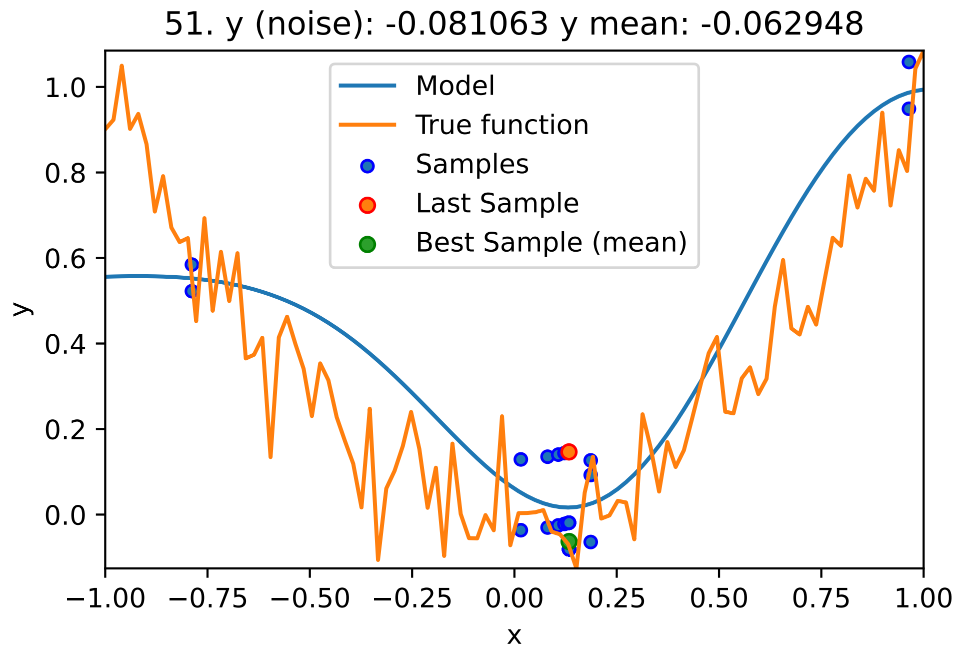

36. y (noise): -0.081063 y mean: -0.054714
Model
True function
Samples
Last Sample
Best Sample (mean)
y
x
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
0.0
0.2
0.4
0.6
0.8
1.0


39. y (noise): -0.081063 y mean: -0.05691
Model
True function
Samples
Last Sample
Best Sample (mean)
y
x
1.0
0.8
0.6
0.4
0.2
0.0
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00


42. y (noise): -0.081063 y mean: -0.058768
Model
True function
Samples
Last Sample
Best Sample (mean)
y
x
1.0
0.8
0.6
0.4
0.2
0.0
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00


45. y (noise): -0.081063 y mean: -0.06036
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x


48. y (noise): -0.081063 y mean: -0.061741
Model
True function
Samples
Last Sample
Best Sample (mean)
1.0
0.8
0.6
0.4
0.2
0.0
y
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
x




```
<spotPython.spot.spot.Spot at 0x17fec7550>
```

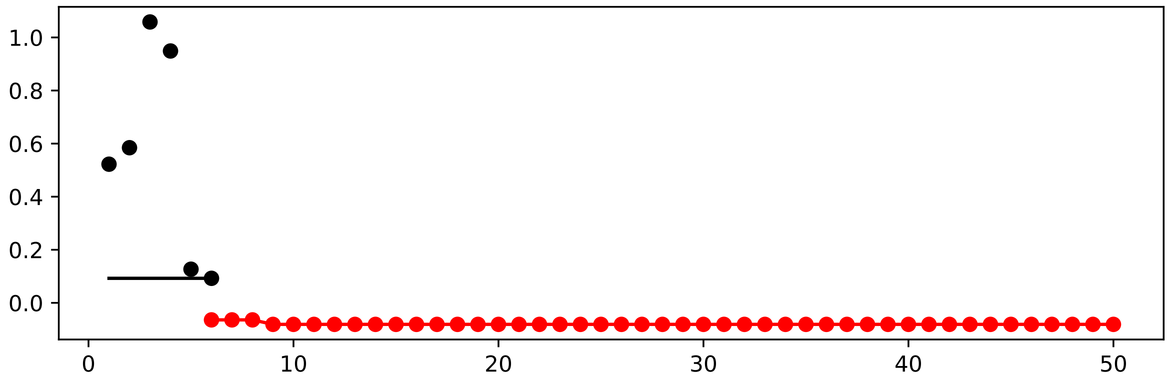
14.2 Print the Results

```
spot_1_noisy.print_results()
```

```
min y: -0.08106318979661208
x0: 0.1335999447536301
min mean y: -0.06294830660588041
x0: 0.1335999447536301
```

```
[['x0', 0.1335999447536301], ['x0', 0.1335999447536301]]
```

```
spot_1_noisy.plot_progress(log_y=False)
```



14.3 Noise and Surrogates: The Nugget Effect

14.3.1 The Noisy Sphere

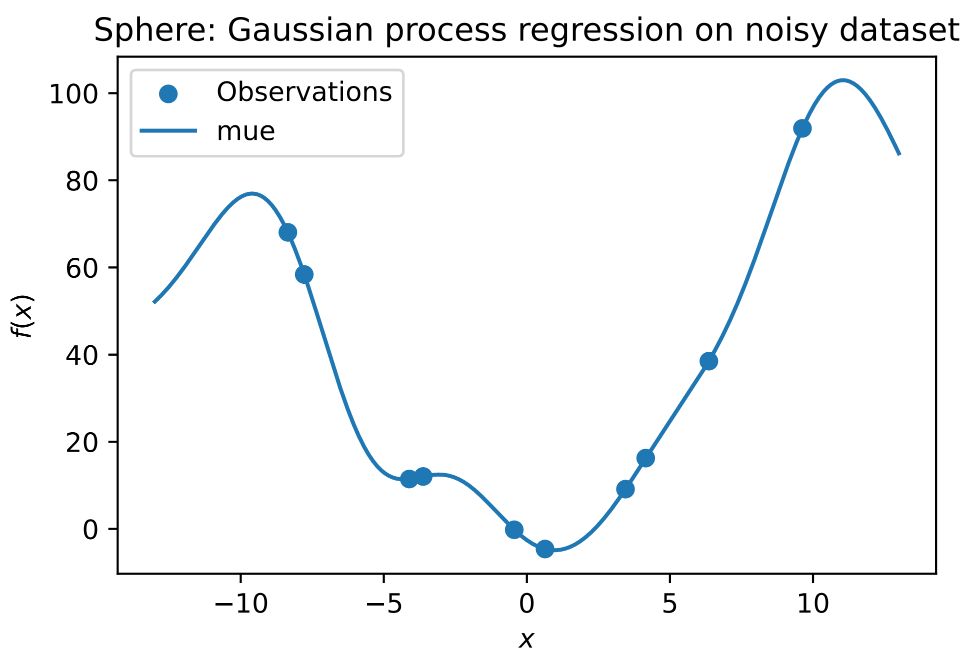
14.3.1.1 The Data

We prepare some data first:

```
import numpy as np
import spotPython
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from spotPython.design.spacefilling import spacefilling
from spotPython.build.kriging import Kriging
import matplotlib.pyplot as plt

gen = spacefilling(1)
rng = np.random.RandomState(1)
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_sphere
fun_control = {"sigma": 2,
               "seed": 125}
X = gen.scipy_lhd(10, lower=lower, upper = upper)
y = fun(X, fun_control=fun_control)
X_train = X.reshape(-1,1)
y_train = y
```

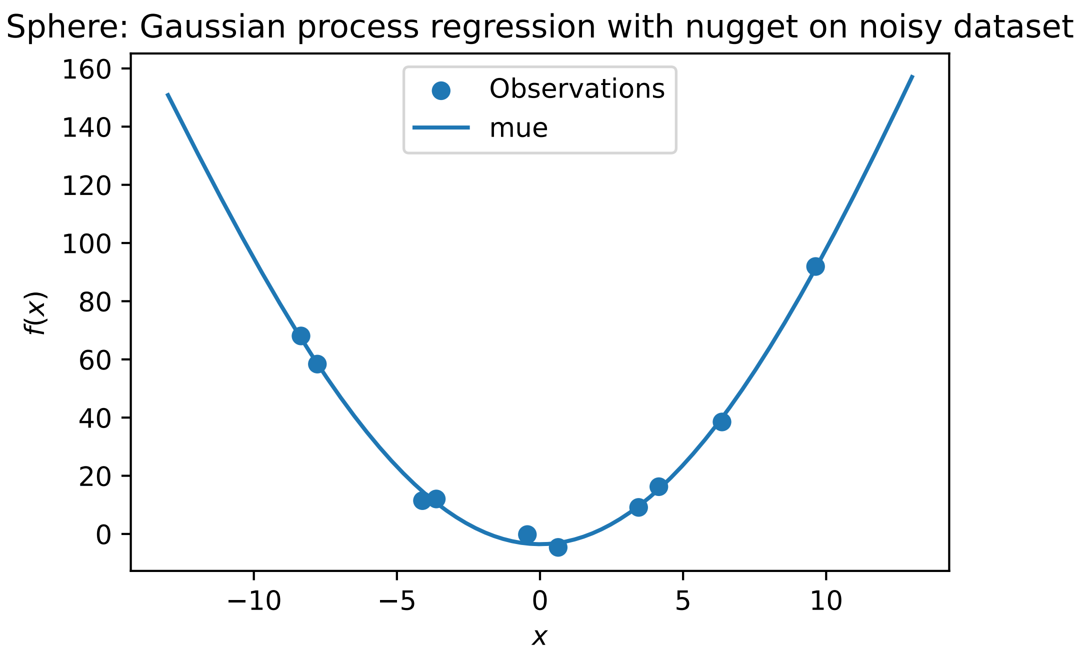
A surrogate without nugget is fitted to these data:

```
S = Kriging(name='kriging',
            seed=123,
            log_level=50,
            n_theta=1,
            noise=False)
S.fit(X_train, y_train)

X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S.predict(X_axis, return_val="all")

plt.scatter(X_train, y_train, label="Observations")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Sphere: Gaussian process regression on noisy dataset")
```



In comparison to the surrogate without nugget, we fit a surrogate with nugget to the data:

```python
S_nug = Kriging(name='kriging',
            seed=123,
            log_level=50,
            n_theta=1,
            noise=True)
S_nug.fit(X_train, y_train)
X_axis = np.linspace(start=-13, stop=13, num=1000).reshape(-1, 1)
mean_prediction, std_prediction, ei = S_nug.predict(X_axis, return_val="all")
plt.scatter(X_train, y_train, label="Observations")
plt.plot(X_axis, mean_prediction, label="mue")
plt.legend()
plt.xlabel("$x$")
plt.ylabel("$f(x)$")
_ = plt.title("Sphere: Gaussian process regression with nugget on noisy dataset")
```



The value of the nugget term can be extracted from the model as follows:

```python
S.Lambda
```

```python
S_nug.Lambda
```

```
9.088150066416743e-05
```

We see:

- the first model `S` has no nugget,
- whereas the second model has a nugget value (`Lambda`) larger than zero.

14.4 Exercises

14.4.1 Noisy `fun_cubed`

Analyse the effect of noise on the `fun_cubed` function with the following settings:

```
fun = analytical().fun_cubed
fun_control = {"sigma": 10,
               "seed": 123}
lower = np.array([-10])
upper = np.array([10])
```

14.4.2 `fun_runge`

Analyse the effect of noise on the `fun_runge` function with the following settings:

```
lower = np.array([-10])
upper = np.array([10])
fun = analytical().fun_runge
fun_control = {"sigma": 0.25,
               "seed": 123}
```

14.4.3 `fun_forrester`

Analyse the effect of noise on the `fun_forrester` function with the following settings:

```
lower = np.array([0])
upper = np.array([1])
fun = analytical().fun_forrester
fun_control = {"sigma": 5,
               "seed": 123}
```

14.4.4 `fun_xsin`

Analyse the effect of noise on the `fun_xsin` function with the following settings:

```
lower = np.array([-1.])
upper = np.array([1.])
fun = analytical().fun_xsin
fun_control = {"sigma": 0.5,
               "seed": 123}
```

```
spot_1_noisy.mean_y.shape[0]
```

```
18
```

15 HPT: sklearn SVC on Moons Data

This document refers to the following software versions:

- `python`: 3.10.10

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                    0.2.33
spotRiver                     0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

15.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time and the initial design size.

```
MAX_TIME = 1
INIT_SIZE = 5
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '10-sklearn' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(INIT_
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
10-sklearn_p040025_1min_5init_2023-06-16_20-19-12
```

15.2 Step 1: Initialization of the Empty `fun_control` Dictionary

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/10_spot_hpt_sklearn_classification")
```

15.3 Step 2: SKlearn Load Data (Classification)

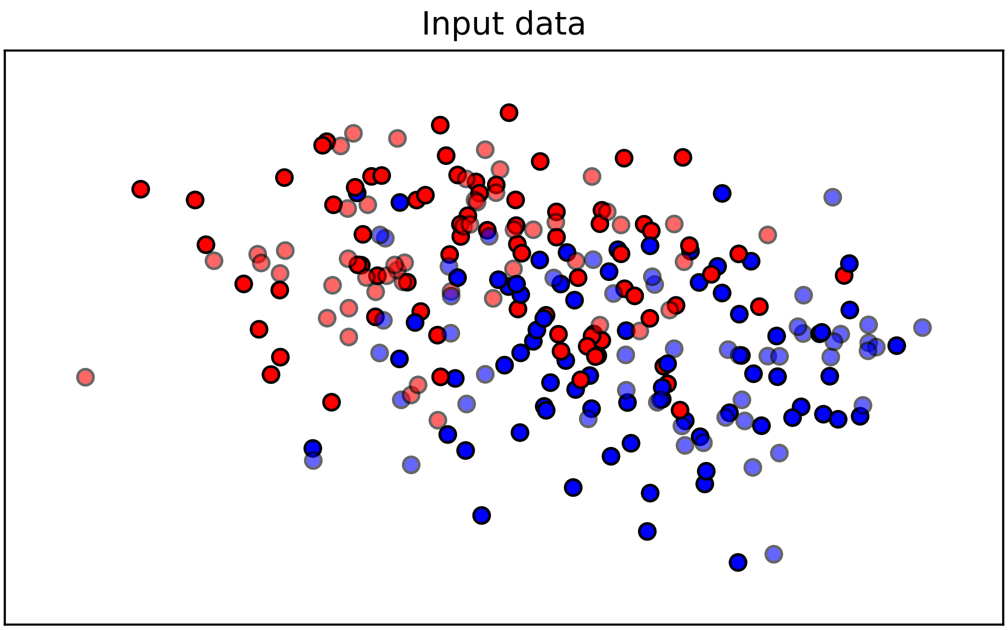
Randomly generate classification data.

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.datasets import make_moons, make_circles, make_classification
n_features = 2
n_samples = 250
target_column = "y"
ds =  make_moons(n_samples, noise=0.5, random_state=0)
X, y = ds
X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.4, random_state=42
)
```

```python
train = pd.DataFrame(np.hstack((X_train, y_train.reshape(-1, 1))))
test = pd.DataFrame(np.hstack((X_test, y_test.reshape(-1, 1))))
train.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
test.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
train.head()
```

	x1	x2	y
0	1.083978	-1.246111	1.0
1	0.074916	0.868104	0.0
2	-1.668535	0.751752	0.0
3	1.286597	1.454165	0.0
4	1.387021	0.448355	1.0

```python
import matplotlib.pyplot as plt
from matplotlib.colors import ListedColormap

x_min, x_max = X[:, 0].min() - 0.5, X[:, 0].max() + 0.5
y_min, y_max = X[:, 1].min() - 0.5, X[:, 1].max() + 0.5
cm = plt.cm.RdBu
cm_bright = ListedColormap(["#FF0000", "#0000FF"])
ax = plt.subplot(1, 1, 1)
ax.set_title("Input data")
# Plot the training points
ax.scatter(X_train[:, 0], X_train[:, 1], c=y_train, cmap=cm_bright, edgecolors="k")
# Plot the testing points
ax.scatter(
    X_test[:, 0], X_test[:, 1], c=y_test, cmap=cm_bright, alpha=0.6, edgecolors="k"
)
ax.set_xlim(x_min, x_max)
ax.set_ylim(y_min, y_max)
ax.set_xticks(())
ax.set_yticks(())
plt.tight_layout()
plt.show()
```




```
n_samples = len(train)
# add the dataset to the fun_control
fun_control.update({"data": None, # dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": target_column})
```

15.4 Step 3: Specification of the Preprocessing Model

Data preprocesssing can be very simple, e.g., you can ignore it. Then you would choose the `prep_model` "None":

```
prep_model = None
fun_control.update({"prep_model": prep_model})
```

A default approach for numerical data is the `StandardScaler` (mean 0, variance 1). This can be selected as follows:

```python
from sklearn.preprocessing import StandardScaler
prep_model = StandardScaler()
fun_control.update({"prep_model": prep_model})
```

Even more complicated pre-processing steps are possible, e.g., the follwing pipeline:

```python
# categorical_columns = []
# one_hot_encoder = OneHotEncoder(handle_unknown="ignore", sparse_output=False)
# prep_model = ColumnTransformer(
#         transformers=[
#             ("categorical", one_hot_encoder, categorical_columns),
#         ],
#         remainder=StandardScaler(),
#     )
```

15.5 Step 4: Select `algorithm` and `core_model_hyper_dict`

The selection of the algorithm (ML model) that should be tuned is done by specifying the its name from the `sklearn` implementation. For example, the `SVC` support vector machine classifier is selected as follows:

```python
from sklearn.linear_model import RidgeCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.linear_model import ElasticNet
from spotPython.hyperparameters.values import add_core_model_to_fun_control
from spotPython.data.sklearn_hyper_dict import SklearnHyperDict
from spotPython.fun.hypersklearn import HyperSklearn
```

```python
# core_model  = RidgeCV
# core_model = GradientBoostingRegressor
# core_model = ElasticNet
# core_model = RandomForestClassifier
core_model = SVC
# core_model = LogisticRegression
```

```python
# core_model = KNeighborsClassifier
# core_model = GradientBoostingClassifier
fun_control = add_core_model_to_fun_control(core_model=core_model,
                              fun_control=fun_control,
                              hyper_dict=SklearnHyperDict,
                              filename=None)
```

Now `fun_control` has the information from the JSON file:

```json
    "SVC":
    {
        "C": {
            "type": "float",
            "default": 1.0,
            "transform": "None",
            "lower": 0.1,
            "upper": 10.0},
        "kernel": {
            "levels": ["linear", "poly", "rbf", "sigmoid"],
            "type": "factor",
            "default": "rbf",
            "transform": "None",
            "core_model_parameter_type": "str",
            "lower": 0,
            "upper": 3},
        "degree": {
            "type": "int",
            "default": 3,
            "transform": "None",
            "lower": 3,
            "upper": 3},
        "gamma": {
            "levels": ["scale", "auto"],
            "type": "factor",
            "default": "scale",
            "transform": "None",
            "core_model_parameter_type": "str",
            "lower": 0,
            "upper": 1},
        "coef0": {
            "type": "float",
            "default": 0.0,
```

```
            "transform": "None",
            "lower": 0.0,
            "upper": 0.0},
        "shrinking": {
            "levels": [0, 1],
            "type": "factor",
            "default": 0,
            "transform": "None",
            "core_model_parameter_type": "bool",
            "lower": 0,
            "upper": 1},
        "probability": {
            "levels": [0, 1],
            "type": "factor",
            "default": 0,
            "transform": "None",
            "core_model_parameter_type": "bool",
            "lower": 0,
            "upper": 1},
        "tol": {
            "type": "float",
            "default": 1e-3,
            "transform": "None",
            "lower": 1e-4,
            "upper": 1e-2},
        "cache_size": {
            "type": "float",
            "default": 200,
            "transform": "None",
            "lower": 100,
            "upper": 400},
        "break_ties": {
            "levels": [0, 1],
            "type": "factor",
            "default": 0,
            "transform": "None",
            "core_model_parameter_type": "bool",
            "lower": 0,
            "upper": 1}
    }
```

15.6 Step 5: Modify hyper_dict Hyperparameters for the Selected Algorithm aka core_model

spotPython provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

15.6.1 Modify hyperparameter of type numeric and integer (boolean)

Numeric and boolean values can be modified using the modify_hyper_parameter_bounds method. For example, to change the tol hyperparameter of the SVC model to the interval [1e-3, 1e-2], the following code can be used:

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
fun_control = modify_hyper_parameter_bounds(fun_control, "tol", bounds=[1e-3, 1e-2])
# fun_control = modify_hyper_parameter_bounds(fun_control, "min_samples_split", bounds=[3,
#fun_control = modify_hyper_parameter_bounds(fun_control, "merit_preprune", bounds=[0, 0])
fun_control["core_model_hyper_dict"]["tol"]
```

```
{'type': 'float',
 'default': 0.001,
 'transform': 'None',
 'lower': 0.001,
 'upper': 0.01}
```

15.6.2 Modify hyperparameter of type factor

Factors can be modified with the modify_hyper_parameter_levels function. For example, to exclude the sigmoid kernel from the tuning, the kernel hyperparameter of the SVC model can be modified as follows:

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
fun_control = modify_hyper_parameter_levels(fun_control, "kernel", ["linear", "poly", "rbf
fun_control["core_model_hyper_dict"]["kernel"]
```

```
{'levels': ['linear', 'poly', 'rbf'],
 'type': 'factor',
 'default': 'rbf',
 'transform': 'None',
```

```
'core_model_parameter_type': 'str',
'lower': 0,
'upper': 2}
```

15.6.3 Optimizers

Optimizers are described in Section 20.6.

15.7 Step 6: Selection of the Objective (Loss) Function

There are two metrics:

1. `metric_river` is used for the river based evaluation via `eval_oml_iter_progressive`.
2. `metric_sklearn` is used for the sklearn based evaluation.

```
from sklearn.metrics import mean_absolute_error, accuracy_score, roc_curve, roc_auc_score,
fun_control.update({
               "metric_sklearn": log_loss,
               })
```

15.7.1 Predict Classes or Class Probabilities

If the key `"predict_proba"` is set to `True`, the class probabilities are predicted. `False` is the default, i.e., the classes are predicted.

```
fun_control.update({
               "predict_proba": False,
               })
```

15.8 Step 7: Calling the SPOT Function

15.9 Preparing the SPOT Call

The following code passes the information about the parameter ranges and bounds to `spot`.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
```

```
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name        | type   | default   |   lower |   upper | transform   |
|-------------|--------|-----------|---------|---------|-------------|
| C           | float  | 1.0       |   0.1   |   10    | None        |
| kernel      | factor | rbf       |   0     |    2    | None        |
| degree      | int    | 3         |   3     |    3    | None        |
| gamma       | factor | scale     |   0     |    1    | None        |
| coef0       | float  | 0.0       |   0     |    0    | None        |
| shrinking   | factor | 0         |   0     |    1    | None        |
| probability | factor | 0         |   0     |    1    | None        |
| tol         | float  | 0.001     |   0.001 |    0.01 | None        |
| cache_size  | float  | 200.0     | 100     |  400    | None        |
| break_ties  | factor | 0         |   0     |    1    | None        |
```

15.10 The Objective Function

The objective function is selected next. It implements an interface from `sklearn`'s training, validation, and testing methods to `spotPython`.

```
from spotPython.fun.hypersklearn import HyperSklearn
fun = HyperSklearn().fun_sklearn
```

15.10.1 Run the `Spot` Optimizer

- Run SPOT for approx. x mins (`max_time`).
- Note: the run takes longer, because the evaluation time of initial design (here: `initi_size`, 20 points) is not considered.

```
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=SklearnHyperDict().load()
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
X_start
```

```
array([[1.e+00, 2.e+00, 3.e+00, 0.e+00, 0.e+00, 0.e+00, 0.e+00, 1.e-03,
        2.e+02, 0.e+00]])
```

15.11 Starting the Hyperparameter Tuning

```
import numpy as np
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
                   show_progress= True,
                   fun_control = fun_control,
                   design_control={"init_size": INIT_SIZE,
                                   "repeats": 1},
                   surrogate_control={"noise": True,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": len(var_name),
                                      "model_fun_evals": 10_000,
                                      "log_level": 50
```

```
                                        })
spot_tuner.run(X_start=X_start)
```

```
spotPython tuning: 5.691103166702708 [----------] 2.85%

spotPython tuning: 5.691103166702708 [----------] 4.70%

spotPython tuning: 5.691103166702708 [#---------] 6.29%

spotPython tuning: 5.691103166702708 [#---------] 7.77%

spotPython tuning: 5.691103166702708 [#---------] 9.20%

spotPython tuning: 5.691103166702708 [#---------] 11.66%

spotPython tuning: 5.691103166702708 [#---------] 14.02%

spotPython tuning: 5.691103166702708 [##--------] 16.31%

spotPython tuning: 5.691103166702708 [##--------] 18.65%

spotPython tuning: 5.691103166702708 [##--------] 20.97%

spotPython tuning: 5.691103166702708 [##--------] 23.53%

spotPython tuning: 5.691103166702708 [###-------] 26.19%

spotPython tuning: 5.691103166702708 [####------] 35.02%

spotPython tuning: 5.691103166702708 [#####-----] 47.24%

spotPython tuning: 5.691103166702708 [######----] 60.11%

spotPython tuning: 5.691103166702708 [#######---] 73.12%

spotPython tuning: 5.691103166702708 [#########-] 85.99%

spotPython tuning: 5.691103166702708 [##########] 98.50%

spotPython tuning: 5.691103166702708 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x2af17fbb0>
```

15.11.1 Results

```
SAVE = False
LOAD = False

if SAVE:
    result_file_name = "res_" + experiment_name + ".pkl"
    with open(result_file_name, 'wb') as f:
        pickle.dump(spot_tuner, f)

if LOAD:
    result_file_name = "res_ch10-friedman-hpt-0_maans03_60min_20init_1K_2023-04-14_10-11-1
    with open(result_file_name, 'rb') as f:
        spot_tuner =  pickle.load(f)
```

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

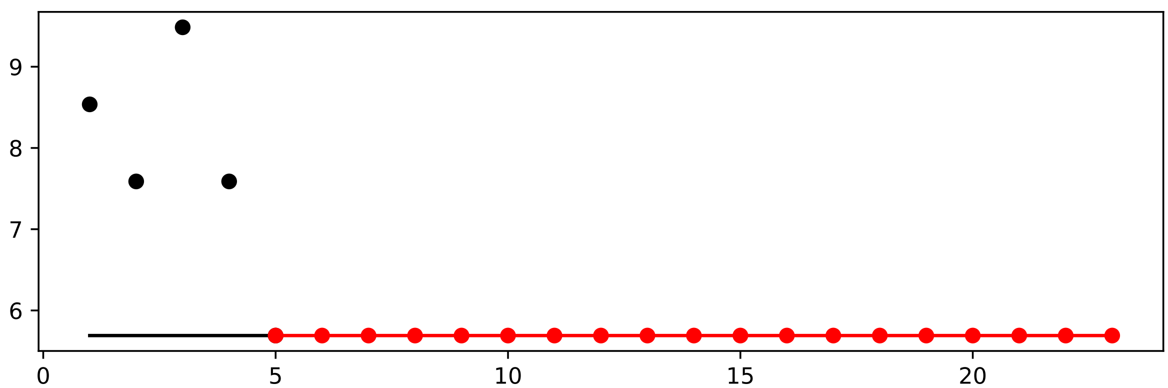


Figure 15.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

- Print the results

```
print(gen_design_table(fun_control=fun_control,
    spot=spot_tuner))
```

```
| name        | type   | default   |   lower |   upper |                tuned | transform
|-------------|--------|-----------|---------|---------|----------------------|-----------
| C           | float  | 1.0       |     0.1 |    10.0 |   3.6280771109650245 | None
| kernel      | factor | rbf       |     0.0 |     2.0 |                  1.0 | None
| degree      | int    | 3         |     3.0 |     3.0 |                  3.0 | None
| gamma       | factor | scale     |     0.0 |     1.0 |                  0.0 | None
| coef0       | float  | 0.0       |     0.0 |     0.0 |                  0.0 | None
| shrinking   | factor | 0         |     0.0 |     1.0 |                  1.0 | None
| probability | factor | 0         |     0.0 |     1.0 |                  0.0 | None
| tol         | float  | 0.001     |   0.001 |    0.01 | 0.006642600916881275 | None
| cache_size  | float  | 200.0     |   100.0 |   400.0 |   202.03372626175258 | None
| break_ties  | factor | 0         |     0.0 |     1.0 |                  1.0 | None
```

15.12 Show variable importance

```
spot_tuner.plot_importance(threshold=0.025, filename="./figures/" + experiment_name+"_impo
```

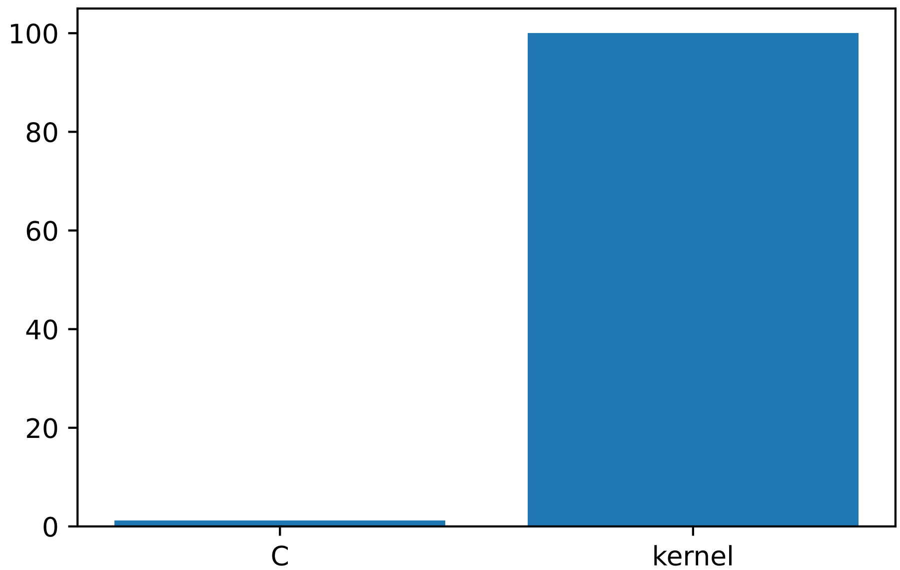


Figure 15.2: Variable importance plot, threshold 0.025.

15.13 Get Default Hyperparameters

```
from spotPython.hyperparameters.values import get_default_values, transform_hyper_paramete
values_default = get_default_values(fun_control)
values_default = transform_hyper_parameter_values(fun_control=fun_control, hyper_parameter
values_default
```

```
{'C': 1.0,
 'kernel': 'rbf',
 'degree': 3,
 'gamma': 'scale',
 'coef0': 0.0,
 'shrinking': 0,
 'probability': 0,
 'tol': 0.001,
 'cache_size': 200.0,
 'break_ties': 0}
```

```
from sklearn.pipeline import make_pipeline
model_default = make_pipeline(fun_control["prep_model"], fun_control["core_model"](**value
model_default
```

```
Pipeline(steps=[('standardscaler', StandardScaler()),
                ('svc',
                 SVC(break_ties=0, cache_size=200.0, probability=0,
                     shrinking=0))])
```

15.14 Get SPOT Results

```
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
print(X)
```

```
[[3.62807711e+00 1.00000000e+00 3.00000000e+00 0.00000000e+00
  0.00000000e+00 1.00000000e+00 0.00000000e+00 6.64260092e-03
  2.02033726e+02 1.00000000e+00]]
```

```
from spotPython.hyperparameters.values import assign_values, return_conf_list_from_var_dic
v_dict = assign_values(X, fun_control["var_name"])
return_conf_list_from_var_dict(var_dict=v_dict, fun_control=fun_control)
```

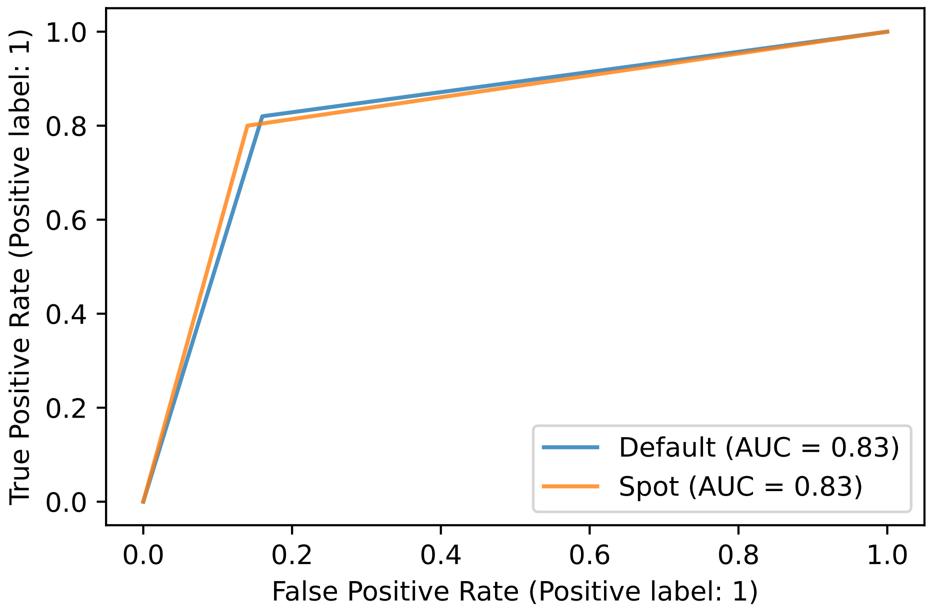
```
[{'C': 3.6280771109650245,
  'kernel': 'poly',
  'degree': 3,
  'gamma': 'scale',
  'coef0': 0.0,
  'shrinking': 1,
  'probability': 0,
  'tol': 0.006642600916881275,
  'cache_size': 202.03372626175258,
  'break_ties': 1}]
```

```
from spotPython.hyperparameters.values import get_one_sklearn_model_from_X
model_spot = get_one_sklearn_model_from_X(X, fun_control)
model_spot
```

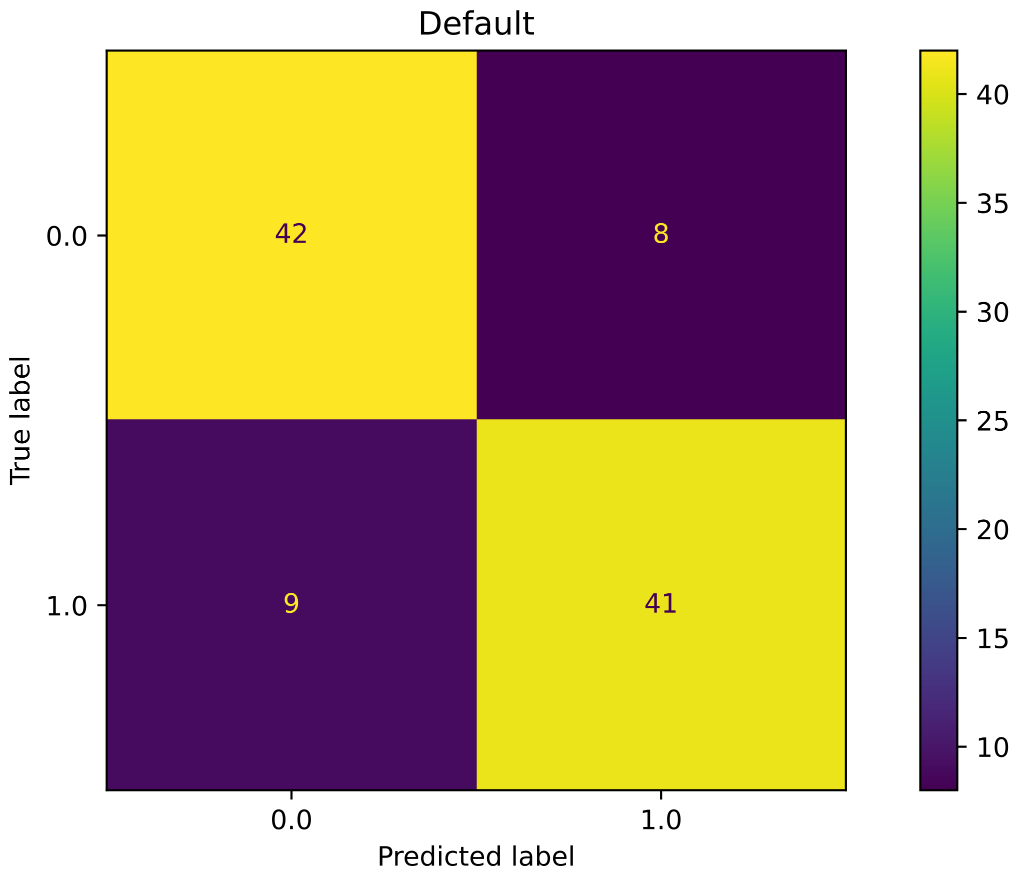
```
Pipeline(steps=[('standardscaler', StandardScaler()),
                ('svc',
                 SVC(C=3.6280771109650245, break_ties=1,
                     cache_size=202.03372626175258, kernel='poly',
                     probability=0, shrinking=1, tol=0.006642600916881275))])
```

15.15 Plot: Compare Predictions

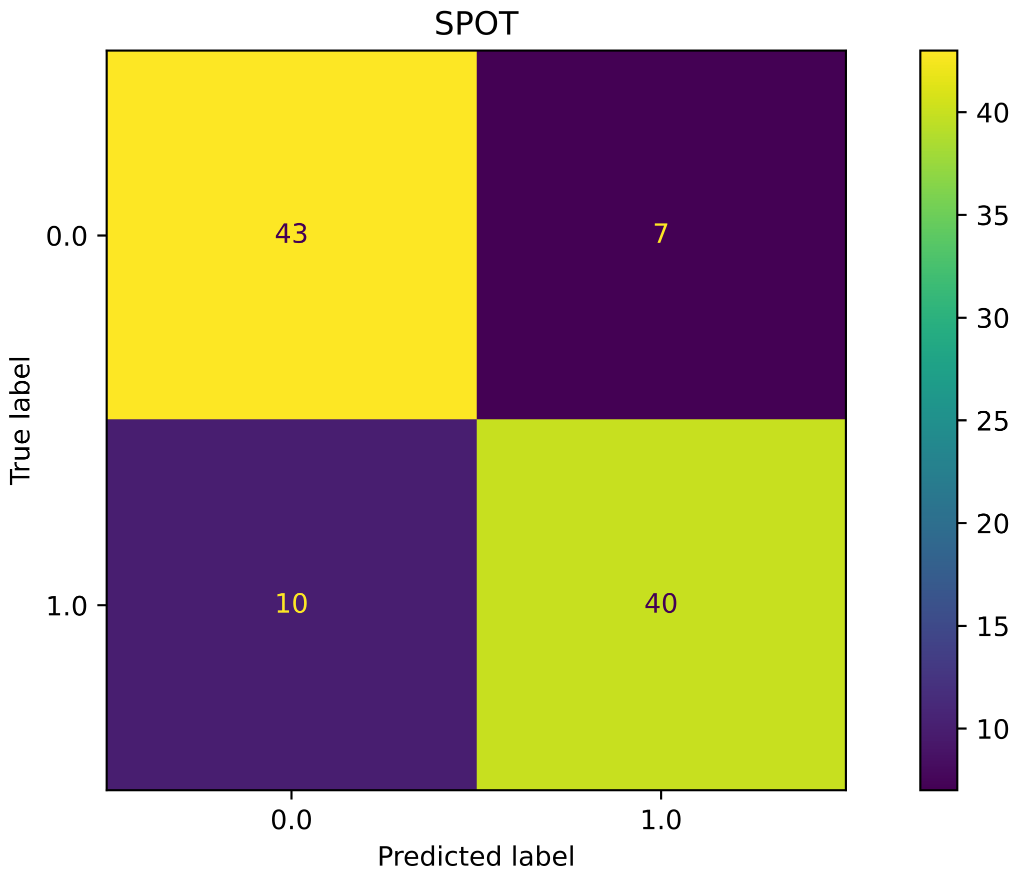
```
from spotPython.plot.validation import plot_roc
plot_roc([model_default, model_spot], fun_control, model_names=["Default", "Spot"])
```




```
from spotPython.plot.validation import plot_confusion_matrix
plot_confusion_matrix(model_default, fun_control, title = "Default")
```




```
plot_confusion_matrix(model_spot, fun_control, title="SPOT")
```



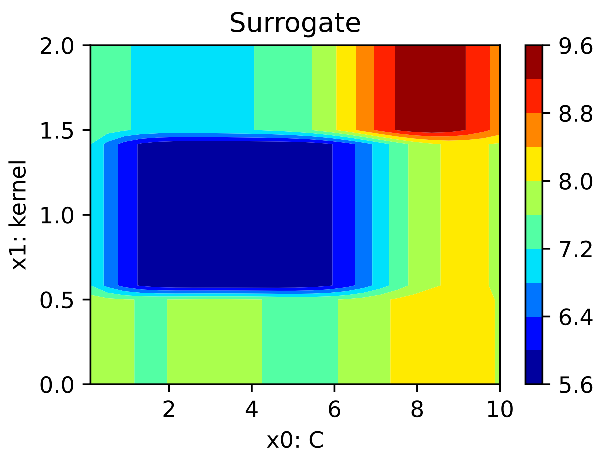

```
min(spot_tuner.y), max(spot_tuner.y)
```

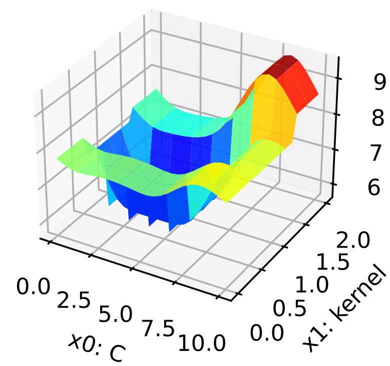
```
(5.691103166702708, 9.485171944504513)
```

15.16 Detailed Hyperparameter Plots

```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

```
C:  1.1399176173997725
kernel:  100.0
```





15.17 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

```
Unable to display output for mime type(s): text/html
```

15.18 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
            spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

16 HPT: PyTorch With fashionMNIST

In this tutorial, we will show how `spotPython` can be integrated into the `PyTorch` training workflow.

This document refers to the following software versions:

- `python`: 3.10.10
- `torch`: 2.0.1
- `torchvision`: 0.15.0

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                  0.2.33
spotRiver                   0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

16.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time, initial design size and the device that is used.

```
MAX_TIME = 1
INIT_SIZE = 5
DEVICE = "cpu" # "cuda:0"
```

```
from spotPython.utils.device import getDevice
DEVICE = getDevice(DEVICE)
print(DEVICE)
```

```
cpu
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '11-torch' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(INIT_SI
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
11-torch_p040025_1min_5init_2023-06-16_20-25-33
```

16.2 Step 1: Initialization of the Empty `fun_control` Dictionary

`spotPython` uses a Python dictionary for storing the information required for the hyperparameter tuning process, which was described in Section 20.2.

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/11_spot_hpt_torch_fashion_mnist",
    device=DEVICE)
```

16.3 PyTorch Data Loading

16.4 Step 2: Load fashionMNIST Data

```python
from torchvision import datasets, transforms
from torchvision.transforms import ToTensor
def load_data(data_dir="./data"):
    # Download training data from open datasets.
    training_data = datasets.FashionMNIST(
        root=data_dir,
        train=True,
        download=True,
        transform=ToTensor(),
    )
    # Download test data from open datasets.
    test_data = datasets.FashionMNIST(
        root=data_dir,
        train=False,
        download=True,
        transform=ToTensor(),
    )
    return training_data, test_data
```

```python
train, test = load_data()
train.data.shape, test.data.shape
```

```
(torch.Size([60000, 28, 28]), torch.Size([10000, 28, 28]))
```

```python
n_samples = len(train)
# add the dataset to the fun_control
fun_control.update({"data": None,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": None})
```

16.5 The Model (Algorithm) to be Tuned

16.6 Step 3: Specification of the Preprocessing Model

After the training and test data are specified and added to the `fun_control` dictionary, `spotPython` allows the specification of a data preprocessing pipeline, e.g., for the scaling of the data or for the one-hot encoding of categorical variables, see Section 20.4.1. This feature is not used here, so we do not change the default value (which is `None`).

16.7 Step 4: Select `algorithm` and `core_model_hyper_dict`

`spotPython` implements a class which is similar to the class described in the PyTorch tutorial. The class is called `Net_fashionMNIST` and is implemented in the file `netfashionMNIST.py`. The class is imported here.

```
from torch import nn
import spotPython.torch.netcore as netcore


class Net_fashionMNIST(netcore.Net_Core):
    def __init__(self, l1, l2, lr_mult, batch_size, epochs, k_folds, patience, optimizer,
        super(Net_fashionMNIST, self).__init__(
            lr_mult=lr_mult,
            batch_size=batch_size,
            epochs=epochs,
            k_folds=k_folds,
            patience=patience,
            optimizer=optimizer,
            sgd_momentum=sgd_momentum,
        )
        self.flatten = nn.Flatten()
        self.linear_relu_stack = nn.Sequential(
            nn.Linear(28 * 28, l1),
            nn.ReLU(),
            nn.Linear(l1, l2),
            nn.ReLU(),
            nn.Linear(l2, 10)
        )

    def forward(self, x):
```

```
        x = self.flatten(x)
        logits = self.linear_relu_stack(x)
        return logits
```

This class inherits from the class `Net_Core` which is implemented in the file `netcore.py`, see **?@sec-the-net-core-class-24**.

```
from spotPython.data.torch_hyper_dict import TorchHyperDict
from spotPython.torch.netfashionMNIST import Net_fashionMNIST
from spotPython.hyperparameters.values import add_core_model_to_fun_control
fun_control = add_core_model_to_fun_control(core_model=Net_fashionMNIST,
                              fun_control=fun_control,
                              hyper_dict=TorchHyperDict,
                              filename=None)
```

16.8 The Search Space

16.8.1 Configuring the Search Space With spotPython

16.8.1.1 The `hyper_dict` Hyperparameters for the Selected Algorithm

`spotPython` uses `JSON` files for the specification of the hyperparameters, which were described in Section 20.5.2.

The corresponding entries for the `Net_fashionMNIST` class are shown below.

```
 "Net_fashionMNIST":
    {
        "l1": {
            "type": "int",
            "default": 5,
            "transform": "transform_power_2_int",
            "lower": 2,
            "upper": 9},
        "l2": {
            "type": "int",
            "default": 5,
            "transform": "transform_power_2_int",
            "lower": 2,
            "upper": 9},
```

```
        "lr_mult": {
            "type": "float",
            "default": 1.0,
            "transform": "None",
            "lower": 0.1,
            "upper": 10.0},
        "batch_size": {
            "type": "int",
            "default": 4,
            "transform": "transform_power_2_int",
            "lower": 1,
            "upper": 4},
        "epochs": {
                "type": "int",
                "default": 3,
                "transform": "transform_power_2_int",
                "lower": 3,
                "upper": 4},
        "k_folds": {
            "type": "int",
            "default": 1,
            "transform": "None",
            "lower": 1,
            "upper": 1},
        "patience": {
            "type": "int",
            "default": 5,
            "transform": "None",
            "lower": 2,
            "upper": 10
        },
        "optimizer": {
            "levels": ["Adadelta",
                        "Adagrad",
                        "Adam",
                        "AdamW",
                        "SparseAdam",
                        "Adamax",
                        "ASGD",
                        "NAdam",
                        "RAdam",
```

```
                        "RMSprop",
                        "Rprop",
                        "SGD"],
            "type": "factor",
            "default": "SGD",
            "transform": "None",
            "core_model_parameter_type": "str",
            "lower": 0,
            "upper": 12},
        "sgd_momentum": {
            "type": "float",
            "default": 0.0,
            "transform": "None",
            "lower": 0.0,
            "upper": 1.0}
    },
```

16.9 Step 5: Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

16.9.1 Modify hyperparameter of type numeric and integer (boolean)

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
# fun_control = modify_hyper_parameter_bounds(fun_control, "delta", bounds=[1e-10, 1e-6])
# fun_control = modify_hyper_parameter_bounds(fun_control, "min_samples_split", bounds=[3,
#fun_control = modify_hyper_parameter_bounds(fun_control, "merit_preprune", bounds=[0, 0])
# fun_control["core_model_hyper_dict"]
fun_control = modify_hyper_parameter_bounds(fun_control, "k_folds", bounds=[0, 0])
fun_control = modify_hyper_parameter_bounds(fun_control, "patience", bounds=[2, 2])
fun_control = modify_hyper_parameter_bounds(fun_control, "epochs", bounds=[2, 3])
```

16.9.2 Modify hyperparameter of type factor

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
# fun_control = modify_hyper_parameter_levels(fun_control, "leaf_model", ["LinearRegressio
# fun_control["core_model_hyper_dict"]
```

16.9.3 Optimizers

Optimizers are described in Section 20.6.

16.10 Step 6: Selection of the Objective (Loss) Function

16.10.1 Evaluation

The evaluation procedure requires the specification of two elements:

1. the way how the data is split into a train and a test set and
2. the loss function (and a metric).

These are described in Section 25.9.

The key `"loss_function"` specifies the loss function which is used during the optimization, see Section 20.8.

We will use CrossEntropy loss for the multiclass-classification task.

```
from torch.nn import CrossEntropyLoss
loss_function = CrossEntropyLoss()
fun_control.update({
        "loss_function": loss_function,
        "shuffle": True,
        "eval":  "train_hold_out"
        })
```

16.10.2 Metric

```
from torchmetrics import Accuracy
metric_torch = Accuracy(task="multiclass", num_classes=10).to(fun_control["device"])
fun_control.update({"metric_torch": metric_torch})
```

16.11 Preparing the SPOT Call

The following code passes the information about the parameter ranges and bounds to `spot`.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name         | type   | default   |   lower |   upper | transform              |
|--------------|--------|-----------|---------|---------|------------------------|
| l1           | int    | 5         |     2   |       9 | transform_power_2_int |
| l2           | int    | 5         |     2   |       9 | transform_power_2_int |
| lr_mult      | float  | 1.0       |     0.1 |      10 | None                   |
| batch_size   | int    | 4         |     1   |       4 | transform_power_2_int |
| epochs       | int    | 3         |     2   |       3 | transform_power_2_int |
| k_folds      | int    | 1         |     0   |       0 | None                   |
| patience     | int    | 5         |     2   |       2 | None                   |
| optimizer    | factor | SGD       |     0   |      12 | None                   |
| sgd_momentum | float  | 0.0       |     0   |       1 | None                   |
```

16.12 The Objective Function `fun_torch`

The objective function `fun_torch` is selected next. It implements an interface from `PyTorch`'s training, validation, and testing methods to `spotPython`.

```
from spotPython.fun.hypertorch import HyperTorch
fun = HyperTorch().fun_torch
```

16.13 Starting the Hyperparameter Tuning

```
import numpy as np
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
                   show_progress= True,
                   fun_control = fun_control,
                   design_control={"init_size": INIT_SIZE,
                                   "repeats": 1},
                   surrogate_control={"noise": True,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": len(var_name),
                                      "model_fun_evals": 10_000,
                                      "log_level": 50
                                      })
spot_tuner.run(X_start=X_start)
```

```
config: {'l1': 16, 'l2': 32, 'lr_mult': 9.563687451910228, 'batch_size': 8, 'epochs': 8, 'k_
Epoch: 1

Loss on hold-out set: 0.5947699752871413
Accuracy on hold-out set: 0.8041666666666667
MulticlassAccuracy value on hold-out data: 0.8041666746139526
```

```
Epoch: 2

Loss on hold-out set: 0.5448090022743369
Accuracy on hold-out set: 0.8317083333333334
MulticlassAccuracy value on hold-out data: 0.8317083120346069
Epoch: 3

Loss on hold-out set: 0.5396351795221368
Accuracy on hold-out set: 0.825625
MulticlassAccuracy value on hold-out data: 0.8256250023841858
Epoch: 4

Loss on hold-out set: 0.47730140336897847
Accuracy on hold-out set: 0.8385
MulticlassAccuracy value on hold-out data: 0.8385000228881836
Epoch: 5

Loss on hold-out set: 0.5305384781884107
Accuracy on hold-out set: 0.827625
MulticlassAccuracy value on hold-out data: 0.8276249766349792
Epoch: 6

Loss on hold-out set: 0.550703334528652
Accuracy on hold-out set: 0.7818333333333334
MulticlassAccuracy value on hold-out data: 0.7818333506584167
Early stopping at epoch 5
Returned to Spot: Validation loss: 0.550703334528652
----------------------------------------------

config: {'l1': 128, 'l2': 32, 'lr_mult': 6.258012467639852, 'batch_size': 2, 'epochs': 4, 'k
Epoch: 1

Loss on hold-out set: 0.6375155737375855
Accuracy on hold-out set: 0.8353333333333334
MulticlassAccuracy value on hold-out data: 0.8353333473205566
Epoch: 2

Loss on hold-out set: 0.5128554670288967
Accuracy on hold-out set: 0.86225
MulticlassAccuracy value on hold-out data: 0.8622499704360962
Epoch: 3
```

```
Loss on hold-out set: 0.5054343534577563
Accuracy on hold-out set: 0.8661666666666666
MulticlassAccuracy value on hold-out data: 0.8661666512489319
Epoch: 4

Loss on hold-out set: 0.5337750271596439
Accuracy on hold-out set: 0.8717916666666666
MulticlassAccuracy value on hold-out data: 0.871791660785675
Returned to Spot: Validation loss: 0.5337750271596439
----------------------------------------------

config: {'l1': 256, 'l2': 256, 'lr_mult': 0.2437336281201693, 'batch_size': 16, 'epochs': 8,
Epoch: 1

Loss on hold-out set: 0.4956720653673013
Accuracy on hold-out set: 0.828125
MulticlassAccuracy value on hold-out data: 0.828125
Epoch: 2

Loss on hold-out set: 0.4656954653635621
Accuracy on hold-out set: 0.83825
MulticlassAccuracy value on hold-out data: 0.8382499814033508
Epoch: 3

Loss on hold-out set: 0.4384877798569699
Accuracy on hold-out set: 0.847875
MulticlassAccuracy value on hold-out data: 0.8478749990463257
Epoch: 4

Loss on hold-out set: 0.4283534780057768
Accuracy on hold-out set: 0.8510416666666667
MulticlassAccuracy value on hold-out data: 0.8510416746139526
Epoch: 5

Loss on hold-out set: 0.4214525539676348
Accuracy on hold-out set: 0.853875
MulticlassAccuracy value on hold-out data: 0.8538749814033508
Epoch: 6
```

```
Loss on hold-out set: 0.4128341313178341
Accuracy on hold-out set: 0.857625
MulticlassAccuracy value on hold-out data: 0.8576250076293945
Epoch: 7

Loss on hold-out set: 0.40532414633035657
Accuracy on hold-out set: 0.8591666666666666
MulticlassAccuracy value on hold-out data: 0.85916668176651
Epoch: 8

Loss on hold-out set: 0.40383355725742875
Accuracy on hold-out set: 0.8589583333333334
MulticlassAccuracy value on hold-out data: 0.8589583039283752
Returned to Spot: Validation loss: 0.40383355725742875
----------------------------------------------

config: {'l1': 64, 'l2': 8, 'lr_mult': 2.906205211581667, 'batch_size': 8, 'epochs': 4, 'k_f
Epoch: 1

Loss on hold-out set: 1.0563498033881187
Accuracy on hold-out set: 0.598
MulticlassAccuracy value on hold-out data: 0.5979999899864197
Epoch: 2

Loss on hold-out set: 0.8999664849539598
Accuracy on hold-out set: 0.67675
MulticlassAccuracy value on hold-out data: 0.6767500042915344
Epoch: 3

Loss on hold-out set: 0.8207426746040583
Accuracy on hold-out set: 0.70675
MulticlassAccuracy value on hold-out data: 0.7067499756813049
Epoch: 4

Loss on hold-out set: 0.7595167497768999
Accuracy on hold-out set: 0.7359166666666667
MulticlassAccuracy value on hold-out data: 0.7359166741371155
Returned to Spot: Validation loss: 0.7595167497768999
----------------------------------------------

config: {'l1': 4, 'l2': 128, 'lr_mult': 4.224097306355747, 'batch_size': 4, 'epochs': 8, 'k_
Epoch: 1
```

```
Loss on hold-out set: 0.7054348633141796
Accuracy on hold-out set: 0.779375
MulticlassAccuracy value on hold-out data: 0.7793750166893005
Epoch: 2

Loss on hold-out set: 0.7201900651336421
Accuracy on hold-out set: 0.7784583333333334
MulticlassAccuracy value on hold-out data: 0.7784583568572998
Epoch: 3

Loss on hold-out set: 0.6778516439759348
Accuracy on hold-out set: 0.7828333333333334
MulticlassAccuracy value on hold-out data: 0.7828333377838135
Epoch: 4

Loss on hold-out set: 0.6094762379850487
Accuracy on hold-out set: 0.806625
MulticlassAccuracy value on hold-out data: 0.8066250085830688
Epoch: 5

Loss on hold-out set: 0.6728501877291028
Accuracy on hold-out set: 0.7999166666666667
MulticlassAccuracy value on hold-out data: 0.799916684627533
Epoch: 6

Loss on hold-out set: 0.6346813280634481
Accuracy on hold-out set: 0.8051666666666667
MulticlassAccuracy value on hold-out data: 0.8051666617393494
Early stopping at epoch 5
Returned to Spot: Validation loss: 0.6346813280634481
----------------------------------------------

config: {'l1': 32, 'l2': 128, 'lr_mult': 0.21609110800354453, 'batch_size': 8, 'epochs': 8,
Epoch: 1

Loss on hold-out set: 0.6495621442918976
Accuracy on hold-out set: 0.7694583333333334
MulticlassAccuracy value on hold-out data: 0.7694583535194397
Epoch: 2
```

```
Loss on hold-out set: 0.5782694063863406
Accuracy on hold-out set: 0.7947916666666667
MulticlassAccuracy value on hold-out data: 0.7947916388511658
Epoch: 3

Loss on hold-out set: 0.5470963555177053
Accuracy on hold-out set: 0.8059166666666666
MulticlassAccuracy value on hold-out data: 0.8059166669845581
Epoch: 4

Loss on hold-out set: 0.5285045318193734
Accuracy on hold-out set: 0.813875
MulticlassAccuracy value on hold-out data: 0.8138750195503235
Epoch: 5

Loss on hold-out set: 0.514657638826097
Accuracy on hold-out set: 0.819375
MulticlassAccuracy value on hold-out data: 0.8193749785423279
Epoch: 6

Loss on hold-out set: 0.5042160945180804
Accuracy on hold-out set: 0.8235
MulticlassAccuracy value on hold-out data: 0.8234999775886536
Epoch: 7

Loss on hold-out set: 0.49694297572784124
Accuracy on hold-out set: 0.8287083333333334
MulticlassAccuracy value on hold-out data: 0.8287083506584167
Epoch: 8

Loss on hold-out set: 0.4907790156736349
Accuracy on hold-out set: 0.8310416666666667
MulticlassAccuracy value on hold-out data: 0.831041693687439
Returned to Spot: Validation loss: 0.4907790156736349
----------------------------------------------
spotPython tuning: 0.40383355725742875 [#####-----] 50.49%


config: {'l1': 256, 'l2': 128, 'lr_mult': 0.22918694114526483, 'batch_size': 16, 'epochs': 8
Epoch: 1
```

```
Loss on hold-out set: 0.5189681846499443
Accuracy on hold-out set: 0.82125
MulticlassAccuracy value on hold-out data: 0.8212500214576721
Epoch: 2

Loss on hold-out set: 0.47907520187397795
Accuracy on hold-out set: 0.837125
MulticlassAccuracy value on hold-out data: 0.8371250033378601
Epoch: 3

Loss on hold-out set: 0.45198514268671475
Accuracy on hold-out set: 0.8439166666666666
MulticlassAccuracy value on hold-out data: 0.843916654586792
Epoch: 4

Loss on hold-out set: 0.43912106089293956
Accuracy on hold-out set: 0.8465833333333334
MulticlassAccuracy value on hold-out data: 0.8465833067893982
Epoch: 5

Loss on hold-out set: 0.4308823582008481
Accuracy on hold-out set: 0.851375
MulticlassAccuracy value on hold-out data: 0.8513749837875366
Epoch: 6

Loss on hold-out set: 0.42323217702656984
Accuracy on hold-out set: 0.8530833333333333
MulticlassAccuracy value on hold-out data: 0.8530833125114441
Epoch: 7

Loss on hold-out set: 0.41436702795823416
Accuracy on hold-out set: 0.8567083333333333
MulticlassAccuracy value on hold-out data: 0.8567083477973938
Epoch: 8

Loss on hold-out set: 0.4106187635535995
Accuracy on hold-out set: 0.8591666666666666
MulticlassAccuracy value on hold-out data: 0.85916668176651
Returned to Spot: Validation loss: 0.4106187635535995
----------------------------------------------
```

```
spotPython tuning: 0.40383355725742875 [##########] 98.17%


config: {'l1': 512, 'l2': 512, 'lr_mult': 0.2595664370732177, 'batch_size': 16, 'epochs': 8,
Epoch: 1

Loss on hold-out set: 0.45326062487314145
Accuracy on hold-out set: 0.8375
MulticlassAccuracy value on hold-out data: 0.8374999761581421
Epoch: 2

Loss on hold-out set: 0.43062412275373935
Accuracy on hold-out set: 0.8471666666666666
MulticlassAccuracy value on hold-out data: 0.8471666574478149
Epoch: 3

Loss on hold-out set: 0.3910794263991217
Accuracy on hold-out set: 0.859875
MulticlassAccuracy value on hold-out data: 0.8598750233650208
Epoch: 4

Loss on hold-out set: 0.3988760137148201
Accuracy on hold-out set: 0.8594583333333333
MulticlassAccuracy value on hold-out data: 0.859458327293396
Epoch: 5

Loss on hold-out set: 0.3807026948503529
Accuracy on hold-out set: 0.8674166666666666
MulticlassAccuracy value on hold-out data: 0.8674166798591614
Epoch: 6

Loss on hold-out set: 0.3672554660855482
Accuracy on hold-out set: 0.86825
MulticlassAccuracy value on hold-out data: 0.8682500123977661
Epoch: 7

Loss on hold-out set: 0.36269920409967504
Accuracy on hold-out set: 0.8709166666666667
MulticlassAccuracy value on hold-out data: 0.8709166646003723
Epoch: 8
```

```
Loss on hold-out set: 0.35398230504492917
Accuracy on hold-out set: 0.8738333333333334
MulticlassAccuracy value on hold-out data: 0.8738333582878113
Returned to Spot: Validation loss: 0.35398230504492917
----------------------------------------------
```

```
spotPython tuning: 0.35398230504492917 [##########] 100.00% Done...
```

```
<spotPython.spot.spot.Spot at 0x17fe2bb20>
```

17 Tensorboard

The textual output shown in the console (or code cell) can be visualized with Tensorboard as described in Section 20.13.

17.0.1 Results

After the hyperparameter tuning run is finished, the results can be analyzed as described in Section 20.14.

```
SAVE = False
LOAD = False

if SAVE:
    result_file_name = "res_" + experiment_name + ".pkl"
    with open(result_file_name, 'wb') as f:
        pickle.dump(spot_tuner, f)

if LOAD:
    result_file_name = "ADD THE NAME here, e.g.: res_ch10-friedman-hpt-0_maans03_60min_20i
    with open(result_file_name, 'rb') as f:
        spot_tuner =  pickle.load(f)
```

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

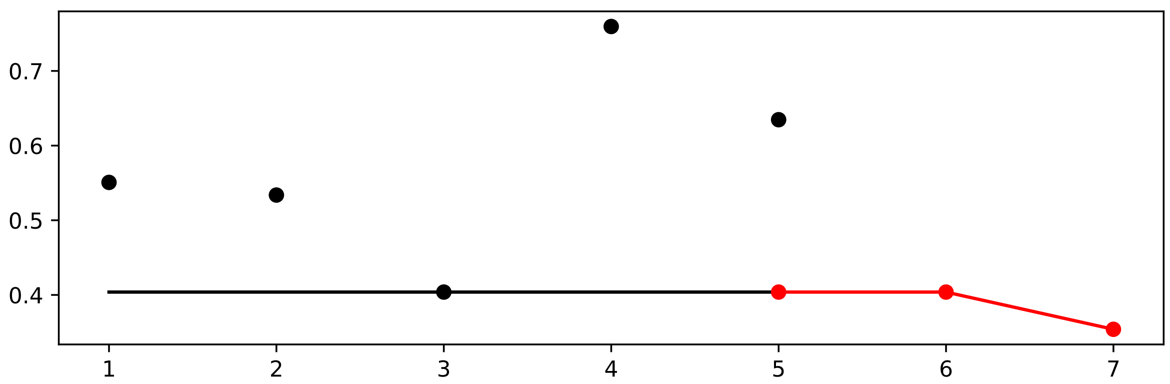


Figure 17.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

- Print the results

```
print(gen_design_table(fun_control=fun_control,
    spot=spot_tuner))
```

```
| name         | type   | default   |   lower |   upper |              tuned | transform
|--------------|--------|-----------|---------|---------|--------------------|---------------
| l1           | int    | 5         |     2.0 |     9.0 |                9.0 | transform_powe
| l2           | int    | 5         |     2.0 |     9.0 |                9.0 | transform_powe
| lr_mult      | float  | 1.0       |     0.1 |    10.0 | 0.2595664370732177 | None
| batch_size   | int    | 4         |     1.0 |     4.0 |                4.0 | transform_powe
| epochs       | int    | 3         |     2.0 |     3.0 |                3.0 | transform_powe
| k_folds      | int    | 1         |     0.0 |     0.0 |                0.0 | None
| patience     | int    | 5         |     2.0 |     2.0 |                2.0 | None
| optimizer    | factor | SGD       |     0.0 |    12.0 |                1.0 | None
| sgd_momentum | float  | 0.0       |     0.0 |     1.0 | 0.3768417655412891 | None
```

17.1 Show variable importance

```
spot_tuner.plot_importance(threshold=0.025, filename="./figures/" + experiment_name+"_impo
```

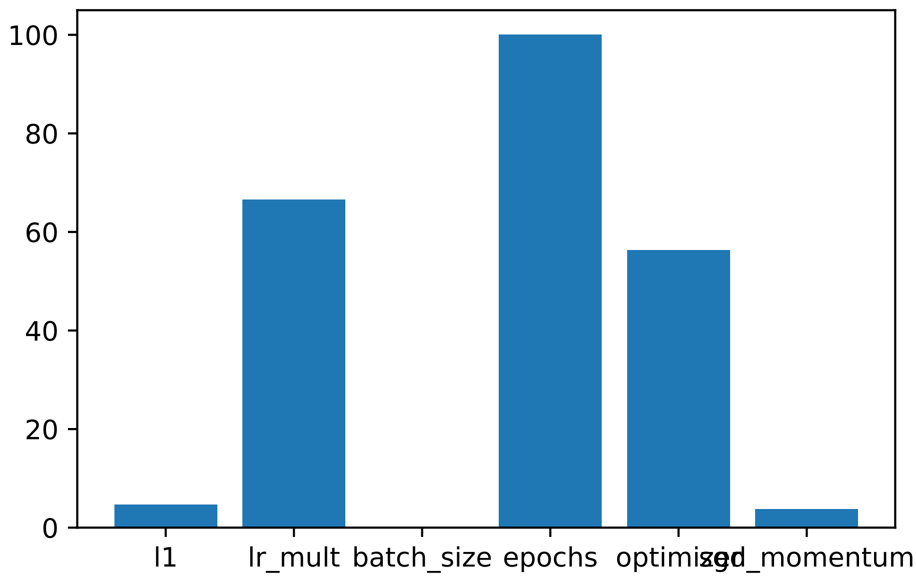


Figure 17.2: Variable importance plot, threshold 0.025.

17.2 Get the Tuned Architecture (SPOT Results)

The architecture of the `spotPython` model can be obtained by the following code:

```
from spotPython.hyperparameters.values import get_one_core_model_from_X
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
model_spot = get_one_core_model_from_X(X, fun_control)
model_spot
```

```
Net_fashionMNIST(
  (flatten): Flatten(start_dim=1, end_dim=-1)
  (linear_relu_stack): Sequential(
    (0): Linear(in_features=784, out_features=512, bias=True)
    (1): ReLU()
    (2): Linear(in_features=512, out_features=512, bias=True)
    (3): ReLU()
    (4): Linear(in_features=512, out_features=10, bias=True)
  )
)
```

17.3 Get Default Hyperparameters

```
fc = fun_control
fc.update({"core_model_hyper_dict":
    hyper_dict[fun_control["core_model"].__name__]})
model_default = get_one_core_model_from_X(X_start, fun_control=fc)
model_default
```

```
Net_fashionMNIST(
  (flatten): Flatten(start_dim=1, end_dim=-1)
  (linear_relu_stack): Sequential(
    (0): Linear(in_features=784, out_features=32, bias=True)
    (1): ReLU()
    (2): Linear(in_features=32, out_features=32, bias=True)
    (3): ReLU()
    (4): Linear(in_features=32, out_features=10, bias=True)
  )
)
```

17.4 Evaluation of the Default and the Tuned Architectures

The method `train_tuned` takes a model architecture without trained weights and trains this model with the train data. The train data is split into train and validation data. The validation data is used for early stopping. The trained model weights are saved as a dictionary.

```
from spotPython.torch.traintest import train_tuned
train_tuned(net=model_default, train_dataset=train, shuffle=True,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        device = fun_control["device"],
        show_batch_interval=1_000_000,
        path=None,
        task=fun_control["task"])
```

```
Epoch: 1

Loss on hold-out set: 2.0012128913402556
Accuracy on hold-out set: 0.31375
MulticlassAccuracy value on hold-out data: 0.3137499988079071
Epoch: 2
```

```
Loss on hold-out set: 1.5150622166792551
Accuracy on hold-out set: 0.5789166666666666
MulticlassAccuracy value on hold-out data: 0.5789166688919067
Epoch: 3

Loss on hold-out set: 1.2365069938898086
Accuracy on hold-out set: 0.6194583333333333
MulticlassAccuracy value on hold-out data: 0.6194583177566528
Epoch: 4

Loss on hold-out set: 1.0827553864717483
Accuracy on hold-out set: 0.6405833333333333
MulticlassAccuracy value on hold-out data: 0.640583336353302
Epoch: 5

Loss on hold-out set: 0.9878708951075872
Accuracy on hold-out set: 0.6655
MulticlassAccuracy value on hold-out data: 0.6654999852180481
Epoch: 6

Loss on hold-out set: 0.9251428727904956
Accuracy on hold-out set: 0.680625
MulticlassAccuracy value on hold-out data: 0.6806250214576721
Epoch: 7

Loss on hold-out set: 0.8810158553322156
Accuracy on hold-out set: 0.6930833333333334
MulticlassAccuracy value on hold-out data: 0.6930833458900452
Epoch: 8

Loss on hold-out set: 0.8480837040742238
Accuracy on hold-out set: 0.7114583333333333
MulticlassAccuracy value on hold-out data: 0.7114583253860474
Returned to Spot: Validation loss: 0.8480837040742238
----------------------------------------------
```

```
from spotPython.torch.traintest import test_tuned
test_tuned(net=model_default, test_dataset=test,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
```

```
          shuffle=False,
          device = fun_control["device"],
          task=fun_control["task"])
```

```
Loss on hold-out set: 0.8654008472442627
Accuracy on hold-out set: 0.697
MulticlassAccuracy value on hold-out data: 0.6970000267028809
Final evaluation: Validation loss: 0.8654008472442627
Final evaluation: Validation metric: 0.6970000267028809
----------------------------------------------
```

```
(0.8654008472442627, nan, tensor(0.6970))
```

The following code trains the model `model_spot`. If `path` is set to a filename, e.g., `path = "model_spot_trained.pt"`, the weights of the trained model will be saved to this file.

```
train_tuned(net=model_spot, train_dataset=train,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        shuffle=True,
        device = fun_control["device"],
        path=None,
        task=fun_control["task"])
```

```
Epoch: 1

Loss on hold-out set: 0.43997473143041113
Accuracy on hold-out set: 0.847875
MulticlassAccuracy value on hold-out data: 0.8478749990463257
Epoch: 2

Loss on hold-out set: 0.41142088433230917
Accuracy on hold-out set: 0.8565416666666666
MulticlassAccuracy value on hold-out data: 0.8565416932106018
Epoch: 3

Loss on hold-out set: 0.3886539824455976
Accuracy on hold-out set: 0.8654583333333333
MulticlassAccuracy value on hold-out data: 0.8654583096504211
Epoch: 4
```

```
Loss on hold-out set: 0.37972592828298607
Accuracy on hold-out set: 0.8657916666666666
MulticlassAccuracy value on hold-out data: 0.8657916784286499
Epoch: 5

Loss on hold-out set: 0.3678056659506013
Accuracy on hold-out set: 0.870375
MulticlassAccuracy value on hold-out data: 0.8703749775886536
Epoch: 6

Loss on hold-out set: 0.36014425377671916
Accuracy on hold-out set: 0.8742916666666667
MulticlassAccuracy value on hold-out data: 0.8742916584014893
Epoch: 7

Loss on hold-out set: 0.35568332858135304
Accuracy on hold-out set: 0.8761666666666666
MulticlassAccuracy value on hold-out data: 0.8761666417121887
Epoch: 8

Loss on hold-out set: 0.3562079004192104
Accuracy on hold-out set: 0.877
MulticlassAccuracy value on hold-out data: 0.8769999742507935
Returned to Spot: Validation loss: 0.3562079004192104
----------------------------------------------
```

```python
test_tuned(net=model_spot, test_dataset=test,
            shuffle=False,
            loss_function=fun_control["loss_function"],
            metric=fun_control["metric_torch"],
            device = fun_control["device"],
            task=fun_control["task"])
```

```
Loss on hold-out set: 0.3888594198584557
Accuracy on hold-out set: 0.8666
MulticlassAccuracy value on hold-out data: 0.866599977016449
Final evaluation: Validation loss: 0.3888594198584557
Final evaluation: Validation metric: 0.866599977016449
----------------------------------------------
```

```
(0.3888594198584557, nan, tensor(0.8666))
```

17.5 Detailed Hyperparameter Plots

```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

```
l1:  4.708460701278852
lr_mult:  66.54503934371562
batch_size:  0.08512442227439436
epochs:  100.0
optimizer:  56.27563123848771
sgd_momentum:  3.751381475985698
```

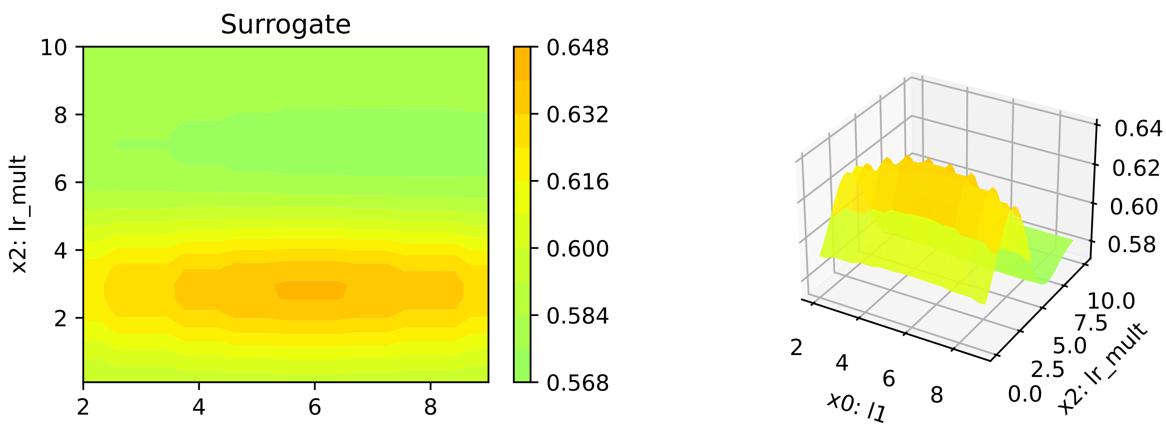
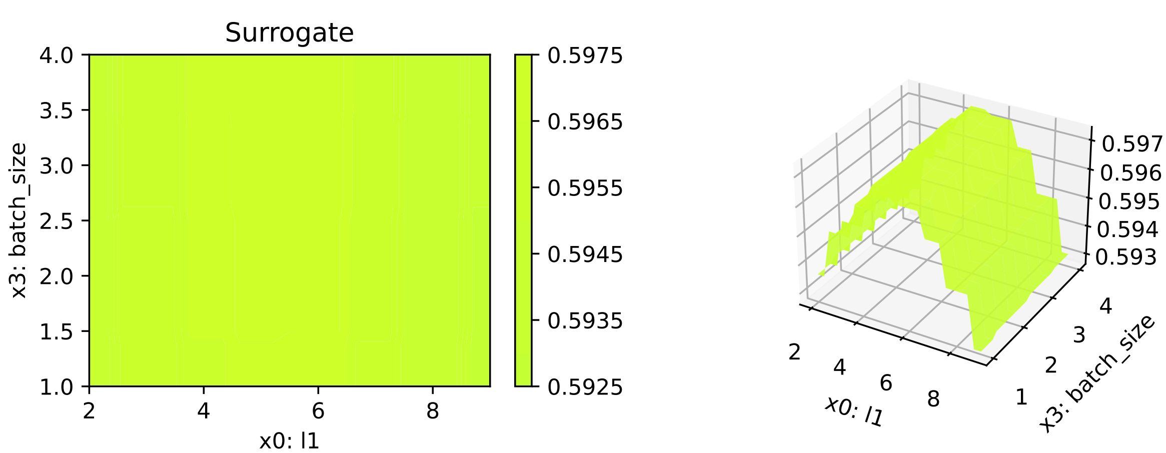
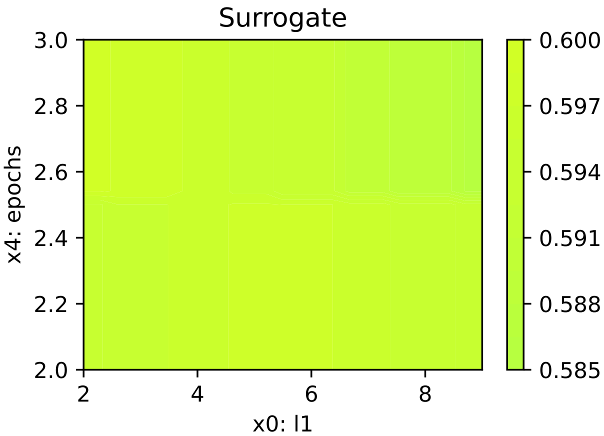
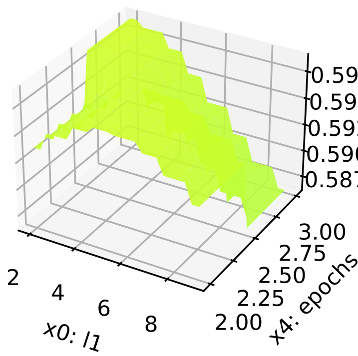
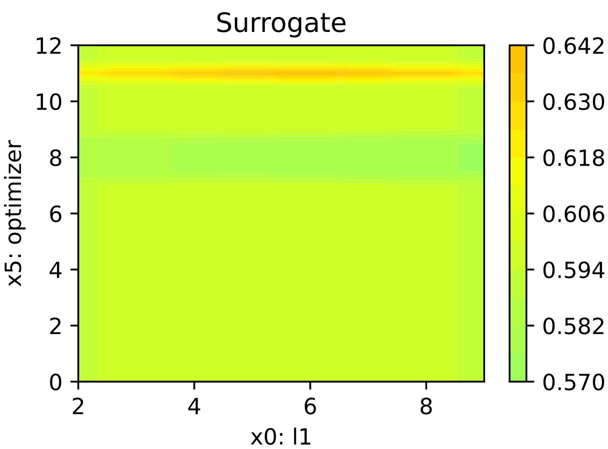


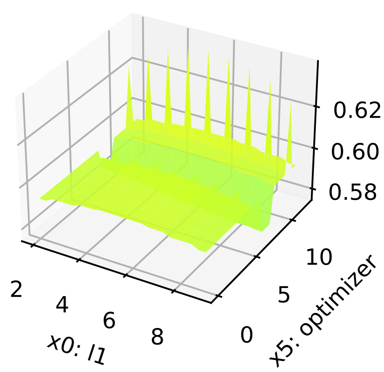
Figure 17.3: Contour plots.

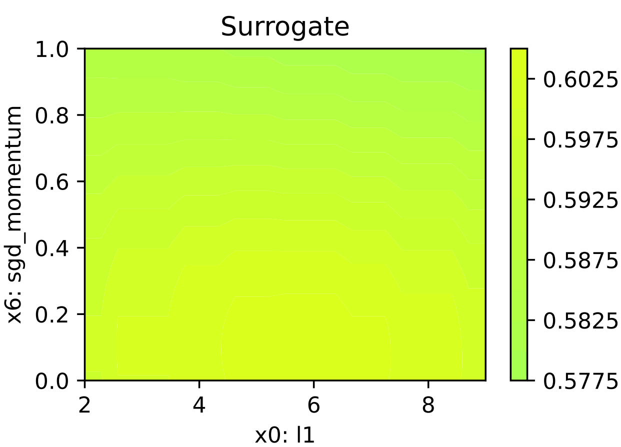


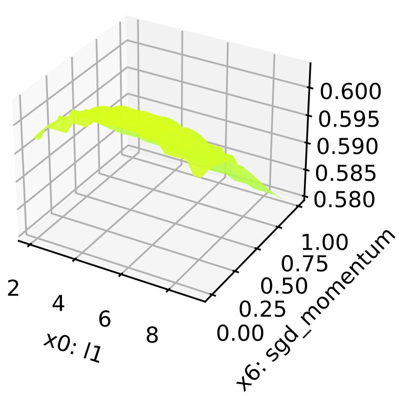

Surrogate
x4: epochs
x0: l1
3.0
2.8
2.6
2.4
2.2
2.0
2
4
6
8
0.600
0.597
0.594
0.591
0.588
0.585

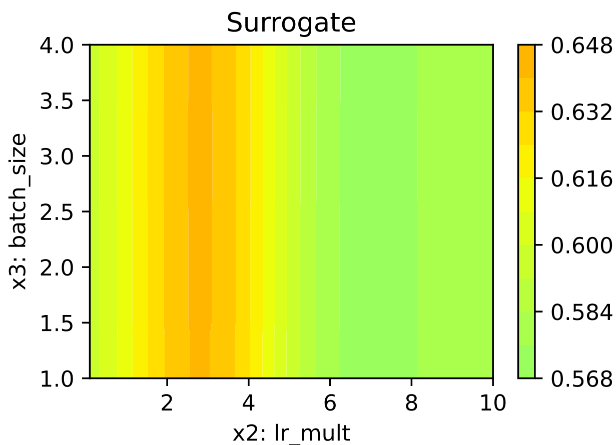

0.5975
0.5950
0.5925
0.5900
0.5875
x0: l1
x4: epochs
2
4
6
8
3.00
2.75
2.50
2.25
2.00

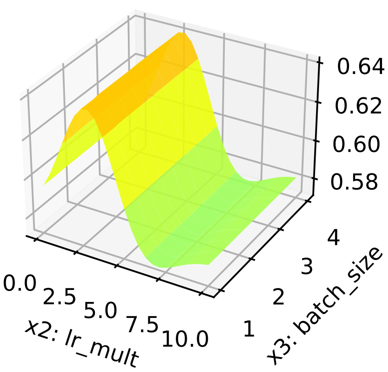

Surrogate
x5: optimizer
x0: l1
12
10
8
6
4
2
0
2
4
6
8
0.642
0.630
0.618
0.606
0.594
0.582
0.570

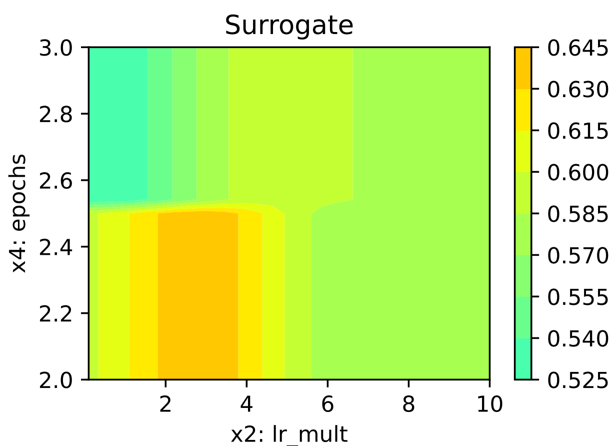

0.62
0.60
0.58
x0: l1
x5: optimizer
2
4
6
8
10
5
0

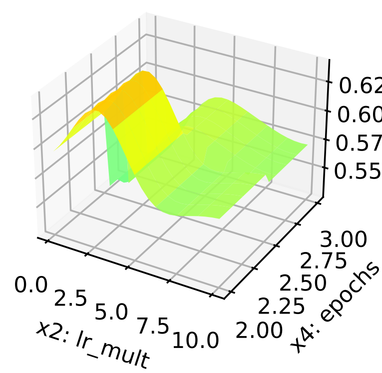

Surrogate
x6: sgd_momentum
x0: l1
1.0
0.8
0.6
0.4
0.2
0.0
2
4
6
8
0.6025
0.5975
0.5925
0.5875
0.5825
0.5775

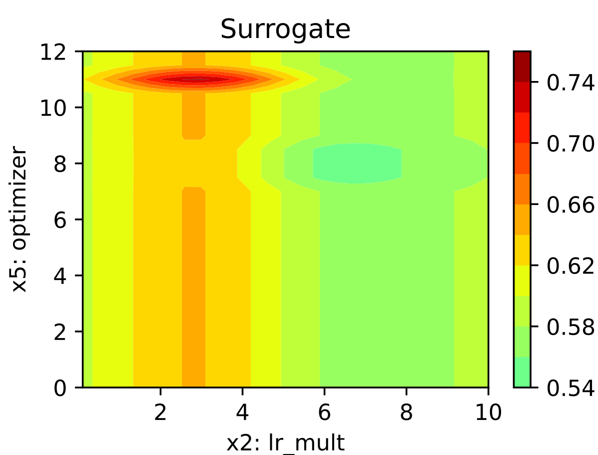

0.600
0.595
0.590
0.585
0.580
x0: l1
x6: sgd_momentum
2
4
6
8
1.00
0.75
0.50
0.25
0.00

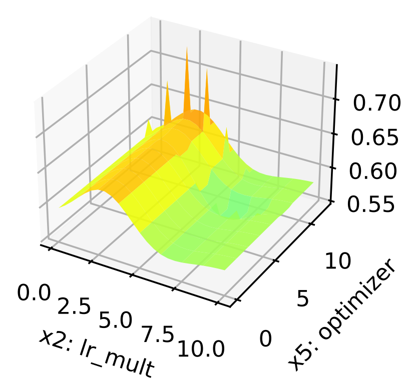

Surrogate
x3: batch_size
x2: lr_mult
4.0
3.5
3.0
2.5
2.0
1.5
1.0
2
4
6
8
10
0.648
0.632
0.616
0.600
0.584
0.568

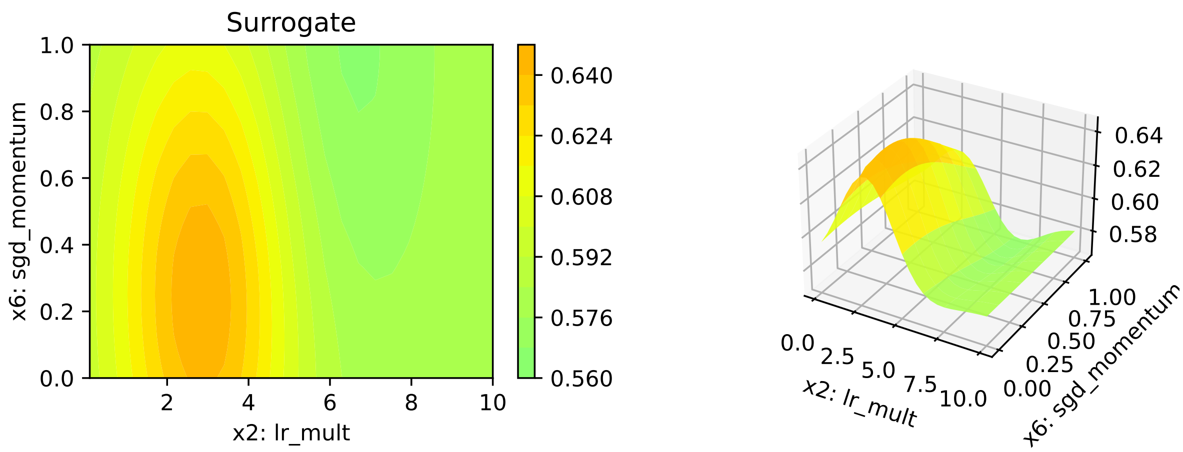

0.64
0.62
0.60
0.58
0.0
2.5
5.0
7.5
10.0
x2: lr_mult
1
2
3
4
x3: batch_size

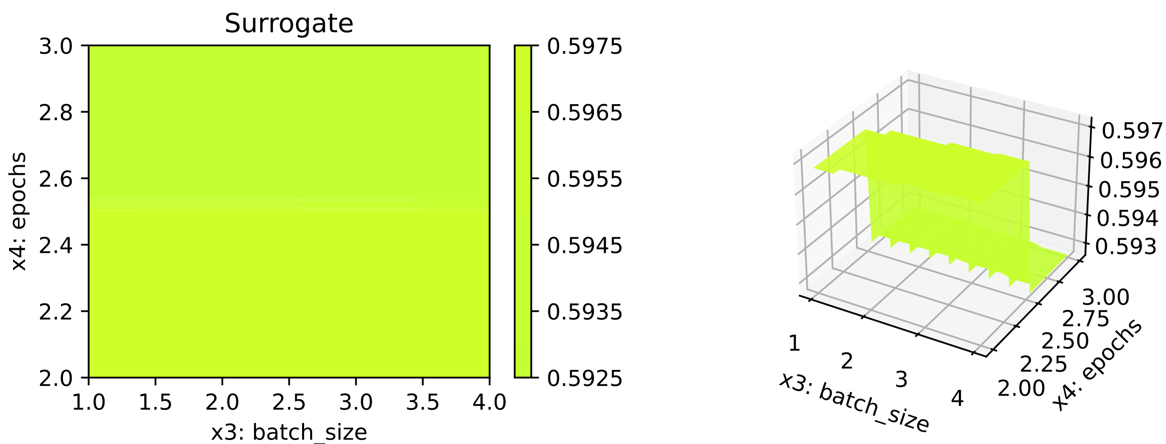

Surrogate
x4: epochs
x2: lr_mult
3.0
2.8
2.6
2.4
2.2
2.0
2
4
6
8
10
0.645
0.630
0.615
0.600
0.585
0.570
0.555
0.540
0.525

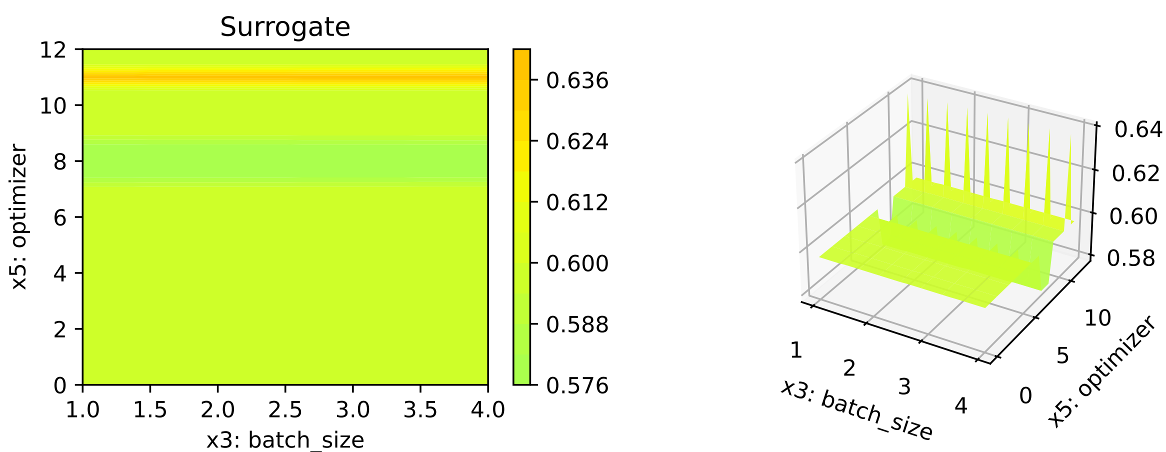

0.625
0.600
0.575
0.550
0.0
2.5
5.0
7.5
10.0
x2: lr_mult
2.00
2.25
2.50
2.75
3.00
x4: epochs

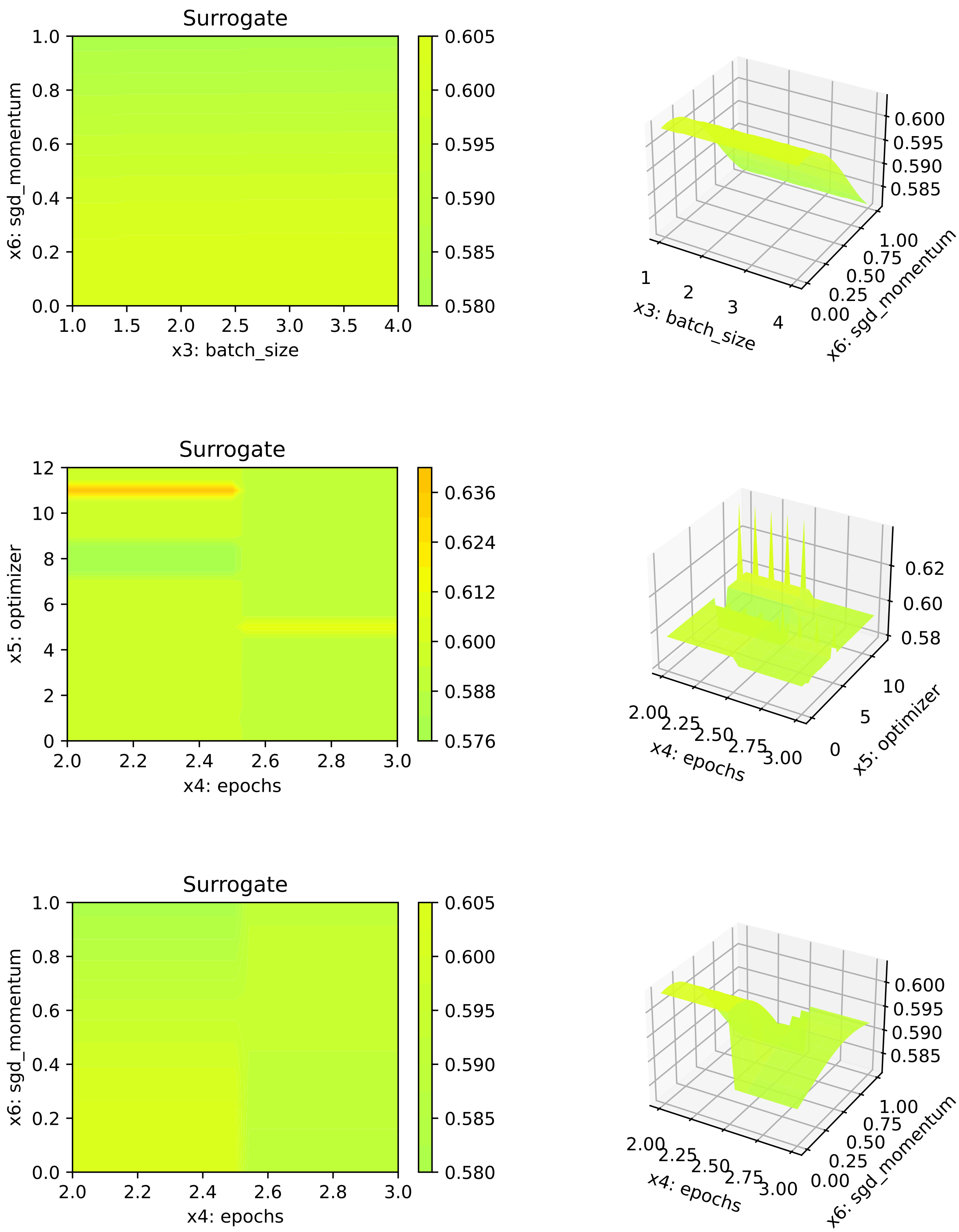

Surrogate
x5: optimizer
x2: lr_mult
12
10
8
6
4
2
0
2
4
6
8
10
0.74
0.70
0.66
0.62
0.58
0.54

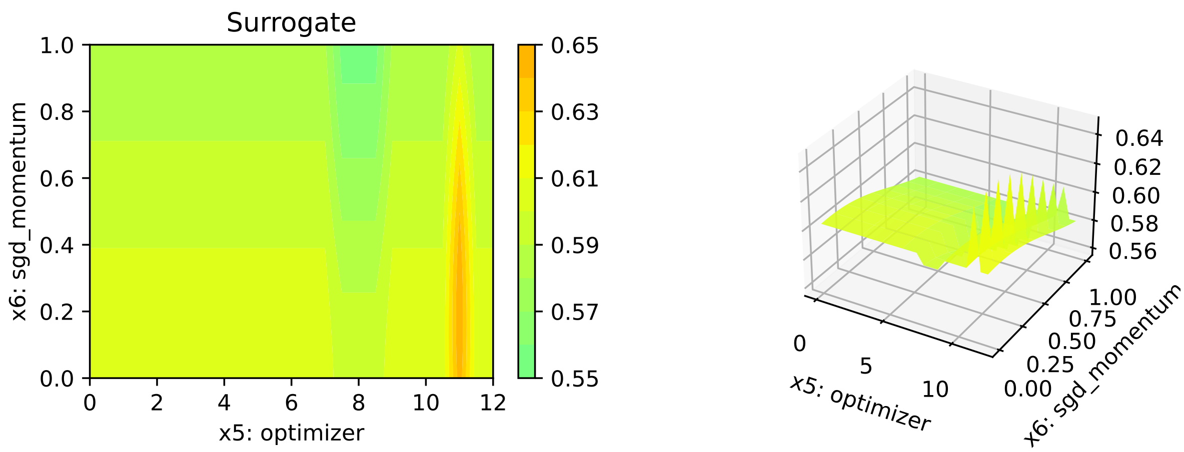

0.70
0.65
0.60
0.55
0.0
2.5
5.0
7.5
10.0
x2: lr_mult
0
5
10
x5: optimizer


Surrogate
x6: sgd_momentum
x2: lr_mult
0.640
0.624
0.608
0.592
0.576
0.560
x2: lr_mult
x6: sgd_momentum


Surrogate
x4: epochs
x3: batch_size
0.5975
0.5965
0.5955
0.5945
0.5935
0.5925
x3: batch_size
x4: epochs


Surrogate
x5: optimizer
x3: batch_size
0.636
0.624
0.612
0.600
0.588
0.576
x3: batch_size
x5: optimizer


Surrogate
x6: sgd_momentum
x3: batch_size
Surrogate
x5: optimizer
x4: epochs
Surrogate
x6: sgd_momentum
x4: epochs



17.6 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

Parallel coordinates plots

```
Unable to display output for mime type(s): text/html
```

17.7 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
            spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

18 HPT: PyTorch With cifar10 Data

In this tutorial, we will show how `spotPython` can be integrated into the `PyTorch` training workflow.

This document refers to the following software versions:

- `python`: 3.10.10
- `torch`: 2.0.1
- `torchvision`: 0.15.0

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                    0.2.33

spotRiver                     0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

18.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time, initial design size and the device that is used.

```
MAX_TIME = 1
INIT_SIZE = 5
DEVICE = None # "cpu" # "cuda:0"
```

```
from spotPython.utils.device import getDevice
DEVICE = getDevice(DEVICE)
print(DEVICE)
```

```
mps
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '12-torch' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(INIT_SI
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
12-torch_p040025_1min_5init_2023-06-16_22-19-08
```

18.2 Initialization of the `fun_control` Dictionary

`spotPython` uses a Python dictionary for storing the information required for the hyperparameter tuning process, which was described in Section 20.2.

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/12_spot_hpt_torch_cifar10",
    device=DEVICE)
```

18.3 PyTorch Data Loading

18.4 1. Load Data Cifar10 Data

```
from torchvision import datasets, transforms
import torchvision
def load_data(data_dir="./data"):
    transform = transforms.Compose([
        transforms.ToTensor(),
        transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))
    ])

    trainset = torchvision.datasets.CIFAR10(
        root=data_dir, train=True, download=True, transform=transform)

    testset = torchvision.datasets.CIFAR10(
        root=data_dir, train=False, download=True, transform=transform)

    return trainset, testset
train, test = load_data()
```

```
Files already downloaded and verified
```

```
Files already downloaded and verified
```

- Since this works fine, we can add the data loading to the `fun_control` dictionary:

```
n_samples = len(train)
# add the dataset to the fun_control
fun_control.update({"data": None, # dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": None})
```

18.5 The Model (Algorithm) to be Tuned

18.6 Specification of the Preprocessing Model

After the training and test data are specified and added to the `fun_control` dictionary, `spotPython` allows the specification of a data preprocessing pipeline, e.g., for the scaling of the data or for the one-hot encoding of categorical variables, see Section 20.4.1. This feature is not used here, so we do not change the default value (which is `None`).

18.7 Step 4: Select `algorithm` and `core_model_hyper_dict`

18.7.1 Implementing a Configurable Neural Network With spotPython

`spotPython` includes the `Net_CIFAR10` class which is implemented in the file `netcifar10.py`. The class is imported here.

This class inherits from the class `Net_Core` which is implemented in the file `netcore.py`, see **?@sec-the-net-core-class-24**.

```
from spotPython.torch.netcifar10 import Net_CIFAR10
from spotPython.data.torch_hyper_dict import TorchHyperDict
from spotPython.hyperparameters.values import add_core_model_to_fun_control
fun_control = add_core_model_to_fun_control(core_model=Net_CIFAR10,
                              fun_control=fun_control,
                              hyper_dict=TorchHyperDict,
                              filename=None)
```

18.8 The Search Space

18.8.1 Configuring the Search Space With spotPython

18.8.1.1 The `hyper_dict` Hyperparameters for the Selected Algorithm

`spotPython` uses `JSON` files for the specification of the hyperparameters, which were described in Section 20.5.2.

The corresponding entries for the `Net_CIFAR10` class are shown below.

```
"Net_CIFAR10":
{
    "l1": {
        "type": "int",
        "default": 5,
        "transform": "transform_power_2_int",
        "lower": 2,
        "upper": 9},
    "l2": {
        "type": "int",
        "default": 5,
        "transform": "transform_power_2_int",
        "lower": 2,
        "upper": 9},
    "lr_mult": {
        "type": "float",
        "default": 1.0,
        "transform": "None",
        "lower": 0.1,
        "upper": 10.0},
    "batch_size": {
        "type": "int",
        "default": 4,
        "transform": "transform_power_2_int",
        "lower": 1,
        "upper": 4},
    "epochs": {
        "type": "int",
        "default": 3,
        "transform": "transform_power_2_int",
        "lower": 3,
        "upper": 4},
    "k_folds": {
        "type": "int",
        "default": 1,
        "transform": "None",
        "lower": 1,
        "upper": 1},
    "patience": {
        "type": "int",
        "default": 5,
```

```
            "transform": "None",
            "lower": 2,
            "upper": 10
        },
        "optimizer": {
            "levels": ["Adadelta",
                       "Adagrad",
                       "Adam",
                       "AdamW",
                       "SparseAdam",
                       "Adamax",
                       "ASGD",
                       "NAdam",
                       "RAdam",
                       "RMSprop",
                       "Rprop",
                       "SGD"],
            "type": "factor",
            "default": "SGD",
            "transform": "None",
            "class_name": "torch.optim",
            "core_model_parameter_type": "str",
            "lower": 0,
            "upper": 12},
        "sgd_momentum": {
            "type": "float",
            "default": 0.0,
            "transform": "None",
            "lower": 0.0,
            "upper": 1.0}
    },
```

18.9 Modifying the Hyperparameters

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

18.9.1 Step 5: Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

18.9.1.1 Modify Hyperparameters of Type numeric and integer (boolean)

The hyperparameter `k_folds` is not used, it is de-activated here by setting the lower and upper bound to the same value.

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
# fun_control = modify_hyper_parameter_bounds(fun_control, "delta", bounds=[1e-10, 1e-6])
# fun_control = modify_hyper_parameter_bounds(fun_control, "min_samples_split", bounds=[3,
#fun_control = modify_hyper_parameter_bounds(fun_control, "merit_preprune", bounds=[0, 0])
# fun_control["core_model_hyper_dict"]
fun_control = modify_hyper_parameter_bounds(fun_control, "k_folds", bounds=[2, 2])
```

18.9.2 Modify hyperparameter of type factor

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
fun_control = modify_hyper_parameter_levels(fun_control, "optimizer", ["Adam"])
# fun_control = modify_hyper_parameter_levels(fun_control, "leaf_model", ["LinearRegressio
# fun_control["core_model_hyper_dict"]
```

18.9.3 Optimizers

Optimizers can be selected as described in Section 25.8.2.

Optimizers are described in Section 20.6.

```
fun_control = modify_hyper_parameter_bounds(fun_control,
    "lr_mult", bounds=[1e-3, 1e-3])
fun_control = modify_hyper_parameter_bounds(fun_control,
    "sgd_momentum", bounds=[0.9, 0.9])
```

18.10 Evaluation

The evaluation procedure requires the specification of two elements:

1. the way how the data is split into a train and a test set and
2. the loss function (and a metric).

These are described in Section 25.9.

The key `"loss_function"` specifies the loss function which is used during the optimization, see Section 20.8.

We will use CrossEntropy loss for the multiclass-classification task.

```
from torch.nn import CrossEntropyLoss
loss_function = CrossEntropyLoss()
fun_control.update({
        "loss_function": loss_function,
        "shuffle": True,
        "eval":  "train_hold_out"
        })
```

18.10.1 Metric

```
import torchmetrics
metric_torch = torchmetrics.Accuracy(task="multiclass",
     num_classes=10).to(fun_control["device"])
fun_control.update({"metric_torch": metric_torch})
```

18.11 Preparing the SPOT Call

The following code passes the information about the parameter ranges and bounds to `spot`.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name        | type   | default   |   lower |   upper | transform             |
|-------------|--------|-----------|---------|---------|-----------------------|
| l1          | int    | 5         |   2     |   9     | transform_power_2_int |
| l2          | int    | 5         |   2     |   9     | transform_power_2_int |
| lr_mult     | float  | 1.0       |   0.001 |   0.001 | None                  |
| batch_size  | int    | 4         |   1     |   4     | transform_power_2_int |
| epochs      | int    | 3         |   3     |   4     | transform_power_2_int |
| k_folds     | int    | 1         |   2     |   2     | None                  |
| patience    | int    | 5         |   2     |  10     | None                  |
| optimizer   | factor | SGD       |   0     |   0     | None                  |
| sgd_momentum | float  | 0.0       |   0.9   |   0.9   | None                  |
```

18.12 The Objective Function `fun_torch`

The objective function `fun_torch` is selected next. It implements an interface from `PyTorch`'s training, validation, and testing methods to `spotPython`.

```
from spotPython.fun.hypertorch import HyperTorch
fun = HyperTorch().fun_torch
```

18.13 Starting the Hyperparameter Tuning

```
import numpy as np
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
```

```python
                    log_level = 50,
                    show_models= False,
                    show_progress= True,
                    fun_control = fun_control,
                    design_control={"init_size": INIT_SIZE,
                                    "repeats": 1},
                    surrogate_control={"noise": True,
                                       "cod_type": "norm",
                                       "min_theta": -4,
                                       "max_theta": 3,
                                       "n_theta": len(var_name),
                                       "model_fun_evals": 10_000,
                                       "log_level": 50
                                       })
spot_tuner.run(X_start=X_start)
```

```
config: {'l1': 128, 'l2': 8, 'lr_mult': 0.001, 'batch_size': 16, 'epochs': 16, 'k_folds': 2,
Epoch: 1

Loss on hold-out set: 2.323948062515259
Accuracy on hold-out set: 0.09755
MulticlassAccuracy value on hold-out data: 0.09754999727010727
Epoch: 2

Loss on hold-out set: 2.3219025295257567
Accuracy on hold-out set: 0.09755
MulticlassAccuracy value on hold-out data: 0.09754999727010727
Epoch: 3

Loss on hold-out set: 2.3196583921432494
Accuracy on hold-out set: 0.09755
MulticlassAccuracy value on hold-out data: 0.09754999727010727
Epoch: 4

Loss on hold-out set: 2.3169752292633055
Accuracy on hold-out set: 0.09755
MulticlassAccuracy value on hold-out data: 0.09754999727010727
Epoch: 5
```

```
Loss on hold-out set: 2.313690382194519
Accuracy on hold-out set: 0.09755
MulticlassAccuracy value on hold-out data: 0.09754999727010727
Epoch: 6

Loss on hold-out set: 2.3095909578323366
Accuracy on hold-out set: 0.09825
MulticlassAccuracy value on hold-out data: 0.09825000166893005
Epoch: 7

Loss on hold-out set: 2.304194309043884
Accuracy on hold-out set: 0.1043
MulticlassAccuracy value on hold-out data: 0.10429999977350235
Epoch: 8

Loss on hold-out set: 2.297897082519531
Accuracy on hold-out set: 0.1193
MulticlassAccuracy value on hold-out data: 0.1193000003695488
Epoch: 9

Loss on hold-out set: 2.2914154531478883
Accuracy on hold-out set: 0.1297
MulticlassAccuracy value on hold-out data: 0.12970000505447388
Epoch: 10

Loss on hold-out set: 2.284544203567505
Accuracy on hold-out set: 0.1364
MulticlassAccuracy value on hold-out data: 0.1363999992609024
Epoch: 11

Loss on hold-out set: 2.277190633010864
Accuracy on hold-out set: 0.13855
MulticlassAccuracy value on hold-out data: 0.13854999840259552
Epoch: 12

Loss on hold-out set: 2.269649810028076
Accuracy on hold-out set: 0.1403
MulticlassAccuracy value on hold-out data: 0.14030000567436218
Epoch: 13
```

```
Loss on hold-out set: 2.2620551794052126
Accuracy on hold-out set: 0.14375
MulticlassAccuracy value on hold-out data: 0.14374999701976776
Epoch: 14

Loss on hold-out set: 2.254489493560791
Accuracy on hold-out set: 0.14545
MulticlassAccuracy value on hold-out data: 0.14544999599456787
Epoch: 15

Loss on hold-out set: 2.247057324409485
Accuracy on hold-out set: 0.14755
MulticlassAccuracy value on hold-out data: 0.14755000174045563
Epoch: 16

Loss on hold-out set: 2.2397448022842408
Accuracy on hold-out set: 0.1481
MulticlassAccuracy value on hold-out data: 0.14810000360012054
Returned to Spot: Validation loss: 2.2397448022842408
----------------------------------------------

config: {'l1': 16, 'l2': 16, 'lr_mult': 0.001, 'batch_size': 8, 'epochs': 8, 'k_folds': 2, '
Epoch: 1

Loss on hold-out set: 2.309121612930298
Accuracy on hold-out set: 0.10165
MulticlassAccuracy value on hold-out data: 0.10164999961853027
Epoch: 2

Loss on hold-out set: 2.306665670776367
Accuracy on hold-out set: 0.10165
MulticlassAccuracy value on hold-out data: 0.10164999961853027
Epoch: 3

Loss on hold-out set: 2.3041253012657164
Accuracy on hold-out set: 0.10165
MulticlassAccuracy value on hold-out data: 0.10164999961853027
Epoch: 4
```

```
Loss on hold-out set: 2.301276202583313
Accuracy on hold-out set: 0.10165
MulticlassAccuracy value on hold-out data: 0.10164999961853027
Epoch: 5

Loss on hold-out set: 2.2979230412483216
Accuracy on hold-out set: 0.10165
MulticlassAccuracy value on hold-out data: 0.10164999961853027
Epoch: 6

Loss on hold-out set: 2.294171500968933
Accuracy on hold-out set: 0.102
MulticlassAccuracy value on hold-out data: 0.10199999809265137
Epoch: 7

Loss on hold-out set: 2.290639483451843
Accuracy on hold-out set: 0.1014
MulticlassAccuracy value on hold-out data: 0.10140000283718109
Epoch: 8

Loss on hold-out set: 2.287336975002289
Accuracy on hold-out set: 0.1002
MulticlassAccuracy value on hold-out data: 0.10019999742507935
Returned to Spot: Validation loss: 2.287336975002289
----------------------------------------------

config: {'l1': 256, 'l2': 128, 'lr_mult': 0.001, 'batch_size': 2, 'epochs': 16, 'k_folds': 2
Epoch: 1

Loss on hold-out set: 2.2892952758312224
Accuracy on hold-out set: 0.14825
MulticlassAccuracy value on hold-out data: 0.14824999868869781
Epoch: 2

Loss on hold-out set: 2.254370941519737
Accuracy on hold-out set: 0.24035
MulticlassAccuracy value on hold-out data: 0.24034999310970306
Epoch: 3
```

```
Loss on hold-out set: 2.1991649141788483
Accuracy on hold-out set: 0.2319
MulticlassAccuracy value on hold-out data: 0.23190000653266907
Epoch: 4

Loss on hold-out set: 2.14526918759346
Accuracy on hold-out set: 0.24255
MulticlassAccuracy value on hold-out data: 0.24255000054836273
Epoch: 5

Loss on hold-out set: 2.1044174639344218
Accuracy on hold-out set: 0.25175
MulticlassAccuracy value on hold-out data: 0.25174999237060547
Epoch: 6

Loss on hold-out set: 2.0744747653365136
Accuracy on hold-out set: 0.2656
MulticlassAccuracy value on hold-out data: 0.2655999958515167
Epoch: 7

Loss on hold-out set: 2.049839153188467
Accuracy on hold-out set: 0.27575
MulticlassAccuracy value on hold-out data: 0.2757500112056732
Epoch: 8

Loss on hold-out set: 2.0278992693960665
Accuracy on hold-out set: 0.283
MulticlassAccuracy value on hold-out data: 0.28299999237060547
Epoch: 9

Loss on hold-out set: 2.009617194610834
Accuracy on hold-out set: 0.28915
MulticlassAccuracy value on hold-out data: 0.2891499996185303
Epoch: 10

Loss on hold-out set: 1.990246349966526
Accuracy on hold-out set: 0.29565
MulticlassAccuracy value on hold-out data: 0.29565000534057617
Epoch: 11
```

```
Loss on hold-out set: 1.9748748294472693
Accuracy on hold-out set: 0.3001
MulticlassAccuracy value on hold-out data: 0.3000999987125397
Epoch: 12

Loss on hold-out set: 1.9605326904118061
Accuracy on hold-out set: 0.3036
MulticlassAccuracy value on hold-out data: 0.303600013256073
Epoch: 13

Loss on hold-out set: 1.9465455166220664
Accuracy on hold-out set: 0.3106
MulticlassAccuracy value on hold-out data: 0.31060001254081726
Epoch: 14

Loss on hold-out set: 1.9352574664056301
Accuracy on hold-out set: 0.31255
MulticlassAccuracy value on hold-out data: 0.31255000829696655
Epoch: 15

Loss on hold-out set: 1.9226177741497754
Accuracy on hold-out set: 0.3197
MulticlassAccuracy value on hold-out data: 0.3197000026702881
Epoch: 16

Loss on hold-out set: 1.9122581829100846
Accuracy on hold-out set: 0.3216
MulticlassAccuracy value on hold-out data: 0.3215999901294708
Returned to Spot: Validation loss: 1.9122581829100846
----------------------------------------------

config: {'l1': 8, 'l2': 32, 'lr_mult': 0.001, 'batch_size': 4, 'epochs': 8, 'k_folds': 2, 'pa
Epoch: 1

Loss on hold-out set: 2.312094221496582
Accuracy on hold-out set: 0.1008
MulticlassAccuracy value on hold-out data: 0.10080000013113022
Epoch: 2
```

```
Loss on hold-out set: 2.311186871957779
Accuracy on hold-out set: 0.1015
MulticlassAccuracy value on hold-out data: 0.1014999970793724
Epoch: 3

Loss on hold-out set: 2.3102302481651305
Accuracy on hold-out set: 0.10245
MulticlassAccuracy value on hold-out data: 0.10244999825954437
Epoch: 4

Loss on hold-out set: 2.309217641401291
Accuracy on hold-out set: 0.1023
MulticlassAccuracy value on hold-out data: 0.1023000031709671
Epoch: 5

Loss on hold-out set: 2.3081008192539216
Accuracy on hold-out set: 0.102
MulticlassAccuracy value on hold-out data: 0.10199999809265137
Epoch: 6

Loss on hold-out set: 2.3068475499153136
Accuracy on hold-out set: 0.09985
MulticlassAccuracy value on hold-out data: 0.09984999895095825
Epoch: 7

Loss on hold-out set: 2.30545875453949
Accuracy on hold-out set: 0.09975
MulticlassAccuracy value on hold-out data: 0.09974999725818634
Epoch: 8

Loss on hold-out set: 2.3040032766342162
Accuracy on hold-out set: 0.1001
MulticlassAccuracy value on hold-out data: 0.10010000318288803
Returned to Spot: Validation loss: 2.3040032766342162
----------------------------------------------

config: {'l1': 64, 'l2': 512, 'lr_mult': 0.001, 'batch_size': 8, 'epochs': 16, 'k_folds': 2,
Epoch: 1
```

```
Loss on hold-out set: 2.2989193734169007
Accuracy on hold-out set: 0.10145
MulticlassAccuracy value on hold-out data: 0.10145000368356705
Epoch: 2

Loss on hold-out set: 2.293341431427002
Accuracy on hold-out set: 0.10485
MulticlassAccuracy value on hold-out data: 0.10485000163316727
Epoch: 3

Loss on hold-out set: 2.284049084854126
Accuracy on hold-out set: 0.1599
MulticlassAccuracy value on hold-out data: 0.1598999947309494
Epoch: 4

Loss on hold-out set: 2.2693090936660765
Accuracy on hold-out set: 0.20165
MulticlassAccuracy value on hold-out data: 0.2016499936580658
Epoch: 5

Loss on hold-out set: 2.2480563654899597
Accuracy on hold-out set: 0.2097
MulticlassAccuracy value on hold-out data: 0.20970000326633453
Epoch: 6

Loss on hold-out set: 2.220326471328735
Accuracy on hold-out set: 0.21395
MulticlassAccuracy value on hold-out data: 0.2139499932527542
Epoch: 7

Loss on hold-out set: 2.1877622247695925
Accuracy on hold-out set: 0.22105
MulticlassAccuracy value on hold-out data: 0.22104999423027039
Epoch: 8

Loss on hold-out set: 2.1537774778842924
Accuracy on hold-out set: 0.2329
MulticlassAccuracy value on hold-out data: 0.2328999936580658
Epoch: 9
```

```
Loss on hold-out set: 2.121610161066055
Accuracy on hold-out set: 0.24425
MulticlassAccuracy value on hold-out data: 0.24424999952316284
Epoch: 10

Loss on hold-out set: 2.0934228717327117
Accuracy on hold-out set: 0.25485
MulticlassAccuracy value on hold-out data: 0.25485000014305115
Epoch: 11

Loss on hold-out set: 2.0703310544013975
Accuracy on hold-out set: 0.26175
MulticlassAccuracy value on hold-out data: 0.2617500126361847
Epoch: 12

Loss on hold-out set: 2.051359773826599
Accuracy on hold-out set: 0.26605
MulticlassAccuracy value on hold-out data: 0.2660500109195709
Epoch: 13

Loss on hold-out set: 2.0357075070381163
Accuracy on hold-out set: 0.2702
MulticlassAccuracy value on hold-out data: 0.2702000141143799
Epoch: 14

Loss on hold-out set: 2.0225205682754517
Accuracy on hold-out set: 0.27405
MulticlassAccuracy value on hold-out data: 0.2740499973297119
Epoch: 15

Loss on hold-out set: 2.0110210342407226
Accuracy on hold-out set: 0.27565
MulticlassAccuracy value on hold-out data: 0.2756499946117401
Epoch: 16

Loss on hold-out set: 2.0006853229522705
Accuracy on hold-out set: 0.279
MulticlassAccuracy value on hold-out data: 0.27900001406669617
Returned to Spot: Validation loss: 2.0006853229522705
----------------------------------------------
```

```
config: {'l1': 256, 'l2': 128, 'lr_mult': 0.001, 'batch_size': 2, 'epochs': 16, 'k_folds': 2
Epoch: 1

Loss on hold-out set: 2.2974272313833235
Accuracy on hold-out set: 0.1783
MulticlassAccuracy value on hold-out data: 0.17829999327659607
Epoch: 2

Loss on hold-out set: 2.2798960317373274
Accuracy on hold-out set: 0.1724
MulticlassAccuracy value on hold-out data: 0.17239999771118164
Epoch: 3

Loss on hold-out set: 2.2348098106741907
Accuracy on hold-out set: 0.23345
MulticlassAccuracy value on hold-out data: 0.2334499955177307
Epoch: 4

Loss on hold-out set: 2.153962100696564
Accuracy on hold-out set: 0.2689
MulticlassAccuracy value on hold-out data: 0.2689000070095062
Epoch: 5

Loss on hold-out set: 2.080927157151699
Accuracy on hold-out set: 0.2809
MulticlassAccuracy value on hold-out data: 0.2809000015258789
Epoch: 6

Loss on hold-out set: 2.0320364062964917
Accuracy on hold-out set: 0.28565
MulticlassAccuracy value on hold-out data: 0.28565001487731934
Epoch: 7

Loss on hold-out set: 2.0003550383150577
Accuracy on hold-out set: 0.2891
MulticlassAccuracy value on hold-out data: 0.2890999913215637
Epoch: 8
```

```
Loss on hold-out set: 1.978043717634678
Accuracy on hold-out set: 0.29415
MulticlassAccuracy value on hold-out data: 0.2941499948501587
Epoch: 9

Loss on hold-out set: 1.9619637477219105
Accuracy on hold-out set: 0.29735
MulticlassAccuracy value on hold-out data: 0.2973499894142151
Epoch: 10

Loss on hold-out set: 1.9485805957049132
Accuracy on hold-out set: 0.3025
MulticlassAccuracy value on hold-out data: 0.30250000953674316
Epoch: 11

Loss on hold-out set: 1.9375497945457696
Accuracy on hold-out set: 0.3057
MulticlassAccuracy value on hold-out data: 0.30570000410079956
Epoch: 12

Loss on hold-out set: 1.9274970385015011
Accuracy on hold-out set: 0.3104
MulticlassAccuracy value on hold-out data: 0.31040000915527344
Epoch: 13

Loss on hold-out set: 1.9190160211235285
Accuracy on hold-out set: 0.31455
MulticlassAccuracy value on hold-out data: 0.3145500123500824
Epoch: 14

Loss on hold-out set: 1.9112264146387576
Accuracy on hold-out set: 0.31405
MulticlassAccuracy value on hold-out data: 0.31404998898506165
Epoch: 15

Loss on hold-out set: 1.904019815811515
Accuracy on hold-out set: 0.3175
MulticlassAccuracy value on hold-out data: 0.3174999952316284
Epoch: 16
```

```
Loss on hold-out set: 1.8963912369027733
Accuracy on hold-out set: 0.32175
MulticlassAccuracy value on hold-out data: 0.3217499852180481
Returned to Spot: Validation loss: 1.8963912369027733
----------------------------------------------
```

```
spotPython tuning: 1.8963912369027733 [##########] 100.00% Done...
```

```
<spotPython.spot.spot.Spot at 0x2a77d2bc0>
```

19 Tensorboard

The textual output shown in the console (or code cell) can be visualized with Tensorboard as described in Section 20.13.

19.0.1 Results

After the hyperparameter tuning run is finished, the results can be analyzed as described in Section 20.14.

```
SAVE = False
LOAD = False

if SAVE:
    result_file_name = "res_" + experiment_name + ".pkl"
    with open(result_file_name, 'wb') as f:
        pickle.dump(spot_tuner, f)

if LOAD:
    result_file_name = "ADD THE NAME here, e.g.: res_ch10-friedman-hpt-0_maans03_60min_20i
    with open(result_file_name, 'rb') as f:
        spot_tuner =  pickle.load(f)
```

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

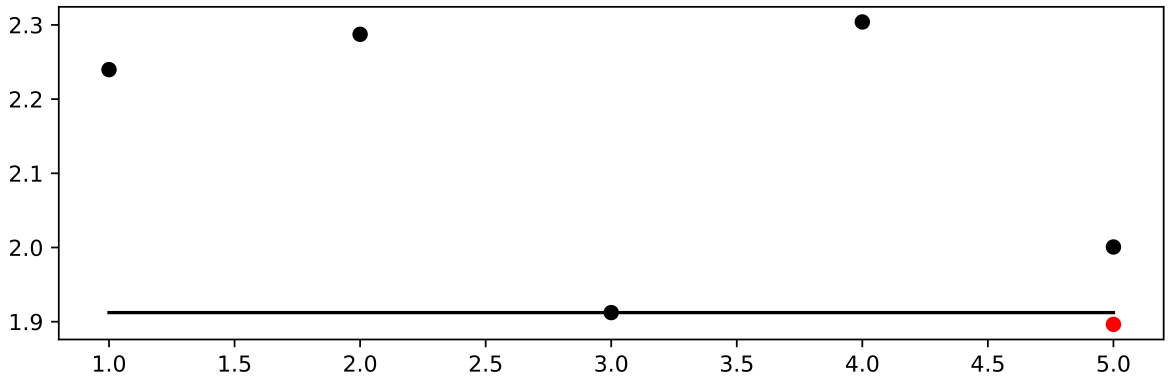


Figure 19.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

- Print the results

```
print(gen_design_table(fun_control=fun_control,
    spot=spot_tuner))
```

```
| name         | type   | default   |    lower |    upper |    tuned | transform              |
|--------------|--------|-----------|----------|----------|----------|------------------------|--
| l1           | int    | 5         |      2.0 |      9.0 |      8.0 | transform_power_2_int |
| l2           | int    | 5         |      2.0 |      9.0 |      7.0 | transform_power_2_int |
| lr_mult      | float  | 1.0       |    0.001 |    0.001 |    0.001 | None                   |
| batch_size   | int    | 4         |      1.0 |      4.0 |      1.0 | transform_power_2_int |
| epochs       | int    | 3         |      3.0 |      4.0 |      4.0 | transform_power_2_int |
| k_folds      | int    | 1         |      2.0 |      2.0 |      2.0 | None                   |
| patience     | int    | 5         |      2.0 |     10.0 |     10.0 | None                   |
| optimizer    | factor | SGD       |      0.0 |      0.0 |      0.0 | None                   |
| sgd_momentum | float  | 0.0       |      0.9 |      0.9 |      0.9 | None                   |
```

19.1 Show variable importance

```
spot_tuner.plot_importance(threshold=0.025, filename="./figures/" + experiment_name+"_impo
```

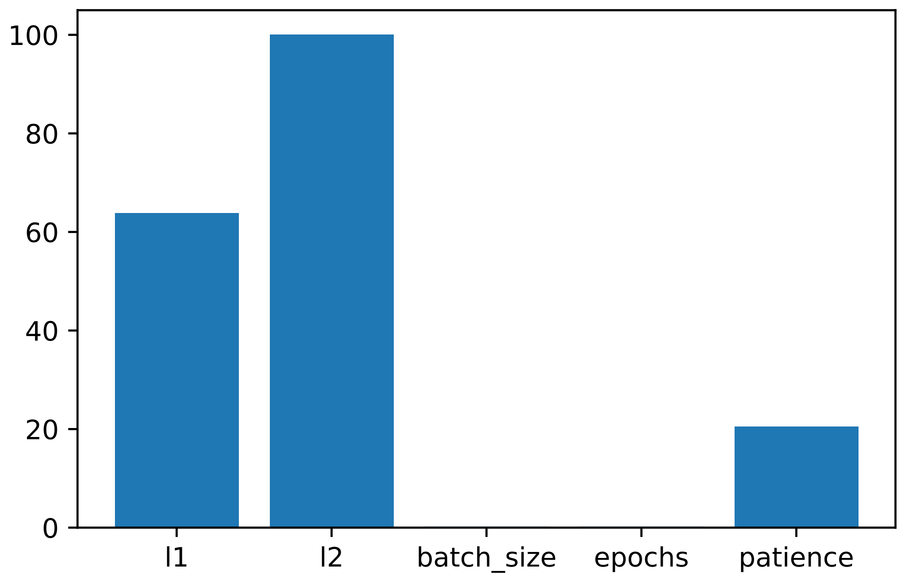


Figure 19.2: Variable importance plot, threshold 0.025.

19.2 Get the Tuned Architecture (SPOT Results)

The architecture of the spotPython model can be obtained by the following code:

```
from spotPython.hyperparameters.values import get_one_core_model_from_X
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
model_spot = get_one_core_model_from_X(X, fun_control)
model_spot
```

```
Net_CIFAR10(
  (conv1): Conv2d(3, 6, kernel_size=(5, 5), stride=(1, 1))
  (pool): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
  (conv2): Conv2d(6, 16, kernel_size=(5, 5), stride=(1, 1))
  (fc1): Linear(in_features=400, out_features=256, bias=True)
  (fc2): Linear(in_features=256, out_features=128, bias=True)
  (fc3): Linear(in_features=128, out_features=10, bias=True)
)
```

19.3 Evaluation of the Tuned Architecture

```python
from spotPython.torch.traintest import (
    train_tuned,
    test_tuned,
    )
```

```python
train_tuned(net=model_spot, train_dataset=train,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        shuffle=True,
        device = fun_control["device"],
        path=None,
        task=fun_control["task"],)
```

```
Epoch: 1

Batch: 10000. Batch Size: 2. Training Loss (running): 2.303

Loss on hold-out set: 2.3002651344776153
Accuracy on hold-out set: 0.1067
MulticlassAccuracy value on hold-out data: 0.10670000314712524
Epoch: 2

Batch: 10000. Batch Size: 2. Training Loss (running): 2.298

Loss on hold-out set: 2.292454411530495
Accuracy on hold-out set: 0.159
MulticlassAccuracy value on hold-out data: 0.1589999943971634
Epoch: 3

Batch: 10000. Batch Size: 2. Training Loss (running): 2.287

Loss on hold-out set: 2.272455233335495
Accuracy on hold-out set: 0.21045
MulticlassAccuracy value on hold-out data: 0.21044999361038208
Epoch: 4

Batch: 10000. Batch Size: 2. Training Loss (running): 2.260
```

```
Loss on hold-out set: 2.2285228635787964
Accuracy on hold-out set: 0.22855
MulticlassAccuracy value on hold-out data: 0.2285500019788742
Epoch: 5

Batch: 10000. Batch Size: 2. Training Loss (running): 2.209

Loss on hold-out set: 2.165561222910881
Accuracy on hold-out set: 0.23795
MulticlassAccuracy value on hold-out data: 0.23794999718666077
Epoch: 6

Batch: 10000. Batch Size: 2. Training Loss (running): 2.146

Loss on hold-out set: 2.10649606180191
Accuracy on hold-out set: 0.24685
MulticlassAccuracy value on hold-out data: 0.24684999883174896
Epoch: 7

Batch: 10000. Batch Size: 2. Training Loss (running): 2.095

Loss on hold-out set: 2.059719757604599
Accuracy on hold-out set: 0.2544
MulticlassAccuracy value on hold-out data: 0.25440001487731934
Epoch: 8

Batch: 10000. Batch Size: 2. Training Loss (running): 2.053

Loss on hold-out set: 2.0211560929119585
Accuracy on hold-out set: 0.26435
MulticlassAccuracy value on hold-out data: 0.2643499970436096
Epoch: 9

Batch: 10000. Batch Size: 2. Training Loss (running): 2.016

Loss on hold-out set: 1.9876540986776352
Accuracy on hold-out set: 0.27595
MulticlassAccuracy value on hold-out data: 0.27595001459121704
Epoch: 10
```

```
Batch: 10000. Batch Size: 2. Training Loss (running): 1.984

Loss on hold-out set: 1.9595931525349617
Accuracy on hold-out set: 0.28395
MulticlassAccuracy value on hold-out data: 0.28395000100135803
Epoch: 11

Batch: 10000. Batch Size: 2. Training Loss (running): 1.955

Loss on hold-out set: 1.9373873460829258
Accuracy on hold-out set: 0.28895
MulticlassAccuracy value on hold-out data: 0.28894999623298645
Epoch: 12

Batch: 10000. Batch Size: 2. Training Loss (running): 1.932

Loss on hold-out set: 1.9198673758447171
Accuracy on hold-out set: 0.29555
MulticlassAccuracy value on hold-out data: 0.29554998874664307
Epoch: 13

Batch: 10000. Batch Size: 2. Training Loss (running): 1.910

Loss on hold-out set: 1.9058051634848119
Accuracy on hold-out set: 0.30005
MulticlassAccuracy value on hold-out data: 0.3000499904155731
Epoch: 14

Batch: 10000. Batch Size: 2. Training Loss (running): 1.896

Loss on hold-out set: 1.8928194347918033
Accuracy on hold-out set: 0.30685
MulticlassAccuracy value on hold-out data: 0.30684998631477356
Epoch: 15

Batch: 10000. Batch Size: 2. Training Loss (running): 1.882
```

```
Loss on hold-out set: 1.8813219832390546
Accuracy on hold-out set: 0.31315
MulticlassAccuracy value on hold-out data: 0.31314998865127563
Epoch: 16

Batch: 10000. Batch Size: 2. Training Loss (running): 1.877

Loss on hold-out set: 1.8710505510479212
Accuracy on hold-out set: 0.31695
MulticlassAccuracy value on hold-out data: 0.3169499933719635
Returned to Spot: Validation loss: 1.8710505510479212
----------------------------------------------
```

If `path` is set to a filename, e.g., `path = "model_spot_trained.pt"`, the weights of the trained model will be loaded from this file.

```
test_tuned(net=model_spot, test_dataset=test,
            shuffle=False,
            loss_function=fun_control["loss_function"],
            metric=fun_control["metric_torch"],
            device = fun_control["device"],
            task=fun_control["task"],)
```

```
Loss on hold-out set: 1.8615335381805898
Accuracy on hold-out set: 0.3257
MulticlassAccuracy value on hold-out data: 0.3257000148296356
Final evaluation: Validation loss: 1.8615335381805898
Final evaluation: Validation metric: 0.3257000148296356
----------------------------------------------

(1.8615335381805898, nan, tensor(0.3257, device='mps:0'))
```

19.4 Cross-validated Evaluations

```
from spotPython.torch.traintest import evaluate_cv
# modify k-kolds:
setattr(model_spot, "k_folds",  10)
df_eval, df_preds, df_metrics = evaluate_cv(net=model_spot,
            dataset=fun_control["data"],
```

```
                loss_function=fun_control["loss_function"],
                metric=fun_control["metric_torch"],
                task=fun_control["task"],
                writer=fun_control["writer"],
                writerId="model_spot_cv",
                device = fun_control["device"])
```

```
Error in Net_Core. Call to evaluate_cv() failed. err=TypeError("Expected sequence or array-li
```

```
metric_name = type(fun_control["metric_torch"]).__name__
print(f"loss: {df_eval}, Cross-validated {metric_name}: {df_metrics}")
```

```
loss: nan, Cross-validated MulticlassAccuracy: nan
```

19.5 Detailed Hyperparameter Plots

```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

```
l1:  63.86536562896963
l2:  100.0
batch_size:  0.18330726177105025
epochs:  0.1845002789569447
patience:  20.465098126857225
```

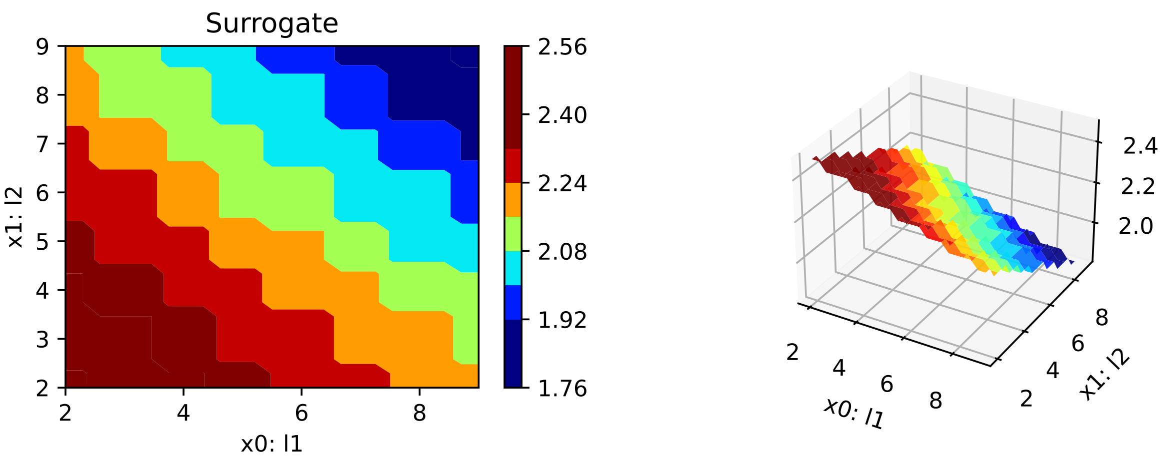
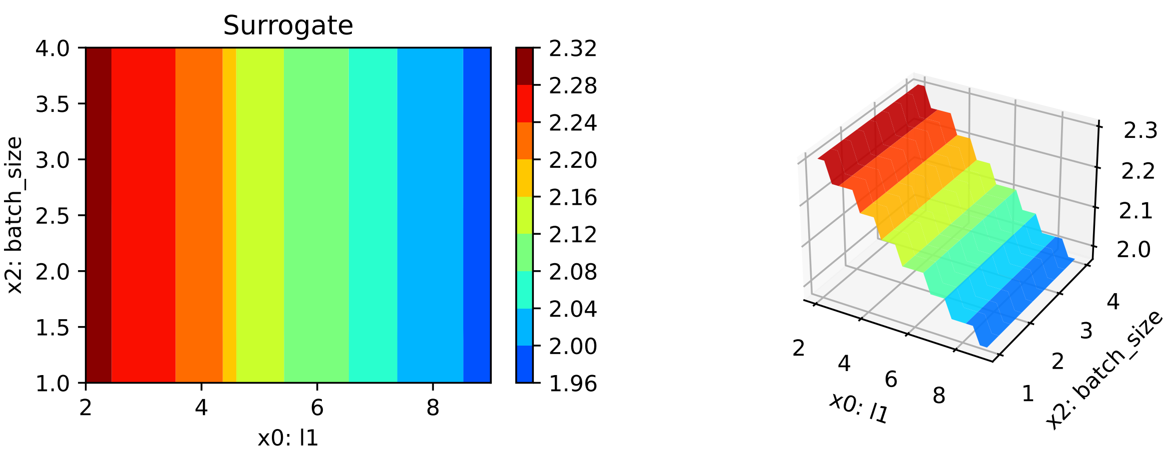
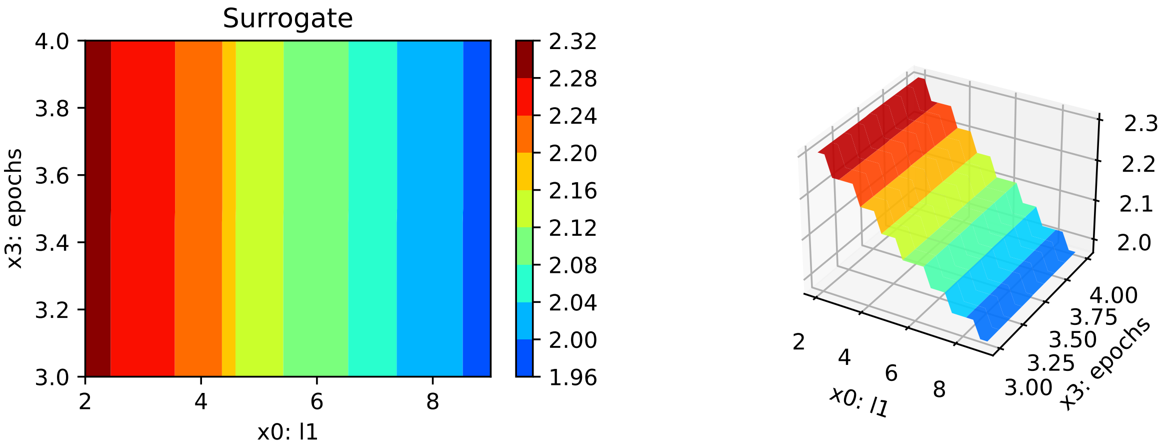
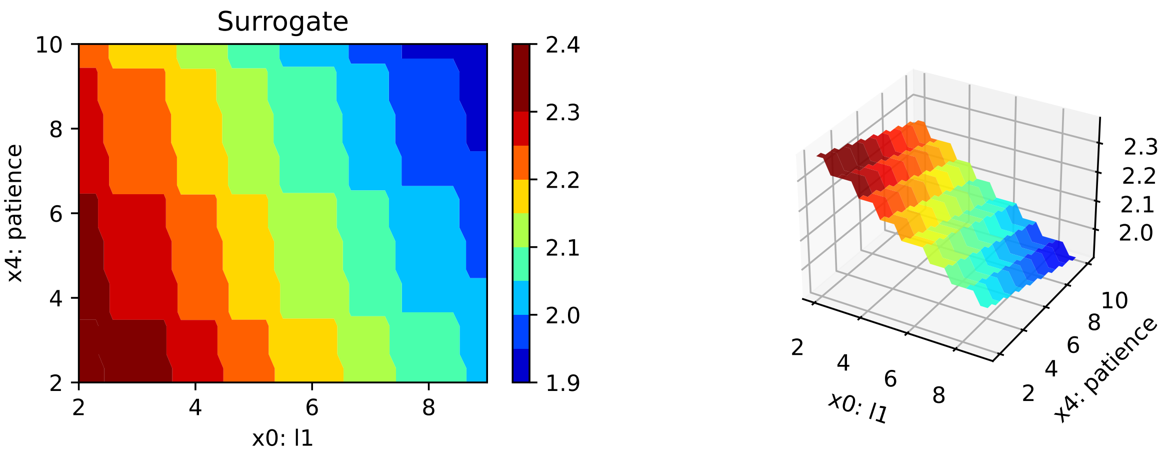
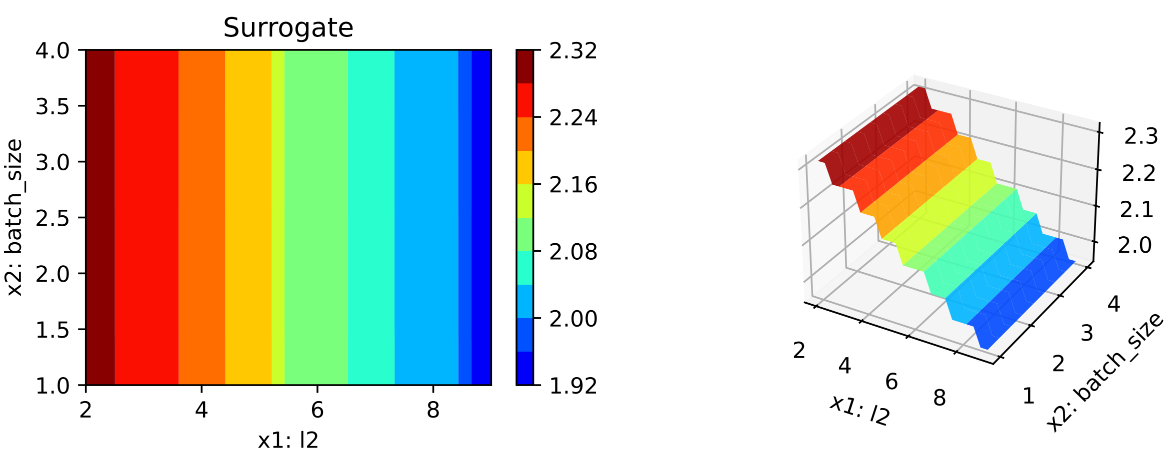


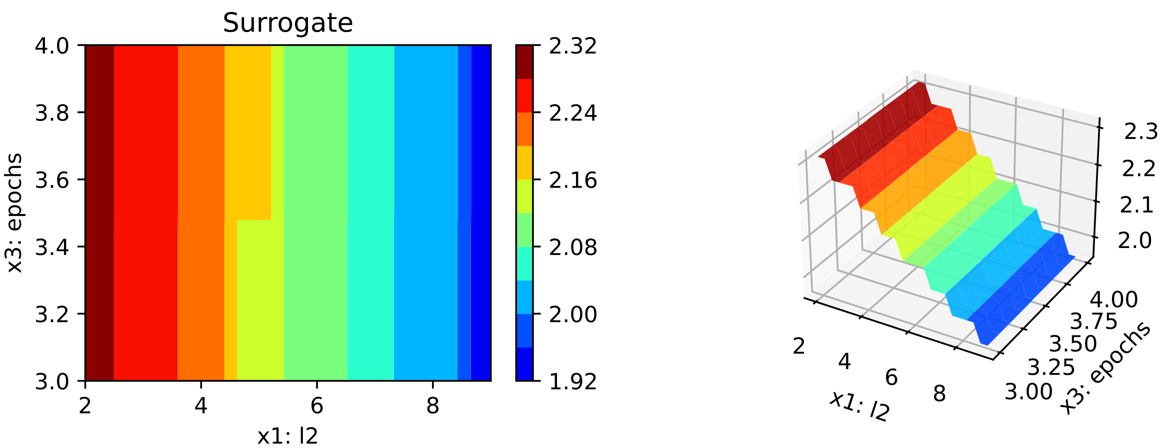
Figure 19.3: Contour plots.

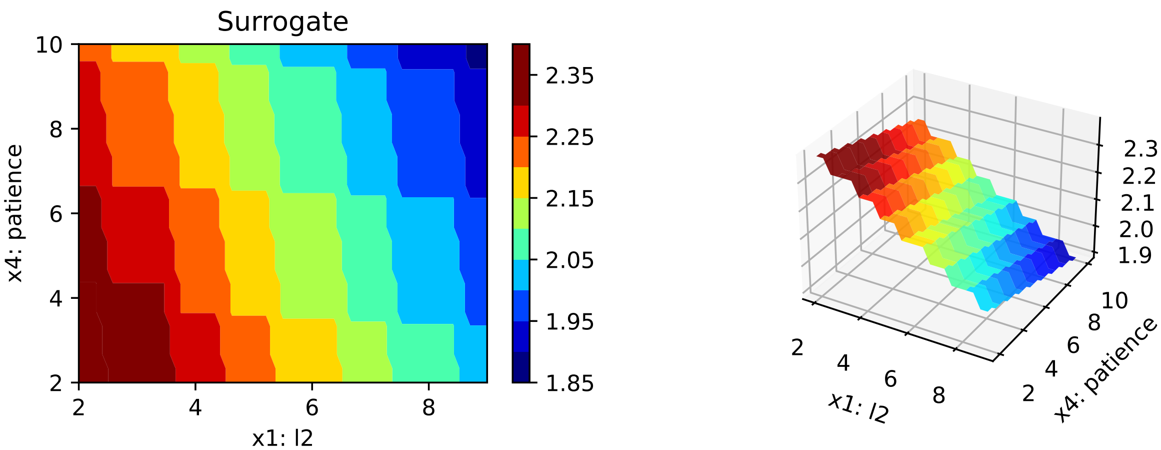


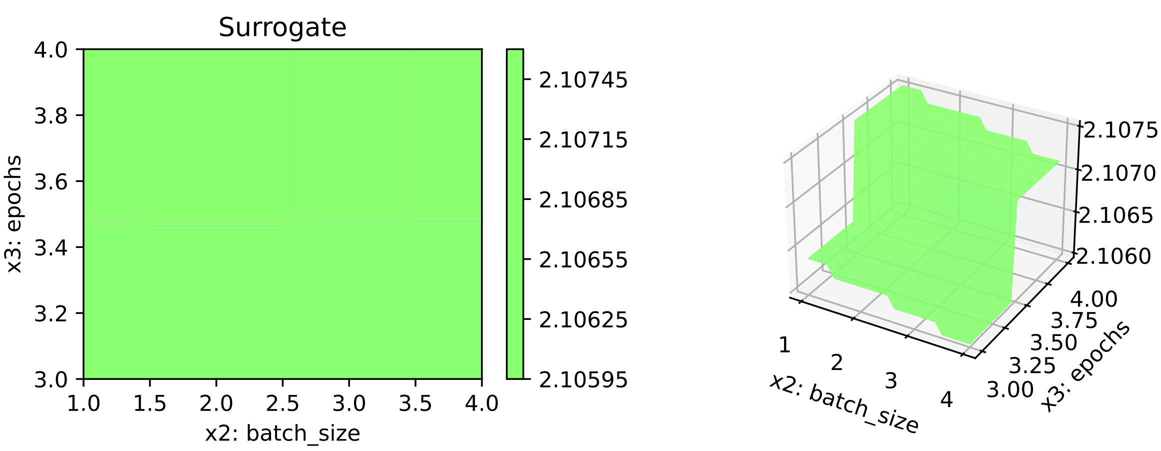

Surrogate
x3: epochs
x0: l1
x0: l1
x3: epochs

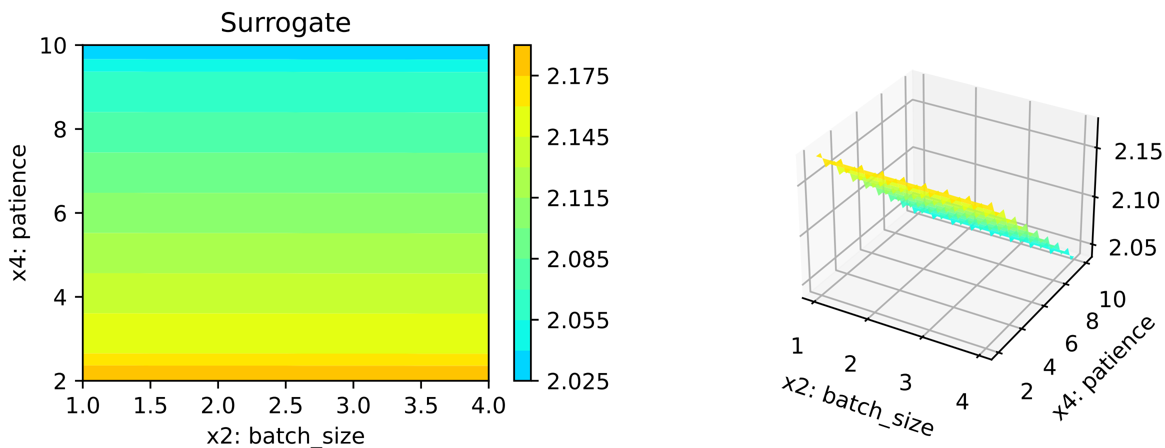

Surrogate
x4: patience
x0: l1
x0: l1
x4: patience

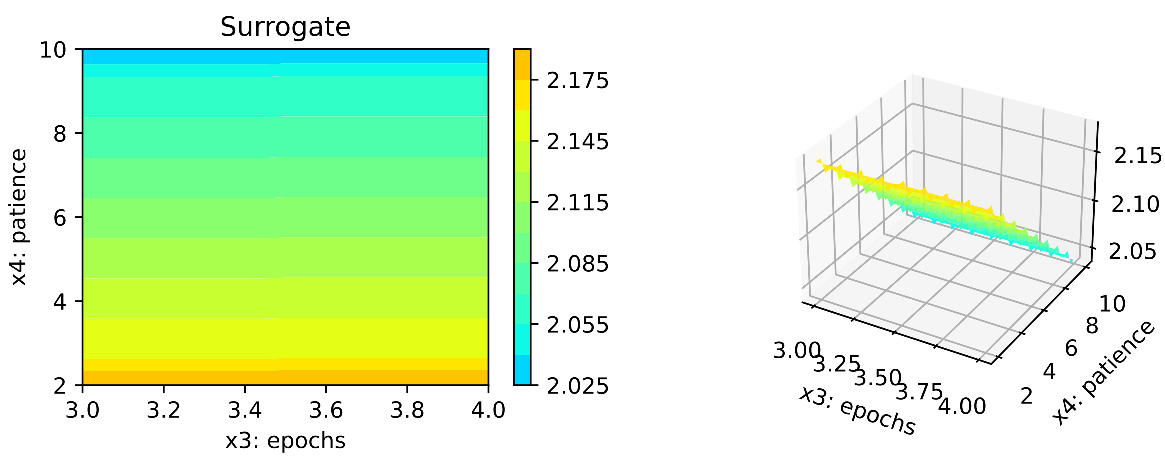

Surrogate
x2: batch_size
x1: l2
x1: l2
x2: batch_size


Surrogate
x3: epochs
x1: l2
2.32
2.24
2.16
2.08
2.00
1.92
x1: l2
x3: epochs


Surrogate
x4: patience
x1: l2
2.35
2.25
2.15
2.05
1.95
1.85
x1: l2
x4: patience


Surrogate
x3: epochs
x2: batch_size
2.10745
2.10715
2.10685
2.10655
2.10625
2.10595
x2: batch_size
x3: epochs





19.6 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

Parallel coordinates plots

```
Unable to display output for mime type(s): text/html
```

19.7 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
            spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

20 HPT: PyTorch With spotPython and Ray Tune on CIFAR10

In this tutorial, we will show how spotPython can be integrated into the PyTorch training workflow. It is based on the tutorial "Hyperparameter Tuning with Ray Tune" from the PyTorch documentation (PyTorch 2023a), which is an extension of the tutorial "Training a Classifier" (PyTorch 2023b) for training a CIFAR10 image classifier.

This document refers to the following software versions:

- python: 3.10.10
- torch: 2.0.1
- torchvision: 0.15.0

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                    0.2.33
spotRiver                     0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

spotPython can be installed via pip[1].

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of spotPython from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

[1]Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

Results that refer to the Ray Tune package are taken from https://PyTorch.org/tutorials/beginner/hyperparameter_tuning_tutorial.html[2].

20.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time, initial design size and the device that is used.

```
MAX_TIME = 30
INIT_SIZE = 10
DEVICE = "cpu" # "cuda:0"
```

```
from spotPython.utils.device import getDevice
DEVICE = getDevice(DEVICE)
print(DEVICE)
```

```
cpu
```

```
import os
import copy
import socket
import warnings
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '14-torch' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(INIT_SI
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
warnings.filterwarnings("ignore")
```

```
14-torch_p040025_30min_10init_2023-06-17_01-04-24
```

[2] We were not able to install Ray Tune on our system. Therefore, we used the results from the PyTorch tutorial.

20.2 Initialization of the fun_control Dictionary

spotPython uses a Python dictionary for storing the information required for the hyperparameter tuning process. This dictionary is called fun_control and is initialized with the function fun_control_init. The function fun_control_init returns a skeleton dictionary. The dictionary is filled with the required information for the hyperparameter tuning process. It stores the hyperparameter tuning settings, e.g., the deep learning network architecture that should be tuned, the classification (or regression) problem, and the data that is used for the tuning. The dictionary is used as an input for the SPOT function.

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/14_spot_ray_hpt_torch_cifar10",
    device=DEVICE,)
```

20.3 PyTorch Data Loading

The data loading process is implemented in the same manner as described in the Section "Data loaders" in PyTorch (2023a). The data loaders are wrapped into the function load_data_cifar10 which is identical to the function load_data in PyTorch (2023a). A global data directory is used, which allows sharing the data directory between different trials. The method load_data_cifar10 is part of the spotPython package and can be imported from spotPython.data.torchdata.

In the following step, the test and train data are added to the dictionary fun_control.

```
from spotPython.data.torchdata import load_data_cifar10
train, test = load_data_cifar10()
n_samples = len(train)
# add the dataset to the fun_control
fun_control.update({
    "train": train,
    "test": test,
    "n_samples": n_samples})
```

```
Files already downloaded and verified
```

```
Files already downloaded and verified
```

20.4 The Model (Algorithm) to be Tuned

20.4.1 Specification of the Preprocessing Model

After the training and test data are specified and added to the `fun_control` dictionary, `spotPython` allows the specification of a data preprocessing pipeline, e.g., for the scaling of the data or for the one-hot encoding of categorical variables. The preprocessing model is called `prep_model` ("preparation" or pre-processing) and includes steps that are not subject to the hyperparameter tuning process. The preprocessing model is specified in the `fun_control` dictionary. The preprocessing model can be implemented as a `sklearn` pipeline. The following code shows a typical preprocessing pipeline:

```
categorical_columns = ["cities", "colors"]
one_hot_encoder = OneHotEncoder(handle_unknown="ignore",
                                    sparse_output=False)
prep_model = ColumnTransformer(
        transformers=[
             ("categorical", one_hot_encoder, categorical_columns),
         ],
         remainder=StandardScaler(),
     )
```

Because the Ray Tune (`ray[tune]`) hyperparameter tuning as described in PyTorch (2023a) does not use a preprocessing model, the preprocessing model is set to `None` here.

```
prep_model = None
fun_control.update({"prep_model": prep_model})
```

20.4.2 Select `algorithm` and `core_model_hyper_dict`

The same neural network model as implemented in the section "Configurable neural network" of the `PyTorch` tutorial (PyTorch 2023a) is used here. We will show the implementation from PyTorch (2023a) in Section 20.4.2.1 first, before the extended implementation with `spotPython` is shown in **?@sec-implementation-with-spotpython**.

20.4.2.1 Implementing a Configurable Neural Network With Ray Tune

We used the same hyperparameters that are implemented as configurable in the `PyTorch` tutorial. We specify the layer sizes, namely `l1` and `l2`, of the fully connected layers:

```
class Net(nn.Module):
    def __init__(self, l1=120, l2=84):
        super(Net, self).__init__()
        self.conv1 = nn.Conv2d(3, 6, 5)
        self.pool = nn.MaxPool2d(2, 2)
        self.conv2 = nn.Conv2d(6, 16, 5)
        self.fc1 = nn.Linear(16 * 5 * 5, l1)
        self.fc2 = nn.Linear(l1, l2)
        self.fc3 = nn.Linear(l2, 10)

    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))
        x = self.pool(F.relu(self.conv2(x)))
        x = x.view(-1, 16 * 5 * 5)
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = self.fc3(x)
        return x
```

The learning rate, i.e., `lr`, of the optimizer is made configurable, too:

```
optimizer = optim.SGD(net.parameters(), lr=config["lr"], momentum=0.9)
```

20.4.2.2 Implementing a Configurable Neural Network With spotPython

`spotPython` implements a class which is similar to the class described in the `PyTorch` tutorial. The class is called `Net_CIFAR10` and is implemented in the file `netcifar10.py`.

```
from torch import nn
import torch.nn.functional as F
import spotPython.torch.netcore as netcore


class Net_CIFAR10(netcore.Net_Core):
    def __init__(self, l1, l2, lr_mult, batch_size, epochs, k_folds, patience,
    optimizer, sgd_momentum):
        super(Net_CIFAR10, self).__init__(
            lr_mult=lr_mult,
            batch_size=batch_size,
            epochs=epochs,
            k_folds=k_folds,
```

```
            patience=patience,
            optimizer=optimizer,
            sgd_momentum=sgd_momentum,
        )
        self.conv1 = nn.Conv2d(3, 6, 5)
        self.pool = nn.MaxPool2d(2, 2)
        self.conv2 = nn.Conv2d(6, 16, 5)
        self.fc1 = nn.Linear(16 * 5 * 5, l1)
        self.fc2 = nn.Linear(l1, l2)
        self.fc3 = nn.Linear(l2, 10)

    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))
        x = self.pool(F.relu(self.conv2(x)))
        x = x.view(-1, 16 * 5 * 5)
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = self.fc3(x)
        return x
```

20.4.3 The `Net_Core` class

`Net_CIFAR10` inherits from the class `Net_Core` which is implemented in the file `netcore.py`. It implements the additional attributes that are common to all neural network models. The `Net_Core` class is implemented in the file `netcore.py`. It implements hyperparameters as attributes, that are not used by the `core_model`, e.g.:

- optimizer (`optimizer`),
- learning rate (`lr`),
- batch size (`batch_size`),
- epochs (`epochs`),
- k_folds (`k_folds`), and
- early stopping criterion "patience" (`patience`).

Users can add further attributes to the class. The class `Net_Core` is shown below.

```
from torch import nn


class Net_Core(nn.Module):
    def __init__(self, lr_mult, batch_size, epochs, k_folds, patience,
```

```
            optimizer, sgd_momentum):
        super(Net_Core, self).__init__()
        self.lr_mult = lr_mult
        self.batch_size = batch_size
        self.epochs = epochs
        self.k_folds = k_folds
        self.patience = patience
        self.optimizer = optimizer
        self.sgd_momentum = sgd_momentum
```

20.4.4 Comparison of the Approach Described in the PyTorch Tutorial With spotPython

Comparing the class `Net` from the `PyTorch` tutorial and the class `Net_CIFAR10` from `spotPython`, we see that the class `Net_CIFAR10` has additional attributes and does not inherit from `nn` directly. It adds an additional class, `Net_core`, that takes care of additional attributes that are common to all neural network models, e.g., the learning rate multiplier `lr_mult` or the batch size `batch_size`.

`spotPython`'s `core_model` implements an instance of the `Net_CIFAR10` class. In addition to the basic neural network model, the `core_model` can use these additional attributes. `spotPython` provides methods for handling these additional attributes to guarantee 100% compatibility with the `PyTorch` classes. The method `add_core_model_to_fun_control` adds the hyper-parameters and additional attributes to the `fun_control` dictionary. The method is shown below.

```
from spotPython.torch.netcifar10 import Net_CIFAR10
from spotPython.data.torch_hyper_dict import TorchHyperDict
from spotPython.hyperparameters.values import add_core_model_to_fun_control
core_model = Net_CIFAR10
fun_control = add_core_model_to_fun_control(core_model=core_model,
                              fun_control=fun_control,
                              hyper_dict=TorchHyperDict,
                              filename=None)
```

20.5 The Search Space: Hyperparameters

In Section 20.5.1, we first describe how to configure the search space with `ray[tune]` (as shown in PyTorch (2023a)) and then how to configure the search space with `spotPython` in **?@sec-configuring-the-search-space-with-spotpython**.

20.5.1 Configuring the Search Space With Ray Tune

Ray Tune's search space can be configured as follows (PyTorch 2023a):

```
config = {
    "l1": tune.sample_from(lambda _: 2**np.random.randint(2, 9)),
    "l2": tune.sample_from(lambda _: 2**np.random.randint(2, 9)),
    "lr": tune.loguniform(1e-4, 1e-1),
    "batch_size": tune.choice([2, 4, 8, 16])
}
```

The `tune.sample_from()` function enables the user to define sample methods to obtain hyperparameters. In this example, the `l1` and `l2` parameters should be powers of 2 between 4 and 256, so either 4, 8, 16, 32, 64, 128, or 256. The `lr` (learning rate) should be uniformly sampled between 0.0001 and 0.1. Lastly, the batch size is a choice between 2, 4, 8, and 16.

At each trial, `ray[tune]` will randomly sample a combination of parameters from these search spaces. It will then train a number of models in parallel and find the best performing one among these. `ray[tune]` uses the `ASHAScheduler` which will terminate bad performing trials early.

20.5.2 Configuring the Search Space With spotPython

20.5.2.1 The `hyper_dict` Hyperparameters for the Selected Algorithm

`spotPython` uses `JSON` files for the specification of the hyperparameters. Users can specify their individual `JSON` files, or they can use the `JSON` files provided by `spotPython`. The `JSON` file for the `core_model` is called `torch_hyper_dict.json`.

In contrast to `ray[tune]`, `spotPython` can handle numerical, boolean, and categorical hyperparameters. They can be specified in the `JSON` file in a similar way as the numerical hyperparameters as shown below. Each entry in the `JSON` file represents one hyperparameter with the following structure: `type`, `default`, `transform`, `lower`, and `upper`.

```
"factor_hyperparameter": {
    "levels": ["A", "B", "C"],
    "type": "factor",
    "default": "B",
    "transform": "None",
    "core_model_parameter_type": "str",
    "lower": 0,
    "upper": 2},
```

The corresponding entries for the `Net_CIFAR10` class are shown below.

```
{"Net_CIFAR10":
    {
        "l1": {
            "type": "int",
            "default": 5,
            "transform": "transform_power_2_int",
            "lower": 2,
            "upper": 9},
        "l2": {
            "type": "int",
            "default": 5,
            "transform": "transform_power_2_int",
            "lower": 2,
            "upper": 9},
        "lr_mult": {
            "type": "float",
            "default": 1.0,
            "transform": "None",
            "lower": 0.1,
            "upper": 10},
        "batch_size": {
            "type": "int",
            "default": 4,
            "transform": "transform_power_2_int",
            "lower": 1,
            "upper": 4},
        "epochs": {
            "type": "int",
            "default": 3,
            "transform": "transform_power_2_int",
            "lower": 1,
            "upper": 4},
        "k_folds": {
            "type": "int",
            "default": 2,
            "transform": "None",
            "lower": 2,
            "upper": 3},
        "patience": {
            "type": "int",
```

```
            "default": 5,
            "transform": "None",
            "lower": 2,
            "upper": 10},
        "optimizer": {
            "levels": ["Adadelta",
                       "Adagrad",
                       "Adam",
                       "AdamW",
                       "SparseAdam",
                       "Adamax",
                       "ASGD",
                       "LBFGS",
                       "NAdam",
                       "RAdam",
                       "RMSprop",
                       "Rprop",
                       "SGD"],
            "type": "factor",
            "default": "SGD",
            "transform": "None",
            "class_name": "torch.optim",
            "core_model_parameter_type": "str",
            "lower": 0,
            "upper": 12},
        "sgd_momentum": {
            "type": "float",
            "default": 0.0,
            "transform": "None",
            "lower": 0.0,
            "upper": 1.0}
    }
}
```

20.5.3 Modifying the Hyperparameters

Ray tune (PyTorch 2023a) does not provide a way to change the specified hyperparameters without re-compilation. However, `spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions are described in the following.

20.5.3.1 Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

After specifying the model, the corresponding hyperparameters, their types and bounds are loaded from the JSON file `torch_hyper_dict.json`. After loading, the user can modify the hyperparameters, e.g., the bounds. `spotPython` provides a simple rule for de-activating hyperparameters: If the lower and the upper bound are set to identical values, the hyperparameter is de-activated. This is useful for the hyperparameter tuning, because it allows to specify a hyperparameter in the JSON file, but to de-activate it in the `fun_control` dictionary. This is done in the next step.

20.5.3.2 Modify Hyperparameters of Type numeric and integer (boolean)

Since the hyperparameter `k_folds` is not used in the PyTorch tutorial, it is de-activated here by setting the lower and upper bound to the same value. Note, `k_folds` is of type "integer".

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
fun_control = modify_hyper_parameter_bounds(fun_control,
    "batch_size", bounds=[1, 5])
fun_control = modify_hyper_parameter_bounds(fun_control,
    "k_folds", bounds=[0, 0])
fun_control = modify_hyper_parameter_bounds(fun_control,
    "patience", bounds=[3, 3])
```

20.5.3.3 Modify Hyperparameter of Type factor

In a similar manner as for the numerical hyperparameters, the categorical hyperparameters can be modified. New configurations can be chosen by adding or deleting levels. For example, the hyperparameter `optimizer` can be re-configured as follows:

In the following setting, two optimizers (`"SGD"` and `"Adam"`) will be compared during the `spotPython` hyperparameter tuning. The hyperparameter `optimizer` is active.

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
fun_control = modify_hyper_parameter_levels(fun_control,
     "optimizer", ["SGD", "Adam"])
```

The hyperparameter `optimizer` can be de-activated by choosing only one value (level), here: `"SGD"`.

```
fun_control = modify_hyper_parameter_levels(fun_control, "optimizer", ["SGD"])
```

As discussed in Section 20.6, there are some issues with the LBFGS optimizer. Therefore, the usage of the LBFGS optimizer is not deactivated in `spotPython` by default. However, the LBFGS optimizer can be activated by adding it to the list of optimizers. `Rprop` was removed, because it does perform very poorly (as some pre-tests have shown). However, it can also be activated by adding it to the list of optimizers. Since `SparseAdam` does not support dense gradients, `Adam` was used instead. Therefore, there are 10 default optimizers:

```
fun_control = modify_hyper_parameter_levels(fun_control, "optimizer",
    ["Adadelta", "Adagrad", "Adam", "AdamW", "Adamax", "ASGD",
    "NAdam", "RAdam", "RMSprop", "SGD"])
```

20.6 Optimizers

Table 20.1 shows some of the optimizers available in `PyTorch`:

a denotes (0.9,0.999), b (0.5,1.2), and c (1e-6, 50), respectively. R denotes `required, but unspecified`. "m" denotes `momentum`, "w_d" `weight_decay`, "d" `dampening`, "n" `nesterov`, "r" `rho`, "l_s" `learning rate for scaling delta`, "l_d" `lr_decay`, "b" `betas`, "l" `lambd`, "a" `alpha`, "m_d" for `momentum_decay`, "e" `etas`, and "s_s" for `step_sizes`.

Table 20.1: Optimizers available in PyTorch (selection). The default values are shown in the table.

Optimizer	lr	m	w_d	d	n	r	l_s	l_d	b	l	a	m_d	e	s_s
Adadelta	-	-	0.	-	-	0.9	1.	-	-	-	-	-	-	-
Adagrad	1e-2	-	0.	-	-	-	-	0.	-	-	-	-	-	-
Adam	1e-3	-	0.	-	-	-	-	-	a	-	-	-	-	-
AdamW	1e-3	-	1e-2	-	-	-	-	-	a	-	-	-	-	-
SparseAdam	1e-3	-	-	-	-	-	-	-	a	-	-	-	-	-
Adamax	2e-3	-	0.	-	-	-	-	-	a	-	-	-	-	-
ASGD	1e-2	.9	0.	-	F	-	-	-	-	1e-4	.75	-	-	-
LBFGS	1.	-	-	-	-	-	-	-	-	-	-	-	-	-
NAdam	2e-3	-	0.	-	-	-	-	-	a	-	-	0	-	-
RAdam	1e-3	-	0.	-	-	-	-	-	a	-	-	-	-	-
RMSprop	1e-2	0.	0.	-	-	-	-	-	a	-	-	-	-	-
Rprop	1e-2	-	-	-	-	-	-	-	-	-	b	c	-	-
SGD	R	0.	0.	0.	F	-	-	-	-	-	-	-	-	-

`spotPython` implements an `optimization` handler that maps the optimizer names to the corresponding `PyTorch` optimizers.

A note on LBFGS

We recommend deactivating `PyTorch`'s LBFGS optimizer, because it does not perform very well. The `PyTorch` documentation, see https://pytorch.org/docs/stable/generated/torch.optim.LBFGS.html#torch.optim.LBFGS, states:

> This is a very memory intensive optimizer (it requires additional `param_bytes * (history_size + 1)` bytes). If it doesn't fit in memory try reducing the history size, or use a different algorithm.

Furthermore, the LBFGS optimizer is not compatible with the `PyTorch` tutorial. The reason is that the LBFGS optimizer requires the `closure` function, which is not implemented in the `PyTorch` tutorial. Therefore, the `LBFGS` optimizer is recommended here. Since there are ten optimizers in the portfolio, it is not recommended tuning the hyperparameters that effect one single optimizer only.

A note on the learning rate

`spotPython` provides a multiplier for the default learning rates, `lr_mult`, because optimizers use different learning rates. Using a multiplier for the learning rates might enable a simultaneous tuning of the learning rates for all optimizers. However, this is not recommended, because the learning rates are not comparable across optimizers. Therefore, we recommend fixing the learning rate for all optimizers if multiple optimizers are used. This can be done by setting the lower and upper bounds of the learning rate multiplier to the same value as shown below.
Thus, the learning rate, which affects the `SGD` optimizer, will be set to a fixed value. We choose the default value of `1e-3` for the learning rate, because it is used in other `PyTorch` examples (it is also the default value used by `spotPython` as defined in the `optimizer_handler()` method). We recommend tuning the learning rate later, when a reduced set of optimizers is fixed. Here, we will demonstrate how to select in a screening phase the optimizers that should be used for the hyperparameter tuning.

For the same reason, we will fix the `sgd_momentum` to `0.9`.

```
fun_control = modify_hyper_parameter_bounds(fun_control,
    "lr_mult", bounds=[1.0, 1.0])
fun_control = modify_hyper_parameter_bounds(fun_control,
    "sgd_momentum", bounds=[0.9, 0.9])
```

20.7 Evaluation: Data Splitting

The evaluation procedure requires the specification of the way how the data is split into a train and a test set and the loss function (and a metric). As a default, `spotPython` provides a standard hold-out data split and cross validation.

20.7.1 Hold-out Data Split

If a hold-out data split is used, the data will be partitioned into a training, a validation, and a test data set. The split depends on the setting of the `eval` parameter. If `eval` is set to `train_hold_out`, one data set, usually the original training data set, is split into a new training and a validation data set. The training data set is used for training the model. The validation data set is used for the evaluation of the hyperparameter configuration and early stopping to prevent overfitting. In this case, the original test data set is not used.

> **Note**
>
> `spotPython` returns the hyperparameters of the machine learning and deep learning models, e.g., number of layers, learning rate, or optimizer, but not the model weights. Therefore, after the SPOT run is finished, the corresponding model with the optimized architecture has to be trained again with the best hyperparameter configuration. The training is performed on the training data set. The test data set is used for the final evaluation of the model.
> Summarizing, the following splits are performed in the hold-out setting:
>
> 1. Run `spotPython` with `eval` set to `train_hold_out` to determine the best hyperparameter configuration.
> 2. Train the model with the best hyperparameter configuration ("architecture") on the training data set: `train_tuned(model_spot, train, "model_spot.pt")`.
> 3. Test the model on the test data: `test_tuned(model_spot, test, "model_spot.pt")`
>
> These steps will be exemplified in the following sections.

In addition to this `hold-out` setting, `spotPython` provides another hold-out setting, where an explicit test data is specified by the user that will be used as the validation set. To choose this option, the `eval` parameter is set to `test_hold_out`. In this case, the training data set is used for the model training. Then, the explicitly defined test data set is used for the evaluation of the hyperparameter configuration (the validation).

20.7.2 Cross-Validation

The cross validation setting is used by setting the `eval` parameter to `train_cv` or `test_cv`. In both cases, the data set is split into k folds. The model is trained on $k-1$ folds and evaluated on the remaining fold. This is repeated k times, so that each fold is used exactly once for evaluation. The final evaluation is performed on the test data set. The cross validation setting is useful for small data sets, because it allows to use all data for training and evaluation. However, it is computationally expensive, because the model has to be trained k times.

> **Note**
>
> Combinations of the above settings are possible, e.g., cross validation can be used for training and hold-out for evaluation or *vice versa*. Also, cross validation can be used for training and testing. Because cross validation is not used in the `PyTorch` tutorial (PyTorch 2023a), it is not considered further here.

20.7.3 Overview of the Evaluation Settings

20.7.3.1 Settings for the Hyperparameter Tuning

An overview of the training evaluations is shown in Table 20.2. `"train_cv"` and `"test_cv"` use `sklearn.model_selection.KFold()` internally. More details on the data splitting are provided in Section 29.14 (in the Appendix).

Table 20.2: Overview of the evaluation settings.

`eval`	`train`	`test`	function	comment
`"train_hold_out"`	✓		`train_one_epoch()`, `validate_one_epoch()` for early stopping	splits the `train` data set internally
`"test_hold_out"`	✓	✓	`train_one_epoch()`, `validate_one_epoch()` for early stopping	use the `test data set` for `validate_one_epoch()`
`"train_cv"`	✓		`evaluate_cv(net, train)`	CV using the `train` data set
`"test_cv"`		✓	`evaluate_cv(net, test)`	CV using the `test` data set . Identical to `"train_cv"`, uses only test data.

20.7.3.2 Settings for the Final Evaluation of the Tuned Architecture

20.7.3.2.1 Training of the Tuned Architecture

`train_tuned(model, train)`: train the model with the best hyperparameter configuration (or simply the default) on the training data set. It splits the `train`data into new `train` and `validation` sets using `create_train_val_data_loaders()`, which calls `torch.utils.data.random_split()` internally. Currently, 60% of the data is used for training and 40% for validation. The `train` data is used for training the model with `train_hold_out()`. The `validation` data is used for early stopping using `validate_fold_or_hold_out()` on the `validation` data set.

20.7.3.2.2 Testing of the Tuned Architecture

`test_tuned(model, test)`: test the model on the test data set. No data splitting is performed. The (trained) model is evaluated using the `validate_fold_or_hold_out()` function. Note: During training, `"shuffle"` is set to `True`, whereas during testing, `"shuffle"` is set to `False`.

Section 29.14.1.4 describes the final evaluation of the tuned architecture.

```
fun_control.update({
    "eval": "train_hold_out",
    "path": "torch_model.pt",
    "shuffle": True})
```

20.8 Evaluation: Loss Functions and Metrics

The key `"loss_function"` specifies the loss function which is used during the optimization. There are several different loss functions under `PyTorch`'s `nn` package. For example, a simple loss is `MSELoss`, which computes the mean-squared error between the output and the target. In this tutorial we will use `CrossEntropyLoss`, because it is also used in the `PyTorch` tutorial.

```
from torch.nn import CrossEntropyLoss
loss_function = CrossEntropyLoss()
fun_control.update({"loss_function": loss_function})
```

In addition to the loss functions, `spotPython` provides access to a large number of metrics.

- The key `"metric_sklearn"` is used for metrics that follow the `scikit-learn` conventions.
- The key `"river_metric"` is used for the river based evaluation (Montiel et al. 2021) via `eval_oml_iter_progressive`, and

- the key "metric_torch" is used for the metrics from TorchMetrics.

TorchMetrics is a collection of more than 90 PyTorch metrics, see https://torchmetrics.readthedocs.io/en/latest/. Because the PyTorch tutorial uses the accuracy as metric, we use the same metric here. Currently, accuracy is computed in the tutorial's example code. We will use TorchMetrics instead, because it offers more flexibilty, e.g., it can be used for regression and classification. Furthermore, TorchMetrics offers the following advantages:

```
* A standardized interface to increase reproducibility
* Reduces Boilerplate
* Distributed-training compatible
* Rigorously tested
* Automatic accumulation over batches
* Automatic synchronization between multiple devices
```

Therefore, we set

```
import torchmetrics
metric_torch = torchmetrics.Accuracy(task="multiclass", num_classes=10).to(fun_control["de
fun_control.update({"metric_torch": metric_torch})
```

20.9 Preparing the SPOT Call

The following code passes the information about the parameter ranges and bounds to spot.

```
from spotPython.hyperparameters.values import (
    get_var_type,
    get_var_name,
    get_bound_values
    )
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})

lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

Now, the dictionary fun_control contains all information needed for the hyperparameter tuning. Before the hyperparameter tuning is started, it is recommended to take a look at the experimental design. The method gen_design_table generates a design table as follows:

```python
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name         | type   | default   |   lower |   upper | transform             |
|--------------|--------|-----------|---------|---------|-----------------------|
| l1           | int    | 5         |     2   |       9 | transform_power_2_int |
| l2           | int    | 5         |     2   |       9 | transform_power_2_int |
| lr_mult      | float  | 1.0       |     1   |       1 | None                  |
| batch_size   | int    | 4         |     1   |       5 | transform_power_2_int |
| epochs       | int    | 3         |     3   |       4 | transform_power_2_int |
| k_folds      | int    | 1         |     0   |       0 | None                  |
| patience     | int    | 5         |     3   |       3 | None                  |
| optimizer    | factor | SGD       |     0   |       9 | None                  |
| sgd_momentum | float  | 0.0       |     0.9 |     0.9 | None                  |
```

This allows to check if all information is available and if the information is correct. **?@tbl-design** shows the experimental design for the hyperparameter tuning. The table shows the hyperparameters, their types, default values, lower and upper bounds, and the transformation function. The transformation function is used to transform the hyperparameter values from the unit hypercube to the original domain. The transformation function is applied to the hyperparameter values before the evaluation of the objective function. Hyperparameter transformations are shown in the column "transform", e.g., the `l1` default is `5`, which results in the value $2^5 = 32$ for the network, because the transformation `transform_power_2_int` was selected in the `JSON` file. The default value of the `batch_size` is set to `4`, which results in a batch size of $2^4 = 16$.

20.10 The Objective Function `fun_torch`

The objective function `fun_torch` is selected next. It implements an interface from `PyTorch`'s training, validation, and testing methods to `spotPython`.

```python
from spotPython.fun.hypertorch import HyperTorch
fun = HyperTorch().fun_torch
```

20.11 Using Default Hyperparameters or Results from Previous Runs

We add the default setting to the initial design:

```python
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=TorchHyperDict().load()
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
```

20.12 Starting the Hyperparameter Tuning

The `spotPython` hyperparameter tuning is started by calling the `Spot` function. Here, we will run the tuner for approximately 30 minutes (`max_time`). Note: the initial design is always evaluated in the `spotPython` run. As a consequence, the run may take longer than specified by `max_time`, because the evaluation time of initial design (here: `init_size`, 10 points) is performed independently of `max_time`. During the run, results from the training is shown. These results can be visualized with Tensorboard as will be shown in Section 20.13.

```python
from spotPython.spot import spot
from math import inf
import numpy as np
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
                   show_progress= True,
                   fun_control = fun_control,
                   design_control={"init_size": INIT_SIZE,
                                   "repeats": 1},
                   surrogate_control={"noise": True,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": len(var_name),
```

```python
                                        "model_fun_evals": 10_000,
                                        "log_level": 50
                                        })
spot_tuner.run(X_start=X_start)
```

```
config: {'l1': 64, 'l2': 16, 'lr_mult': 1.0, 'batch_size': 16, 'epochs': 16, 'k_folds': 0, 'p
Epoch: 1

Loss on hold-out set: 1.4306812642097473
Accuracy on hold-out set: 0.47925
MulticlassAccuracy value on hold-out data: 0.4792500138282776
Epoch: 2

Loss on hold-out set: 1.2874604991436005
Accuracy on hold-out set: 0.5396
MulticlassAccuracy value on hold-out data: 0.5396000146865845
Epoch: 3

Loss on hold-out set: 1.282828919172287
Accuracy on hold-out set: 0.543
MulticlassAccuracy value on hold-out data: 0.5429999828338623
Epoch: 4

Loss on hold-out set: 1.2265083372831345
Accuracy on hold-out set: 0.56795
MulticlassAccuracy value on hold-out data: 0.5679500102996826
Epoch: 5

Loss on hold-out set: 1.2173708676815034
Accuracy on hold-out set: 0.57715
MulticlassAccuracy value on hold-out data: 0.5771499872207642
Epoch: 6

Loss on hold-out set: 1.1786785787343979
Accuracy on hold-out set: 0.58525
MulticlassAccuracy value on hold-out data: 0.5852500200271606
Epoch: 7
```

```
Loss on hold-out set: 1.1622201404571533
Accuracy on hold-out set: 0.59505
MulticlassAccuracy value on hold-out data: 0.5950499773025513
Epoch: 8

Loss on hold-out set: 1.170149846291542
Accuracy on hold-out set: 0.59195
MulticlassAccuracy value on hold-out data: 0.591949999332428
Epoch: 9

Loss on hold-out set: 1.2647821523427962
Accuracy on hold-out set: 0.57555
MulticlassAccuracy value on hold-out data: 0.5755500197410583
Epoch: 10

Loss on hold-out set: 1.1802328905344008
Accuracy on hold-out set: 0.59865
MulticlassAccuracy value on hold-out data: 0.5986499786376953
Early stopping at epoch 9
Returned to Spot: Validation loss: 1.1802328905344008
----------------------------------------------

config: {'l1': 16, 'l2': 128, 'lr_mult': 1.0, 'batch_size': 4, 'epochs': 16, 'k_folds': 0, '
Epoch: 1

Loss on hold-out set: 1.6067573073595762
Accuracy on hold-out set: 0.42145
MulticlassAccuracy value on hold-out data: 0.4214499890804291
Epoch: 2

Loss on hold-out set: 1.5253735073313117
Accuracy on hold-out set: 0.46095
MulticlassAccuracy value on hold-out data: 0.46094998717308044
Epoch: 3

Loss on hold-out set: 1.455203768053651
Accuracy on hold-out set: 0.48335
MulticlassAccuracy value on hold-out data: 0.48335000872612
Epoch: 4
```

```
Loss on hold-out set: 1.4042273283287883
Accuracy on hold-out set: 0.50515
MulticlassAccuracy value on hold-out data: 0.5051500201225281
Epoch: 5

Loss on hold-out set: 1.4249091316588223
Accuracy on hold-out set: 0.51115
MulticlassAccuracy value on hold-out data: 0.5111500024795532
Epoch: 6

Loss on hold-out set: 1.3886437204213813
Accuracy on hold-out set: 0.53065
MulticlassAccuracy value on hold-out data: 0.5306500196456909
Epoch: 7

Loss on hold-out set: 1.3819100944750011
Accuracy on hold-out set: 0.5279
MulticlassAccuracy value on hold-out data: 0.527899980545044
Epoch: 8

Loss on hold-out set: 1.4032988684602081
Accuracy on hold-out set: 0.53495
MulticlassAccuracy value on hold-out data: 0.5349500179290771
Epoch: 9

Loss on hold-out set: 1.4039077767902985
Accuracy on hold-out set: 0.53715
MulticlassAccuracy value on hold-out data: 0.5371500253677368
Epoch: 10

Loss on hold-out set: 1.3967863650199026
Accuracy on hold-out set: 0.53045
MulticlassAccuracy value on hold-out data: 0.5304499864578247
Early stopping at epoch 9
Returned to Spot: Validation loss: 1.3967863650199026
----------------------------------------------

config: {'l1': 32, 'l2': 8, 'lr_mult': 1.0, 'batch_size': 8, 'epochs': 8, 'k_folds': 0, 'pat
Epoch: 1
```

```
Loss on hold-out set: 1.9100081262111663
Accuracy on hold-out set: 0.2839
MulticlassAccuracy value on hold-out data: 0.2838999927043915
Epoch: 2

Loss on hold-out set: 1.791040790128708
Accuracy on hold-out set: 0.3297
MulticlassAccuracy value on hold-out data: 0.3296999931335449
Epoch: 3

Loss on hold-out set: 1.7061185071229934
Accuracy on hold-out set: 0.36485
MulticlassAccuracy value on hold-out data: 0.3648500144481659
Epoch: 4

Loss on hold-out set: 1.6543560555696488
Accuracy on hold-out set: 0.38695
MulticlassAccuracy value on hold-out data: 0.38694998621940613
Epoch: 5

Loss on hold-out set: 1.6165665497779846
Accuracy on hold-out set: 0.39945
MulticlassAccuracy value on hold-out data: 0.39945000410079956
Epoch: 6

Loss on hold-out set: 1.575402531671524
Accuracy on hold-out set: 0.41915
MulticlassAccuracy value on hold-out data: 0.4191499948501587
Epoch: 7

Loss on hold-out set: 1.539512190747261
Accuracy on hold-out set: 0.4307
MulticlassAccuracy value on hold-out data: 0.43070000410079956
Epoch: 8

Loss on hold-out set: 1.5153949534654618
Accuracy on hold-out set: 0.4432
MulticlassAccuracy value on hold-out data: 0.4431999921798706
Returned to Spot: Validation loss: 1.5153949534654618
----------------------------------------------
```

```
config: {'l1': 8, 'l2': 64, 'lr_mult': 1.0, 'batch_size': 4, 'epochs': 8, 'k_folds': 0, 'pat
Epoch: 1

Loss on hold-out set: 1.5793986296474933
Accuracy on hold-out set: 0.41925
MulticlassAccuracy value on hold-out data: 0.4192500114440918
Epoch: 2

Loss on hold-out set: 1.4967218861848115
Accuracy on hold-out set: 0.4642
MulticlassAccuracy value on hold-out data: 0.4641999900341034
Epoch: 3

Loss on hold-out set: 1.3964832404613494
Accuracy on hold-out set: 0.48815
MulticlassAccuracy value on hold-out data: 0.4881500005722046
Epoch: 4

Loss on hold-out set: 1.3773920050263404
Accuracy on hold-out set: 0.5078
MulticlassAccuracy value on hold-out data: 0.5077999830245972
Epoch: 5

Loss on hold-out set: 1.320092147295177
Accuracy on hold-out set: 0.52535
MulticlassAccuracy value on hold-out data: 0.5253499746322632
Epoch: 6

Loss on hold-out set: 1.322293487522006
Accuracy on hold-out set: 0.53175
MulticlassAccuracy value on hold-out data: 0.5317500233650208
Epoch: 7

Loss on hold-out set: 1.2887177420910447
Accuracy on hold-out set: 0.54355
MulticlassAccuracy value on hold-out data: 0.5435500144958496
Epoch: 8
```

```
Loss on hold-out set: 1.3636402491550892
Accuracy on hold-out set: 0.52875
MulticlassAccuracy value on hold-out data: 0.5287500023841858
Returned to Spot: Validation loss: 1.3636402491550892
----------------------------------------------

config: {'l1': 128, 'l2': 32, 'lr_mult': 1.0, 'batch_size': 8, 'epochs': 16, 'k_folds': 0, '
Epoch: 1

Loss on hold-out set: 1.4678894515395164
Accuracy on hold-out set: 0.46215
MulticlassAccuracy value on hold-out data: 0.4621500074863434
Epoch: 2

Loss on hold-out set: 1.365934226000309
Accuracy on hold-out set: 0.51235
MulticlassAccuracy value on hold-out data: 0.5123500227928162
Epoch: 3

Loss on hold-out set: 1.2513481228232384
Accuracy on hold-out set: 0.55815
MulticlassAccuracy value on hold-out data: 0.5581499934196472
Epoch: 4

Loss on hold-out set: 1.2532231189429759
Accuracy on hold-out set: 0.56565
MulticlassAccuracy value on hold-out data: 0.5656499862670898
Epoch: 5

Loss on hold-out set: 1.2208727785050868
Accuracy on hold-out set: 0.5757
MulticlassAccuracy value on hold-out data: 0.5756999850273132
Epoch: 6

Loss on hold-out set: 1.2484364964842796
Accuracy on hold-out set: 0.5826
MulticlassAccuracy value on hold-out data: 0.5825999975204468
Epoch: 7
```

```
Loss on hold-out set: 1.201146934700012
Accuracy on hold-out set: 0.5929
MulticlassAccuracy value on hold-out data: 0.5928999781608582
Epoch: 8

Loss on hold-out set: 1.210643686041236
Accuracy on hold-out set: 0.5952
MulticlassAccuracy value on hold-out data: 0.5952000021934509
Epoch: 9

Loss on hold-out set: 1.176044738766551
Accuracy on hold-out set: 0.6093
MulticlassAccuracy value on hold-out data: 0.6093000173568726
Epoch: 10

Loss on hold-out set: 1.2495336310520768
Accuracy on hold-out set: 0.59325
MulticlassAccuracy value on hold-out data: 0.5932499766349792
Epoch: 11

Loss on hold-out set: 1.2167631362348794
Accuracy on hold-out set: 0.6071
MulticlassAccuracy value on hold-out data: 0.6071000099182129
Epoch: 12

Loss on hold-out set: 1.2408745487242938
Accuracy on hold-out set: 0.61185
MulticlassAccuracy value on hold-out data: 0.6118500232696533
Early stopping at epoch 11
Returned to Spot: Validation loss: 1.2408745487242938
----------------------------------------------

config: {'l1': 512, 'l2': 16, 'lr_mult': 1.0, 'batch_size': 4, 'epochs': 16, 'k_folds': 0, '
Epoch: 1

Loss on hold-out set: 2.3047315659999845
Accuracy on hold-out set: 0.10055
MulticlassAccuracy value on hold-out data: 0.10055000334978104
Epoch: 2
```

```
Loss on hold-out set: 2.3063664959430694
Accuracy on hold-out set: 0.09805
MulticlassAccuracy value on hold-out data: 0.09804999828338623
Epoch: 3

Loss on hold-out set: 2.30809696393013
Accuracy on hold-out set: 0.0996
MulticlassAccuracy value on hold-out data: 0.09960000216960907
Epoch: 4

Loss on hold-out set: 2.3044415742874147
Accuracy on hold-out set: 0.10055
MulticlassAccuracy value on hold-out data: 0.10055000334978104
Epoch: 5

Loss on hold-out set: 2.305350080871582
Accuracy on hold-out set: 0.09975
MulticlassAccuracy value on hold-out data: 0.09974999725818634
Epoch: 6

Loss on hold-out set: 2.3052612186908723
Accuracy on hold-out set: 0.09925
MulticlassAccuracy value on hold-out data: 0.09925000369548798
Epoch: 7

Loss on hold-out set: 2.3088435369491576
Accuracy on hold-out set: 0.09805
MulticlassAccuracy value on hold-out data: 0.09804999828338623
Early stopping at epoch 6
Returned to Spot: Validation loss: 2.3088435369491576
----------------------------------------------

config: {'l1': 8, 'l2': 8, 'lr_mult': 1.0, 'batch_size': 16, 'epochs': 8, 'k_folds': 0, 'pat
Epoch: 1

Loss on hold-out set: 1.8623754084587096
Accuracy on hold-out set: 0.27325
MulticlassAccuracy value on hold-out data: 0.273250013589859
Epoch: 2
```

```
Loss on hold-out set: 1.776235922050476
Accuracy on hold-out set: 0.3235
MulticlassAccuracy value on hold-out data: 0.32350000739097595
Epoch: 3

Loss on hold-out set: 1.741853544330597
Accuracy on hold-out set: 0.3294
MulticlassAccuracy value on hold-out data: 0.3294000029563904
Epoch: 4

Loss on hold-out set: 1.7033901275634766
Accuracy on hold-out set: 0.35165
MulticlassAccuracy value on hold-out data: 0.3516499996185303
Epoch: 5

Loss on hold-out set: 1.6888611122131347
Accuracy on hold-out set: 0.36405
MulticlassAccuracy value on hold-out data: 0.3640500009059906
Epoch: 6

Loss on hold-out set: 1.6654997769832611
Accuracy on hold-out set: 0.3705
MulticlassAccuracy value on hold-out data: 0.37049999833106995
Epoch: 7

Loss on hold-out set: 1.6557770826339722
Accuracy on hold-out set: 0.3746
MulticlassAccuracy value on hold-out data: 0.37459999322891235
Epoch: 8

Loss on hold-out set: 1.6404891629219056
Accuracy on hold-out set: 0.3777
MulticlassAccuracy value on hold-out data: 0.37770000100135803
Returned to Spot: Validation loss: 1.6404891629219056
----------------------------------------------

config: {'l1': 256, 'l2': 64, 'lr_mult': 1.0, 'batch_size': 16, 'epochs': 8, 'k_folds': 0, '
Epoch: 1
```

```
Loss on hold-out set: 2.305667311286926
Accuracy on hold-out set: 0.1029
MulticlassAccuracy value on hold-out data: 0.10289999842643738
Epoch: 2

Loss on hold-out set: 2.305792136764526
Accuracy on hold-out set: 0.1003
MulticlassAccuracy value on hold-out data: 0.10029999911785126
Epoch: 3

Loss on hold-out set: 2.3036944473266603
Accuracy on hold-out set: 0.10035
MulticlassAccuracy value on hold-out data: 0.10034999996423721
Epoch: 4

Loss on hold-out set: 2.305685601043701
Accuracy on hold-out set: 0.1001
MulticlassAccuracy value on hold-out data: 0.10010000318288803
Epoch: 5

Loss on hold-out set: 2.303972578239441
Accuracy on hold-out set: 0.101
MulticlassAccuracy value on hold-out data: 0.10100000351667404
Epoch: 6

Loss on hold-out set: 2.3042093198776246
Accuracy on hold-out set: 0.1013
MulticlassAccuracy value on hold-out data: 0.10130000114440918
Early stopping at epoch 5
Returned to Spot: Validation loss: 2.3042093198776246
----------------------------------------------

config: {'l1': 256, 'l2': 512, 'lr_mult': 1.0, 'batch_size': 2, 'epochs': 8, 'k_folds': 0, '
Epoch: 1

Loss on hold-out set: 1.525756211230543
Accuracy on hold-out set: 0.4557
MulticlassAccuracy value on hold-out data: 0.45570001006126404
Epoch: 2
```

```
Loss on hold-out set: 1.7670370767640067
Accuracy on hold-out set: 0.4843
MulticlassAccuracy value on hold-out data: 0.48429998755455017
Epoch: 3

Loss on hold-out set: 1.5397802023611196
Accuracy on hold-out set: 0.5167
MulticlassAccuracy value on hold-out data: 0.516700029373169
Epoch: 4

Loss on hold-out set: 1.6149244302175834
Accuracy on hold-out set: 0.5255
MulticlassAccuracy value on hold-out data: 0.5254999995231628
Early stopping at epoch 3
Returned to Spot: Validation loss: 1.6149244302175834
----------------------------------------------

config: {'l1': 4, 'l2': 256, 'lr_mult': 1.0, 'batch_size': 32, 'epochs': 16, 'k_folds': 0, 'p
Epoch: 1

Loss on hold-out set: 1.6024003856658935
Accuracy on hold-out set: 0.41265
MulticlassAccuracy value on hold-out data: 0.4126499891281128
Epoch: 2

Loss on hold-out set: 1.4382855454444885
Accuracy on hold-out set: 0.46365
MulticlassAccuracy value on hold-out data: 0.4636499881744385
Epoch: 3

Loss on hold-out set: 1.4241823273658751
Accuracy on hold-out set: 0.469
MulticlassAccuracy value on hold-out data: 0.4690000116825104
Epoch: 4

Loss on hold-out set: 1.4171467416763306
Accuracy on hold-out set: 0.48055
MulticlassAccuracy value on hold-out data: 0.48054999113082886
Epoch: 5
```

```
Loss on hold-out set: 1.4680054027557372
Accuracy on hold-out set: 0.46185
MulticlassAccuracy value on hold-out data: 0.46184998750686646
Epoch: 6

Loss on hold-out set: 1.369798958492279
Accuracy on hold-out set: 0.503
MulticlassAccuracy value on hold-out data: 0.503000020980835
Epoch: 7

Loss on hold-out set: 1.3302633212089539
Accuracy on hold-out set: 0.5191
MulticlassAccuracy value on hold-out data: 0.51910001039505
Epoch: 8

Loss on hold-out set: 1.3390391869544982
Accuracy on hold-out set: 0.51955
MulticlassAccuracy value on hold-out data: 0.5195500254631042
Epoch: 9

Loss on hold-out set: 1.3369562252044678
Accuracy on hold-out set: 0.5133
MulticlassAccuracy value on hold-out data: 0.5133000016212463
Epoch: 10

Loss on hold-out set: 1.4652663353919984
Accuracy on hold-out set: 0.49225
MulticlassAccuracy value on hold-out data: 0.492249995470047
Early stopping at epoch 9
Returned to Spot: Validation loss: 1.4652663353919984
----------------------------------------------


config: {'l1': 64, 'l2': 8, 'lr_mult': 1.0, 'batch_size': 16, 'epochs': 16, 'k_folds': 0, 'pa
Epoch: 1

Loss on hold-out set: 1.6278654213905335
Accuracy on hold-out set: 0.39095
MulticlassAccuracy value on hold-out data: 0.3909499943256378
Epoch: 2
```

```
Loss on hold-out set: 1.5118595982074738
Accuracy on hold-out set: 0.44775
MulticlassAccuracy value on hold-out data: 0.4477500021457672
Epoch: 3

Loss on hold-out set: 1.4134510925769805
Accuracy on hold-out set: 0.4844
MulticlassAccuracy value on hold-out data: 0.4844000041484833
Epoch: 4

Loss on hold-out set: 1.3681308899402618
Accuracy on hold-out set: 0.4933
MulticlassAccuracy value on hold-out data: 0.4932999908924103
Epoch: 5

Loss on hold-out set: 1.3098559761047364
Accuracy on hold-out set: 0.52605
MulticlassAccuracy value on hold-out data: 0.5260499715805054
Epoch: 6

Loss on hold-out set: 1.2718631707191468
Accuracy on hold-out set: 0.5426
MulticlassAccuracy value on hold-out data: 0.5425999760627747
Epoch: 7

Loss on hold-out set: 1.2704580859661103
Accuracy on hold-out set: 0.5432
MulticlassAccuracy value on hold-out data: 0.5432000160217285
Epoch: 8

Loss on hold-out set: 1.2742108643054961
Accuracy on hold-out set: 0.5497
MulticlassAccuracy value on hold-out data: 0.5497000217437744
Epoch: 9

Loss on hold-out set: 1.2228587022304536
Accuracy on hold-out set: 0.5622
MulticlassAccuracy value on hold-out data: 0.5622000098228455
Epoch: 10
```

```
Loss on hold-out set: 1.2450310061216354
Accuracy on hold-out set: 0.563
MulticlassAccuracy value on hold-out data: 0.5630000233650208
Epoch: 11

Loss on hold-out set: 1.2360585430145263
Accuracy on hold-out set: 0.56465
MulticlassAccuracy value on hold-out data: 0.5646499991416931
Epoch: 12

Loss on hold-out set: 1.2640958865880967
Accuracy on hold-out set: 0.57295
MulticlassAccuracy value on hold-out data: 0.572950005531311
Early stopping at epoch 11
Returned to Spot: Validation loss: 1.2640958865880967
----------------------------------------------

spotPython tuning: 1.1802328905344008 [#---------] 8.26%


config: {'l1': 4, 'l2': 32, 'lr_mult': 1.0, 'batch_size': 8, 'epochs': 8, 'k_folds': 0, 'pat
Epoch: 1

Loss on hold-out set: 1.5730457491397858
Accuracy on hold-out set: 0.39705
MulticlassAccuracy value on hold-out data: 0.39704999327659607
Epoch: 2

Loss on hold-out set: 1.5095504369974135
Accuracy on hold-out set: 0.4332
MulticlassAccuracy value on hold-out data: 0.43320000171661377
Epoch: 3

Loss on hold-out set: 1.5143839775323868
Accuracy on hold-out set: 0.4395
MulticlassAccuracy value on hold-out data: 0.43950000405311584
Epoch: 4

Loss on hold-out set: 1.5047466913223266
Accuracy on hold-out set: 0.4441
MulticlassAccuracy value on hold-out data: 0.4440999925136566
Epoch: 5
```

```
Loss on hold-out set: 1.5035711761713029
Accuracy on hold-out set: 0.45065
MulticlassAccuracy value on hold-out data: 0.45065000653266907
Epoch: 6

Loss on hold-out set: 1.5125028732061385
Accuracy on hold-out set: 0.4466
MulticlassAccuracy value on hold-out data: 0.4465999901294708
Epoch: 7

Loss on hold-out set: 1.4745117701292039
Accuracy on hold-out set: 0.46655
MulticlassAccuracy value on hold-out data: 0.46654999256134033
Epoch: 8

Loss on hold-out set: 1.4829563977599145
Accuracy on hold-out set: 0.45455
MulticlassAccuracy value on hold-out data: 0.45454999804496765
Returned to Spot: Validation loss: 1.4829563977599145
----------------------------------------------

spotPython tuning: 1.1802328905344008 [#---------] 12.33%


config: {'l1': 64, 'l2': 8, 'lr_mult': 1.0, 'batch_size': 32, 'epochs': 16, 'k_folds': 0, 'pa
Epoch: 1

Loss on hold-out set: 1.5147586137771607
Accuracy on hold-out set: 0.4381
MulticlassAccuracy value on hold-out data: 0.43810001015663147
Epoch: 2

Loss on hold-out set: 1.430424554824829
Accuracy on hold-out set: 0.4781
MulticlassAccuracy value on hold-out data: 0.4781000018119812
Epoch: 3

Loss on hold-out set: 1.2610683115005492
Accuracy on hold-out set: 0.5406
MulticlassAccuracy value on hold-out data: 0.5406000018119812
Epoch: 4
```

```
Loss on hold-out set: 1.2136215579032898
Accuracy on hold-out set: 0.56045
MulticlassAccuracy value on hold-out data: 0.56045001745224
Epoch: 5

Loss on hold-out set: 1.2058160799980164
Accuracy on hold-out set: 0.5682
MulticlassAccuracy value on hold-out data: 0.5681999921798706
Epoch: 6

Loss on hold-out set: 1.207321606349945
Accuracy on hold-out set: 0.57505
MulticlassAccuracy value on hold-out data: 0.5750499963760376
Epoch: 7

Loss on hold-out set: 1.1816756633758545
Accuracy on hold-out set: 0.58065
MulticlassAccuracy value on hold-out data: 0.5806499719619751
Epoch: 8

Loss on hold-out set: 1.2365768922805787
Accuracy on hold-out set: 0.5755
MulticlassAccuracy value on hold-out data: 0.5755000114440918
Epoch: 9

Loss on hold-out set: 1.1826863099098206
Accuracy on hold-out set: 0.5864
MulticlassAccuracy value on hold-out data: 0.5863999724388123
Epoch: 10

Loss on hold-out set: 1.1524706124305726
Accuracy on hold-out set: 0.59805
MulticlassAccuracy value on hold-out data: 0.5980499982833862
Epoch: 11

Loss on hold-out set: 1.1985977031707764
Accuracy on hold-out set: 0.59155
MulticlassAccuracy value on hold-out data: 0.5915499925613403
Epoch: 12
```

```
Loss on hold-out set: 1.1777251099586488
Accuracy on hold-out set: 0.59205
MulticlassAccuracy value on hold-out data: 0.5920500159263611
Epoch: 13

Loss on hold-out set: 1.1950836897850037
Accuracy on hold-out set: 0.5955
MulticlassAccuracy value on hold-out data: 0.5954999923706055
Early stopping at epoch 12
Returned to Spot: Validation loss: 1.1950836897850037
----------------------------------------------

spotPython tuning: 1.1802328905344008 [##--------] 20.06%


config: {'l1': 64, 'l2': 512, 'lr_mult': 1.0, 'batch_size': 2, 'epochs': 16, 'k_folds': 0, '
Epoch: 1

Loss on hold-out set: 1.8480640769589227
Accuracy on hold-out set: 0.392
MulticlassAccuracy value on hold-out data: 0.3919999897480011
Epoch: 2

Loss on hold-out set: 1.6815134282298532
Accuracy on hold-out set: 0.4179
MulticlassAccuracy value on hold-out data: 0.4178999960422516
Epoch: 3

Loss on hold-out set: 1.6031534906628075
Accuracy on hold-out set: 0.4297
MulticlassAccuracy value on hold-out data: 0.42969998717308044
Epoch: 4

Loss on hold-out set: 1.6721884826379934
Accuracy on hold-out set: 0.4513
MulticlassAccuracy value on hold-out data: 0.4512999951839447
Epoch: 5

Loss on hold-out set: 1.670200563044157
Accuracy on hold-out set: 0.4522
MulticlassAccuracy value on hold-out data: 0.4521999955177307
Epoch: 6
```

```
Loss on hold-out set: 1.6717594033969443
Accuracy on hold-out set: 0.4621
MulticlassAccuracy value on hold-out data: 0.46209999918937683
Early stopping at epoch 5
Returned to Spot: Validation loss: 1.6717594033969443
----------------------------------------------

spotPython tuning: 1.1802328905344008 [###-------] 27.62%


config: {'l1': 512, 'l2': 16, 'lr_mult': 1.0, 'batch_size': 8, 'epochs': 16, 'k_folds': 0, 'p
Epoch: 1

Loss on hold-out set: 1.4677921263575553
Accuracy on hold-out set: 0.46455
MulticlassAccuracy value on hold-out data: 0.4645499885082245
Epoch: 2

Loss on hold-out set: 1.3399489173173904
Accuracy on hold-out set: 0.52515
MulticlassAccuracy value on hold-out data: 0.5251500010490417
Epoch: 3

Loss on hold-out set: 1.2953410104691983
Accuracy on hold-out set: 0.54465
MulticlassAccuracy value on hold-out data: 0.5446500182151794
Epoch: 4

Loss on hold-out set: 1.2323901757925748
Accuracy on hold-out set: 0.5808
MulticlassAccuracy value on hold-out data: 0.5807999968528748
Epoch: 5

Loss on hold-out set: 1.2806281982243062
Accuracy on hold-out set: 0.5774
MulticlassAccuracy value on hold-out data: 0.5774000287055969
Epoch: 6

Loss on hold-out set: 1.372455614438653
Accuracy on hold-out set: 0.5554
MulticlassAccuracy value on hold-out data: 0.555400013923645
Epoch: 7
```

```
Loss on hold-out set: 1.377231997743249
Accuracy on hold-out set: 0.5765
MulticlassAccuracy value on hold-out data: 0.5764999985694885
Early stopping at epoch 6
Returned to Spot: Validation loss: 1.377231997743249
----------------------------------------------

spotPython tuning: 1.1802328905344008 [###-------] 32.24%


config: {'l1': 4, 'l2': 32, 'lr_mult': 1.0, 'batch_size': 16, 'epochs': 16, 'k_folds': 0, 'pa
Epoch: 1

Loss on hold-out set: 1.767074877166748
Accuracy on hold-out set: 0.30095
MulticlassAccuracy value on hold-out data: 0.30094999074935913
Epoch: 2

Loss on hold-out set: 1.6564425223350525
Accuracy on hold-out set: 0.35335
MulticlassAccuracy value on hold-out data: 0.3533500134944916
Epoch: 3

Loss on hold-out set: 1.6362954303741455
Accuracy on hold-out set: 0.36355
MulticlassAccuracy value on hold-out data: 0.36355000734329224
Epoch: 4

Loss on hold-out set: 1.5928654369354247
Accuracy on hold-out set: 0.37195
MulticlassAccuracy value on hold-out data: 0.3719500005245209
Epoch: 5

Loss on hold-out set: 1.59244803647995
Accuracy on hold-out set: 0.39545
MulticlassAccuracy value on hold-out data: 0.39544999599456787
Epoch: 6

Loss on hold-out set: 1.5562037865161895
Accuracy on hold-out set: 0.40925
MulticlassAccuracy value on hold-out data: 0.4092499911785126
Epoch: 7
```

```
Loss on hold-out set: 1.5433967335224152
Accuracy on hold-out set: 0.40515
MulticlassAccuracy value on hold-out data: 0.40514999628067017
Epoch: 8

Loss on hold-out set: 1.539534424686432
Accuracy on hold-out set: 0.4162
MulticlassAccuracy value on hold-out data: 0.41620001196861267
Epoch: 9

Loss on hold-out set: 1.5377267260074616
Accuracy on hold-out set: 0.41375
MulticlassAccuracy value on hold-out data: 0.4137499928474426
Epoch: 10

Loss on hold-out set: 1.558548340511322
Accuracy on hold-out set: 0.41875
MulticlassAccuracy value on hold-out data: 0.41874998807907104
Epoch: 11

Loss on hold-out set: 1.464742281293869
Accuracy on hold-out set: 0.457
MulticlassAccuracy value on hold-out data: 0.4569999873638153
Epoch: 12

Loss on hold-out set: 1.4302316156864165
Accuracy on hold-out set: 0.4697
MulticlassAccuracy value on hold-out data: 0.46970000863075256
Epoch: 13

Loss on hold-out set: 1.4001909207820893
Accuracy on hold-out set: 0.47725
MulticlassAccuracy value on hold-out data: 0.47725000977516174
Epoch: 14

Loss on hold-out set: 1.4104538776874542
Accuracy on hold-out set: 0.4793
MulticlassAccuracy value on hold-out data: 0.47929999232292175
Epoch: 15
```

```
Loss on hold-out set: 1.4472184437274933
Accuracy on hold-out set: 0.4637
MulticlassAccuracy value on hold-out data: 0.46369999647140503
Epoch: 16

Loss on hold-out set: 1.4021585139274597
Accuracy on hold-out set: 0.4678
MulticlassAccuracy value on hold-out data: 0.46779999136924744
Early stopping at epoch 15
Returned to Spot: Validation loss: 1.4021585139274597
----------------------------------------------

spotPython tuning: 1.1802328905344008 [####------] 43.41%


config: {'l1': 64, 'l2': 16, 'lr_mult': 1.0, 'batch_size': 32, 'epochs': 16, 'k_folds': 0, 'p
Epoch: 1

Loss on hold-out set: 1.4979570333480834
Accuracy on hold-out set: 0.45555
MulticlassAccuracy value on hold-out data: 0.4555499851703644
Epoch: 2

Loss on hold-out set: 1.3484232211112976
Accuracy on hold-out set: 0.52025
MulticlassAccuracy value on hold-out data: 0.5202500224113464
Epoch: 3

Loss on hold-out set: 1.3005399406433105
Accuracy on hold-out set: 0.5315
MulticlassAccuracy value on hold-out data: 0.531499981880188
Epoch: 4

Loss on hold-out set: 1.2074069131851197
Accuracy on hold-out set: 0.57065
MulticlassAccuracy value on hold-out data: 0.5706499814987183
Epoch: 5

Loss on hold-out set: 1.2013441180229187
Accuracy on hold-out set: 0.5717
MulticlassAccuracy value on hold-out data: 0.5716999769210815
Epoch: 6
```

```
Loss on hold-out set: 1.181404997253418
Accuracy on hold-out set: 0.5932
MulticlassAccuracy value on hold-out data: 0.5932000279426575
Epoch: 7

Loss on hold-out set: 1.1909063232421875
Accuracy on hold-out set: 0.5935
MulticlassAccuracy value on hold-out data: 0.593500018119812
Epoch: 8

Loss on hold-out set: 1.1779074981689452
Accuracy on hold-out set: 0.5939
MulticlassAccuracy value on hold-out data: 0.5939000248908997
Epoch: 9

Loss on hold-out set: 1.1767949049472808
Accuracy on hold-out set: 0.5987
MulticlassAccuracy value on hold-out data: 0.5986999869346619
Epoch: 10

Loss on hold-out set: 1.1978304590702056
Accuracy on hold-out set: 0.59935
MulticlassAccuracy value on hold-out data: 0.5993499755859375
Epoch: 11

Loss on hold-out set: 1.1749360719680786
Accuracy on hold-out set: 0.6063
MulticlassAccuracy value on hold-out data: 0.6062999963760376
Epoch: 12

Loss on hold-out set: 1.2009423115730287
Accuracy on hold-out set: 0.6081
MulticlassAccuracy value on hold-out data: 0.6080999970436096
Epoch: 13

Loss on hold-out set: 1.2604847757339477
Accuracy on hold-out set: 0.59005
MulticlassAccuracy value on hold-out data: 0.5900499820709229
Epoch: 14
```

```
Loss on hold-out set: 1.19312126994133
Accuracy on hold-out set: 0.6127
MulticlassAccuracy value on hold-out data: 0.6126999855041504
Early stopping at epoch 13
Returned to Spot: Validation loss: 1.19312126994133
----------------------------------------------

spotPython tuning: 1.1802328905344008 [#####-----] 51.99%


config: {'l1': 64, 'l2': 16, 'lr_mult': 1.0, 'batch_size': 2, 'epochs': 16, 'k_folds': 0, 'pa
Epoch: 1

Loss on hold-out set: 1.7198110010744305
Accuracy on hold-out set: 0.4253
MulticlassAccuracy value on hold-out data: 0.4253000020980835
Epoch: 2

Loss on hold-out set: 1.6668502329445074
Accuracy on hold-out set: 0.4728
MulticlassAccuracy value on hold-out data: 0.47279998660087585
Epoch: 3

Loss on hold-out set: 1.5580049613073497
Accuracy on hold-out set: 0.49185
MulticlassAccuracy value on hold-out data: 0.49184998869895935
Epoch: 4

Loss on hold-out set: 1.7295640666895267
Accuracy on hold-out set: 0.49095
MulticlassAccuracy value on hold-out data: 0.49094998836517334
Epoch: 5

Loss on hold-out set: 1.738008914046018
Accuracy on hold-out set: 0.5042
MulticlassAccuracy value on hold-out data: 0.5041999816894531
Epoch: 6
```

```
Loss on hold-out set: 1.614613788712496
Accuracy on hold-out set: 0.523
MulticlassAccuracy value on hold-out data: 0.5230000019073486
Early stopping at epoch 5
Returned to Spot: Validation loss: 1.614613788712496
----------------------------------------------

spotPython tuning: 1.1802328905344008 [######----] 59.08%


config: {'l1': 64, 'l2': 4, 'lr_mult': 1.0, 'batch_size': 16, 'epochs': 16, 'k_folds': 0, 'pa
Epoch: 1

Loss on hold-out set: 1.6416352329254151
Accuracy on hold-out set: 0.3832
MulticlassAccuracy value on hold-out data: 0.3831999897956848
Epoch: 2

Loss on hold-out set: 1.6298327936649322
Accuracy on hold-out set: 0.3969
MulticlassAccuracy value on hold-out data: 0.3968999981880188
Epoch: 3

Loss on hold-out set: 1.467239964866638
Accuracy on hold-out set: 0.4652
MulticlassAccuracy value on hold-out data: 0.4652000069618225
Epoch: 4

Loss on hold-out set: 1.4411556251525879
Accuracy on hold-out set: 0.48325
MulticlassAccuracy value on hold-out data: 0.4832499921321869
Epoch: 5

Loss on hold-out set: 1.4595259920597077
Accuracy on hold-out set: 0.49245
MulticlassAccuracy value on hold-out data: 0.4924499988555908
Epoch: 6

Loss on hold-out set: 1.4222022557258607
Accuracy on hold-out set: 0.4893
MulticlassAccuracy value on hold-out data: 0.489300012588501
Epoch: 7
```

```
Loss on hold-out set: 1.3861358450889587
Accuracy on hold-out set: 0.5107
MulticlassAccuracy value on hold-out data: 0.510699987411499
Epoch: 8

Loss on hold-out set: 1.418025268149376
Accuracy on hold-out set: 0.4979
MulticlassAccuracy value on hold-out data: 0.49790000915527344
Epoch: 9

Loss on hold-out set: 1.4708105335474013
Accuracy on hold-out set: 0.5131
MulticlassAccuracy value on hold-out data: 0.5131000280380249
Epoch: 10

Loss on hold-out set: 1.433475613451004
Accuracy on hold-out set: 0.5087
MulticlassAccuracy value on hold-out data: 0.5087000131607056
Early stopping at epoch 9
Returned to Spot: Validation loss: 1.433475613451004
----------------------------------------------

spotPython tuning: 1.1802328905344008 [#######---] 66.10%


config: {'l1': 512, 'l2': 4, 'lr_mult': 1.0, 'batch_size': 32, 'epochs': 16, 'k_folds': 0, '
Epoch: 1

Loss on hold-out set: 1.747515173149109
Accuracy on hold-out set: 0.3548
MulticlassAccuracy value on hold-out data: 0.3547999858856201
Epoch: 2

Loss on hold-out set: 1.4889630786895751
Accuracy on hold-out set: 0.4657
MulticlassAccuracy value on hold-out data: 0.4657000005245209
Epoch: 3

Loss on hold-out set: 1.426540014076233
Accuracy on hold-out set: 0.49175
MulticlassAccuracy value on hold-out data: 0.49175000190734863
Epoch: 4
```

```
Loss on hold-out set: 1.3289828909873962
Accuracy on hold-out set: 0.5207
MulticlassAccuracy value on hold-out data: 0.5206999778747559
Epoch: 5

Loss on hold-out set: 1.308058195590973
Accuracy on hold-out set: 0.53715
MulticlassAccuracy value on hold-out data: 0.5371500253677368
Epoch: 6

Loss on hold-out set: 1.338618159198761
Accuracy on hold-out set: 0.5316
MulticlassAccuracy value on hold-out data: 0.5315999984741211
Epoch: 7

Loss on hold-out set: 1.2721350644111633
Accuracy on hold-out set: 0.5512
MulticlassAccuracy value on hold-out data: 0.5511999726295471
Epoch: 8

Loss on hold-out set: 1.246745396900177
Accuracy on hold-out set: 0.56105
MulticlassAccuracy value on hold-out data: 0.5610499978065491
Epoch: 9

Loss on hold-out set: 1.2311819702148437
Accuracy on hold-out set: 0.57875
MulticlassAccuracy value on hold-out data: 0.5787500143051147
Epoch: 10

Loss on hold-out set: 1.2693853902816772
Accuracy on hold-out set: 0.58095
MulticlassAccuracy value on hold-out data: 0.5809500217437744
Epoch: 11

Loss on hold-out set: 1.2594838012695313
Accuracy on hold-out set: 0.5727
MulticlassAccuracy value on hold-out data: 0.572700023651123
Epoch: 12
```

```
Loss on hold-out set: 1.311672718811035
Accuracy on hold-out set: 0.57515
MulticlassAccuracy value on hold-out data: 0.5751500129699707
Early stopping at epoch 11
Returned to Spot: Validation loss: 1.311672718811035
----------------------------------------------

spotPython tuning: 1.1802328905344008 [#######---] 73.75%


config: {'l1': 512, 'l2': 64, 'lr_mult': 1.0, 'batch_size': 32, 'epochs': 16, 'k_folds': 0,
Epoch: 1

Loss on hold-out set: 1.5296148230552673
Accuracy on hold-out set: 0.4492
MulticlassAccuracy value on hold-out data: 0.44920000433921814
Epoch: 2

Loss on hold-out set: 1.2828962532043457
Accuracy on hold-out set: 0.54685
MulticlassAccuracy value on hold-out data: 0.5468500256538391
Epoch: 3

Loss on hold-out set: 1.2191106435775756
Accuracy on hold-out set: 0.5731
MulticlassAccuracy value on hold-out data: 0.5730999708175659
Epoch: 4

Loss on hold-out set: 1.1923338871002198
Accuracy on hold-out set: 0.58605
MulticlassAccuracy value on hold-out data: 0.5860499739646912
Epoch: 5

Loss on hold-out set: 1.193533663702011
Accuracy on hold-out set: 0.59115
MulticlassAccuracy value on hold-out data: 0.5911499857902527
Epoch: 6

Loss on hold-out set: 1.2682401436805726
Accuracy on hold-out set: 0.5865
MulticlassAccuracy value on hold-out data: 0.5864999890327454
Epoch: 7
```

```
Loss on hold-out set: 1.2735447607040404
Accuracy on hold-out set: 0.59795
MulticlassAccuracy value on hold-out data: 0.5979499816894531
Early stopping at epoch 6
Returned to Spot: Validation loss: 1.2735447607040404
----------------------------------------------

spotPython tuning: 1.1802328905344008 [########--] 78.34%


config: {'l1': 512, 'l2': 4, 'lr_mult': 1.0, 'batch_size': 32, 'epochs': 16, 'k_folds': 0, 'p
Epoch: 1

Loss on hold-out set: 1.5863910293579102
Accuracy on hold-out set: 0.3943
MulticlassAccuracy value on hold-out data: 0.39430001378059387
Epoch: 2

Loss on hold-out set: 1.4885105583190918
Accuracy on hold-out set: 0.45595
MulticlassAccuracy value on hold-out data: 0.455949991941452
Epoch: 3

Loss on hold-out set: 1.388596639251709
Accuracy on hold-out set: 0.49415
MulticlassAccuracy value on hold-out data: 0.4941500127315521
Epoch: 4

Loss on hold-out set: 1.3743185086250305
Accuracy on hold-out set: 0.508
MulticlassAccuracy value on hold-out data: 0.5080000162124634
Epoch: 5

Loss on hold-out set: 1.3180398864746095
Accuracy on hold-out set: 0.52725
MulticlassAccuracy value on hold-out data: 0.5272499918937683
Epoch: 6

Loss on hold-out set: 1.3520528792381286
Accuracy on hold-out set: 0.52335
MulticlassAccuracy value on hold-out data: 0.5233500003814697
Epoch: 7
```

```
Loss on hold-out set: 1.3772667338371276
Accuracy on hold-out set: 0.5247
MulticlassAccuracy value on hold-out data: 0.5246999859809875
Epoch: 8

Loss on hold-out set: 1.3573063610076905
Accuracy on hold-out set: 0.5458
MulticlassAccuracy value on hold-out data: 0.545799970626831
Early stopping at epoch 7
Returned to Spot: Validation loss: 1.3573063610076905
----------------------------------------------

spotPython tuning: 1.1802328905344008 [########--] 83.52%


config: {'l1': 4, 'l2': 512, 'lr_mult': 1.0, 'batch_size': 32, 'epochs': 16, 'k_folds': 0, 'p
Epoch: 1

Loss on hold-out set: 1.5642913465499877
Accuracy on hold-out set: 0.4057
MulticlassAccuracy value on hold-out data: 0.4056999981403351
Epoch: 2

Loss on hold-out set: 1.5492258783340453
Accuracy on hold-out set: 0.4246
MulticlassAccuracy value on hold-out data: 0.4246000051498413
Epoch: 3

Loss on hold-out set: 1.4504609309196472
Accuracy on hold-out set: 0.46095
MulticlassAccuracy value on hold-out data: 0.46094998717308044
Epoch: 4

Loss on hold-out set: 1.3742767093658448
Accuracy on hold-out set: 0.49515
MulticlassAccuracy value on hold-out data: 0.49514999985694885
Epoch: 5

Loss on hold-out set: 1.3144136981964112
Accuracy on hold-out set: 0.5174
MulticlassAccuracy value on hold-out data: 0.5174000263214111
Epoch: 6
```

```
Loss on hold-out set: 1.327462582874298
Accuracy on hold-out set: 0.5138
MulticlassAccuracy value on hold-out data: 0.5138000249862671
Epoch: 7

Loss on hold-out set: 1.2993877670288085
Accuracy on hold-out set: 0.51955
MulticlassAccuracy value on hold-out data: 0.5195500254631042
Epoch: 8

Loss on hold-out set: 1.2980572251319886
Accuracy on hold-out set: 0.53145
MulticlassAccuracy value on hold-out data: 0.5314499735832214
Epoch: 9

Loss on hold-out set: 1.2747584173202515
Accuracy on hold-out set: 0.54315
MulticlassAccuracy value on hold-out data: 0.543150007724762
Epoch: 10

Loss on hold-out set: 1.2664027747154236
Accuracy on hold-out set: 0.5413
MulticlassAccuracy value on hold-out data: 0.5412999987602234
Epoch: 11

Loss on hold-out set: 1.2681085478782654
Accuracy on hold-out set: 0.5419
MulticlassAccuracy value on hold-out data: 0.5418999791145325
Epoch: 12

Loss on hold-out set: 1.2699455046653747
Accuracy on hold-out set: 0.5416
MulticlassAccuracy value on hold-out data: 0.5415999889373779
Epoch: 13

Loss on hold-out set: 1.2285598253250123
Accuracy on hold-out set: 0.55375
MulticlassAccuracy value on hold-out data: 0.5537499785423279
Epoch: 14
```

```
Loss on hold-out set: 1.262396694278717
Accuracy on hold-out set: 0.54875
MulticlassAccuracy value on hold-out data: 0.5487499833106995
Epoch: 15

Loss on hold-out set: 1.2417179253578186
Accuracy on hold-out set: 0.5502
MulticlassAccuracy value on hold-out data: 0.5501999855041504
Epoch: 16

Loss on hold-out set: 1.2338941304206847
Accuracy on hold-out set: 0.557
MulticlassAccuracy value on hold-out data: 0.5569999814033508
Early stopping at epoch 15
Returned to Spot: Validation loss: 1.2338941304206847
----------------------------------------------

spotPython tuning: 1.1802328905344008 [#########-] 93.21%


config: {'l1': 8, 'l2': 64, 'lr_mult': 1.0, 'batch_size': 8, 'epochs': 16, 'k_folds': 0, 'pa
Epoch: 1

Loss on hold-out set: 1.6579994116067887
Accuracy on hold-out set: 0.37885
MulticlassAccuracy value on hold-out data: 0.3788500130176544
Epoch: 2

Loss on hold-out set: 1.5948645925283431
Accuracy on hold-out set: 0.40485
MulticlassAccuracy value on hold-out data: 0.4048500061035156
Epoch: 3

Loss on hold-out set: 1.5601264312505723
Accuracy on hold-out set: 0.4181
MulticlassAccuracy value on hold-out data: 0.4180999994277954
Epoch: 4

Loss on hold-out set: 1.525576484155655
Accuracy on hold-out set: 0.43225
MulticlassAccuracy value on hold-out data: 0.4322499930858612
Epoch: 5
```

```
Loss on hold-out set: 1.5033734943628312
Accuracy on hold-out set: 0.4426
MulticlassAccuracy value on hold-out data: 0.4426000118255615
Epoch: 6

Loss on hold-out set: 1.4778610036373139
Accuracy on hold-out set: 0.45455
MulticlassAccuracy value on hold-out data: 0.45454999804496765
Epoch: 7

Loss on hold-out set: 1.464682808470726
Accuracy on hold-out set: 0.46115
MulticlassAccuracy value on hold-out data: 0.46114999055862427
Epoch: 8

Loss on hold-out set: 1.4540493513822557
Accuracy on hold-out set: 0.4638
MulticlassAccuracy value on hold-out data: 0.46380001306533813
Epoch: 9

Loss on hold-out set: 1.4392803713321687
Accuracy on hold-out set: 0.47085
MulticlassAccuracy value on hold-out data: 0.47084999084472656
Epoch: 10

Loss on hold-out set: 1.4342941479206086
Accuracy on hold-out set: 0.47425
MulticlassAccuracy value on hold-out data: 0.4742499887943268
Epoch: 11

Loss on hold-out set: 1.4243134921073914
Accuracy on hold-out set: 0.47805
MulticlassAccuracy value on hold-out data: 0.47804999351501465
Epoch: 12

Loss on hold-out set: 1.4232912694215774
Accuracy on hold-out set: 0.4775
MulticlassAccuracy value on hold-out data: 0.47749999165534973
Epoch: 13
```

```
Loss on hold-out set: 1.4131548616290093
Accuracy on hold-out set: 0.4815
MulticlassAccuracy value on hold-out data: 0.4814999997615814
Epoch: 14

Loss on hold-out set: 1.403885018646717
Accuracy on hold-out set: 0.4855
MulticlassAccuracy value on hold-out data: 0.4855000078678131
Epoch: 15

Loss on hold-out set: 1.402349520587921
Accuracy on hold-out set: 0.48665
MulticlassAccuracy value on hold-out data: 0.4866499900817871
Epoch: 16

Loss on hold-out set: 1.3963685985565186
Accuracy on hold-out set: 0.4894
MulticlassAccuracy value on hold-out data: 0.4893999993801117
Returned to Spot: Validation loss: 1.3963685985565186
----------------------------------------------

spotPython tuning: 1.1802328905344008 [##########] 100.00% Done...
```

```
<spotPython.spot.spot.Spot at 0x169ca6a10>
```

20.13 Tensorboard

The textual output shown in the console (or code cell) can be visualized with Tensorboard.

20.13.1 Tensorboard: Start Tensorboard

Start TensorBoard through the command line to visualize data you logged. Specify the root log directory as used in `fun_control = fun_control_init(task="regression", tensorboard_path="runs/24_spot_torch_regression")` as the `tensorboard_path`. The argument logdir points to directory where TensorBoard will look to find event files that it can display. TensorBoard will recursively walk the directory structure rooted at logdir, looking for *.tfevents.* files.

```
tensorboard --logdir=runs
```

Go to the URL it provides or to http://localhost:6006/. The following figures show some screenshots of Tensorboard.

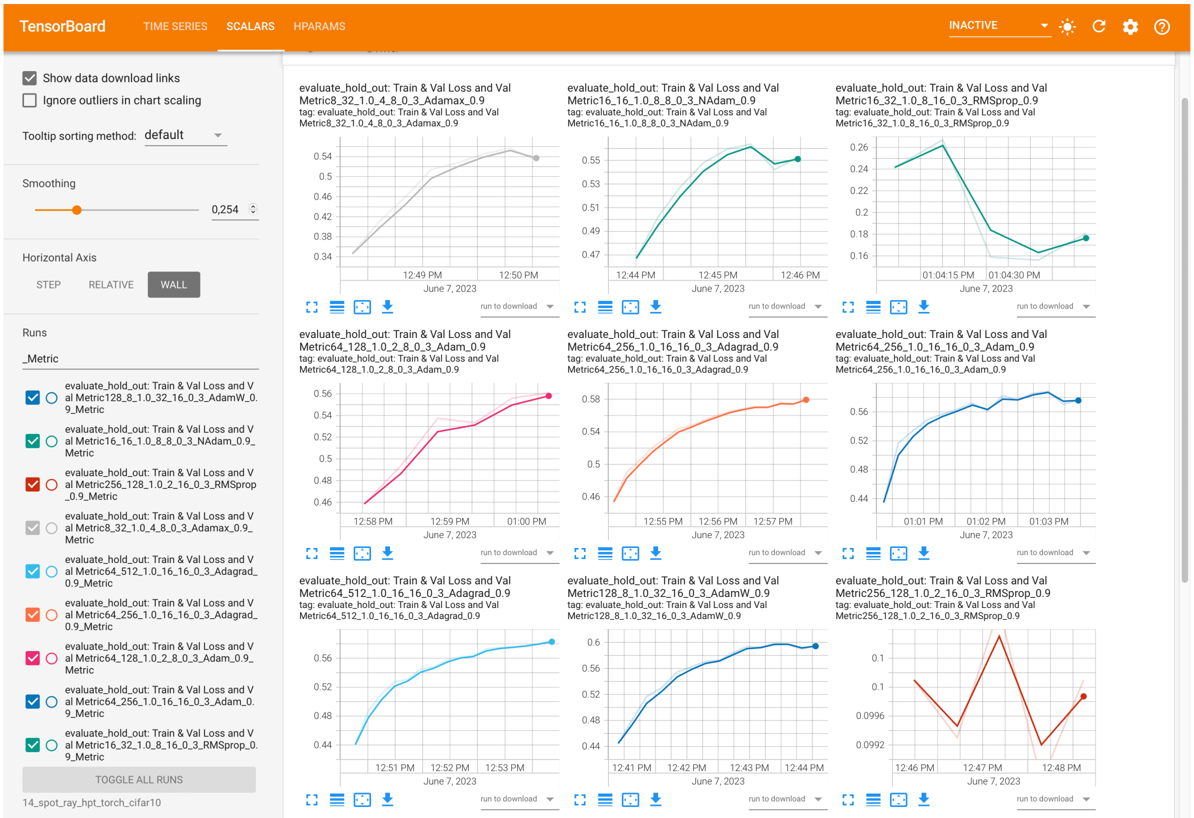


Figure 20.1: Tensorboard

20.13.2 Saving the State of the Notebook

The state of the notebook can be saved and reloaded as follows:

```
import pickle
SAVE = False
LOAD = False

if SAVE:
    result_file_name = "res_" + experiment_name + ".pkl"
```

Figure 20.2: Tensorboard

```
    with open(result_file_name, 'wb') as f:
        pickle.dump(spot_tuner, f)

if LOAD:
    result_file_name = "add_the_name_of_the_result_file_here.pkl"
    with open(result_file_name, 'rb') as f:
        spot_tuner =  pickle.load(f)
```

20.14 Results

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

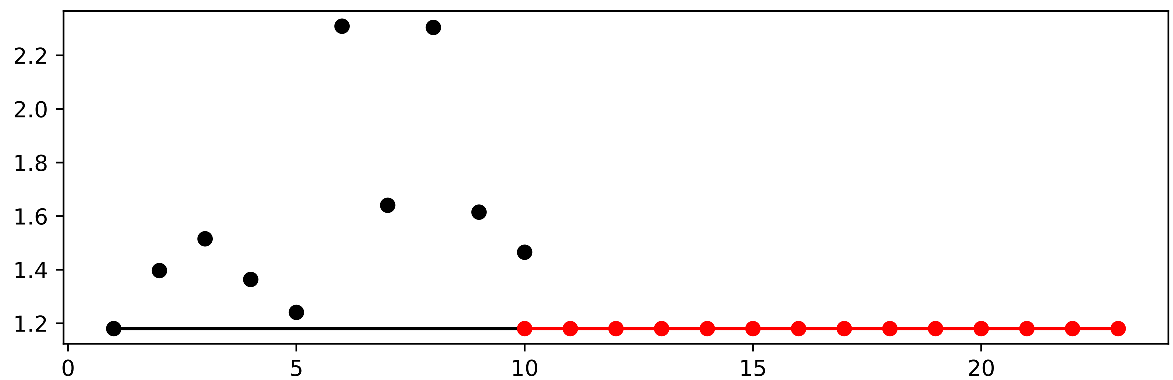


Figure 20.3: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

?@fig-progress shows a typical behaviour that can be observed in many hyperparameter studies (Bartz et al. 2022): the largest improvement is obtained during the evaluation of the initial design. The surrogate model based optimization-optimization with the surrogate refines the results. **?@fig-progress** also illustrates one major difference between `ray[tune]` as used in PyTorch (2023a) and `spotPython`: the `ray[tune]` uses a random search and will generate results similar to the *black* dots, whereas `spotPython` uses a surrogate model based optimization and presents results represented by *red* dots in **?@fig-progress**. The surrogate model based optimization is considered to be more efficient than a random search, because the surrogate model guides the search towards promising regions in the hyperparameter space.

In addition to the improved ("optimized") hyperparameter values, `spotPython` allows a statistical analysis, e.g., a sensitivity analysis, of the results. We can print the results of the hyperparameter tuning, see **?@tbl-results**. The table shows the hyperparameters, their types, default values, lower and upper bounds, and the transformation function. The column "tuned" shows the tuned values. The column "importance" shows the importance of the hyperparameters. The column "stars" shows the importance of the hyperparameters in stars. The importance is computed by the SPOT software.

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control=fun_control, spot=spot_tuner))
```

```
| name         | type   | default    |    lower |    upper |    tuned | transform              |
|--------------|--------|------------|----------|----------|----------|------------------------|-
| l1           | int    | 5          |      2.0 |      9.0 |      6.0 | transform_power_2_int |
| l2           | int    | 5          |      2.0 |      9.0 |      4.0 | transform_power_2_int |
| lr_mult      | float  | 1.0        |      1.0 |      1.0 |      1.0 | None                  |
| batch_size   | int    | 4          |      1.0 |      5.0 |      4.0 | transform_power_2_int |
```

```
| epochs       | int    | 3          |      3.0 |      4.0 |      4.0 | transform_power_2_int |
| k_folds      | int    | 1          |      0.0 |      0.0 |      0.0 | None                  |
| patience     | int    | 5          |      3.0 |      3.0 |      3.0 | None                  |
| optimizer    | factor | SGD        |      0.0 |      9.0 |      6.0 | None                  |
| sgd_momentum | float  | 0.0        |      0.9 |      0.9 |      0.9 | None                  |
```

To visualize the most important hyperparameters, `spotPython` provides the function `plot_importance`. The following code generates the importance plot from **?@fig-importance**.

```
spot_tuner.plot_importance(threshold=0.025,
    filename="./figures/" + experiment_name+"_importance.png")
```

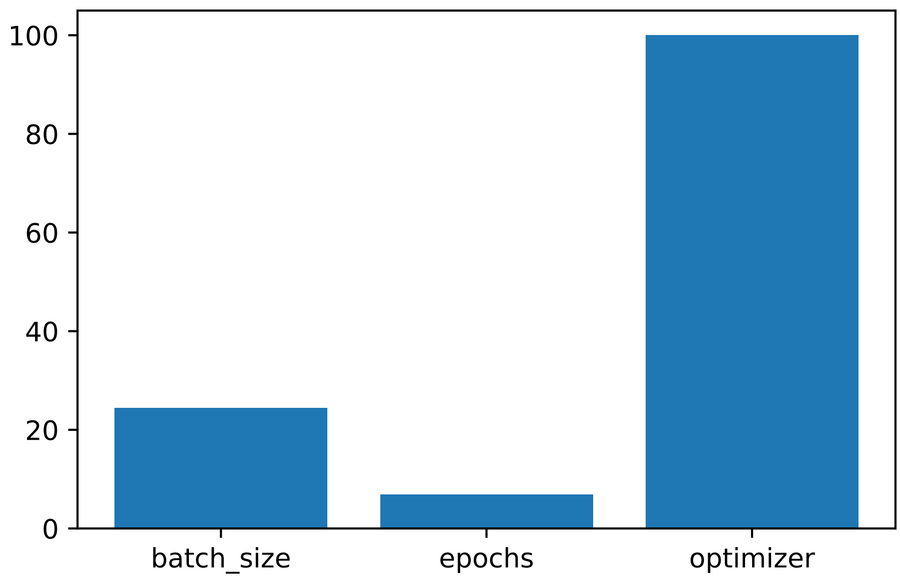


Figure 20.4: Variable importance plot, threshold 0.025.

20.14.1 Get the Tuned Architecture (SPOT Results)

The architecture of the `spotPython` model can be obtained as follows. First, the numerical representation of the hyperparameters are obtained, i.e., the numpy array `X` is generated. This array is then used to generate the model `model_spot` by the function `get_one_core_model_from_X`. The model `model_spot` has the following architecture:

```python
from spotPython.hyperparameters.values import get_one_core_model_from_X
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
model_spot = get_one_core_model_from_X(X, fun_control)
model_spot
```

```
Net_CIFAR10(
  (conv1): Conv2d(3, 6, kernel_size=(5, 5), stride=(1, 1))
  (pool): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
  (conv2): Conv2d(6, 16, kernel_size=(5, 5), stride=(1, 1))
  (fc1): Linear(in_features=400, out_features=64, bias=True)
  (fc2): Linear(in_features=64, out_features=16, bias=True)
  (fc3): Linear(in_features=16, out_features=10, bias=True)
)
```

20.14.2 Get Default Hyperparameters

In a similar manner as in **?@sec-get-spot-results**, the default hyperparameters can be obtained.

```python
# fun_control was modified, we generate a new one with the original
# default hyperparameters
from spotPython.hyperparameters.values import get_one_core_model_from_X
fc = fun_control
fc.update({"core_model_hyper_dict":
    hyper_dict[fun_control["core_model"].__name__]})
model_default = get_one_core_model_from_X(X_start, fun_control=fc)
model_default
```

```
Net_CIFAR10(
  (conv1): Conv2d(3, 6, kernel_size=(5, 5), stride=(1, 1))
  (pool): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
  (conv2): Conv2d(6, 16, kernel_size=(5, 5), stride=(1, 1))
  (fc1): Linear(in_features=400, out_features=32, bias=True)
  (fc2): Linear(in_features=32, out_features=32, bias=True)
  (fc3): Linear(in_features=32, out_features=10, bias=True)
)
```

20.14.3 Evaluation of the Default Architecture

The method `train_tuned` takes a model architecture without trained weights and trains this model with the train data. The train data is split into train and validation data. The validation data is used for early stopping. The trained model weights are saved as a dictionary.

This evaluation is similar to the final evaluation in PyTorch (2023a).

```
from spotPython.torch.traintest import (
    train_tuned,
    test_tuned,
    )
train_tuned(net=model_default, train_dataset=train, shuffle=True,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        device = fun_control["device"], show_batch_interval=1_000_000,
        path=None,
        task=fun_control["task"],)

test_tuned(net=model_default, test_dataset=test,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        shuffle=False,
        device = fun_control["device"],
        task=fun_control["task"],)
```

```
Epoch: 1

Loss on hold-out set: 2.3029150186538696
Accuracy on hold-out set: 0.1074
MulticlassAccuracy value on hold-out data: 0.10740000009536743
Epoch: 2

Loss on hold-out set: 2.3002824243545534
Accuracy on hold-out set: 0.14095
MulticlassAccuracy value on hold-out data: 0.14094999432563782
Epoch: 3

Loss on hold-out set: 2.296199912071228
Accuracy on hold-out set: 0.15585
MulticlassAccuracy value on hold-out data: 0.15584999322891235
Epoch: 4
```

```
Loss on hold-out set: 2.2874134258270264
Accuracy on hold-out set: 0.16425
MulticlassAccuracy value on hold-out data: 0.16425000131130219
Epoch: 5

Loss on hold-out set: 2.259429723358154
Accuracy on hold-out set: 0.1721
MulticlassAccuracy value on hold-out data: 0.1720999926328659
Epoch: 6

Loss on hold-out set: 2.193149740886688
Accuracy on hold-out set: 0.219
MulticlassAccuracy value on hold-out data: 0.21899999678134918
Epoch: 7

Loss on hold-out set: 2.1353907121658326
Accuracy on hold-out set: 0.2307
MulticlassAccuracy value on hold-out data: 0.23070000112056732
Epoch: 8

Loss on hold-out set: 2.0849213462829588
Accuracy on hold-out set: 0.2411
MulticlassAccuracy value on hold-out data: 0.2410999983549118
Returned to Spot: Validation loss: 2.0849213462829588
----------------------------------------------

Loss on hold-out set: 2.0719224979400637
Accuracy on hold-out set: 0.2523
MulticlassAccuracy value on hold-out data: 0.2522999942302704
Final evaluation: Validation loss: 2.0719224979400637
Final evaluation: Validation metric: 0.2522999942302704
----------------------------------------------

(2.0719224979400637, nan, tensor(0.2523))
```

20.14.4 Evaluation of the Tuned Architecture

The following code trains the model `model_spot`.

If `path` is set to a filename, e.g., `path = "model_spot_trained.pt"`, the weights of the trained model will be saved to this file.

If `path` is set to a filename, e.g., `path = "model_spot_trained.pt"`, the weights of the trained model will be loaded from this file.

```
train_tuned(net=model_spot, train_dataset=train,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        shuffle=True,
        device = fun_control["device"],
        path=None,
        task=fun_control["task"],)
test_tuned(net=model_spot, test_dataset=test,
            shuffle=False,
            loss_function=fun_control["loss_function"],
            metric=fun_control["metric_torch"],
            device = fun_control["device"],
            task=fun_control["task"],)
```

```
Epoch: 1

Loss on hold-out set: 1.493098261833191
Accuracy on hold-out set: 0.46375
MulticlassAccuracy value on hold-out data: 0.4637500047683716
Epoch: 2

Loss on hold-out set: 1.3179876404762267
Accuracy on hold-out set: 0.5349
MulticlassAccuracy value on hold-out data: 0.5349000096321106
Epoch: 3

Loss on hold-out set: 1.235466090774536
Accuracy on hold-out set: 0.5606
MulticlassAccuracy value on hold-out data: 0.5605999827384949
Epoch: 4
```

```
Loss on hold-out set: 1.2309290711164476
Accuracy on hold-out set: 0.56855
MulticlassAccuracy value on hold-out data: 0.5685499906539917
Epoch: 5

Loss on hold-out set: 1.2268116580963135
Accuracy on hold-out set: 0.57855
MulticlassAccuracy value on hold-out data: 0.5785499811172485
Epoch: 6

Loss on hold-out set: 1.1801288648843766
Accuracy on hold-out set: 0.5929
MulticlassAccuracy value on hold-out data: 0.5928999781608582
Epoch: 7

Loss on hold-out set: 1.2274013827323913
Accuracy on hold-out set: 0.58235
MulticlassAccuracy value on hold-out data: 0.5823500156402588
Epoch: 8

Loss on hold-out set: 1.2194126366853715
Accuracy on hold-out set: 0.58675
MulticlassAccuracy value on hold-out data: 0.5867499709129333
Epoch: 9

Loss on hold-out set: 1.2356583701372146
Accuracy on hold-out set: 0.588
MulticlassAccuracy value on hold-out data: 0.5879999995231628
Early stopping at epoch 8
Returned to Spot: Validation loss: 1.2356583701372146
----------------------------------------------

Loss on hold-out set: 1.2385452413082123
Accuracy on hold-out set: 0.5918
MulticlassAccuracy value on hold-out data: 0.5917999744415283
Final evaluation: Validation loss: 1.2385452413082123
Final evaluation: Validation metric: 0.5917999744415283
----------------------------------------------

(1.2385452413082123, nan, tensor(0.5918))
```

20.14.5 Detailed Hyperparameter Plots

The contour plots in this section visualize the interactions of the three most important hyperparameters. Since some of these hyperparameters take fatorial or integer values, sometimes step-like fitness landcapes (or response surfaces) are generated. SPOT draws the interactions of the main hyperparameters by default. It is also possible to visualize all interactions.

```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

```
batch_size:  24.357992988643815
epochs:  6.882011634296389
optimizer:  100.0
```

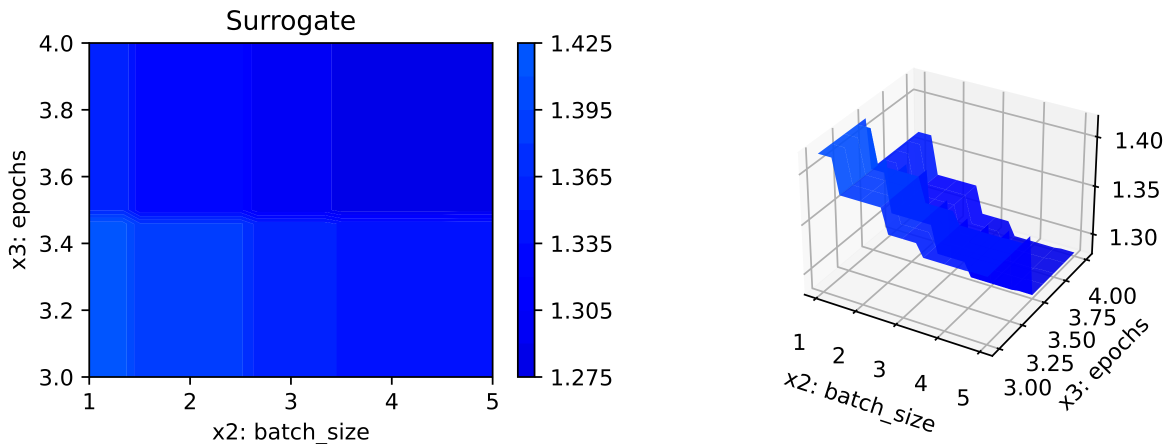
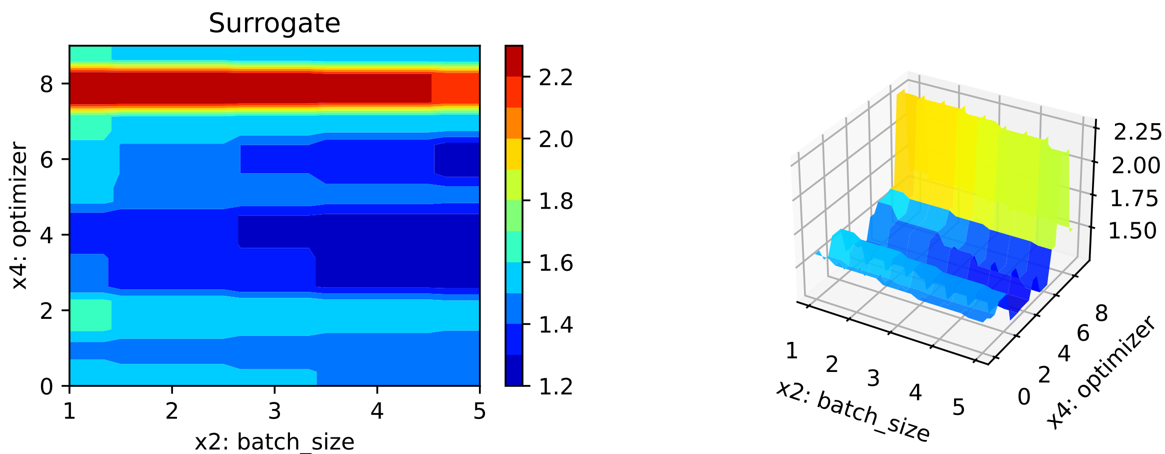
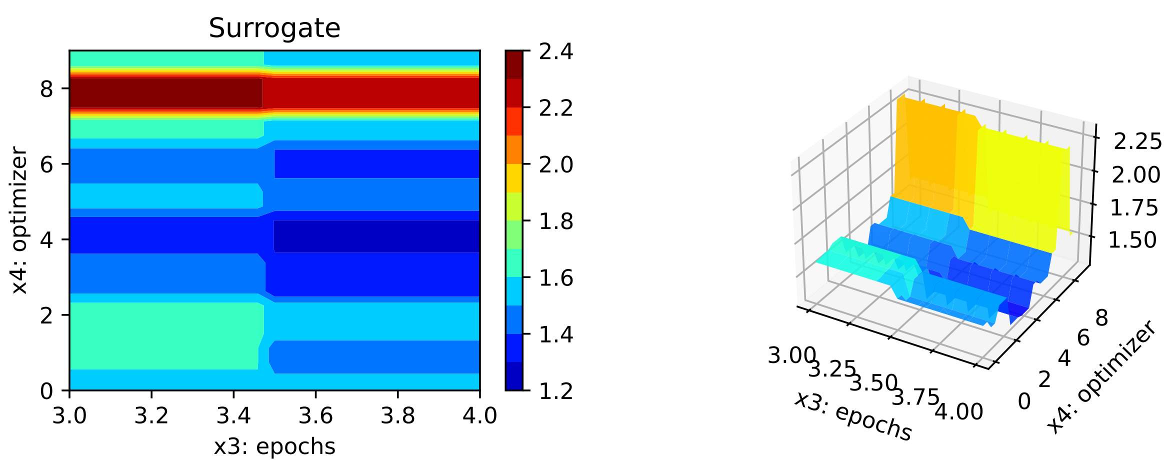


Figure 20.5: Contour plots.





The figures (**?@fig-contour**) show the contour plots of the loss as a function of the hyperparameters. These plots are very helpful for benchmark studies and for understanding neural networks. `spotPython` provides additional tools for a visual inspection of the results and give valuable insights into the hyperparameter tuning process. This is especially useful for model explainability, transparency, and trustworthiness. In addition to the contour plots, **?@fig-parallel** shows the parallel plot of the hyperparameters.

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

Parallel coordinates plots

```
Unable to display output for mime type(s): text/html
```

20.15 Summary and Outlook

This tutorial presents the hyperparameter tuning open source software `spotPython` for `PyTorch`. To show its basic features, a comparison with the "official" `PyTorch` hyperparameter tuning tutorial (PyTorch 2023a) is presented. Some of the advantages of `spotPython` are:

- Numerical and categorical hyperparameters.
- Powerful surrogate models.
- Flexible approach and easy to use.
- Simple JSON files for the specification of the hyperparameters.
- Extension of default and user specified network classes.
- Noise handling techniques.
- Interaction with `tensorboard`.

Currently, only rudimentary parallel and distributed neural network training is possible, but these capabilities will be extended in the future. The next version of `spotPython` will also include a more detailed documentation and more examples.

> **!** Important
>
> Important: This tutorial does not present a complete benchmarking study (Bartz-Beielstein et al. 2020). The results are only preliminary and highly dependent on the local configuration (hard- and software). Our goal is to provide a first impression of the performance of the hyperparameter tuning package `spotPython`. To demonstrate its capabilities, a quick comparison with `ray[tune]` was performed. `ray[tune]` was chosen, because it is presented as "an industry standard tool for distributed hyperparameter tuning." The results should be interpreted with care.

20.16 Appendix

20.16.1 Sample Output From Ray Tune's Run

The output from `ray[tune]` could look like this (PyTorch 2023b):

```
Number of trials: 10 (10 TERMINATED)
------+------+-------------+--------------+---------+------------+--------------------+
|   l1 |   l2 |          lr |   batch_size |    loss |   accuracy | training_iteration |
```

```
+------+------+-------------+--------------+---------+------------+--------------------|
|   64 |    4 | 0.00011629  |            2 | 1.87273 |     0.244  |                  2 |
|   32 |   64 | 0.000339763 |            8 | 1.23603 |     0.567  |                  8 |
|    8 |   16 | 0.00276249  |           16 | 1.1815  |     0.5836 |                 10 |
|    4 |   64 | 0.000648721 |            4 | 1.31131 |     0.5224 |                  8 |
|   32 |   16 | 0.000340753 |            8 | 1.26454 |     0.5444 |                  8 |
|    8 |    4 | 0.000699775 |            8 | 1.99594 |     0.1983 |                  2 |
|  256 |    8 | 0.0839654   |           16 | 2.3119  |     0.0993 |                  1 |
|   16 |  128 | 0.0758154   |           16 | 2.33575 |     0.1327 |                  1 |
|   16 |    8 | 0.0763312   |           16 | 2.31129 |     0.1042 |                  4 |
|  128 |   16 | 0.000124903 |            4 | 2.26917 |     0.1945 |                  1 |
+-----+------+------+------------+-------------+---------+------------+------------------
Best trial config: {'l1': 8, 'l2': 16, 'lr': 0.00276249, 'batch_size': 16, 'data_dir': '..
Best trial final validation loss: 1.181501
Best trial final validation accuracy: 0.5836
Best trial test set accuracy: 0.5806
```

21 HPT: sklearn RandomForestClassifier VBDP Data

This document refers to the following software versions:

- `python`: 3.10.10

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                    0.2.33
spotRiver                     0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

21.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time and the initial design size.

```
MAX_TIME = 1
INIT_SIZE = 5
ORIGINAL = False
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '16-rf-sklearn' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(IN
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
16-rf-sklearn_p040025_1min_5init_2023-06-17_01-57-55
```

```
import warnings
warnings.filterwarnings("ignore")
```

21.2 Step 1: Initialization of the Empty `fun_control` Dictionary

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/16_spot_hpt_sklearn_classification")
```

21.3 1. Load Data: Classification

21.4 VBDP

```
import pandas as pd
if ORIGINAL == True:
    train_df = pd.read_csv('./data/VBDP/trainn.csv')
    test_df = pd.read_csv('./data/VBDP/testt.csv')
```

```
else:
    train_df = pd.read_csv('./data/VBDP/train.csv')
    # remove the id column
    train_df = train_df.drop(columns=['id'])
```

```
from sklearn.preprocessing import OrdinalEncoder
n_samples = train_df.shape[0]
n_features = train_df.shape[1] - 1
target_column = "prognosis"
# Encoder our prognosis labels as integers for easier decoding later
enc = OrdinalEncoder()
train_df[target_column] = enc.fit_transform(train_df[[target_column]])
train_df.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train_df.shape)
train_df.head()
```

```
(707, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	...	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0
3	0.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	...	0.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0

The full data set `train_df` 64 features. The target column is labeled as `prognosis`.

21.5 Holdout Train and Test Data

We split out a hold-out test set (25% of the data) so we can calculate an example MAP@K

```
import numpy as np
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(train_df.drop(target_column, axis=1),
                                                    random_state=42,
                                                    test_size=0.25,
                                                    stratify=train_df[target_column])
train = pd.DataFrame(np.hstack((X_train, np.array(y_train).reshape(-1, 1))))
```

```
test = pd.DataFrame(np.hstack((X_test, np.array(y_test).reshape(-1, 1))))
train.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
test.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train.shape)
print(test.shape)
train.head()
```

```
(530, 65)
(177, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
3	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
# add the dataset to the fun_control
fun_control.update({"data": train_df, # full dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": target_column})
```

21.6 Step 3: Specification of the Preprocessing Model

Data preprocesssing can be very simple, e.g., you can ignore it. Then you would choose the `prep_model` "None":

```
prep_model = None
fun_control.update({"prep_model": prep_model})
```

A default approach for numerical data is the `StandardScaler` (mean 0, variance 1). This can be selected as follows:

```
# prep_model = StandardScaler()
# fun_control.update({"prep_model": prep_model})
```

Even more complicated pre-processing steps are possible, e.g., the follwing pipeline:

```
# categorical_columns = []
# one_hot_encoder = OneHotEncoder(handle_unknown="ignore", sparse_output=False)
# prep_model = ColumnTransformer(
#         transformers=[
#             ("categorical", one_hot_encoder, categorical_columns),
#         ],
#         remainder=StandardScaler(),
#     )
```

21.7 Step 4: Select `algorithm` and `core_model_hyper_dict`

The selection of the algorithm (ML model) that should be tuned is done by specifying the its name from the `sklearn` implementation. For example, the `SVC` support vector machine classifier is selected as follows:

`fun_control = add_core_model_to_fun_control(SVC, fun_control, SklearnHyperDict)`

Other core_models are, e.g.,:

- RidgeCV
- GradientBoostingRegressor
- ElasticNet
- RandomForestClassifier
- LogisticRegression
- KNeighborsClassifier
- RandomForestClassifier
- GradientBoostingClassifier
- HistGradientBoostingClassifier

We will use the `RandomForestClassifier` classifier in this example.

```
from sklearn.linear_model import RidgeCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.linear_model import ElasticNet
from spotPython.hyperparameters.values import add_core_model_to_fun_control
```

```python
from spotPython.data.sklearn_hyper_dict import SklearnHyperDict
from spotPython.fun.hypersklearn import HyperSklearn
```

```python
# core_model  = RidgeCV
# core_model = GradientBoostingRegressor
# core_model = ElasticNet
core_model = RandomForestClassifier
# core_model = SVC
# core_model = LogisticRegression
# core_model = KNeighborsClassifier
# core_model = GradientBoostingClassifier
fun_control = add_core_model_to_fun_control(core_model=core_model,
                              fun_control=fun_control,
                              hyper_dict=SklearnHyperDict,
                              filename=None)
```

Now `fun_control` has the information from the JSON file. The available hyperparameters are:

```python
print(*fun_control["core_model_hyper_dict"].keys(), sep="\n")
```

```
n_estimators
criterion
max_depth
min_samples_split
min_samples_leaf
min_weight_fraction_leaf
max_features
max_leaf_nodes
min_impurity_decrease
bootstrap
oob_score
```

21.8 Step 5: Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

21.8.1 Modify hyperparameter of type numeric and integer (boolean)

Numeric and boolean values can be modified using the `modify_hyper_parameter_bounds` method. For example, to change the `tol` hyperparameter of the `SVC` model to the interval

[1e-3, 1e-2], the following code can be used:

`fun_control = modify_hyper_parameter_bounds(fun_control, "tol", bounds=[1e-3, 1e-2])`

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
# fun_control = modify_hyper_parameter_bounds(fun_control, "tol", bounds=[1e-3, 1e-2])
# fun_control = modify_hyper_parameter_bounds(fun_control, "min_samples_split", bounds=[3,
# fun_control = modify_hyper_parameter_bounds(fun_control, "dual", bounds=[0, 0])
# fun_control = modify_hyper_parameter_bounds(fun_control, "probability", bounds=[1, 1])
# fun_control["core_model_hyper_dict"]["tol"]
# fun_control = modify_hyper_parameter_bounds(fun_control, "min_samples_leaf", bounds=[1,
# fun_control = modify_hyper_parameter_bounds(fun_control, "n_estimators", bounds=[5, 10])
```

21.8.2 Modify hyperparameter of type factor

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

Factors can be modified with the `modify_hyper_parameter_levels` function. For example, to exclude the `sigmoid` kernel from the tuning, the `kernel` hyperparameter of the `SVC` model can be modified as follows:

`fun_control = modify_hyper_parameter_levels(fun_control, "kernel", ["linear", "rbf"])`

The new setting can be controlled via:

`fun_control["core_model_hyper_dict"]["kernel"]`

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
# XGBoost:
# fun_control = modify_hyper_parameter_levels(fun_control, "loss", ["log_loss"])
```

> **Note: RandomForestClassifier and Out-of-bag Estimation**
>
> Since `oob_score` requires the `bootstrap` hyperparameter to `True`, we set the `oob_score` parameter to `False`. The `oob_score` is later discussed in Section 21.11.1.

```
fun_control = modify_hyper_parameter_bounds(fun_control, "bootstrap", bounds=[0, 1])
fun_control = modify_hyper_parameter_bounds(fun_control, "oob_score", bounds=[0, 0])
```

21.8.3 Optimizers

Optimizers are described in Section 20.6.

21.9 5. Selection of the Objective: Metric and Loss Functions

- Machine learning models are optimized with respect to a metric, for example, the `accuracy` function.
- Deep learning, e.g., neural networks are optimized with respect to a loss function, for example, the `cross_entropy` function and evaluated with respect to a metric, for example, the `accuracy` function.

21.10 Step 6: Selection of the Objective (Loss) Function

The loss function, that is usually used in deep learning for optimizing the weights of the net, is stored in the `fun_control` dictionary as `"loss_function"`.

21.10.1 Metric Function

There are two different types of metrics in `spotPython`:

1. `"metric_river"` is used for the river based evaluation via `eval_oml_iter_progressive`.
2. `"metric_sklearn"` is used for the sklearn based evaluation.

We will consider multi-class classification metrics, e.g., `mapk_score` and `top_k_accuracy_score`.

> **Predict Probabilities**
>
> In this multi-class classification example the machine learning algorithm should return the probabilities of the specific classes (`"predict_proba"`) instead of the predicted values.

We set `"predict_proba"` to `True` in the `fun_control` dictionary.

21.10.1.1 The MAPK Metric

To select the MAPK metric, the following two entries can be added to the `fun_control` dictionary:

`"metric_sklearn": mapk_score"`

`"metric_params": {"k": 3}`.

21.10.1.2 Other Metrics

Alternatively, other metrics for multi-class classification can be used, e.g.,: * top_k_accuracy_score or * roc_auc_score

The metric `roc_auc_score` requires the parameter `"multi_class"`, e.g.,

`"multi_class": "ovr"`.

This is set in the `fun_control` dictionary.

> **Weights**
>
> `spotPython` performs a minimization, therefore, metrics that should be maximized have to be multiplied by -1. This is done by setting `"weights"` to `-1`.

- The complete setup for the metric in our example is:

```
from spotPython.utils.metrics import mapk_score
fun_control.update({
               "weights": -1,
               "metric_sklearn": mapk_score,
               "predict_proba": True,
               "metric_params": {"k": 3},
               })
```

21.11 Evaluation on Hold-out Data

- The default method for computing the performance is `"eval_holdout"`.
- Alternatively, cross-validation can be used for every machine learning model.
- Specifically for RandomForests, the OOB-score can be used.

```
fun_control.update({
    "eval": "train_hold_out",
})
```

21.11.1 OOB Score

Using the OOB-Score is a very efficient way to estimate the performance of a random forest classifier. The OOB-Score is calculated on the training data and does not require a hold-out test set. If the OOB-Score is used, the key “eval” in the `fun_control` dictionary should be set to `"oob_score"` as shown below.

> **OOB-Score**
>
> In addition to setting the key `"eval"` in the `fun_control` dictionary to `"oob_score"`, the keys `"oob_score"` and `"bootstrap"` have to be set to `True`, because the OOB-Score requires the bootstrap method.

- Uncomment the following lines to use the OOB-Score:

```
fun_control.update({
    "eval": "eval_oob_score",
})
fun_control = modify_hyper_parameter_bounds(fun_control, "bootstrap", bounds=[1, 1])
fun_control = modify_hyper_parameter_bounds(fun_control, "oob_score", bounds=[1, 1])
```

21.11.1.1 Cross Validation

Instead of using the OOB-score, the classical cross validation can be used. The number of folds is set by the key `"k_folds"`. For example, to use 5-fold cross validation, the key `"k_folds"` is set to `5`. Uncomment the following line to use cross validation:

```
# fun_control.update({
#      "eval": "train_cv",
#      "k_folds": 10,
# })
```

21.12 6. Calling the SPOT Function

21.13 Preparing the SPOT Call

- Get types and variable names as well as lower and upper bounds for the hyperparameters.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
```

```python
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```python
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name                     | type   | default   |    lower |    upper | transform
|--------------------------|--------|-----------|----------|----------|------------------------
| n_estimators             | int    | 7         |        5 |   10     | transform_power_2_int
| criterion                | factor | gini      |        0 |    2     | None
| max_depth                | int    | 10        |        1 |   20     | transform_power_2_int
| min_samples_split        | int    | 2         |        2 |  100     | None
| min_samples_leaf         | int    | 1         |        1 |   25     | None
| min_weight_fraction_leaf | float  | 0.0       |        0 |    0.01  | None
| max_features             | factor | sqrt      |        0 |    1     | transform_none_to_None
| max_leaf_nodes           | int    | 10        |        7 |   12     | transform_power_2_int
| min_impurity_decrease    | float  | 0.0       |        0 |    0.01  | None
| bootstrap                | factor | 1         |        1 |    1     | None
| oob_score                | factor | 0         |        1 |    1     | None
```

21.14 The Objective Function

The objective function is selected next. It implements an interface from `sklearn`'s training, validation, and testing methods to `spotPython`.

```python
from spotPython.fun.hypersklearn import HyperSklearn
fun = HyperSklearn().fun_sklearn
```

21.14.1 Run the `Spot` Optimizer

- Run SPOT for approx. x mins (`max_time`).
- Note: the run takes longer, because the evaluation time of initial design (here: `initi_size`, 20 points) is not considered.

```python
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=SklearnHyperDict().load()
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
X_start
```

```
array([[ 7.,  0., 10.,  2.,  1.,  0.,  0., 10.,  0.,  1.,  0.]])
```

```python
import numpy as np
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
                   show_progress= True,
                   fun_control = fun_control,
                   design_control={"init_size": INIT_SIZE,
                                   "repeats": 1},
                   surrogate_control={"noise": True,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": len(var_name),
                                      "model_fun_evals": 10_000,
                                      "log_level": 50
                                      })
spot_tuner.run(X_start=X_start)
```

```
spotPython tuning: -0.3462264150943396 [----------] 0.51%
```

```
spotPython tuning: -0.3462264150943396 [----------] 1.86%

spotPython tuning: -0.3462264150943396 [----------] 2.33%

spotPython tuning: -0.3462264150943396 [----------] 3.46%

spotPython tuning: -0.3462264150943396 [----------] 4.37%

spotPython tuning: -0.3462264150943396 [#---------] 5.93%

spotPython tuning: -0.3462264150943396 [#---------] 6.47%

spotPython tuning: -0.3462264150943396 [#---------] 7.20%

spotPython tuning: -0.3462264150943396 [#---------] 8.33%

spotPython tuning: -0.3474842767295597 [#---------] 9.91%

spotPython tuning: -0.3474842767295597 [#---------] 11.31%

spotPython tuning: -0.3474842767295597 [#---------] 13.15%

spotPython tuning: -0.3474842767295597 [##--------] 16.87%

spotPython tuning: -0.3474842767295597 [##--------] 20.82%

spotPython tuning: -0.3474842767295597 [###-------] 25.70%

spotPython tuning: -0.3474842767295597 [###-------] 30.23%

spotPython tuning: -0.3534591194968553 [####------] 35.20%

spotPython tuning: -0.3641509433962264 [####------] 39.72%

spotPython tuning: -0.3641509433962264 [####------] 43.95%

spotPython tuning: -0.3641509433962264 [#####-----] 50.51%
```

```
spotPython tuning: -0.3641509433962264 [######----] 55.35%

spotPython tuning: -0.3641509433962264 [######----] 59.53%

spotPython tuning: -0.3641509433962264 [######----] 63.50%

spotPython tuning: -0.3641509433962264 [#######---] 67.29%

spotPython tuning: -0.3641509433962264 [#######---] 70.96%

spotPython tuning: -0.3641509433962264 [#######---] 74.83%

spotPython tuning: -0.3641509433962264 [########--] 78.56%

spotPython tuning: -0.3641509433962264 [########--] 83.03%

spotPython tuning: -0.3641509433962264 [#########-] 88.34%

spotPython tuning: -0.3641509433962264 [#########-] 93.18%

spotPython tuning: -0.3641509433962264 [##########] 99.11%

spotPython tuning: -0.3641509433962264 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x140b2c040>
```

21.14.2 Results

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

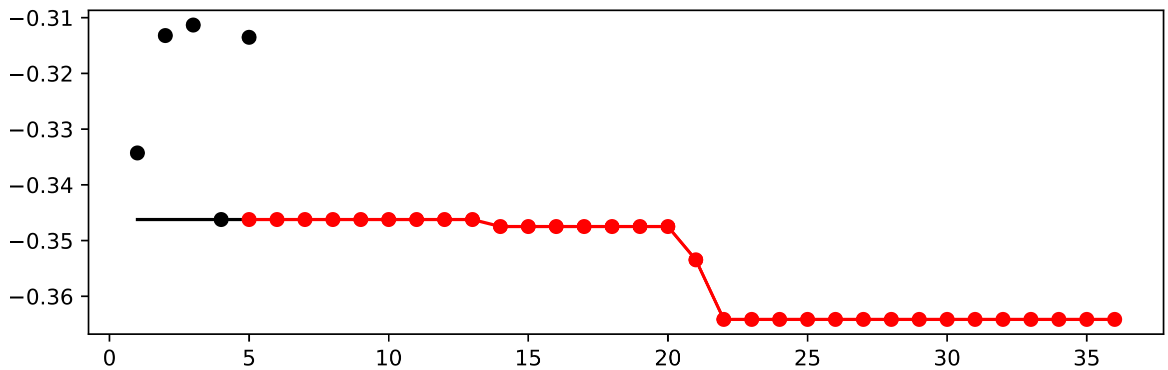


Figure 21.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

- Print the results

```
print(gen_design_table(fun_control=fun_control,
    spot=spot_tuner))
```

```
| name                     | type   | default   |    lower |    upper |                  tuned
|--------------------------|--------|-----------|----------|----------|-----------------------
| n_estimators             | int    | 7         |      5.0 |     10.0 |                    8.0
| criterion                | factor | gini      |      0.0 |      2.0 |                    1.0
| max_depth                | int    | 10        |      1.0 |     20.0 |                    6.0
| min_samples_split        | int    | 2         |      2.0 |    100.0 |                    7.0
| min_samples_leaf         | int    | 1         |      1.0 |     25.0 |                    1.0
| min_weight_fraction_leaf | float  | 0.0       |      0.0 |     0.01 |  0.0021626106904605842
| max_features             | factor | sqrt      |      0.0 |      1.0 |                    0.0
| max_leaf_nodes           | int    | 10        |      7.0 |     12.0 |                   10.0
| min_impurity_decrease    | float  | 0.0       |      0.0 |     0.01 |   0.006384942876947473
| bootstrap                | factor | 1         |      1.0 |      1.0 |                    1.0
| oob_score                | factor | 0         |      1.0 |      1.0 |                    1.0
```

21.15 Show variable importance

```
spot_tuner.plot_importance(threshold=0.025, filename="./figures/" + experiment_name+"_impo
```

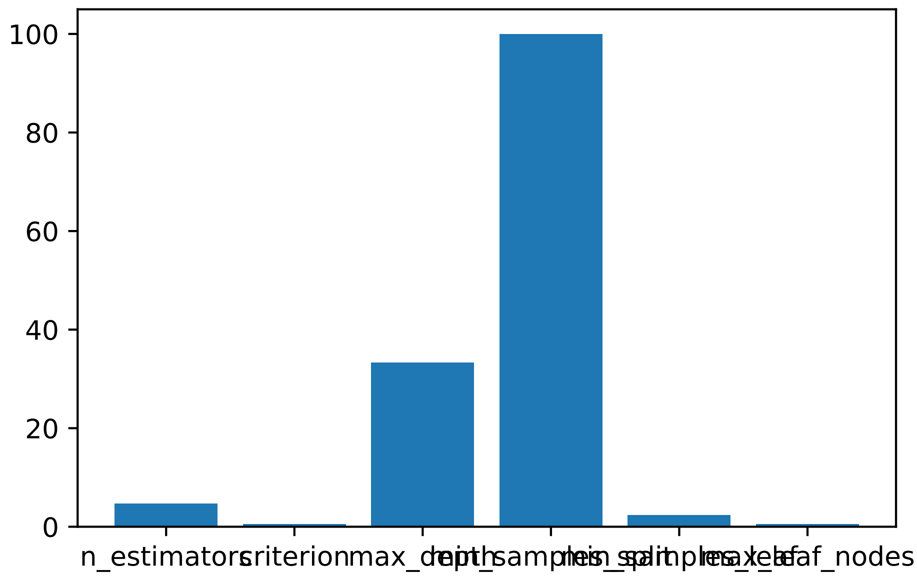


Figure 21.2: Variable importance plot, threshold 0.025.

21.16 Get Default Hyperparameters

```
from spotPython.hyperparameters.values import get_default_values, transform_hyper_paramete
values_default = get_default_values(fun_control)
values_default = transform_hyper_parameter_values(fun_control=fun_control, hyper_parameter
values_default
```

```
{'n_estimators': 128,
 'criterion': 'gini',
 'max_depth': 1024,
 'min_samples_split': 2,
 'min_samples_leaf': 1,
 'min_weight_fraction_leaf': 0.0,
 'max_features': 'sqrt',
 'max_leaf_nodes': 1024,
```

```
 'min_impurity_decrease': 0.0,
 'bootstrap': 1,
 'oob_score': 0}
```

```
from sklearn.pipeline import make_pipeline
model_default = make_pipeline(fun_control["prep_model"], fun_control["core_model"](**value
model_default
```

```
Pipeline(steps=[('nonetype', None),
                ('randomforestclassifier',
                 RandomForestClassifier(bootstrap=1, max_depth=1024,
                                        max_leaf_nodes=1024, n_estimators=128,
                                        oob_score=0))])
```

21.17 Get SPOT Results

```
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
print(X)
```

```
[[8.00000000e+00 1.00000000e+00 6.00000000e+00 7.00000000e+00
  1.00000000e+00 2.16261069e-03 0.00000000e+00 1.00000000e+01
  6.38494288e-03 1.00000000e+00 1.00000000e+00]]
```

```
from spotPython.hyperparameters.values import assign_values, return_conf_list_from_var_dic
v_dict = assign_values(X, fun_control["var_name"])
return_conf_list_from_var_dict(var_dict=v_dict, fun_control=fun_control)
```

```
[{'n_estimators': 256,
  'criterion': 'entropy',
  'max_depth': 64,
  'min_samples_split': 7,
  'min_samples_leaf': 1,
  'min_weight_fraction_leaf': 0.0021626106904605842,
  'max_features': 'sqrt',
  'max_leaf_nodes': 1024,
  'min_impurity_decrease': 0.006384942876947473,
  'bootstrap': 1,
  'oob_score': 1}]
```

```python
from spotPython.hyperparameters.values import get_one_sklearn_model_from_X
model_spot = get_one_sklearn_model_from_X(X, fun_control)
model_spot
```

```
RandomForestClassifier(bootstrap=1, criterion='entropy', max_depth=64,
                       max_leaf_nodes=1024,
                       min_impurity_decrease=0.006384942876947473,
                       min_samples_split=7,
                       min_weight_fraction_leaf=0.0021626106904605842,
                       n_estimators=256, oob_score=1)
```

21.18 Evaluate SPOT Results

- Fetch the data.

```python
from spotPython.utils.convert import get_Xy_from_df
X_train, y_train = get_Xy_from_df(fun_control["train"], fun_control["target_column"])
X_test, y_test = get_Xy_from_df(fun_control["test"], fun_control["target_column"])
X_test.shape, y_test.shape
```

```
((177, 64), (177,))
```

- Fit the model with the tuned hyperparameters. This gives one result:

```python
model_spot.fit(X_train, y_train)
y_pred = model_spot.predict_proba(X_test)
res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
res
```

```
0.37099811676082856
```

```python
def repeated_eval(n, model):
    res_values = []
    for i in range(n):
        model.fit(X_train, y_train)
        y_pred = model.predict_proba(X_test)
        res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
        res_values.append(res)
```

```python
    mean_res = np.mean(res_values)
    print(f"mean_res: {mean_res}")
    std_res = np.std(res_values)
    print(f"std_res: {std_res}")
    min_res = np.min(res_values)
    print(f"min_res: {min_res}")
    max_res = np.max(res_values)
    print(f"max_res: {max_res}")
    median_res = np.median(res_values)
    print(f"median_res: {median_res}")
    return mean_res, std_res, min_res, max_res, median_res
```

21.18.1 Handling Non-deterministic Results

- Because the model is non-determinstic, we perform $n = 30$ runs and calculate the mean and standard deviation of the performance metric.

```python
_ = repeated_eval(30, model_spot)
```

```
mean_res: 0.3579409918392969
std_res: 0.010184399262810239
min_res: 0.3305084745762712
max_res: 0.37476459510357824
median_res: 0.35969868173258
```

21.18.2 Evalution of the Default Hyperparameters

```python
model_default.fit(X_train, y_train)["randomforestclassifier"]
```

```
RandomForestClassifier(bootstrap=1, max_depth=1024, max_leaf_nodes=1024,
                       n_estimators=128, oob_score=0)
```

- One evaluation of the default hyperparameters is performed on the hold-out test set.

```python
y_pred = model_default.predict_proba(X_test)
mapk_score(y_true=y_test, y_pred=y_pred, k=3)
```

```
0.34086629001883234
```

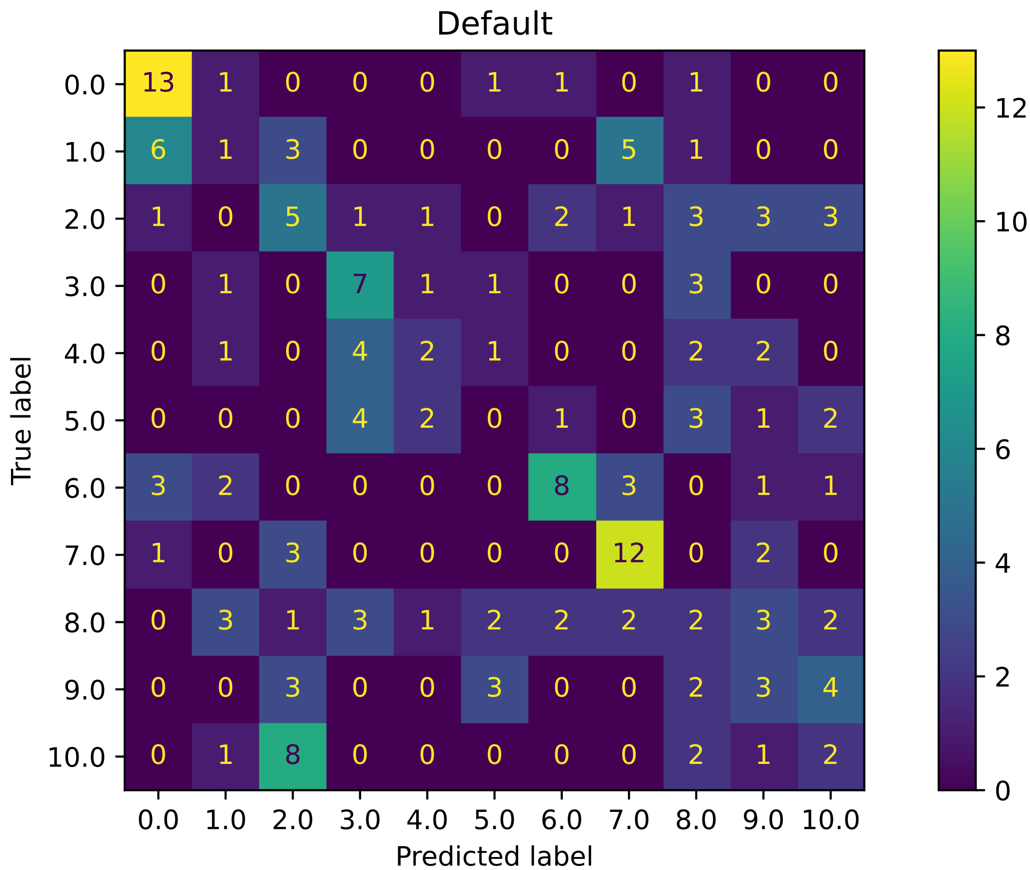
Since one single evaluation is not meaningful, we perform, similar to the evaluation of the SPOT results, $n = 30$ runs of the default setting and and calculate the mean and standard deviation of the performance metric.

```
_ = repeated_eval(30, model_default)
```

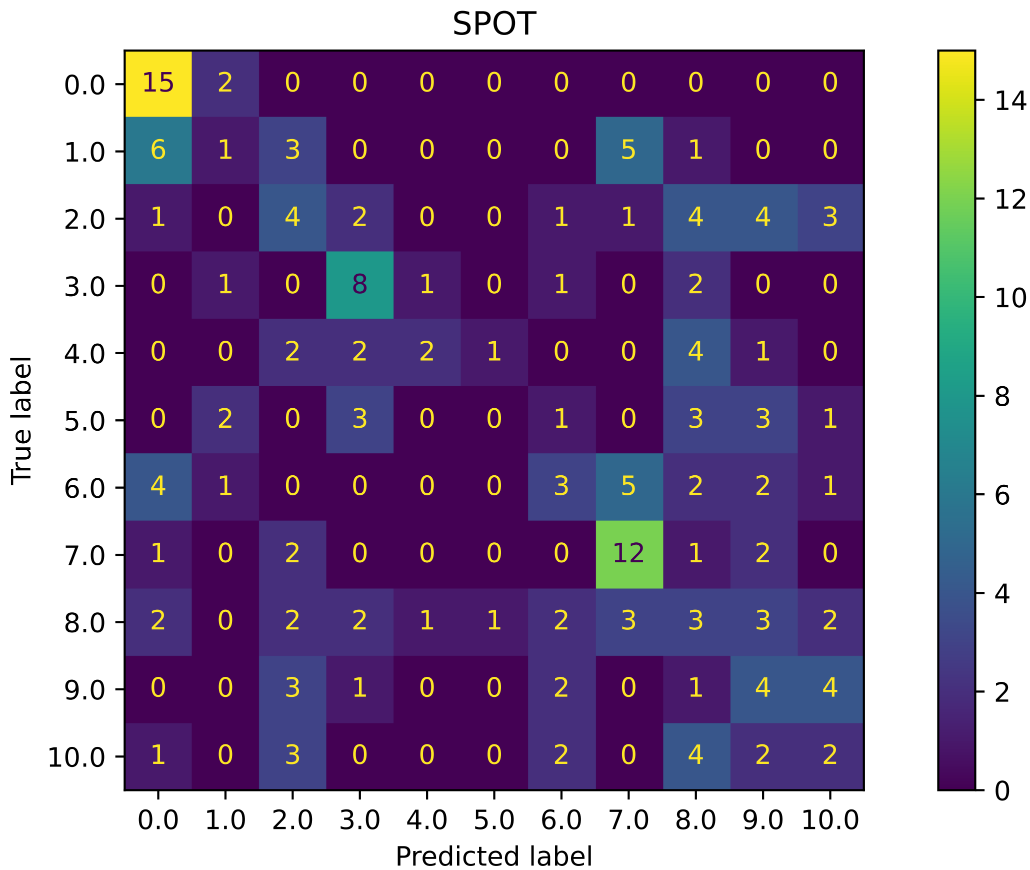
```
mean_res: 0.34344005021971125
std_res: 0.0143442454042421
min_res: 0.3182674199623352
max_res: 0.371939736346516
median_res: 0.3418079096045198
```

21.19 Plot: Compare Predictions

```
from spotPython.plot.validation import plot_confusion_matrix
plot_confusion_matrix(model_default, fun_control, title = "Default")
```




```python
plot_confusion_matrix(model_spot, fun_control, title="SPOT")
```




```
min(spot_tuner.y), max(spot_tuner.y)
```

```
(-0.3641509433962264, -0.2748427672955975)
```

21.20 Cross-validated Evaluations

```
from spotPython.sklearn.traintest import evaluate_cv
fun_control.update({
     "eval": "train_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.3528301886792453, None)
```

```
fun_control.update({
     "eval": "test_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.32690631808278864, None)
```

- This is the evaluation that will be used in the comparison:

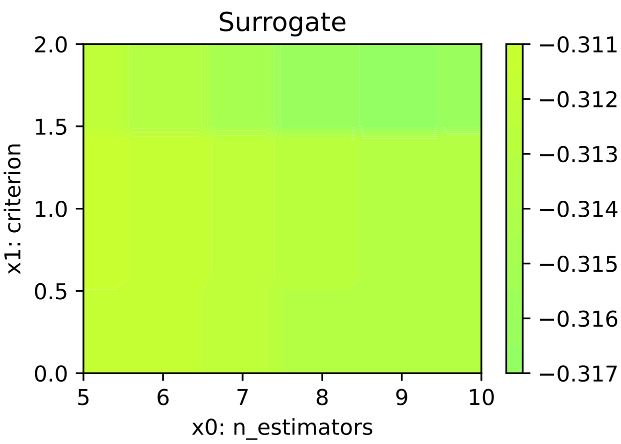
```
fun_control.update({
     "eval": "data_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

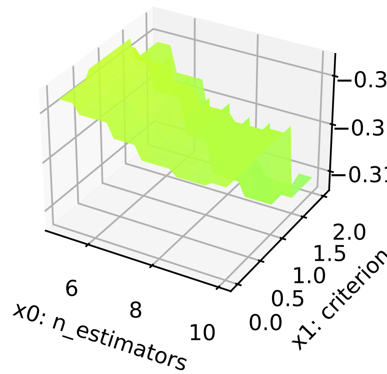
```
(0.3678839704896043, None)
```

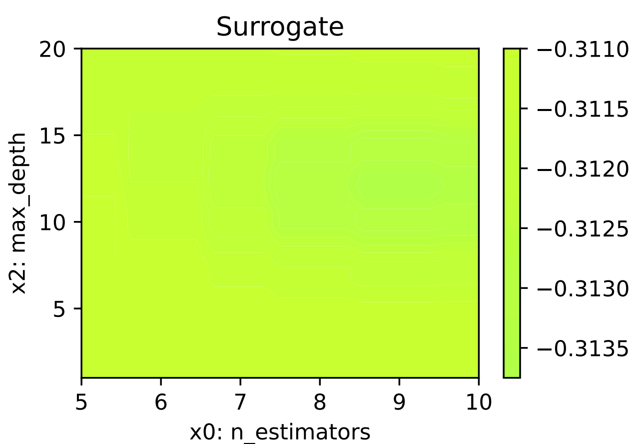
21.20.1 Detailed Hyperparameter Plots

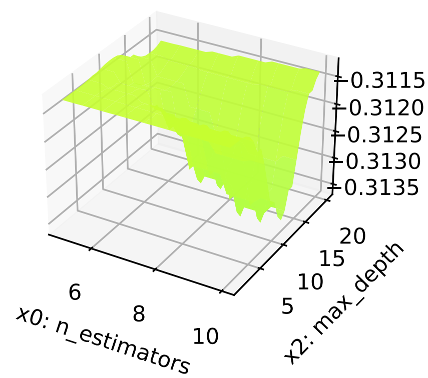
```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

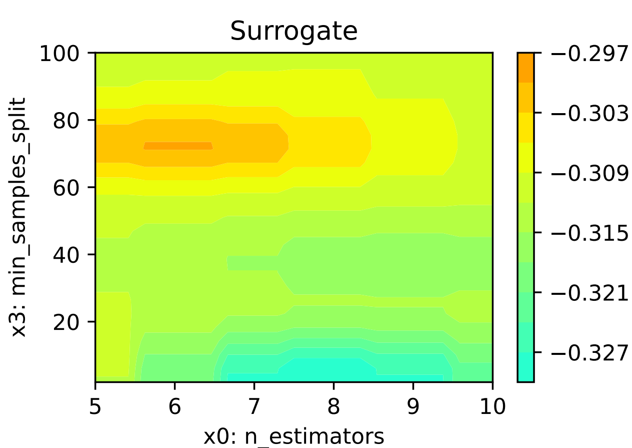
```
n_estimators:  4.7467723365384655
criterion:  0.5785521610708949
max_depth:  33.30033560556498
min_samples_split:  100.0
min_samples_leaf:  2.366919823143397
max_leaf_nodes:  0.5232399101565642
```

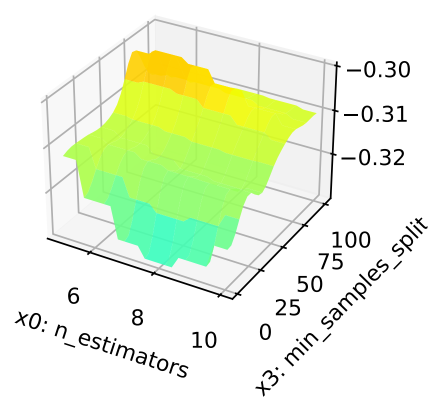

Surrogate
x1: criterion
2.0
1.5
1.0
0.5
0.0
5
6
7
8
9
10
x0: n_estimators
−0.311
−0.312
−0.313
−0.314
−0.315
−0.316
−0.317

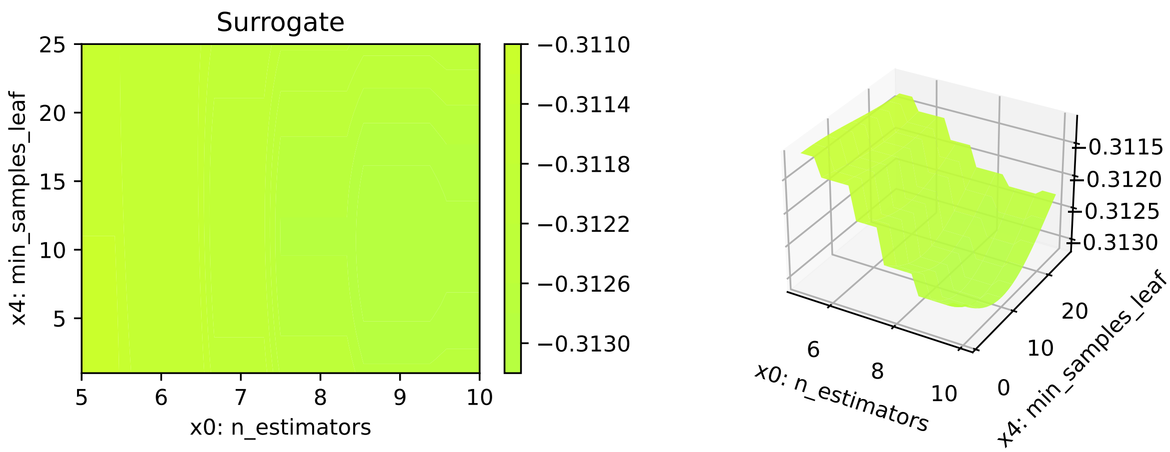

−0.312
−0.314
−0.316
6
8
10
x0: n_estimators
0.0
0.5
1.0
1.5
2.0
x1: criterion

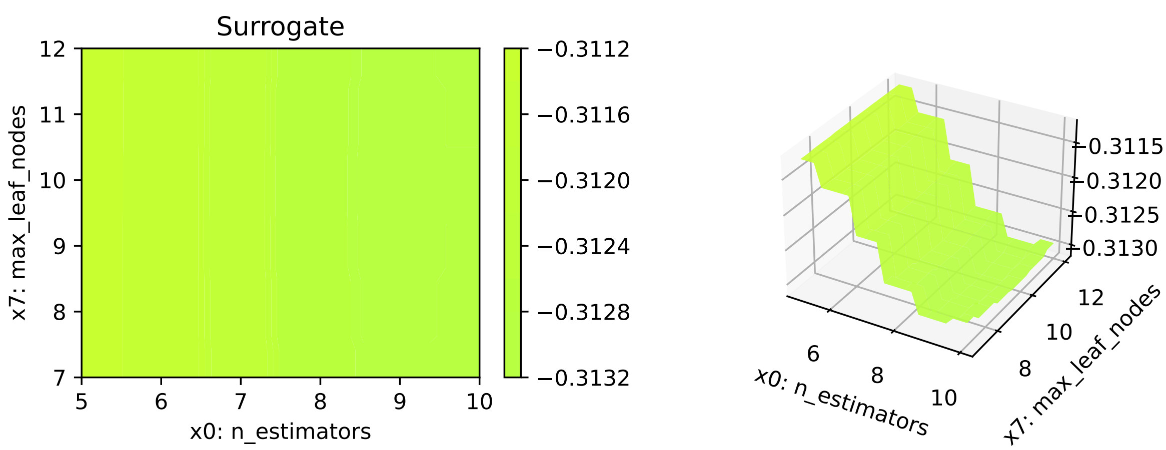

Surrogate
x2: max_depth
20
15
10
5
5
6
7
8
9
10
x0: n_estimators
−0.3110
−0.3115
−0.3120
−0.3125
−0.3130
−0.3135

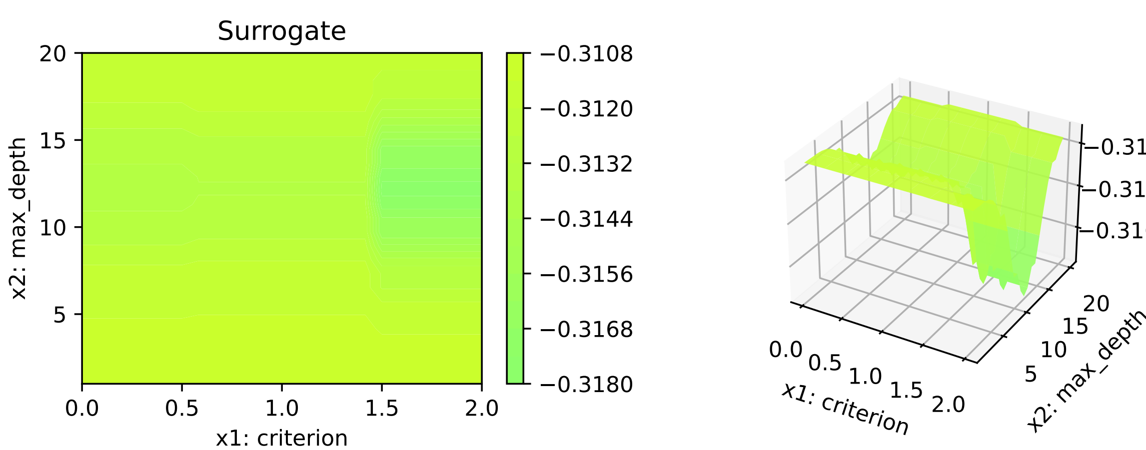

−0.3115
−0.3120
−0.3125
−0.3130
−0.3135
6
8
10
x0: n_estimators
5
10
15
20
x2: max_depth

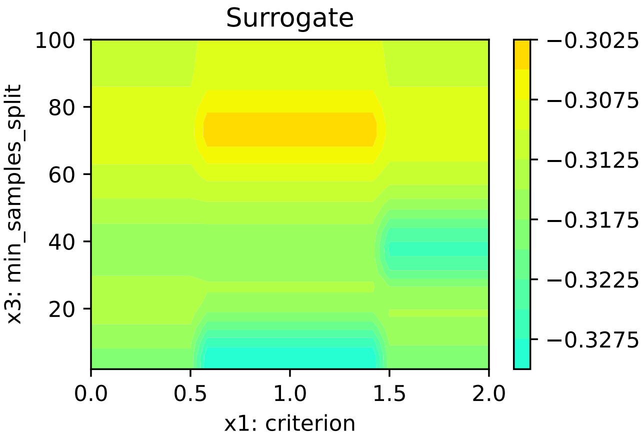

Surrogate
x3: min_samples_split
100
80
60
40
20
5
6
7
8
9
10
x0: n_estimators
−0.297
−0.303
−0.309
−0.315
−0.321
−0.327

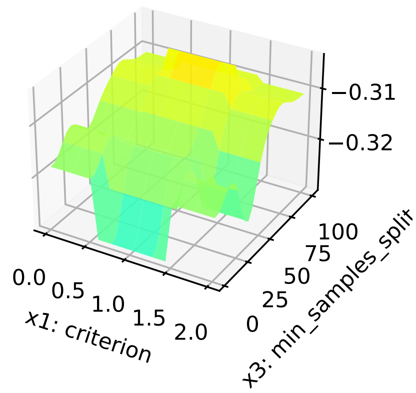

−0.30
−0.31
−0.32
6
8
10
x0: n_estimators
0
25
50
75
100
x3: min_samples_split

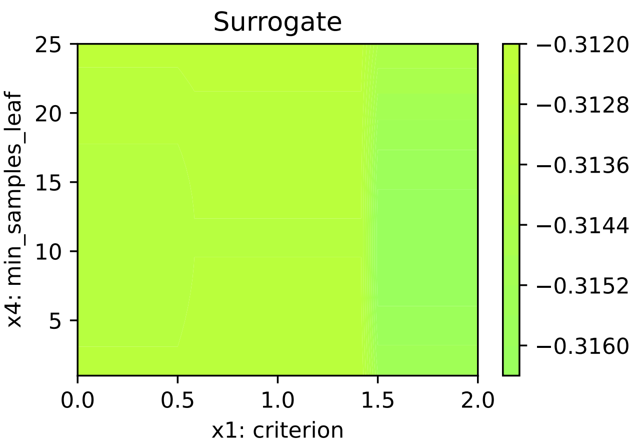

Surrogate
x4: min_samples_leaf
x0: n_estimators
−0.3110
−0.3114
−0.3118
−0.3122
−0.3126
−0.3130
0.3115
0.3120
0.3125
0.3130

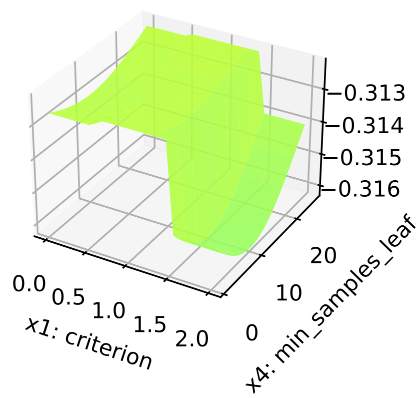

Surrogate
x7: max_leaf_nodes
x0: n_estimators
−0.3112
−0.3116
−0.3120
−0.3124
−0.3128
−0.3132
0.3115
0.3120
0.3125
0.3130

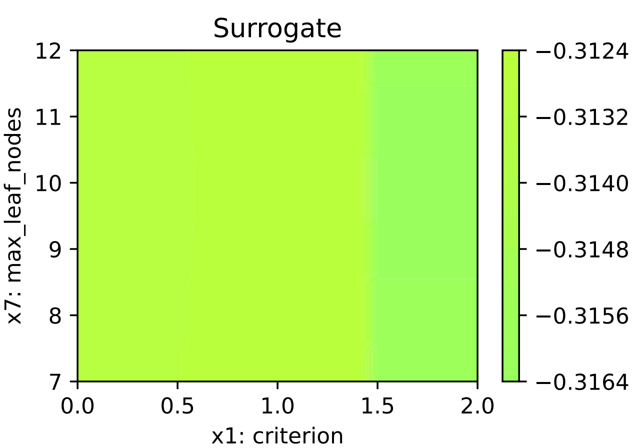

Surrogate
x2: max_depth
x1: criterion
−0.3108
−0.3120
−0.3132
−0.3144
−0.3156
−0.3168
−0.3180
−0.312
−0.314
−0.316

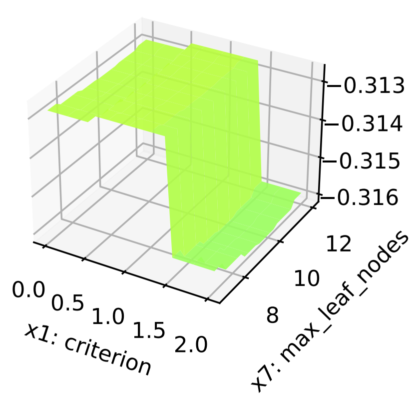

Surrogate
x3: min_samples_split
x1: criterion
−0.3025
−0.3075
−0.3125
−0.3175
−0.3225
−0.3275

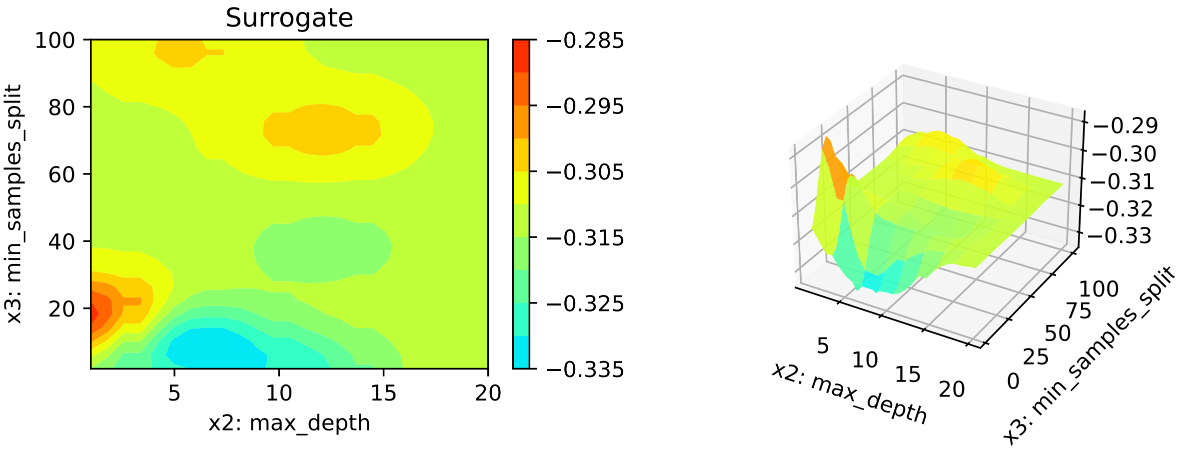

x1: criterion
x3: min_samples_split
−0.31
−0.32

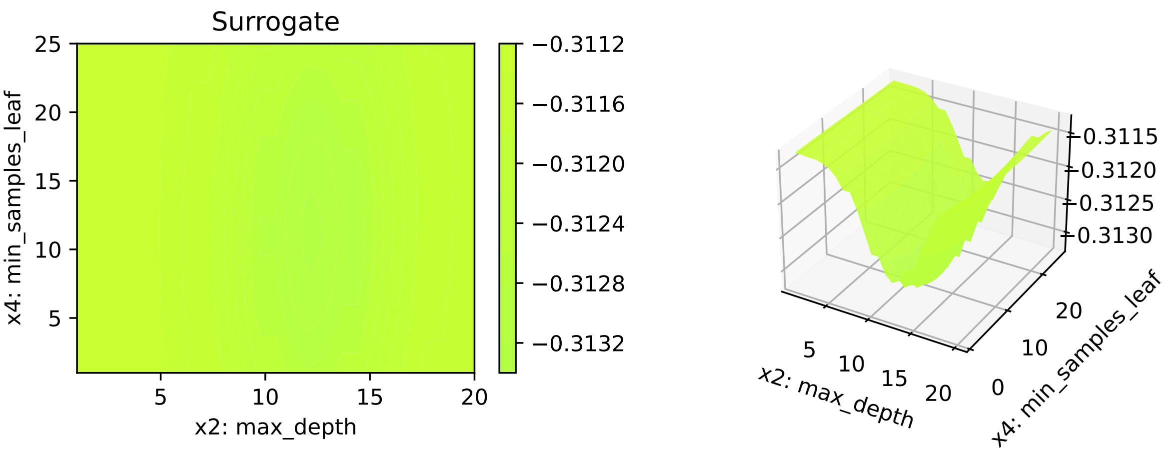

Surrogate
x4: min_samples_leaf
x1: criterion
−0.3120
−0.3128
−0.3136
−0.3144
−0.3152
−0.3160

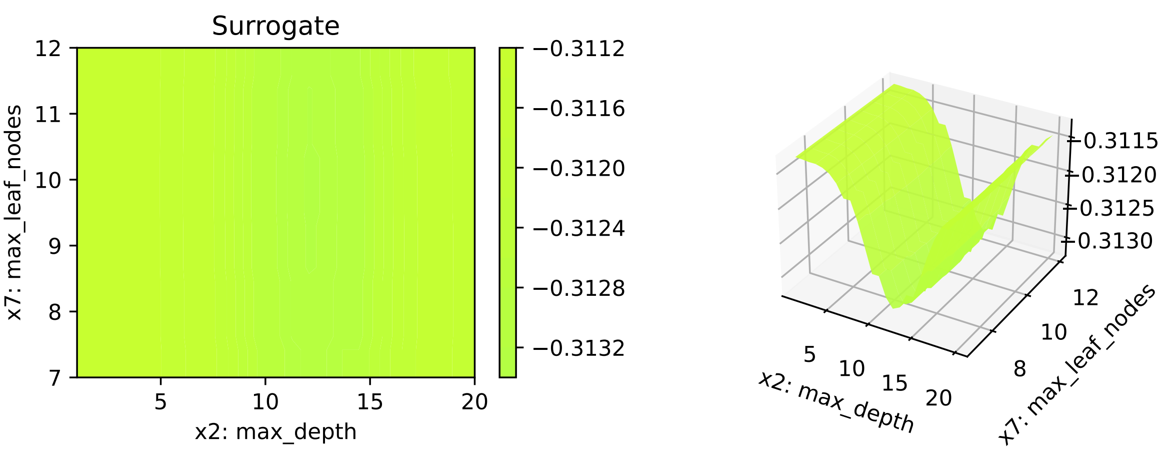

x1: criterion
x4: min_samples_leaf
−0.313
−0.314
−0.315
−0.316

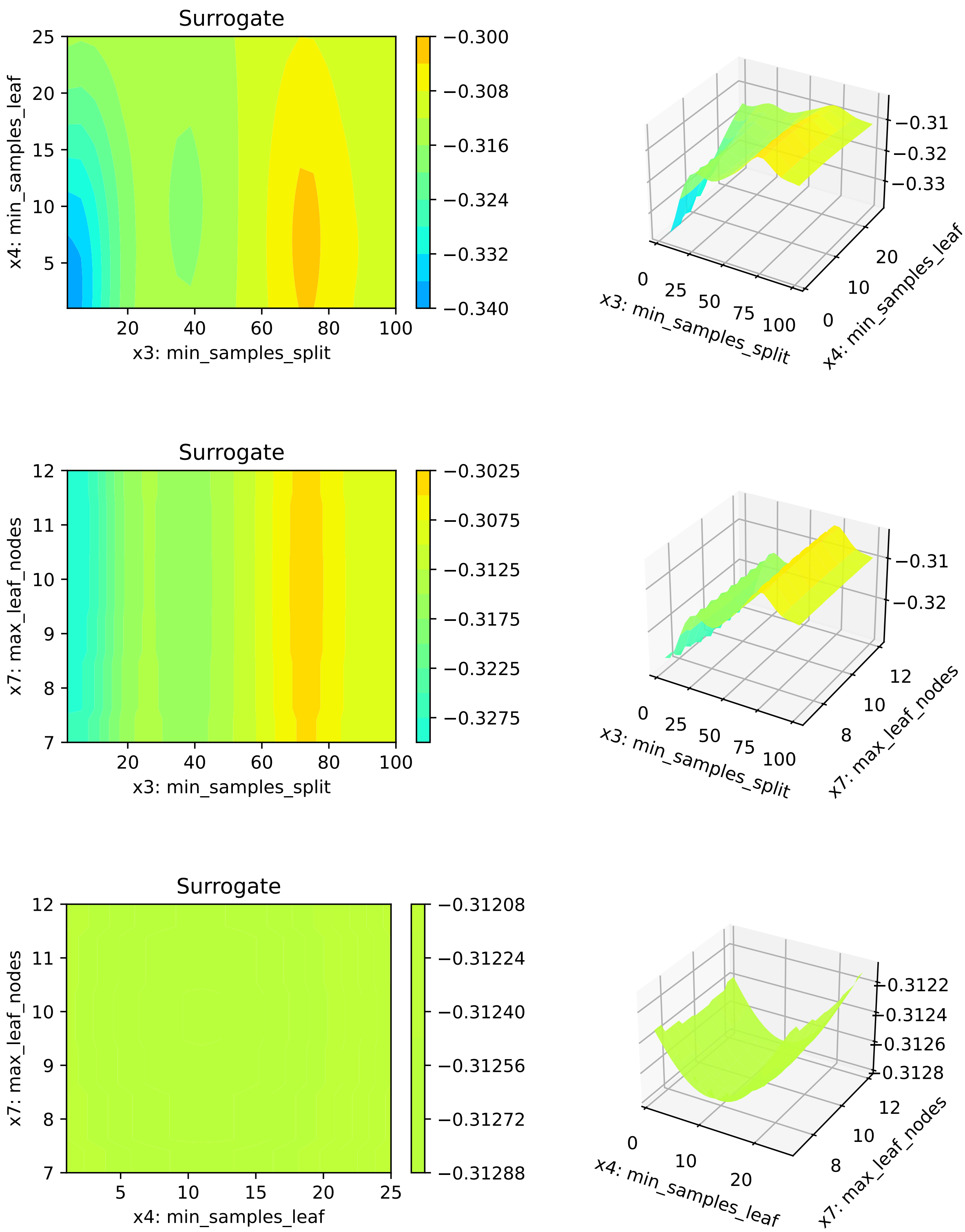

Surrogate
x7: max_leaf_nodes
x1: criterion
−0.3124
−0.3132
−0.3140
−0.3148
−0.3156
−0.3164


x1: criterion
x7: max_leaf_nodes
−0.313
−0.314
−0.315
−0.316


Surrogate
x3: min_samples_split
x2: max_depth
−0.285
−0.295
−0.305
−0.315
−0.325
−0.335
x3: min_samples_split
x2: max_depth


Surrogate
x4: min_samples_leaf
x2: max_depth
−0.3112
−0.3116
−0.3120
−0.3124
−0.3128
−0.3132
x4: min_samples_leaf
x2: max_depth


Surrogate
x7: max_leaf_nodes
x2: max_depth
−0.3112
−0.3116
−0.3120
−0.3124
−0.3128
−0.3132
x7: max_leaf_nodes
x2: max_depth


Surrogate
x4: min_samples_leaf
x3: min_samples_split
−0.300
−0.308
−0.316
−0.324
−0.332
−0.340
−0.31
−0.32
−0.33
Surrogate
x7: max_leaf_nodes
x3: min_samples_split
−0.3025
−0.3075
−0.3125
−0.3175
−0.3225
−0.3275
Surrogate
x7: max_leaf_nodes
x4: min_samples_leaf
−0.31208
−0.31224
−0.31240
−0.31256
−0.31272
−0.31288
−0.3122
−0.3124
−0.3126
−0.3128

21.21 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

```
Unable to display output for mime type(s): text/html
```

21.22 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
            spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

22 HPT: sklearn XGB Classifier VBDP Data

This document refers to the following software versions:

- `python`: 3.10.10

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                   0.2.33
spotRiver                    0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

22.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time and the initial design size.

```
MAX_TIME = 1
INIT_SIZE = 5
ORIGINAL = False
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '17-xgb-sklearn' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(I
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
17-xgb-sklearn_p040025_1min_5init_2023-06-17_02-07-01
```

```
import warnings
warnings.filterwarnings("ignore")
```

22.2 Step 1: Initialization of the Empty `fun_control` Dictionary

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/16_spot_hpt_sklearn_classification")
```

22.3 1. Load Data: Classification

22.4 VBDP

```
import pandas as pd
if ORIGINAL == True:
    train_df = pd.read_csv('./data/VBDP/trainn.csv')
    test_df = pd.read_csv('./data/VBDP/testt.csv')
else:
    train_df = pd.read_csv('./data/VBDP/train.csv')
    # remove the id column
    train_df = train_df.drop(columns=['id'])
```

```python
from sklearn.preprocessing import OrdinalEncoder
n_samples = train_df.shape[0]
n_features = train_df.shape[1] - 1
target_column = "prognosis"
# Encoder our prognosis labels as integers for easier decoding later
enc = OrdinalEncoder()
train_df[target_column] = enc.fit_transform(train_df[[target_column]])
train_df.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train_df.shape)
train_df.head()
```

```
(707, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	...	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0
3	0.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	...	0.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0

The full data set `train_df` 64 features. The target column is labeled as `prognosis`.

22.5 Holdout Train and Test Data

We split out a hold-out test set (25% of the data) so we can calculate an example MAP@K

```python
import numpy as np
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(train_df.drop(target_column, axis=1),
                                                    random_state=42,
                                                    test_size=0.25,
                                                    stratify=train_df[target_column])
train = pd.DataFrame(np.hstack((X_train, np.array(y_train).reshape(-1, 1))))
test = pd.DataFrame(np.hstack((X_test, np.array(y_test).reshape(-1, 1))))
train.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
test.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train.shape)
print(test.shape)
```

```
train.head()
```

```
(530, 65)
(177, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
3	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
# add the dataset to the fun_control
fun_control.update({"data": train_df, # full dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": target_column})
```

22.6 Step 3: Specification of the Preprocessing Model

Data preprocesssing can be very simple, e.g., you can ignore it. Then you would choose the `prep_model` "None":

```
prep_model = None
fun_control.update({"prep_model": prep_model})
```

A default approach for numerical data is the `StandardScaler` (mean 0, variance 1). This can be selected as follows:

```
# prep_model = StandardScaler()
# fun_control.update({"prep_model": prep_model})
```

Even more complicated pre-processing steps are possible, e.g., the follwing pipeline:

```
# categorical_columns = []
# one_hot_encoder = OneHotEncoder(handle_unknown="ignore", sparse_output=False)
# prep_model = ColumnTransformer(
```

```
#         transformers=[
#             ("categorical", one_hot_encoder, categorical_columns),
#         ],
#         remainder=StandardScaler(),
#     )
```

22.7 Step 4: Select `algorithm` and `core_model_hyper_dict`

The selection of the algorithm (ML model) that should be tuned is done by specifying the its name from the `sklearn` implementation. For example, the `SVC` support vector machine classifier is selected as follows:

`fun_control = add_core_model_to_fun_control(SVC, fun_control, SklearnHyperDict)`

Other core_models are, e.g.,:

- RidgeCV
- GradientBoostingRegressor
- ElasticNet
- RandomForestClassifier
- LogisticRegression
- KNeighborsClassifier
- RandomForestClassifier
- GradientBoostingClassifier
- HistGradientBoostingClassifier

We will use the `RandomForestClassifier` classifier in this example.

```
from sklearn.linear_model import RidgeCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.ensemble import HistGradientBoostingClassifier
from sklearn.linear_model import ElasticNet
from spotPython.hyperparameters.values import add_core_model_to_fun_control
from spotPython.data.sklearn_hyper_dict import SklearnHyperDict
from spotPython.fun.hypersklearn import HyperSklearn
```

```python
# core_model  = RidgeCV
# core_model = GradientBoostingRegressor
# core_model = ElasticNet
core_model = RandomForestClassifier
# core_model = SVC
# core_model = LogisticRegression
# core_model = KNeighborsClassifier
# core_model = GradientBoostingClassifier
core_model = HistGradientBoostingClassifier
fun_control = add_core_model_to_fun_control(core_model=core_model,
                              fun_control=fun_control,
                              hyper_dict=SklearnHyperDict,
                              filename=None)
```

Now `fun_control` has the information from the JSON file. The available hyperparameters are:

```python
print(*fun_control["core_model_hyper_dict"].keys(), sep="\n")
```

```
loss
learning_rate
max_iter
max_leaf_nodes
max_depth
min_samples_leaf
l2_regularization
max_bins
early_stopping
n_iter_no_change
tol
```

22.8 Step 5: Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

22.8.1 Modify hyperparameter of type numeric and integer (boolean)

Numeric and boolean values can be modified using the `modify_hyper_parameter_bounds` method. For example, to change the `tol` hyperparameter of the `SVC` model to the interval [1e-3, 1e-2], the following code can be used:

`fun_control = modify_hyper_parameter_bounds(fun_control, "tol", bounds=[1e-3, 1e-2])`

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
# fun_control = modify_hyper_parameter_bounds(fun_control, "tol", bounds=[1e-3, 1e-2])
# fun_control = modify_hyper_parameter_bounds(fun_control, "min_samples_split", bounds=[3,
# fun_control = modify_hyper_parameter_bounds(fun_control, "dual", bounds=[0, 0])
# fun_control = modify_hyper_parameter_bounds(fun_control, "probability", bounds=[1, 1])
# fun_control["core_model_hyper_dict"]["tol"]
# fun_control = modify_hyper_parameter_bounds(fun_control, "min_samples_leaf", bounds=[1,
# fun_control = modify_hyper_parameter_bounds(fun_control, "n_estimators", bounds=[5, 10])
```

22.8.2 Modify hyperparameter of type factor

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

Factors can be modified with the `modify_hyper_parameter_levels` function. For example, to exclude the `sigmoid` kernel from the tuning, the `kernel` hyperparameter of the `SVC` model can be modified as follows:

`fun_control = modify_hyper_parameter_levels(fun_control, "kernel", ["linear", "rbf"])`

The new setting can be controlled via:

`fun_control["core_model_hyper_dict"]["kernel"]`

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
# XGBoost:
fun_control = modify_hyper_parameter_levels(fun_control, "loss", ["log_loss"])
```

22.8.3 Optimizers

Optimizers are described in Section 20.6.

22.9 5. Selection of the Objective: Metric and Loss Functions

- Machine learning models are optimized with respect to a metric, for example, the `accuracy` function.

- Deep learning, e.g., neural networks are optimized with respect to a loss function, for example, the `cross_entropy` function and evaluated with respect to a metric, for example, the `accuracy` function.

22.10 Step 6: Selection of the Objective (Loss) Function

The loss function, that is usually used in deep learning for optimizing the weights of the net, is stored in the `fun_control` dictionary as `"loss_function"`.

22.10.1 Metric Function

There are two different types of metrics in `spotPython`:

1. `"metric_river"` is used for the river based evaluation via `eval_oml_iter_progressive`.
2. `"metric_sklearn"` is used for the sklearn based evaluation.

We will consider multi-class classification metrics, e.g., `mapk_score` and `top_k_accuracy_score`.

> **Predict Probabilities**
>
> In this multi-class classification example the machine learning algorithm should return the probabilities of the specific classes (`"predict_proba"`) instead of the predicted values.

We set `"predict_proba"` to `True` in the `fun_control` dictionary.

22.10.1.1 The MAPK Metric

To select the MAPK metric, the following two entries can be added to the `fun_control` dictionary:

`"metric_sklearn": mapk_score"`

`"metric_params": {"k": 3}`.

22.10.1.2 Other Metrics

Alternatively, other metrics for multi-class classification can be used, e.g.,: * top_k_accuracy_score or * roc_auc_score

The metric `roc_auc_score` requires the parameter `"multi_class"`, e.g.,

`"multi_class": "ovr"`.

This is set in the `fun_control` dictionary.

> **Weights**
>
> `spotPython` performs a minimization, therefore, metrics that should be maximized have to be multiplied by -1. This is done by setting `"weights"` to `-1`.

- The complete setup for the metric in our example is:

```
from spotPython.utils.metrics import mapk_score
fun_control.update({
               "weights": -1,
               "metric_sklearn": mapk_score,
               "predict_proba": True,
               "metric_params": {"k": 3},
               })
```

22.11 Evaluation on Hold-out Data

- The default method for computing the performance is `"eval_holdout"`.
- Alternatively, cross-validation can be used for every machine learning model.
- Specifically for RandomForests, the OOB-score can be used.

```
fun_control.update({
    "eval": "train_hold_out",
})
```

22.11.0.1 Cross Validation

Instead of using the OOB-score, the classical cross validation can be used. The number of folds is set by the key `"k_folds"`. For example, to use 5-fold cross validation, the key `"k_folds"` is set to `5`. Uncomment the following line to use cross validation:

```
# fun_control.update({
#      "eval": "train_cv",
#      "k_folds": 10,
# })
```

22.12 6. Calling the SPOT Function

22.13 Preparing the SPOT Call

- Get types and variable names as well as lower and upper bounds for the hyperparameters.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name                | type    | default    |   lower |   upper | transform              |
|---------------------|---------|------------|---------|---------|------------------------|
| loss                | factor  | log_loss   |   0     |   0     | None                   |
| learning_rate       | float   | -1.0       |  -5     |   0     | transform_power_10     |
| max_iter            | int     | 7          |   3     |  10     | transform_power_2_int  |
| max_leaf_nodes      | int     | 5          |   1     |  12     | transform_power_2_int  |
| max_depth           | int     | 2          |   1     |  20     | transform_power_2_int  |
| min_samples_leaf    | int     | 4          |   2     |  10     | transform_power_2_int  |
| l2_regularization   | float   | 0.0        |   0     |  10     | None                   |
| max_bins            | int     | 255        | 127     | 255     | None                   |
| early_stopping      | factor  | 1          |   0     |   1     | None                   |
| n_iter_no_change    | int     | 10         |   5     |  20     | None                   |
| tol                 | float   | 0.0001     |   1e-05 |   0.001 | None                   |
```

22.14 The Objective Function

The objective function is selected next. It implements an interface from `sklearn`'s training, validation, and testing methods to `spotPython`.

```
from spotPython.fun.hypersklearn import HyperSklearn
fun = HyperSklearn().fun_sklearn
```

22.14.1 Run the Spot Optimizer

- Run SPOT for approx. x mins (`max_time`).
- Note: the run takes longer, because the evaluation time of initial design (here: `initi_size`, 20 points) is not considered.

```
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=SklearnHyperDict().load()
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
X_start
```

```
array([[ 0.00e+00, -1.00e+00,  7.00e+00,  5.00e+00,  2.00e+00,  4.00e+00,
         0.00e+00,  2.55e+02,  1.00e+00,  1.00e+01,  1.00e-04]])
```

```
import numpy as np
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
```

```
                    show_progress= True,
                    fun_control = fun_control,
                    design_control={"init_size": INIT_SIZE,
                                    "repeats": 1},
                    surrogate_control={"noise": True,
                                       "cod_type": "norm",
                                       "min_theta": -4,
                                       "max_theta": 3,
                                       "n_theta": len(var_name),
                                       "model_fun_evals": 10_000,
                                       "log_level": 50
                                       })
spot_tuner.run(X_start=X_start)
```

```
spotPython tuning: -0.3508771929824561 [----------] 1.20%

spotPython tuning: -0.3508771929824561 [----------] 2.79%

spotPython tuning: -0.3508771929824561 [#---------] 7.92%

spotPython tuning: -0.3508771929824561 [#---------] 10.91%

spotPython tuning: -0.3508771929824561 [#---------] 14.92%

spotPython tuning: -0.35463659147869675 [##--------] 17.87%

spotPython tuning: -0.35714285714285715 [##--------] 19.91%

spotPython tuning: -0.35714285714285715 [##--------] 21.27%

spotPython tuning: -0.35714285714285715 [##--------] 23.15%

spotPython tuning: -0.35714285714285715 [###-------] 25.01%

spotPython tuning: -0.362155388471178 [###-------] 26.34%

spotPython tuning: -0.362155388471178 [###-------] 28.57%
```

```
spotPython tuning: -0.362155388471178 [###-------] 31.90%

spotPython tuning: -0.362155388471178 [###-------] 34.75%

spotPython tuning: -0.37092731829573933 [####------] 39.41%

spotPython tuning: -0.37092731829573933 [####------] 43.35%

spotPython tuning: -0.37092731829573933 [#####-----] 46.82%

spotPython tuning: -0.3834586466165413 [#####-----] 50.26%

spotPython tuning: -0.3834586466165413 [#####-----] 54.37%

spotPython tuning: -0.3834586466165413 [######----] 59.99%

spotPython tuning: -0.3834586466165413 [######----] 63.83%

spotPython tuning: -0.3834586466165413 [#######---] 67.56%

spotPython tuning: -0.3834586466165413 [#######---] 71.28%

spotPython tuning: -0.3834586466165413 [########--] 75.09%

spotPython tuning: -0.3834586466165413 [########--] 81.19%

spotPython tuning: -0.3834586466165413 [#########-] 86.15%

spotPython tuning: -0.3834586466165413 [#########-] 92.32%

spotPython tuning: -0.3834586466165413 [##########] 97.10%

spotPython tuning: -0.3834586466165413 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x29e379d80>
```

22.14.2 Results

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```python
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

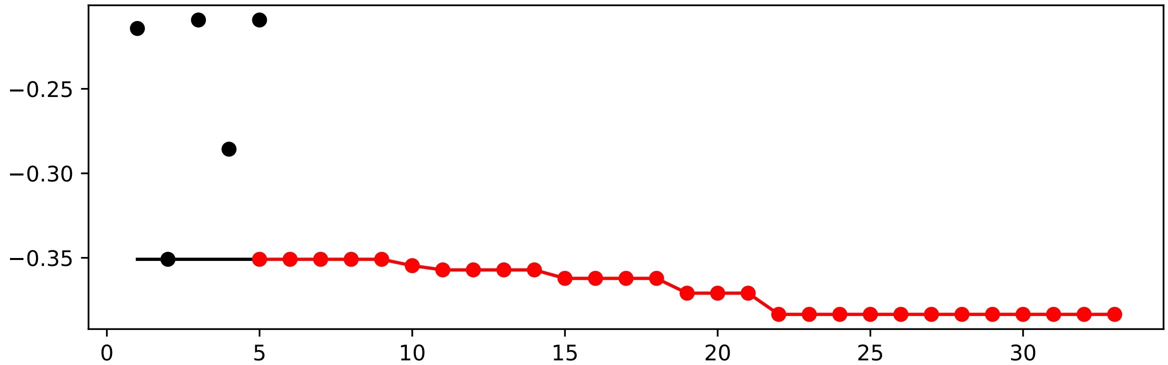


Figure 22.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

- Print the results

```python
print(gen_design_table(fun_control=fun_control,
    spot=spot_tuner))
```

```
| name               | type   | default   |   lower |   upper |                tuned | transi
|--------------------|--------|-----------|---------|---------|----------------------|-------
| loss               | factor | log_loss  |     0.0 |     0.0 |                  0.0 | None
| learning_rate      | float  | -1.0      |    -5.0 |     0.0 |  -0.5572723557033474 | transi
| max_iter           | int    | 7         |     3.0 |    10.0 |                  6.0 | transi
| max_leaf_nodes     | int    | 5         |     1.0 |    12.0 |                  1.0 | transi
| max_depth          | int    | 2         |     1.0 |    20.0 |                  4.0 | transi
| min_samples_leaf   | int    | 4         |     2.0 |    10.0 |                  2.0 | transi
| l2_regularization  | float  | 0.0       |     0.0 |    10.0 |    3.920209015825284 | None
| max_bins           | int    | 255       |   127.0 |   255.0 |                192.0 | None
| early_stopping     | factor | 1         |     0.0 |     1.0 |                  1.0 | None
| n_iter_no_change   | int    | 10        |     5.0 |    20.0 |                  6.0 | None
| tol                | float  | 0.0001    |   1e-05 |   0.001 | 0.000923592087435293 5 | None
```

22.15 Show variable importance

```
spot_tuner.plot_importance(threshold=0.025, filename="./figures/" + experiment_name+"_impo
```

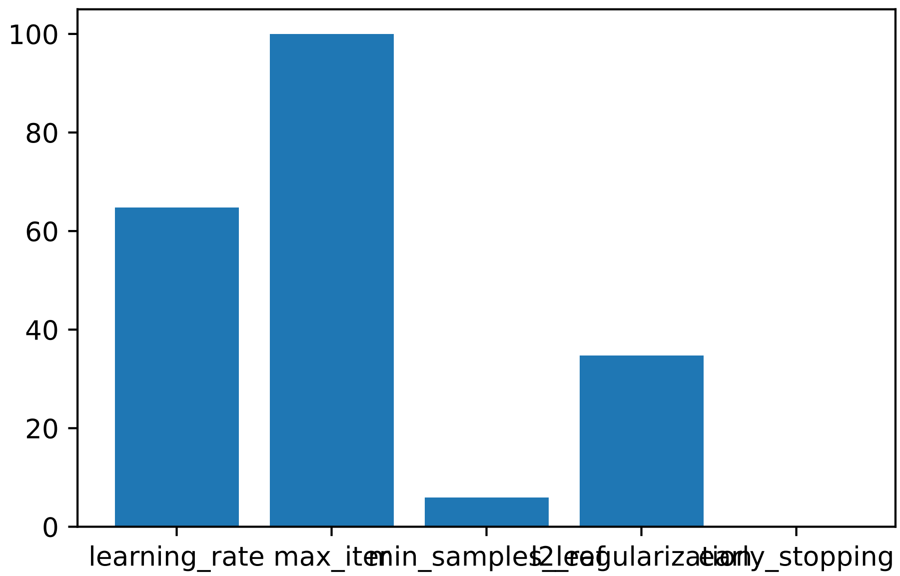


Figure 22.2: Variable importance plot, threshold 0.025.

22.16 Get Default Hyperparameters

```
from spotPython.hyperparameters.values import get_default_values, transform_hyper_paramete
values_default = get_default_values(fun_control)
values_default = transform_hyper_parameter_values(fun_control=fun_control, hyper_parameter
values_default
```

```
{'loss': 'log_loss',
 'learning_rate': 0.1,
 'max_iter': 128,
 'max_leaf_nodes': 32,
 'max_depth': 4,
 'min_samples_leaf': 16,
 'l2_regularization': 0.0,
 'max_bins': 255,
```

 'early_stopping': 1,
 'n_iter_no_change': 10,
 'tol': 0.0001}

```
from sklearn.pipeline import make_pipeline
model_default = make_pipeline(fun_control["prep_model"], fun_control["core_model"](**value
model_default
```

```
Pipeline(steps=[('nonetype', None),
                ('histgradientboostingclassifier',
                 HistGradientBoostingClassifier(early_stopping=1, max_depth=4,
                                                max_iter=128, max_leaf_nodes=32,
                                                min_samples_leaf=16,
                                                tol=0.0001))])
```

22.17 Get SPOT Results

```
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
print(X)
```

```
[[ 0.00000000e+00 -5.57272356e-01  6.00000000e+00  1.00000000e+00
   4.00000000e+00  2.00000000e+00  3.92020902e+00  1.92000000e+02
   1.00000000e+00  6.00000000e+00  9.23592087e-04]]
```

```
from spotPython.hyperparameters.values import assign_values, return_conf_list_from_var_dic
v_dict = assign_values(X, fun_control["var_name"])
return_conf_list_from_var_dict(var_dict=v_dict, fun_control=fun_control)
```

```
[{'loss': 'log_loss',
  'learning_rate': 0.27715814393297633,
  'max_iter': 64,
  'max_leaf_nodes': 2,
  'max_depth': 16,
  'min_samples_leaf': 4,
  'l2_regularization': 3.920209015825284,
  'max_bins': 192,
  'early_stopping': 1,
  'n_iter_no_change': 6,
  'tol': 0.0009235920874352935}]
```

```python
from spotPython.hyperparameters.values import get_one_sklearn_model_from_X
model_spot = get_one_sklearn_model_from_X(X, fun_control)
model_spot
```

```
HistGradientBoostingClassifier(early_stopping=1,
                               l2_regularization=3.920209015825284,
                               learning_rate=0.27715814393297633, max_bins=192,
                               max_depth=16, max_iter=64, max_leaf_nodes=2,
                               min_samples_leaf=4, n_iter_no_change=6,
                               tol=0.0009235920874352935)
```

22.18 Evaluate SPOT Results

- Fetch the data.

```python
from spotPython.utils.convert import get_Xy_from_df
X_train, y_train = get_Xy_from_df(fun_control["train"], fun_control["target_column"])
X_test, y_test = get_Xy_from_df(fun_control["test"], fun_control["target_column"])
X_test.shape, y_test.shape
```

```
((177, 64), (177,))
```

- Fit the model with the tuned hyperparameters. This gives one result:

```python
model_spot.fit(X_train, y_train)
y_pred = model_spot.predict_proba(X_test)
res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
res
```

```
0.3135593220338983
```

```python
def repeated_eval(n, model):
    res_values = []
    for i in range(n):
        model.fit(X_train, y_train)
        y_pred = model.predict_proba(X_test)
        res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
        res_values.append(res)
```

```
    mean_res = np.mean(res_values)
    print(f"mean_res: {mean_res}")
    std_res = np.std(res_values)
    print(f"std_res: {std_res}")
    min_res = np.min(res_values)
    print(f"min_res: {min_res}")
    max_res = np.max(res_values)
    print(f"max_res: {max_res}")
    median_res = np.median(res_values)
    print(f"median_res: {median_res}")
    return mean_res, std_res, min_res, max_res, median_res
```

22.18.1 Handling Non-deterministic Results

- Because the model is non-determinstic, we perform $n = 30$ runs and calculate the mean and standard deviation of the performance metric.

```
_ = repeated_eval(30, model_spot)
```

```
mean_res: 0.33653483992467054
std_res: 0.01160550118475535
min_res: 0.31544256120527303
max_res: 0.3606403013182674
median_res: 0.3352165725047081
```

22.18.2 Evalution of the Default Hyperparameters

```
model_default.fit(X_train, y_train)["histgradientboostingclassifier"]
```

```
HistGradientBoostingClassifier(early_stopping=1, max_depth=4, max_iter=128,
                               max_leaf_nodes=32, min_samples_leaf=16,
                               tol=0.0001)
```

- One evaluation of the default hyperparameters is performed on the hold-out test set.

```
y_pred = model_default.predict_proba(X_test)
mapk_score(y_true=y_test, y_pred=y_pred, k=3)
```

```
0.36158192090395475
```

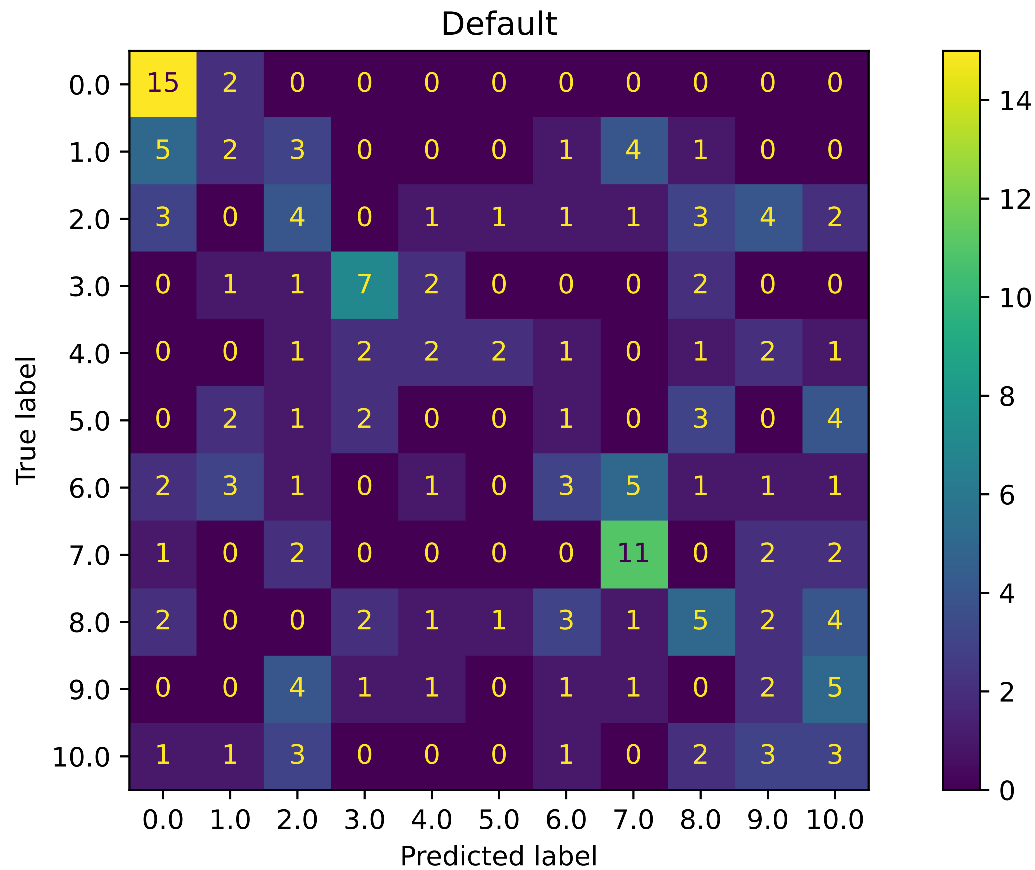
Since one single evaluation is not meaningful, we perform, similar to the evaluation of the SPOT results, $n = 30$ runs of the default setting and and calculate the mean and standard deviation of the performance metric.

```python
_ = repeated_eval(30, model_default)
```

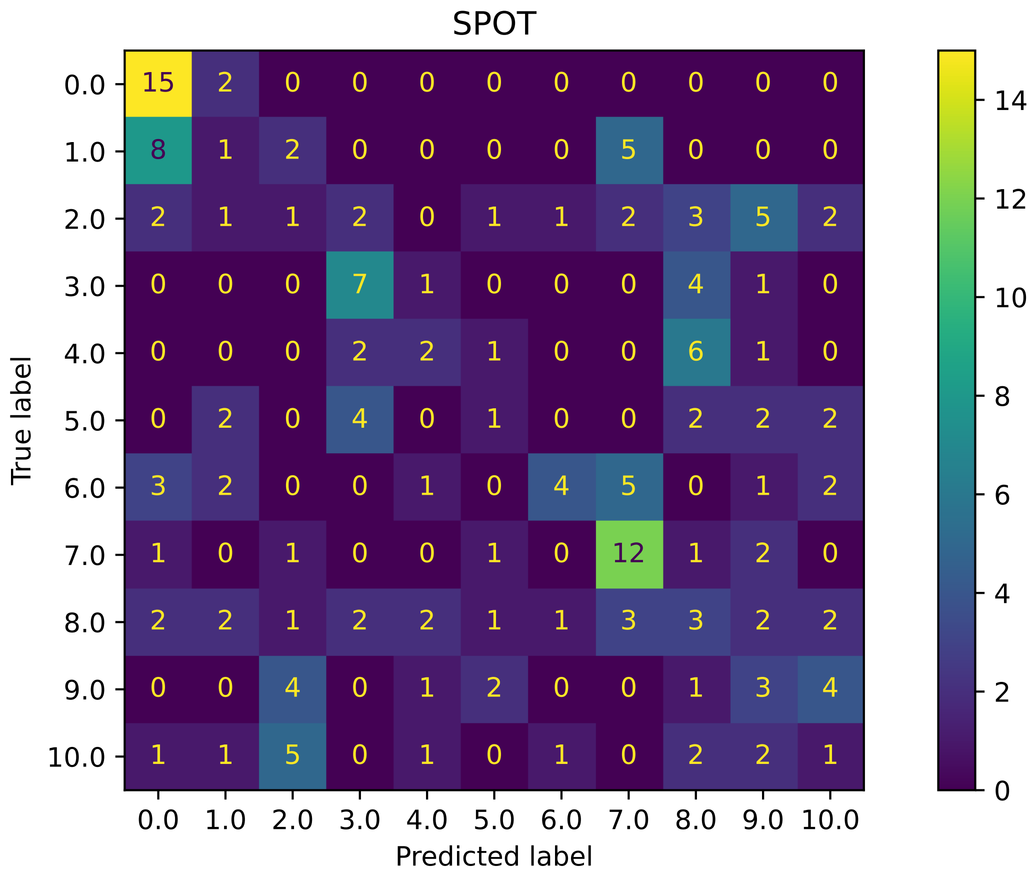
```
mean_res: 0.3399246704331451
std_res: 0.015793779818467184
min_res: 0.3088512241054614
max_res: 0.37099811676082856
median_res: 0.3389830508474576
```

22.19 Plot: Compare Predictions

```python
from spotPython.plot.validation import plot_confusion_matrix
plot_confusion_matrix(model_default, fun_control, title = "Default")
```




```
plot_confusion_matrix(model_spot, fun_control, title="SPOT")
```




```
min(spot_tuner.y), max(spot_tuner.y)
```

```
(-0.3834586466165413, -0.20927318295739344)
```

22.20 Cross-validated Evaluations

```
from spotPython.sklearn.traintest import evaluate_cv
fun_control.update({
     "eval": "train_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.3270440251572327, None)
```

```
fun_control.update({
     "eval": "test_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.26601307189542484, None)
```

- This is the evaluation that will be used in the comparison:

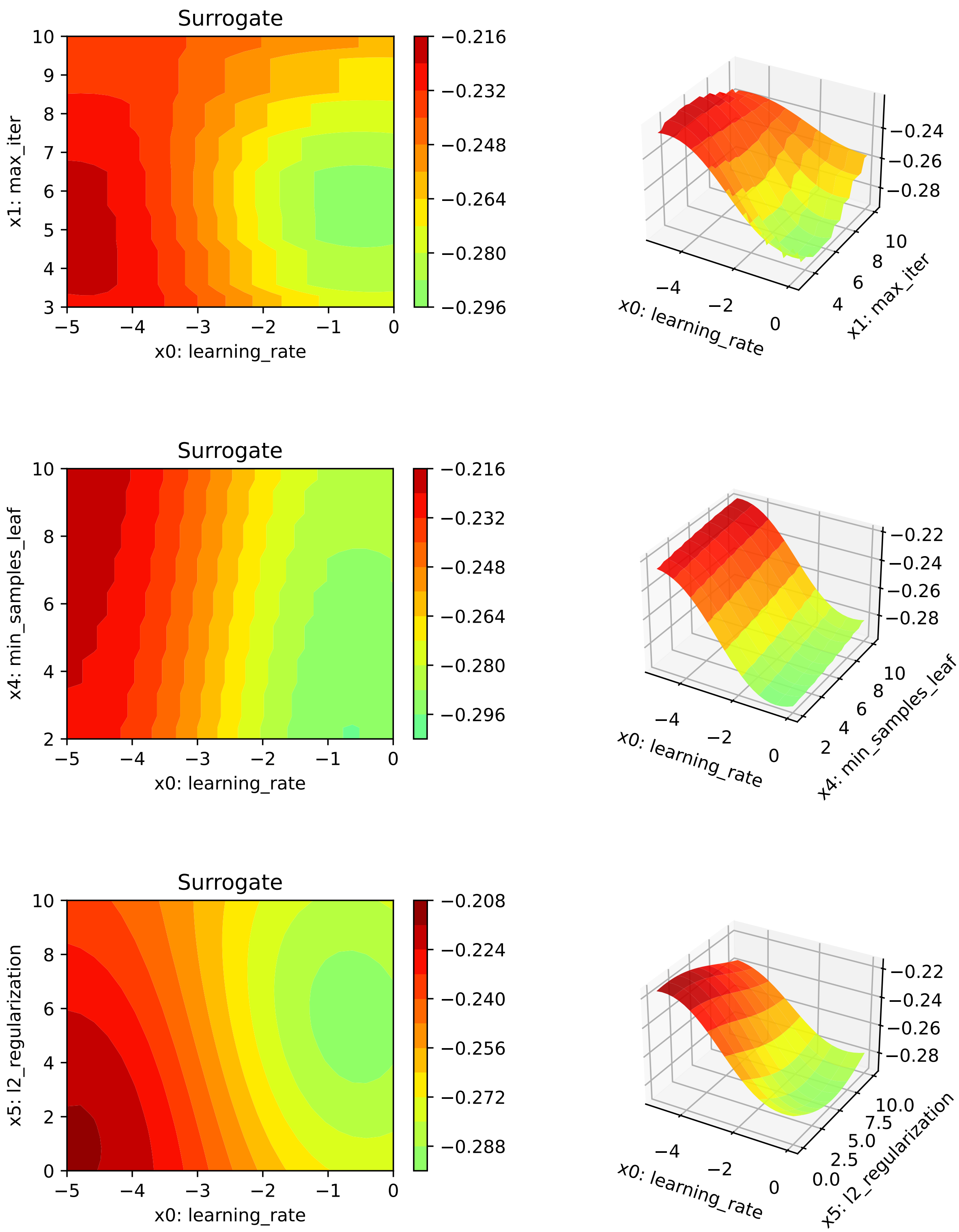
```
fun_control.update({
     "eval": "data_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

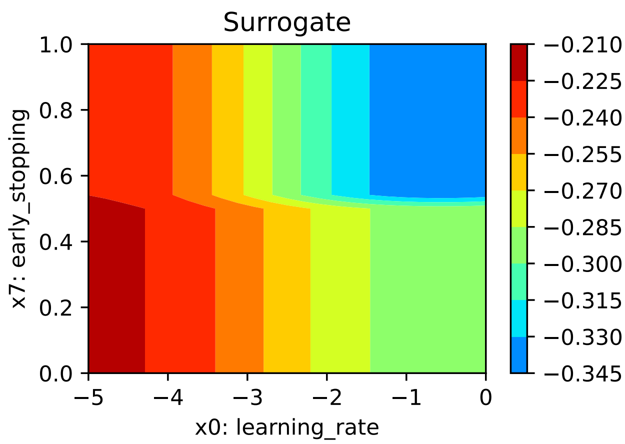
```
(0.33257880617035546, None)
```

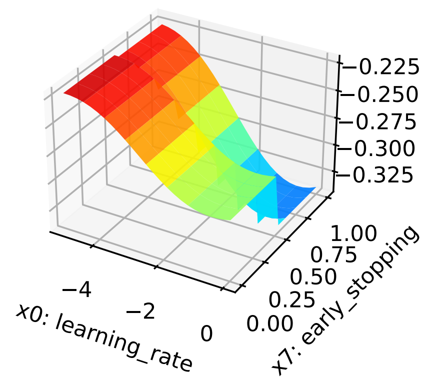
22.20.1 Detailed Hyperparameter Plots

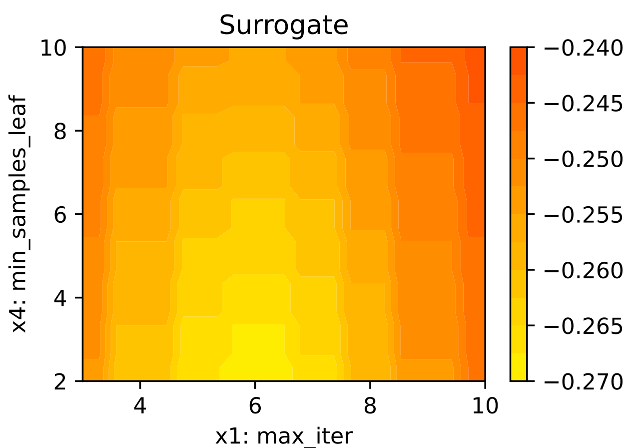
```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

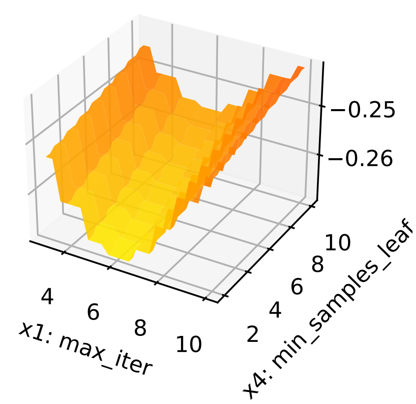
```
learning_rate:  64.76669188193891
max_iter:  99.99999999999999
min_samples_leaf:  5.932438692182067
l2_regularization:  34.79127025121625
early_stopping:  0.029713910673611 72
```

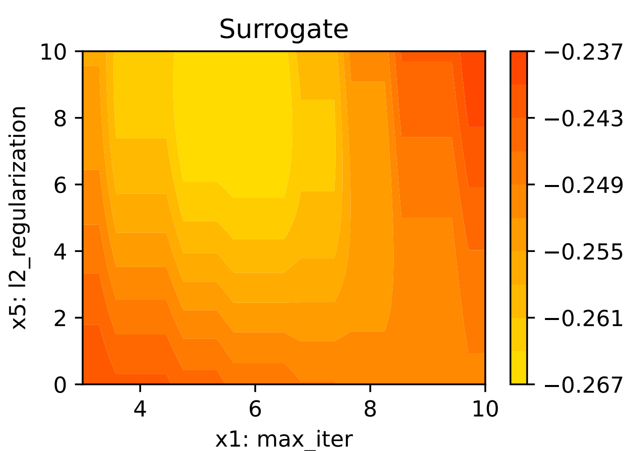

Surrogate
x1: max_iter
x0: learning_rate
−0.216
−0.232
−0.248
−0.264
−0.280
−0.296
x0: learning_rate
x1: max_iter
Surrogate
x4: min_samples_leaf
x0: learning_rate
−0.216
−0.232
−0.248
−0.264
−0.280
−0.296
x0: learning_rate
x4: min_samples_leaf
Surrogate
x5: l2_regularization
x0: learning_rate
−0.208
−0.224
−0.240
−0.256
−0.272
−0.288
x0: learning_rate
x5: l2_regularization

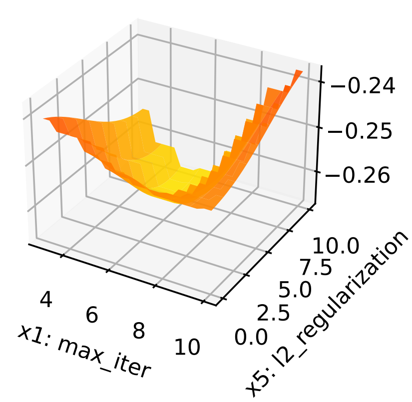

Surrogate
x0: learning_rate
x7: early_stopping
−5 −4 −3 −2 −1 0
0.0 0.2 0.4 0.6 0.8 1.0
−0.210 −0.225 −0.240 −0.255 −0.270 −0.285 −0.300 −0.315 −0.330 −0.345

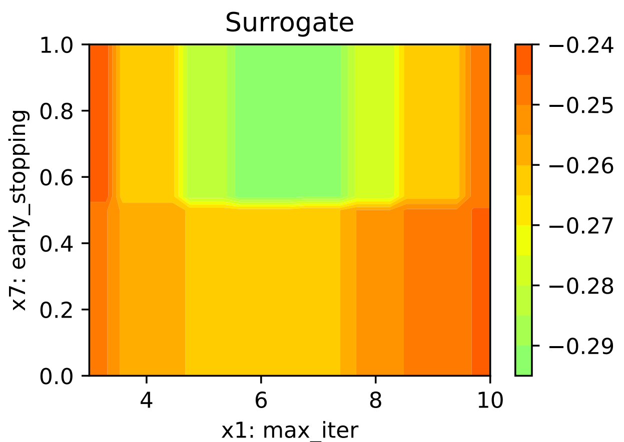

x0: learning_rate
x7: early_stopping
−4 −2 0
0.00 0.25 0.50 0.75 1.00
−0.225 −0.250 −0.275 −0.300 −0.325

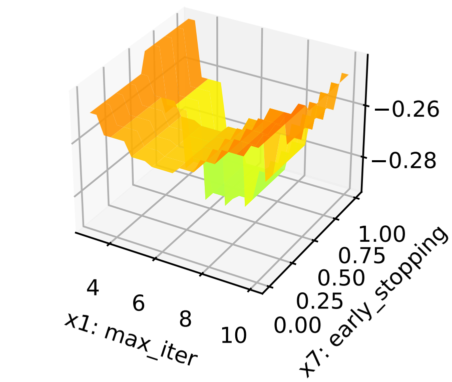

Surrogate
x1: max_iter
x4: min_samples_leaf
4 6 8 10
2 4 6 8 10
−0.240 −0.245 −0.250 −0.255 −0.260 −0.265 −0.270

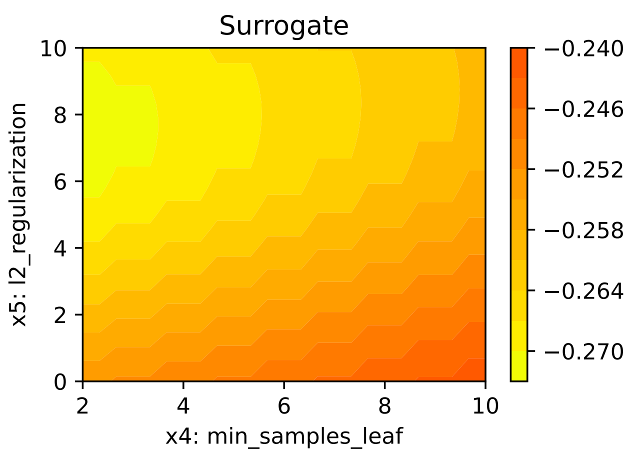

x1: max_iter
x4: min_samples_leaf
4 6 8 10
2 4 6 8 10
−0.25 −0.26

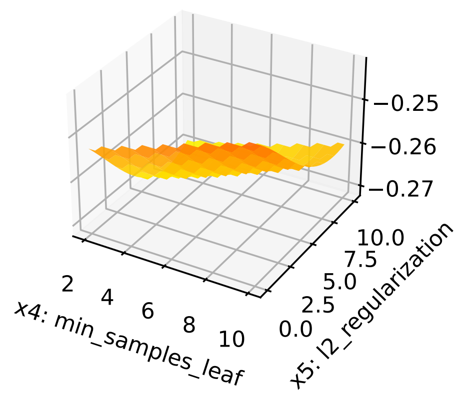

Surrogate
x1: max_iter
x5: l2_regularization
4 6 8 10
0 2 4 6 8 10
−0.237 −0.243 −0.249 −0.255 −0.261 −0.267

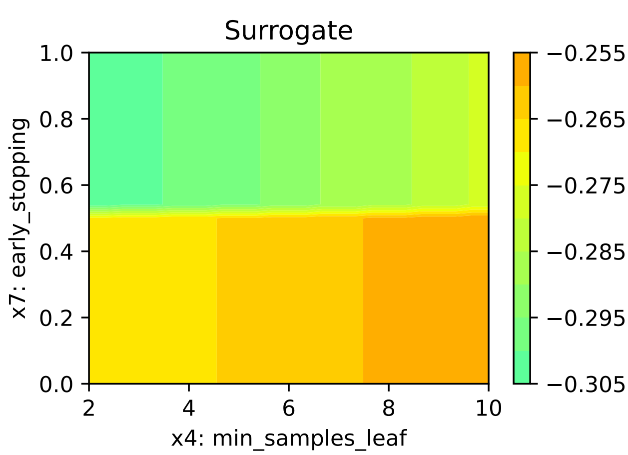

x1: max_iter
x5: l2_regularization
4 6 8 10
0.0 2.5 5.0 7.5 10.0
−0.24 −0.25 −0.26

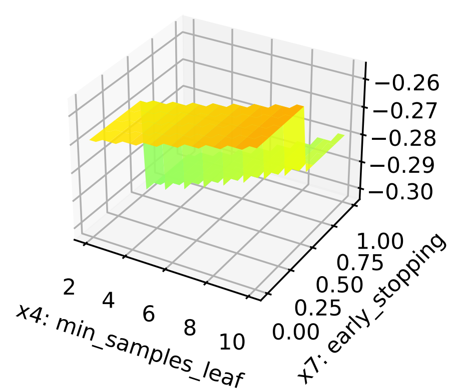

Surrogate
x7: early_stopping
x1: max_iter
1.0
0.8
0.6
0.4
0.2
0.0
4
6
8
10
−0.24
−0.25
−0.26
−0.27
−0.28
−0.29

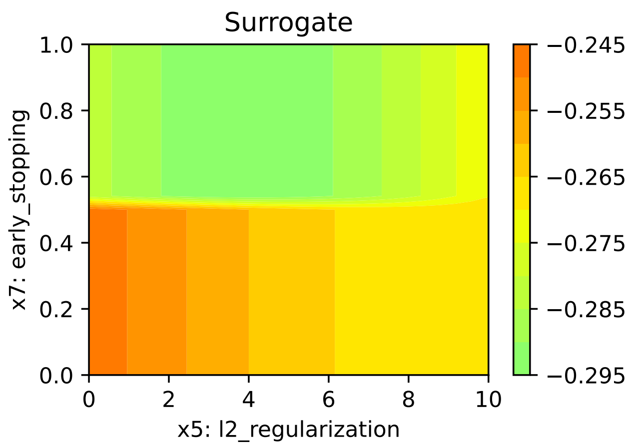

x1: max_iter
x7: early_stopping
4
6
8
10
0.00
0.25
0.50
0.75
1.00
−0.26
−0.28

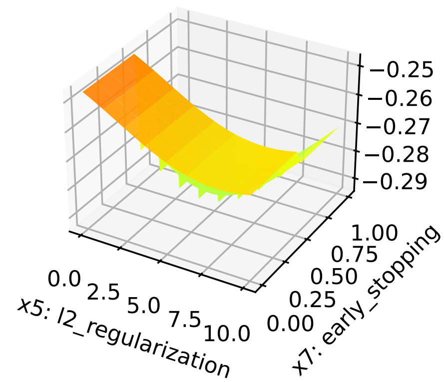

Surrogate
x5: l2_regularization
x4: min_samples_leaf
10
8
6
4
2
0
2
4
6
8
10
−0.240
−0.246
−0.252
−0.258
−0.264
−0.270


x4: min_samples_leaf
x5: l2_regularization
2
4
6
8
10
0.0
2.5
5.0
7.5
10.0
−0.25
−0.26
−0.27


Surrogate
x7: early_stopping
x4: min_samples_leaf
1.0
0.8
0.6
0.4
0.2
0.0
2
4
6
8
10
−0.255
−0.265
−0.275
−0.285
−0.295
−0.305


x4: min_samples_leaf
x7: early_stopping
2
4
6
8
10
0.00
0.25
0.50
0.75
1.00
−0.26
−0.27
−0.28
−0.29
−0.30





22.21 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

```
Unable to display output for mime type(s): text/html
```

22.22 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
            spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

23 HPT: sklearn SVC VBDP Data

This document refers to the following software versions:

- `python`: 3.10.10

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                    0.2.33
spotRiver                     0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

23.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time and the initial design size.

```
MAX_TIME = 1
INIT_SIZE = 5
ORIGINAL = False
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '18-svc-sklearn' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(I
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
18-svc-sklearn_p040025_1min_5init_2023-06-17_02-10-02
```

```
import warnings
warnings.filterwarnings("ignore")
```

23.2 Step 1: Initialization of the Empty `fun_control` Dictionary

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/16_spot_hpt_sklearn_classification")
```

23.3 1. Load Data: Classification

23.4 VBDP

```
import pandas as pd
if ORIGINAL == True:
    train_df = pd.read_csv('./data/VBDP/trainn.csv')
    test_df = pd.read_csv('./data/VBDP/testt.csv')
else:
    train_df = pd.read_csv('./data/VBDP/train.csv')
    # remove the id column
    train_df = train_df.drop(columns=['id'])
```

```python
from sklearn.preprocessing import OrdinalEncoder
n_samples = train_df.shape[0]
n_features = train_df.shape[1] - 1
target_column = "prognosis"
# Encoder our prognosis labels as integers for easier decoding later
enc = OrdinalEncoder()
train_df[target_column] = enc.fit_transform(train_df[[target_column]])
train_df.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train_df.shape)
train_df.head()
```

```
(707, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	...	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0
3	0.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	...	0.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0

The full data set `train_df` 64 features. The target column is labeled as `prognosis`.

23.5 Holdout Train and Test Data

We split out a hold-out test set (25% of the data) so we can calculate an example MAP@K

```python
import numpy as np
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(train_df.drop(target_column, axis=1),
                                                    random_state=42,
                                                    test_size=0.25,
                                                    stratify=train_df[target_column])
train = pd.DataFrame(np.hstack((X_train, np.array(y_train).reshape(-1, 1))))
test = pd.DataFrame(np.hstack((X_test, np.array(y_test).reshape(-1, 1))))
train.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
test.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train.shape)
print(test.shape)
```

```
train.head()
```

```
(530, 65)
(177, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
3	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
# add the dataset to the fun_control
fun_control.update({"data": train_df, # full dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": target_column})
```

23.6 Step 3: Specification of the Preprocessing Model

Data preprocesssing can be very simple, e.g., you can ignore it. Then you would choose the `prep_model` “None”:

```
prep_model = None
fun_control.update({"prep_model": prep_model})
```

A default approach for numerical data is the `StandardScaler` (mean 0, variance 1). This can be selected as follows:

```
# prep_model = StandardScaler()
# fun_control.update({"prep_model": prep_model})
```

Even more complicated pre-processing steps are possible, e.g., the follwing pipeline:

```
# categorical_columns = []
# one_hot_encoder = OneHotEncoder(handle_unknown="ignore", sparse_output=False)
# prep_model = ColumnTransformer(
```

```
#         transformers=[
#             ("categorical", one_hot_encoder, categorical_columns),
#         ],
#         remainder=StandardScaler(),
#     )
```

23.7 Step 4: Select `algorithm` and `core_model_hyper_dict`

The selection of the algorithm (ML model) that should be tuned is done by specifying the its name from the `sklearn` implementation. For example, the `SVC` support vector machine classifier is selected as follows:

`fun_control = add_core_model_to_fun_control(SVC, fun_control, SklearnHyperDict)`

Other core_models are, e.g.,:

- RidgeCV
- GradientBoostingRegressor
- ElasticNet
- RandomForestClassifier
- LogisticRegression
- KNeighborsClassifier
- RandomForestClassifier
- GradientBoostingClassifier
- HistGradientBoostingClassifier

We will use the `RandomForestClassifier` classifier in this example.

```
from sklearn.linear_model import RidgeCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.ensemble import HistGradientBoostingClassifier
from sklearn.linear_model import ElasticNet
from spotPython.hyperparameters.values import add_core_model_to_fun_control
from spotPython.data.sklearn_hyper_dict import SklearnHyperDict
from spotPython.fun.hypersklearn import HyperSklearn
```

```python
# core_model  = RidgeCV
# core_model = GradientBoostingRegressor
# core_model = ElasticNet
# core_model = RandomForestClassifier
core_model = SVC
# core_model = LogisticRegression
# core_model = KNeighborsClassifier
# core_model = GradientBoostingClassifier
# core_model = HistGradientBoostingClassifier
fun_control = add_core_model_to_fun_control(core_model=core_model,
                              fun_control=fun_control,
                              hyper_dict=SklearnHyperDict,
                              filename=None)
```

Now `fun_control` has the information from the JSON file. The available hyperparameters are:

```python
print(*fun_control["core_model_hyper_dict"].keys(), sep="\n")
```

```
C
kernel
degree
gamma
coef0
shrinking
probability
tol
cache_size
break_ties
```

23.8 Step 5: Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

23.8.1 Modify hyperparameter of type numeric and integer (boolean)

Numeric and boolean values can be modified using the `modify_hyper_parameter_bounds` method. For example, to change the `tol` hyperparameter of the `SVC` model to the interval [1e-3, 1e-2], the following code can be used:

`fun_control = modify_hyper_parameter_bounds(fun_control, "tol", bounds=[1e-3, 1e-2])`

```python
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
fun_control = modify_hyper_parameter_bounds(fun_control, "probability", bounds=[1, 1])
```

23.8.2 Modify hyperparameter of type factor

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

Factors can be modified with the `modify_hyper_parameter_levels` function. For example, to exclude the `sigmoid` kernel from the tuning, the `kernel` hyperparameter of the `SVC` model can be modified as follows:

`fun_control = modify_hyper_parameter_levels(fun_control, "kernel", ["linear", "rbf"])`

The new setting can be controlled via:

`fun_control["core_model_hyper_dict"]["kernel"]`

```python
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
fun_control = modify_hyper_parameter_levels(fun_control, "kernel", ["rbf"])
```

23.8.3 Optimizers

Optimizers are described in Section 20.6.

23.9 5. Selection of the Objective: Metric and Loss Functions

- Machine learning models are optimized with respect to a metric, for example, the `accuracy` function.
- Deep learning, e.g., neural networks are optimized with respect to a loss function, for example, the `cross_entropy` function and evaluated with respect to a metric, for example, the `accuracy` function.

23.10 Step 6: Selection of the Objective (Loss) Function

The loss function, that is usually used in deep learning for optimizing the weights of the net, is stored in the `fun_control` dictionary as `"loss_function"`.

23.10.1 Metric Function

There are two different types of metrics in `spotPython`:

1. `"metric_river"` is used for the river based evaluation via `eval_oml_iter_progressive`.
2. `"metric_sklearn"` is used for the sklearn based evaluation.

We will consider multi-class classification metrics, e.g., `mapk_score` and `top_k_accuracy_score`.

> **Predict Probabilities**
>
> In this multi-class classification example the machine learning algorithm should return the probabilities of the specific classes (`"predict_proba"`) instead of the predicted values.

We set `"predict_proba"` to `True` in the `fun_control` dictionary.

23.10.1.1 The MAPK Metric

To select the MAPK metric, the following two entries can be added to the `fun_control` dictionary:

`"metric_sklearn": mapk_score"`

`"metric_params": {"k": 3}`.

23.10.1.2 Other Metrics

Alternatively, other metrics for multi-class classification can be used, e.g.,: * top_k_accuracy_score or * roc_auc_score

The metric `roc_auc_score` requires the parameter `"multi_class"`, e.g.,

`"multi_class": "ovr"`.

This is set in the `fun_control` dictionary.

> **Weights**
>
> `spotPython` performs a minimization, therefore, metrics that should be maximized have to be multiplied by -1. This is done by setting `"weights"` to `-1`.

- The complete setup for the metric in our example is:

```python
from spotPython.utils.metrics import mapk_score
fun_control.update({
               "weights": -1,
               "metric_sklearn": mapk_score,
               "predict_proba": True,
               "metric_params": {"k": 3},
               })
```

23.11 Evaluation on Hold-out Data

- The default method for computing the performance is `"eval_holdout"`.
- Alternatively, cross-validation can be used for every machine learning model.
- Specifically for RandomForests, the OOB-score can be used.

```python
fun_control.update({
    "eval": "train_hold_out",
})
```

23.11.0.1 Cross Validation

Instead of using the OOB-score, the classical cross validation can be used. The number of folds is set by the key `"k_folds"`. For example, to use 5-fold cross validation, the key `"k_folds"` is set to `5`. Uncomment the following line to use cross validation:

```python
# fun_control.update({
#      "eval": "train_cv",
#      "k_folds": 10,
# })
```

23.12 6. Calling the SPOT Function

23.13 Preparing the SPOT Call

- Get types and variable names as well as lower and upper bounds for the hyperparameters.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name        | type   | default   |    lower |   upper | transform   |
|-------------|--------|-----------|----------|---------|-------------|
| C           | float  | 1.0       |   0.1    |   10    | None        |
| kernel      | factor | rbf       |   0      |    0    | None        |
| degree      | int    | 3         |   3      |    3    | None        |
| gamma       | factor | scale     |   0      |    1    | None        |
| coef0       | float  | 0.0       |   0      |    0    | None        |
| shrinking   | factor | 0         |   0      |    1    | None        |
| probability | factor | 0         |   1      |    1    | None        |
| tol         | float  | 0.001     |   0.0001 |    0.01 | None        |
| cache_size  | float  | 200.0     | 100      |  400    | None        |
| break_ties  | factor | 0         |   0      |    1    | None        |
```

23.14 The Objective Function

The objective function is selected next. It implements an interface from `sklearn`'s training, validation, and testing methods to `spotPython`.

```
from spotPython.fun.hypersklearn import HyperSklearn
fun = HyperSklearn().fun_sklearn
```

23.14.1 Run the `Spot` Optimizer

- Run SPOT for approx. x mins (`max_time`).

- Note: the run takes longer, because the evaluation time of initial design (here: `initi_size`, 20 points) is not considered.

```
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=SklearnHyperDict().load()
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
X_start
```

```
array([[1.e+00, 2.e+00, 3.e+00, 0.e+00, 0.e+00, 0.e+00, 0.e+00, 1.e-03,
        2.e+02, 0.e+00]])
```

```
import numpy as np
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
                   show_progress= True,
                   fun_control = fun_control,
                   design_control={"init_size": INIT_SIZE,
                                   "repeats": 1},
                   surrogate_control={"noise": True,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": len(var_name),
                                      "model_fun_evals": 10_000,
                                      "log_level": 50
                                      })
```

```
spot_tuner.run(X_start=X_start)
```

```
spotPython tuning: -0.37092731829573933 [----------] 0.27%

spotPython tuning: -0.37092731829573933 [----------] 0.80%

spotPython tuning: -0.37092731829573933 [----------] 1.34%

spotPython tuning: -0.37092731829573933 [----------] 1.94%

spotPython tuning: -0.37092731829573933 [----------] 2.57%

spotPython tuning: -0.37092731829573933 [----------] 3.05%

spotPython tuning: -0.3746867167919799 [----------] 3.51%

spotPython tuning: -0.3746867167919799 [----------] 4.14%

spotPython tuning: -0.3746867167919799 [----------] 4.60%

spotPython tuning: -0.3746867167919799 [#---------] 5.09%

spotPython tuning: -0.37844611528822053 [#---------] 5.52%

spotPython tuning: -0.37844611528822053 [#---------] 6.31%

spotPython tuning: -0.37844611528822053 [#---------] 7.51%

spotPython tuning: -0.37844611528822053 [#---------] 9.09%

spotPython tuning: -0.37844611528822053 [#---------] 11.28%

spotPython tuning: -0.37844611528822053 [#---------] 12.62%

spotPython tuning: -0.37844611528822053 [#---------] 13.63%
```

```
spotPython tuning: -0.37844611528822053 [#---------] 14.57%

spotPython tuning: -0.37844611528822053 [##--------] 15.52%

spotPython tuning: -0.37844611528822053 [##--------] 16.94%

spotPython tuning: -0.37844611528822053 [##--------] 17.94%

spotPython tuning: -0.37844611528822053 [##--------] 18.76%

spotPython tuning: -0.37844611528822053 [##--------] 19.54%

spotPython tuning: -0.37844611528822053 [##--------] 20.23%

spotPython tuning: -0.37844611528822053 [##--------] 21.05%

spotPython tuning: -0.37844611528822053 [##--------] 21.73%

spotPython tuning: -0.37844611528822053 [##--------] 22.42%

spotPython tuning: -0.37844611528822053 [##--------] 23.38%

spotPython tuning: -0.37844611528822053 [##--------] 24.38%

spotPython tuning: -0.37844611528822053 [###-------] 25.55%

spotPython tuning: -0.37844611528822053 [###-------] 26.70%

spotPython tuning: -0.37844611528822053 [###-------] 27.67%

spotPython tuning: -0.37844611528822053 [###-------] 29.05%

spotPython tuning: -0.37844611528822053 [###-------] 30.35%

spotPython tuning: -0.37969924812030076 [###-------] 31.60%

spotPython tuning: -0.37969924812030076 [###-------] 33.37%
```

```
spotPython tuning: -0.3822055137844611 [###-------] 34.71%

spotPython tuning: -0.3822055137844611 [####------] 36.11%

spotPython tuning: -0.3822055137844611 [####------] 37.35%

spotPython tuning: -0.3822055137844611 [####------] 38.82%

spotPython tuning: -0.3822055137844611 [####------] 40.06%

spotPython tuning: -0.3822055137844611 [####------] 41.30%

spotPython tuning: -0.3822055137844611 [####------] 42.58%

spotPython tuning: -0.3822055137844611 [####------] 44.08%

spotPython tuning: -0.3822055137844611 [#####-----] 45.45%

spotPython tuning: -0.3822055137844611 [#####-----] 46.71%

spotPython tuning: -0.3822055137844611 [#####-----] 48.01%

spotPython tuning: -0.3822055137844611 [#####-----] 49.53%

spotPython tuning: -0.3822055137844611 [#####-----] 50.92%

spotPython tuning: -0.3822055137844611 [#####-----] 52.43%

spotPython tuning: -0.3822055137844611 [#####-----] 53.63%

spotPython tuning: -0.3822055137844611 [######----] 55.01%

spotPython tuning: -0.3822055137844611 [######----] 56.30%

spotPython tuning: -0.3822055137844611 [######----] 57.44%

spotPython tuning: -0.3822055137844611 [######----] 58.63%
```

```
spotPython tuning: -0.3822055137844611 [######----] 59.82%

spotPython tuning: -0.3822055137844611 [######----] 61.03%

spotPython tuning: -0.3822055137844611 [######----] 62.22%

spotPython tuning: -0.3822055137844611 [######----] 64.37%

spotPython tuning: -0.3822055137844611 [#######---] 67.11%

spotPython tuning: -0.3822055137844611 [#######---] 69.55%

spotPython tuning: -0.3822055137844611 [#######---] 72.97%

spotPython tuning: -0.3822055137844611 [########--] 75.51%

spotPython tuning: -0.3822055137844611 [########--] 78.60%

spotPython tuning: -0.3822055137844611 [########--] 81.22%

spotPython tuning: -0.3822055137844611 [########--] 84.46%

spotPython tuning: -0.3822055137844611 [#########-] 86.95%

spotPython tuning: -0.3822055137844611 [#########-] 90.04%

spotPython tuning: -0.3822055137844611 [#########-] 94.30%

spotPython tuning: -0.3822055137844611 [##########] 97.96%

spotPython tuning: -0.3822055137844611 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x14b7e8a90>
```

23.14.2 Results

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```python
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

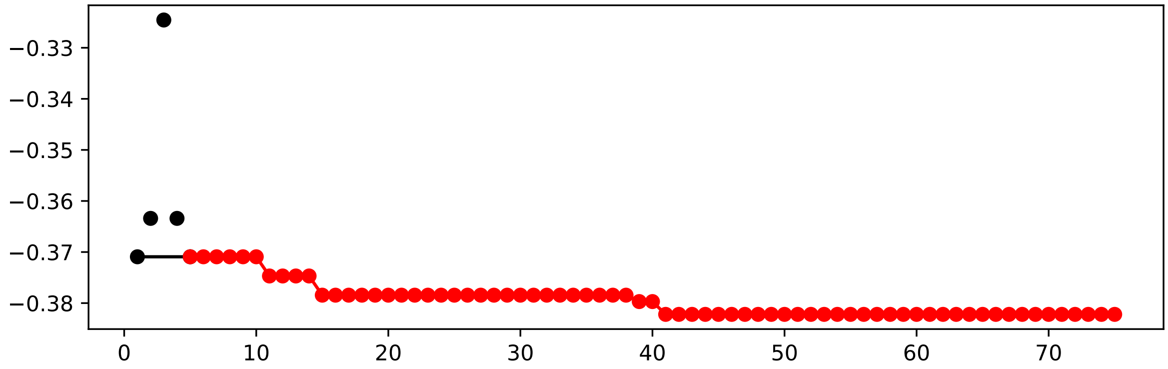


Figure 23.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

- Print the results

```python
print(gen_design_table(fun_control=fun_control,
    spot=spot_tuner))
```

```
| name         | type   | default   |   lower |   upper |              tuned | transform   |
|--------------|--------|-----------|---------|---------|--------------------|-------------|--
| C            | float  | 1.0       |     0.1 |    10.0 |  7.378335310065767 | None        |
| kernel       | factor | rbf       |     0.0 |     0.0 |                0.0 | None        |
| degree       | int    | 3         |     3.0 |     3.0 |                3.0 | None        |
| gamma        | factor | scale     |     0.0 |     1.0 |                1.0 | None        |
| coef0        | float  | 0.0       |     0.0 |     0.0 |                0.0 | None        |
| shrinking    | factor | 0         |     0.0 |     1.0 |                1.0 | None        |
| probability  | factor | 0         |     1.0 |     1.0 |                1.0 | None        |
| tol          | float  | 0.001     |  0.0001 |    0.01 |               0.01 | None        |
| cache_size   | float  | 200.0     |   100.0 |   400.0 |  331.7283101317242 | None        |
| break_ties   | factor | 0         |     0.0 |     1.0 |                0.0 | None        |
```

23.15 Show variable importance

```
spot_tuner.plot_importance(threshold=0.025, filename="./figures/" + experiment_name+"_impo
```

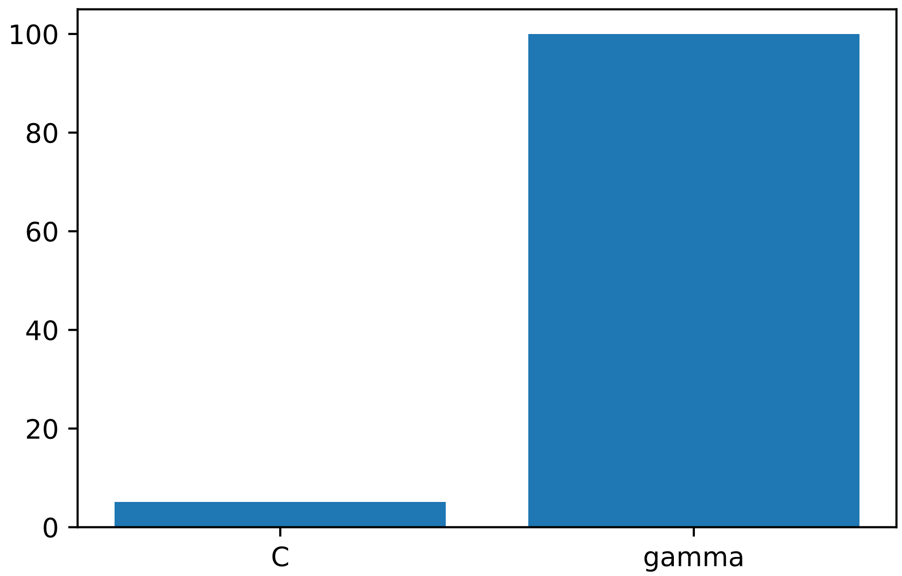


Figure 23.2: Variable importance plot, threshold 0.025.

23.16 Get Default Hyperparameters

```
from spotPython.hyperparameters.values import get_default_values, transform_hyper_paramete
values_default = get_default_values(fun_control)
values_default = transform_hyper_parameter_values(fun_control=fun_control, hyper_parameter
values_default
```

```
{'C': 1.0,
 'kernel': 'rbf',
 'degree': 3,
 'gamma': 'scale',
 'coef0': 0.0,
 'shrinking': 0,
 'probability': 0,
 'tol': 0.001,
```

```
'cache_size': 200.0,
'break_ties': 0}
```

```
from sklearn.pipeline import make_pipeline
model_default = make_pipeline(fun_control["prep_model"], fun_control["core_model"](**value
model_default
```

```
Pipeline(steps=[('nonetype', None),
                ('svc',
                 SVC(break_ties=0, cache_size=200.0, probability=0,
                     shrinking=0))])
```

> **Note**
>
> - Default value for "probability" is False, but we need it to be True for the metric "mapk_score".
>
> ```
> values_default.update({"probability": 1})
> ```

23.17 Get SPOT Results

```
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
print(X)
```

```
[[7.37833531e+00 0.00000000e+00 3.00000000e+00 1.00000000e+00
  0.00000000e+00 1.00000000e+00 1.00000000e+00 1.00000000e-02
  3.31728310e+02 0.00000000e+00]]
```

```
from spotPython.hyperparameters.values import assign_values, return_conf_list_from_var_dic
v_dict = assign_values(X, fun_control["var_name"])
return_conf_list_from_var_dict(var_dict=v_dict, fun_control=fun_control)
```

```
[{'C': 7.378335310065767,
  'kernel': 'rbf',
  'degree': 3,
  'gamma': 'auto',
```

```
 'coef0': 0.0,
 'shrinking': 1,
 'probability': 1,
 'tol': 0.01,
 'cache_size': 331.7283101317242,
 'break_ties': 0}]
```

```
from spotPython.hyperparameters.values import get_one_sklearn_model_from_X
model_spot = get_one_sklearn_model_from_X(X, fun_control)
model_spot
```

```
SVC(C=7.378335310065767, break_ties=0, cache_size=331.7283101317242,
    gamma='auto', probability=1, shrinking=1, tol=0.01)
```

23.18 Evaluate SPOT Results

- Fetch the data.

```
from spotPython.utils.convert import get_Xy_from_df
X_train, y_train = get_Xy_from_df(fun_control["train"], fun_control["target_column"])
X_test, y_test = get_Xy_from_df(fun_control["test"], fun_control["target_column"])
X_test.shape, y_test.shape
```

```
((177, 64), (177,))
```

- Fit the model with the tuned hyperparameters. This gives one result:

```
model_spot.fit(X_train, y_train)
y_pred = model_spot.predict_proba(X_test)
res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
res
```

```
0.3606403013182674
```

```
def repeated_eval(n, model):
    res_values = []
    for i in range(n):
        model.fit(X_train, y_train)
```

```python
        y_pred = model.predict_proba(X_test)
        res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
        res_values.append(res)
    mean_res = np.mean(res_values)
    print(f"mean_res: {mean_res}")
    std_res = np.std(res_values)
    print(f"std_res: {std_res}")
    min_res = np.min(res_values)
    print(f"min_res: {min_res}")
    max_res = np.max(res_values)
    print(f"max_res: {max_res}")
    median_res = np.median(res_values)
    print(f"median_res: {median_res}")
    return mean_res, std_res, min_res, max_res, median_res
```

23.18.1 Handling Non-deterministic Results

- Because the model is non-determinstic, we perform $n = 30$ runs and calculate the mean and standard deviation of the performance metric.

```python
_ = repeated_eval(30, model_spot)
```

```
mean_res: 0.3645951035781544
std_res: 0.004283420491960319
min_res: 0.3559322033898305
max_res: 0.3747645951035781
median_res: 0.3644067796610169
```

23.18.2 Evalution of the Default Hyperparameters

```python
model_default["svc"].probability = True
model_default.fit(X_train, y_train)["svc"]
```

```
SVC(break_ties=0, cache_size=200.0, probability=True, shrinking=0)
```

- One evaluation of the default hyperparameters is performed on the hold-out test set.

```
y_pred = model_default.predict_proba(X_test)
mapk_score(y_true=y_test, y_pred=y_pred, k=3)
```

```
0.3804143126177025
```

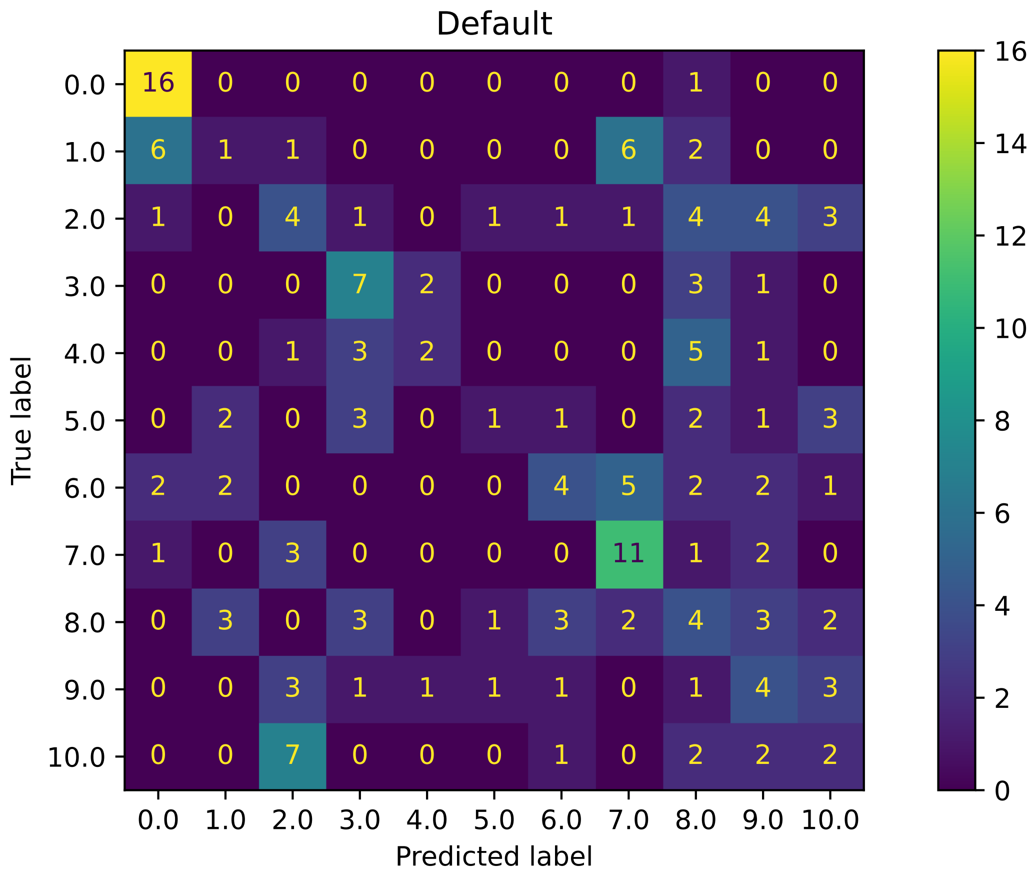
Since one single evaluation is not meaningful, we perform, similar to the evaluation of the SPOT results, $n = 30$ runs of the default setting and and calculate the mean and standard deviation of the performance metric.

```
_ = repeated_eval(30, model_default)
```

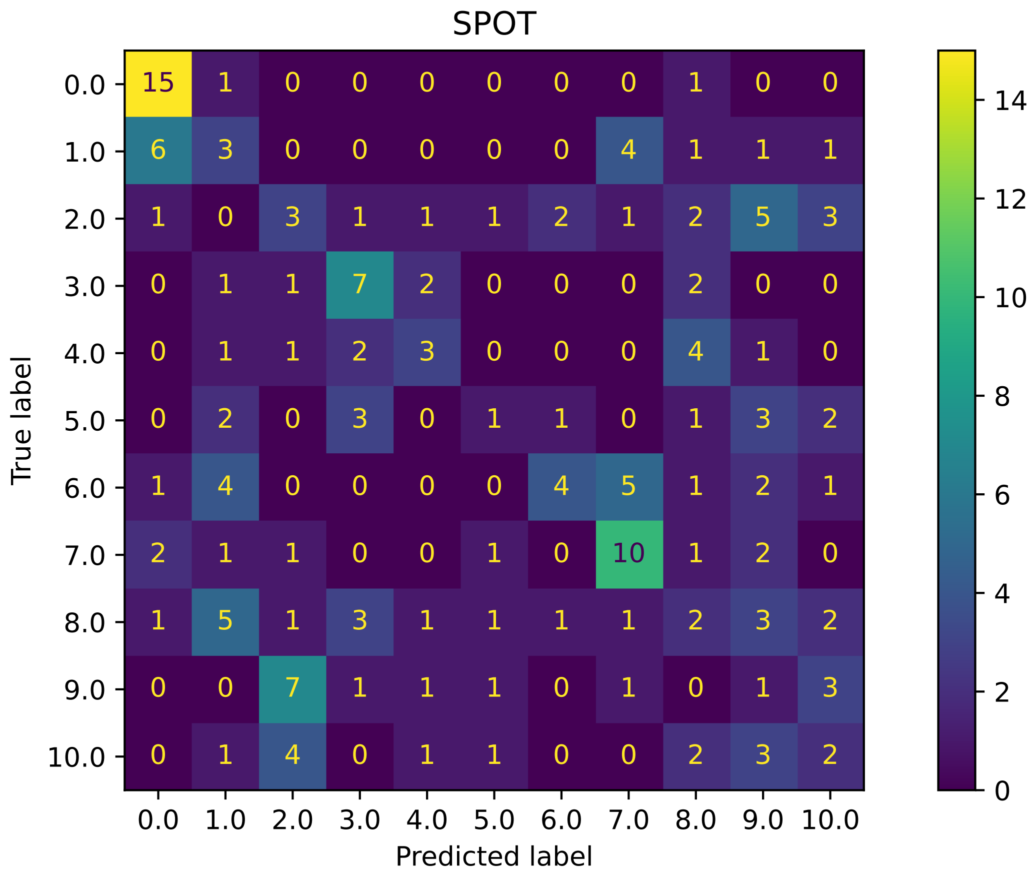
```
mean_res: 0.38549905838041426
std_res: 0.004743121456337376
min_res: 0.37664783427495285
max_res: 0.39453860640301325
median_res: 0.3851224105461393
```

23.19 Plot: Compare Predictions

```
from spotPython.plot.validation import plot_confusion_matrix
plot_confusion_matrix(model_default, fun_control, title = "Default")
```




```
plot_confusion_matrix(model_spot, fun_control, title="SPOT")
```




```
min(spot_tuner.y), max(spot_tuner.y)
```

```
(-0.3822055137844611, -0.32456140350877194)
```

23.20 Cross-validated Evaluations

```
from spotPython.sklearn.traintest import evaluate_cv
fun_control.update({
     "eval": "train_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.3411949685534591, None)
```

```python
fun_control.update({
     "eval": "test_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.35495642701525054, None)
```

- This is the evaluation that will be used in the comparison:

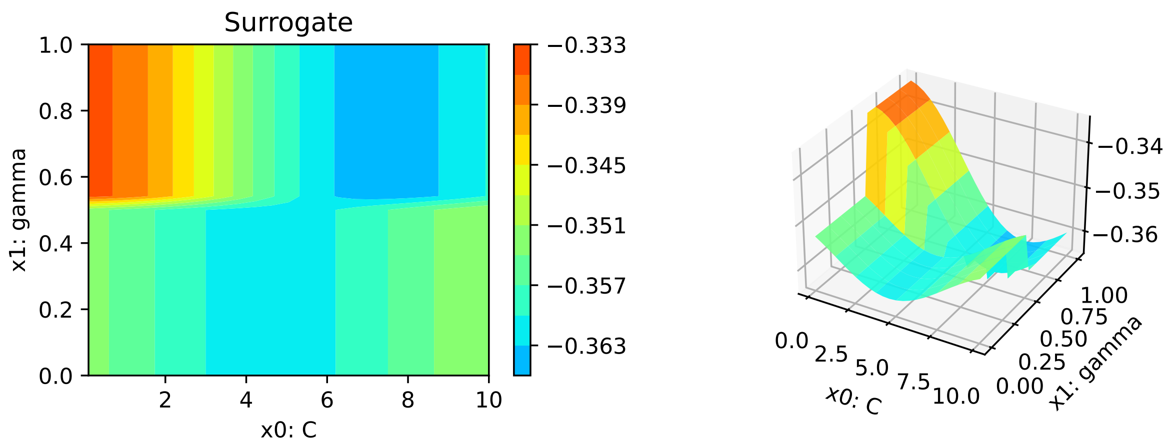
```python
fun_control.update({
     "eval": "data_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.35395036887994635, None)
```

23.20.1 Detailed Hyperparameter Plots

```python
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

```
C:  5.10264652210885
gamma:  99.99999999999999
```



23.21 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

```
Unable to display output for mime type(s): text/html
```

23.22 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
            spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

24 HPT: sklearn KNN Classifier VBDP Data

This document refers to the following software versions:

- `python`: 3.10.10

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                    0.2.33
spotRiver                     0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

24.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time and the initial design size.

```
MAX_TIME = 1
INIT_SIZE = 5
ORIGINAL = False
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '19-knn-sklearn' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(I
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
19-knn-sklearn_p040025_1min_5init_2023-06-17_02-12-31
```

```
import warnings
warnings.filterwarnings("ignore")
```

24.2 Step 1: Initialization of the Empty `fun_control` Dictionary

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/16_spot_hpt_sklearn_classification")
```

24.3 1. Load Data: Classification

24.4 VBDP

```
import pandas as pd
if ORIGINAL == True:
    train_df = pd.read_csv('./data/VBDP/trainn.csv')
    test_df = pd.read_csv('./data/VBDP/testt.csv')
else:
    train_df = pd.read_csv('./data/VBDP/train.csv')
    # remove the id column
    train_df = train_df.drop(columns=['id'])
```

```python
from sklearn.preprocessing import OrdinalEncoder
n_samples = train_df.shape[0]
n_features = train_df.shape[1] - 1
target_column = "prognosis"
# Encoder our prognosis labels as integers for easier decoding later
enc = OrdinalEncoder()
train_df[target_column] = enc.fit_transform(train_df[[target_column]])
train_df.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train_df.shape)
train_df.head()
```

```
(707, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	...	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0
3	0.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	...	0.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0

The full data set `train_df` 64 features. The target column is labeled as `prognosis`.

24.5 Holdout Train and Test Data

We split out a hold-out test set (25% of the data) so we can calculate an example MAP@K

```python
import numpy as np
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(train_df.drop(target_column, axis=1),
                                                    random_state=42,
                                                    test_size=0.25,
                                                    stratify=train_df[target_column])
train = pd.DataFrame(np.hstack((X_train, np.array(y_train).reshape(-1, 1))))
test = pd.DataFrame(np.hstack((X_test, np.array(y_test).reshape(-1, 1))))
train.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
test.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train.shape)
print(test.shape)
```

```
train.head()
```

```
(530, 65)
(177, 65)
```

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	...	x56	x57	x58	x59	x60	x61	x62	x63
0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0
3	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
# add the dataset to the fun_control
fun_control.update({"data": train_df, # full dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": target_column})
```

24.6 Step 3: Specification of the Preprocessing Model

Data preprocesssing can be very simple, e.g., you can ignore it. Then you would choose the `prep_model` “None”:

```
prep_model = None
fun_control.update({"prep_model": prep_model})
```

A default approach for numerical data is the `StandardScaler` (mean 0, variance 1). This can be selected as follows:

```
# prep_model = StandardScaler()
# fun_control.update({"prep_model": prep_model})
```

Even more complicated pre-processing steps are possible, e.g., the follwing pipeline:

```
# categorical_columns = []
# one_hot_encoder = OneHotEncoder(handle_unknown="ignore", sparse_output=False)
# prep_model = ColumnTransformer(
```

```
#         transformers=[
#             ("categorical", one_hot_encoder, categorical_columns),
#         ],
#         remainder=StandardScaler(),
#     )
```

24.7 Step 4: Select `algorithm` and `core_model_hyper_dict`

The selection of the algorithm (ML model) that should be tuned is done by specifying the its name from the `sklearn` implementation. For example, the `SVC` support vector machine classifier is selected as follows:

`fun_control = add_core_model_to_fun_control(SVC, fun_control, SklearnHyperDict)`

Other core_models are, e.g.,:

- RidgeCV
- GradientBoostingRegressor
- ElasticNet
- RandomForestClassifier
- LogisticRegression
- KNeighborsClassifier
- RandomForestClassifier
- GradientBoostingClassifier
- HistGradientBoostingClassifier

We will use the `RandomForestClassifier` classifier in this example.

```python
from sklearn.linear_model import RidgeCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.ensemble import GradientBoostingRegressor
from sklearn.ensemble import HistGradientBoostingClassifier
from sklearn.linear_model import ElasticNet
from spotPython.hyperparameters.values import add_core_model_to_fun_control
from spotPython.data.sklearn_hyper_dict import SklearnHyperDict
from spotPython.fun.hypersklearn import HyperSklearn
```

```
# core_model  = RidgeCV
# core_model = GradientBoostingRegressor
# core_model = ElasticNet
# core_model = RandomForestClassifier
core_model = KNeighborsClassifier
# core_model = LogisticRegression
# core_model = KNeighborsClassifier
# core_model = GradientBoostingClassifier
# core_model = HistGradientBoostingClassifier
fun_control = add_core_model_to_fun_control(core_model=core_model,
                              fun_control=fun_control,
                              hyper_dict=SklearnHyperDict,
                              filename=None)
```

Now `fun_control` has the information from the JSON file. The available hyperparameters are:

```
print(*fun_control["core_model_hyper_dict"].keys(), sep="\n")
```

```
n_neighbors
weights
algorithm
leaf_size
p
```

24.8 Step 5: Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

24.8.1 Modify hyperparameter of type numeric and integer (boolean)

Numeric and boolean values can be modified using the `modify_hyper_parameter_bounds` method. For example, to change the `tol` hyperparameter of the `SVC` model to the interval [1e-3, 1e-2], the following code can be used:

`fun_control = modify_hyper_parameter_bounds(fun_control, "tol", bounds=[1e-3, 1e-2])`

```
# from spotPython.hyperparameters.values import modify_hyper_parameter_bounds
# fun_control = modify_hyper_parameter_bounds(fun_control, "probability", bounds=[1, 1])
```

24.8.2 Modify hyperparameter of type factor

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

Factors can be modified with the `modify_hyper_parameter_levels` function. For example, to exclude the `sigmoid` kernel from the tuning, the `kernel` hyperparameter of the `SVC` model can be modified as follows:

`fun_control = modify_hyper_parameter_levels(fun_control, "kernel", ["linear", "rbf"])`

The new setting can be controlled via:

`fun_control["core_model_hyper_dict"]["kernel"]`

```
# from spotPython.hyperparameters.values import modify_hyper_parameter_levels
# fun_control = modify_hyper_parameter_levels(fun_control, "kernel", ["rbf"])
```

24.8.3 Optimizers

Optimizers are described in Section 20.6.

24.9 5. Selection of the Objective: Metric and Loss Functions

- Machine learning models are optimized with respect to a metric, for example, the `accuracy` function.
- Deep learning, e.g., neural networks are optimized with respect to a loss function, for example, the `cross_entropy` function and evaluated with respect to a metric, for example, the `accuracy` function.

24.10 Step 6: Selection of the Objective (Loss) Function

The loss function, that is usually used in deep learning for optimizing the weights of the net, is stored in the `fun_control` dictionary as `"loss_function"`.

24.10.1 Metric Function

There are two different types of metrics in `spotPython`:

1. `"metric_river"` is used for the river based evaluation via `eval_oml_iter_progressive`.
2. `"metric_sklearn"` is used for the sklearn based evaluation.

We will consider multi-class classification metrics, e.g., `mapk_score` and `top_k_accuracy_score`.

> **Predict Probabilities**
>
> In this multi-class classification example the machine learning algorithm should return the probabilities of the specific classes (`"predict_proba"`) instead of the predicted values.

We set `"predict_proba"` to `True` in the `fun_control` dictionary.

24.10.1.1 The MAPK Metric

To select the MAPK metric, the following two entries can be added to the `fun_control` dictionary:

`"metric_sklearn": mapk_score"`

`"metric_params": {"k": 3}`.

24.10.1.2 Other Metrics

Alternatively, other metrics for multi-class classification can be used, e.g.,: * top_k_accuracy_score or * roc_auc_score

The metric `roc_auc_score` requires the parameter `"multi_class"`, e.g.,

`"multi_class": "ovr"`.

This is set in the `fun_control` dictionary.

> **Weights**
>
> `spotPython` performs a minimization, therefore, metrics that should be maximized have to be multiplied by -1. This is done by setting `"weights"` to `-1`.

- The complete setup for the metric in our example is:

```python
from spotPython.utils.metrics import mapk_score
fun_control.update({
               "weights": -1,
               "metric_sklearn": mapk_score,
               "predict_proba": True,
               "metric_params": {"k": 3},
               })
```

24.11 Evaluation on Hold-out Data

- The default method for computing the performance is `"eval_holdout"`.
- Alternatively, cross-validation can be used for every machine learning model.
- Specifically for RandomForests, the OOB-score can be used.

```python
fun_control.update({
    "eval": "train_hold_out",
})
```

24.11.0.1 Cross Validation

Instead of using the OOB-score, the classical cross validation can be used. The number of folds is set by the key `"k_folds"`. For example, to use 5-fold cross validation, the key `"k_folds"` is set to `5`. Uncomment the following line to use cross validation:

```python
# fun_control.update({
#      "eval": "train_cv",
#      "k_folds": 10,
# })
```

24.12 6. Calling the SPOT Function

24.13 Preparing the SPOT Call

- Get types and variable names as well as lower and upper bounds for the hyperparameters.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name        | type   | default   |   lower |   upper | transform              |
|-------------|--------|-----------|---------|---------|------------------------|
| n_neighbors | int    | 2         |       1 |       7 | transform_power_2_int |
| weights     | factor | uniform   |       0 |       1 | None                   |
| algorithm   | factor | auto      |       0 |       3 | None                   |
| leaf_size   | int    | 5         |       2 |       7 | transform_power_2_int |
| p           | int    | 2         |       1 |       2 | None                   |
```

24.14 The Objective Function

The objective function is selected next. It implements an interface from `sklearn`'s training, validation, and testing methods to `spotPython`.

```
from spotPython.fun.hypersklearn import HyperSklearn
fun = HyperSklearn().fun_sklearn
```

24.14.1 Run the `Spot` Optimizer

- Run SPOT for approx. x mins (`max_time`).
- Note: the run takes longer, because the evaluation time of initial design (here: `initi_size`, 20 points) is not considered.

```
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=SklearnHyperDict().load()
```

```python
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
X_start
```

```
array([[2, 0, 0, 5, 2]])
```

```python
import numpy as np
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
                   show_progress= True,
                   fun_control = fun_control,
                   design_control={"init_size": INIT_SIZE,
                                   "repeats": 1},
                   surrogate_control={"noise": True,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": len(var_name),
                                      "model_fun_evals": 10_000,
                                      "log_level": 50
                                      })
spot_tuner.run(X_start=X_start)
```

```
spotPython tuning: -0.3107769423558897 [----------] 0.24%

spotPython tuning: -0.3107769423558897 [----------] 0.51%
```

```
spotPython tuning: -0.3107769423558897 [----------] 0.76%

spotPython tuning: -0.3107769423558897 [----------] 1.00%

spotPython tuning: -0.3107769423558897 [----------] 1.26%

spotPython tuning: -0.3107769423558897 [----------] 1.57%

spotPython tuning: -0.3107769423558897 [----------] 1.93%

spotPython tuning: -0.3107769423558897 [----------] 2.26%

spotPython tuning: -0.3107769423558897 [----------] 2.57%

spotPython tuning: -0.3107769423558897 [----------] 2.86%

spotPython tuning: -0.3107769423558897 [----------] 3.15%

spotPython tuning: -0.3107769423558897 [----------] 4.14%

spotPython tuning: -0.3107769423558897 [#---------] 5.16%

spotPython tuning: -0.3107769423558897 [#---------] 6.36%

spotPython tuning: -0.3107769423558897 [#---------] 7.54%

spotPython tuning: -0.3107769423558897 [#---------] 8.78%

spotPython tuning: -0.3107769423558897 [#---------] 10.24%

spotPython tuning: -0.3107769423558897 [#---------] 11.36%

spotPython tuning: -0.3107769423558897 [#---------] 13.31%

spotPython tuning: -0.3107769423558897 [#---------] 14.57%

spotPython tuning: -0.3107769423558897 [##--------] 15.59%
```

```
spotPython tuning: -0.3107769423558897 [##--------] 16.46%

spotPython tuning: -0.3107769423558897 [##--------] 17.44%

spotPython tuning: -0.3107769423558897 [##--------] 18.64%

spotPython tuning: -0.3107769423558897 [##--------] 19.59%

spotPython tuning: -0.3107769423558897 [##--------] 20.81%

spotPython tuning: -0.3107769423558897 [##--------] 22.11%

spotPython tuning: -0.3107769423558897 [##--------] 23.65%

spotPython tuning: -0.3107769423558897 [###-------] 25.30%

spotPython tuning: -0.3107769423558897 [###-------] 27.09%

spotPython tuning: -0.3107769423558897 [###-------] 28.73%

spotPython tuning: -0.3107769423558897 [###-------] 31.12%

spotPython tuning: -0.3107769423558897 [###-------] 33.20%

spotPython tuning: -0.3107769423558897 [####------] 35.75%

spotPython tuning: -0.3107769423558897 [####------] 39.59%

spotPython tuning: -0.3107769423558897 [####------] 42.47%

spotPython tuning: -0.3107769423558897 [#####-----] 45.16%

spotPython tuning: -0.3107769423558897 [#####-----] 48.13%

spotPython tuning: -0.3107769423558897 [#####-----] 50.81%

spotPython tuning: -0.3107769423558897 [#####-----] 53.54%
```

```
spotPython tuning: -0.3107769423558897 [######----] 56.57%

spotPython tuning: -0.3107769423558897 [######----] 59.58%

spotPython tuning: -0.3107769423558897 [######----] 62.78%

spotPython tuning: -0.3107769423558897 [#######---] 65.94%

spotPython tuning: -0.3107769423558897 [#######---] 68.73%

spotPython tuning: -0.3107769423558897 [#######---] 71.72%

spotPython tuning: -0.3107769423558897 [########--] 75.81%

spotPython tuning: -0.3107769423558897 [########--] 79.01%

spotPython tuning: -0.3107769423558897 [########--] 82.30%

spotPython tuning: -0.3107769423558897 [#########-] 85.92%

spotPython tuning: -0.3107769423558897 [#########-] 89.86%

spotPython tuning: -0.3107769423558897 [#########-] 93.13%

spotPython tuning: -0.3107769423558897 [##########] 95.55%

spotPython tuning: -0.3107769423558897 [##########] 98.62%

spotPython tuning: -0.3107769423558897 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x2861fd0f0>
```

24.14.2 Results

After the hyperparameter tuning run is finished, the progress of the hyperparameter tuning can be visualized. The following code generates the progress plot from **?@fig-progress**.

```python
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

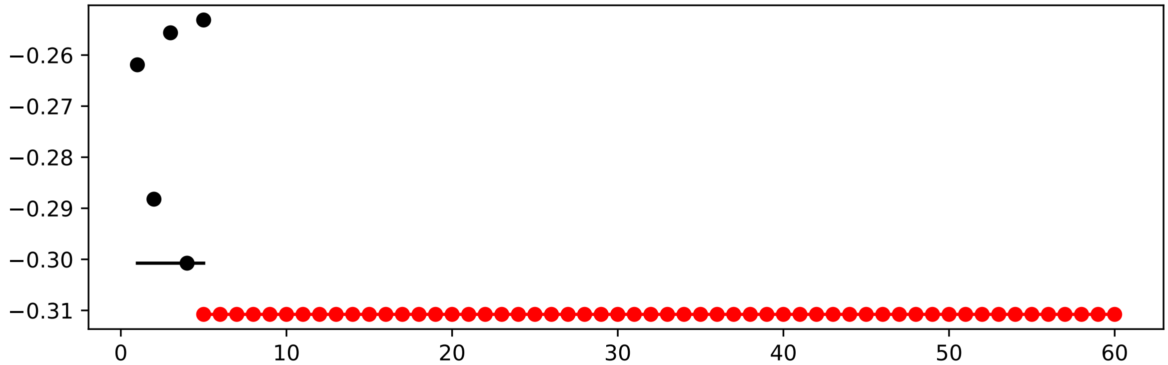


Figure 24.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

- Print the results

```python
print(gen_design_table(fun_control=fun_control,
    spot=spot_tuner))
```

```
| name        | type   | default   |   lower |   upper |   tuned | transform             |
|-------------|--------|-----------|---------|---------|---------|-----------------------|---
| n_neighbors | int    | 2         |       1 |       7 |     4.0 | transform_power_2_int |
| weights     | factor | uniform   |       0 |       1 |     1.0 | None                  |
| algorithm   | factor | auto      |       0 |       3 |     2.0 | None                  |
| leaf_size   | int    | 5         |       2 |       7 |     6.0 | transform_power_2_int |
| p           | int    | 2         |       1 |       2 |     1.0 | None                  |
```

24.15 Show variable importance

```python
spot_tuner.plot_importance(threshold=0.025, filename="./figures/" + experiment_name+"_impo
```

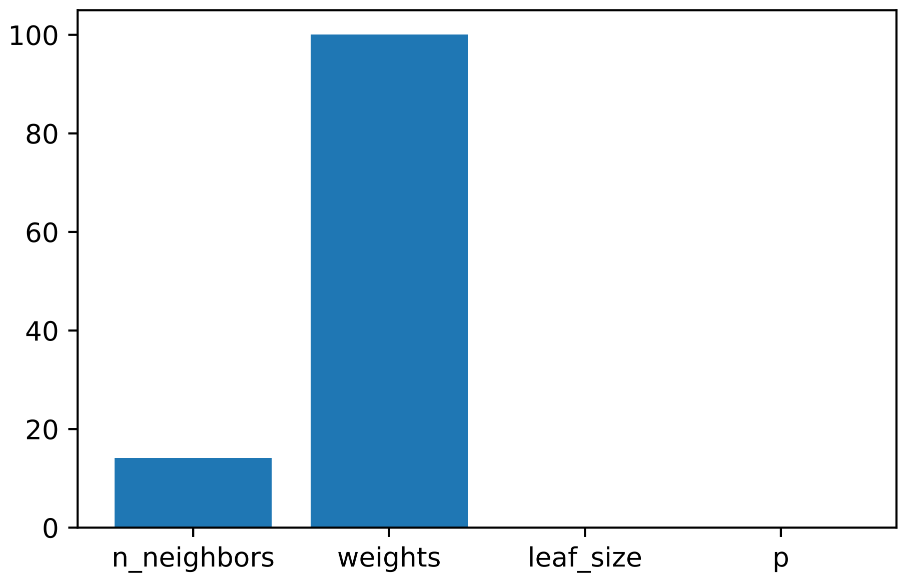


Figure 24.2: Variable importance plot, threshold 0.025.

24.16 Get Default Hyperparameters

```
from spotPython.hyperparameters.values import get_default_values, transform_hyper_paramete
values_default = get_default_values(fun_control)
values_default = transform_hyper_parameter_values(fun_control=fun_control, hyper_parameter
values_default
```

```
{'n_neighbors': 4,
 'weights': 'uniform',
 'algorithm': 'auto',
 'leaf_size': 32,
 'p': 2}
```

```
from sklearn.pipeline import make_pipeline
model_default = make_pipeline(fun_control["prep_model"], fun_control["core_model"](**value
model_default
```

```
Pipeline(steps=[('nonetype', None),
                ('kneighborsclassifier',
                 KNeighborsClassifier(leaf_size=32, n_neighbors=4))])
```

24.17 Get SPOT Results

```
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
print(X)
```

```
[[4. 1. 2. 6. 1.]]
```

```
from spotPython.hyperparameters.values import assign_values, return_conf_list_from_var_dic
v_dict = assign_values(X, fun_control["var_name"])
return_conf_list_from_var_dict(var_dict=v_dict, fun_control=fun_control)
```

```
[{'n_neighbors': 16,
  'weights': 'distance',
  'algorithm': 'kd_tree',
  'leaf_size': 64,
  'p': 1}]
```

```
from spotPython.hyperparameters.values import get_one_sklearn_model_from_X
model_spot = get_one_sklearn_model_from_X(X, fun_control)
model_spot
```

```
KNeighborsClassifier(algorithm='kd_tree', leaf_size=64, n_neighbors=16, p=1,
                     weights='distance')
```

24.18 Evaluate SPOT Results

- Fetch the data.

```
from spotPython.utils.convert import get_Xy_from_df
X_train, y_train = get_Xy_from_df(fun_control["train"], fun_control["target_column"])
X_test, y_test = get_Xy_from_df(fun_control["test"], fun_control["target_column"])
X_test.shape, y_test.shape
```

```
((177, 64), (177,))
```

- Fit the model with the tuned hyperparameters. This gives one result:

```python
model_spot.fit(X_train, y_train)
y_pred = model_spot.predict_proba(X_test)
res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
res
```

```
0.3267419962335216
```

```python
def repeated_eval(n, model):
    res_values = []
    for i in range(n):
        model.fit(X_train, y_train)
        y_pred = model.predict_proba(X_test)
        res = mapk_score(y_true=y_test, y_pred=y_pred, k=3)
        res_values.append(res)
    mean_res = np.mean(res_values)
    print(f"mean_res: {mean_res}")
    std_res = np.std(res_values)
    print(f"std_res: {std_res}")
    min_res = np.min(res_values)
    print(f"min_res: {min_res}")
    max_res = np.max(res_values)
    print(f"max_res: {max_res}")
    median_res = np.median(res_values)
    print(f"median_res: {median_res}")
    return mean_res, std_res, min_res, max_res, median_res
```

24.18.1 Handling Non-deterministic Results

- Because the model is non-determinstic, we perform $n = 30$ runs and calculate the mean and standard deviation of the performance metric.

```python
_ = repeated_eval(30, model_spot)
```

```
mean_res: 0.3267419962335218
std_res: 1.6653345369377348e-16
min_res: 0.3267419962335216
max_res: 0.3267419962335216
median_res: 0.3267419962335216
```

24.18.2 Evalution of the Default Hyperparameters

```python
model_default.fit(X_train, y_train)["kneighborsclassifier"]
```

```
KNeighborsClassifier(leaf_size=32, n_neighbors=4)
```

- One evaluation of the default hyperparameters is performed on the hold-out test set.

```python
y_pred = model_default.predict_proba(X_test)
mapk_score(y_true=y_test, y_pred=y_pred, k=3)
```

```
0.2768361581920904
```

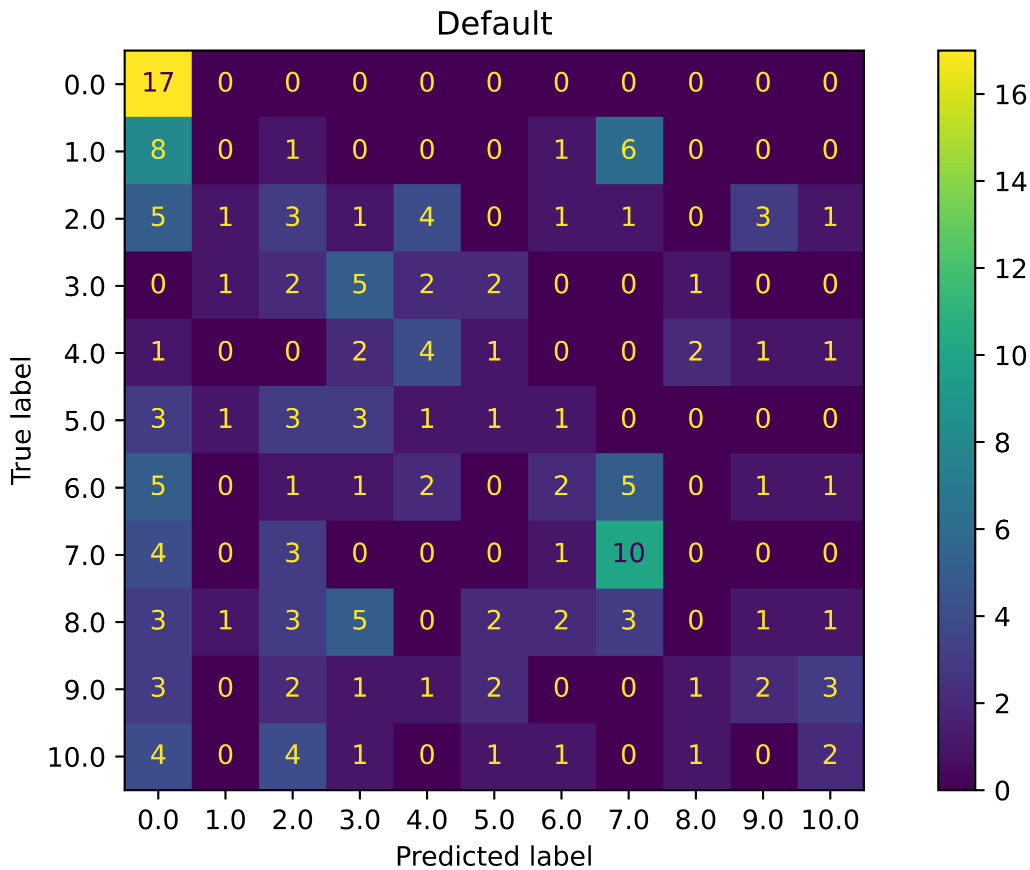
Since one single evaluation is not meaningful, we perform, similar to the evaluation of the SPOT results, $n = 30$ runs of the default setting and and calculate the mean and standard deviation of the performance metric.

```python
_ = repeated_eval(30, model_default)
```

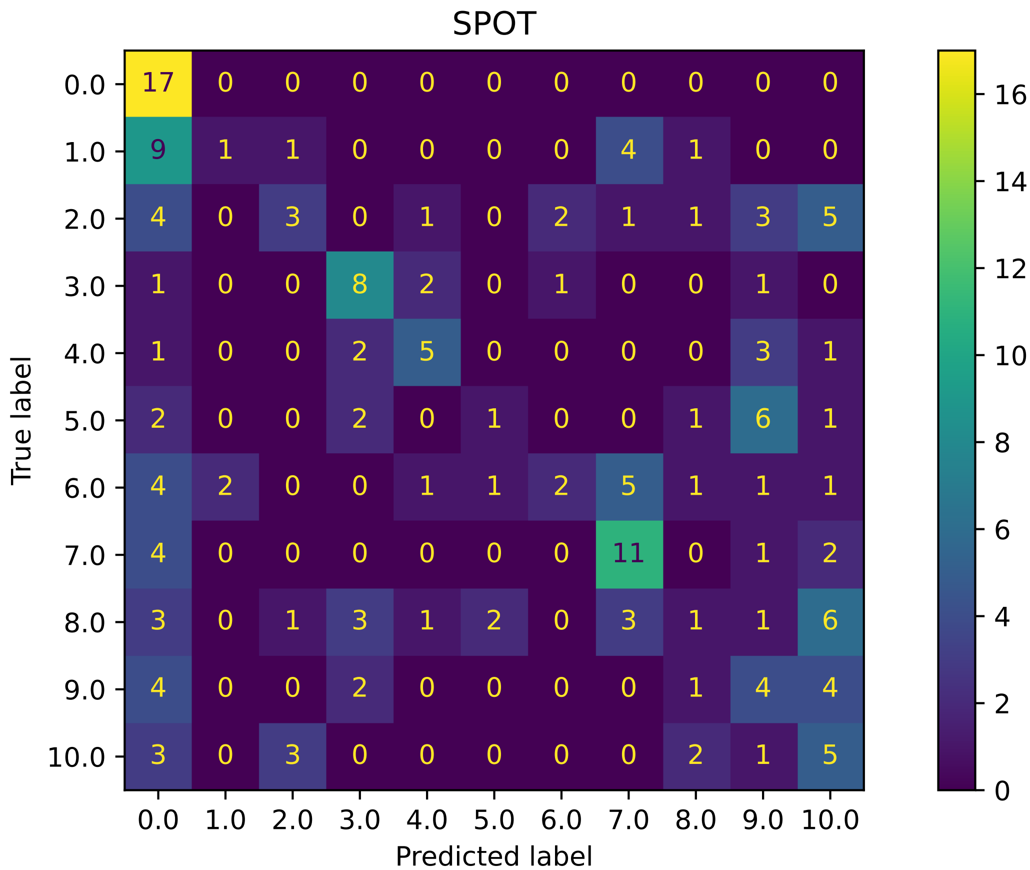
```
mean_res: 0.2768361581920903
std_res: 1.1102230246251565e-16
min_res: 0.2768361581920904
max_res: 0.2768361581920904
median_res: 0.2768361581920904
```

24.19 Plot: Compare Predictions

```python
from spotPython.plot.validation import plot_confusion_matrix
plot_confusion_matrix(model_default, fun_control, title = "Default")
```




```
plot_confusion_matrix(model_spot, fun_control, title="SPOT")
```




```
min(spot_tuner.y), max(spot_tuner.y)
```

```
(-0.3107769423558897, -0.23558897243107768)
```

24.20 Cross-validated Evaluations

```
from spotPython.sklearn.traintest import evaluate_cv
fun_control.update({
     "eval": "train_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.3157232704402516, None)
```

```
fun_control.update({
     "eval": "test_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

```
(0.2832788671023965, None)
```

- This is the evaluation that will be used in the comparison:

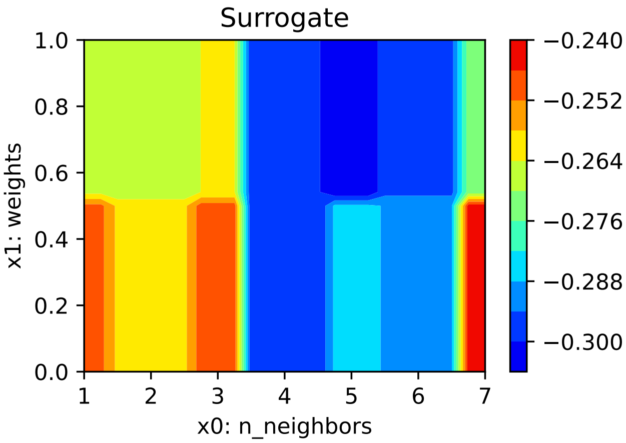
```
fun_control.update({
     "eval": "data_cv",
     "k_folds": 10,
})
evaluate_cv(model=model_spot, fun_control=fun_control, verbose=0)
```

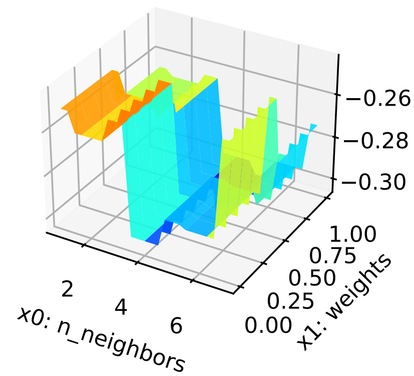
```
(0.3061904761904762, None)
```

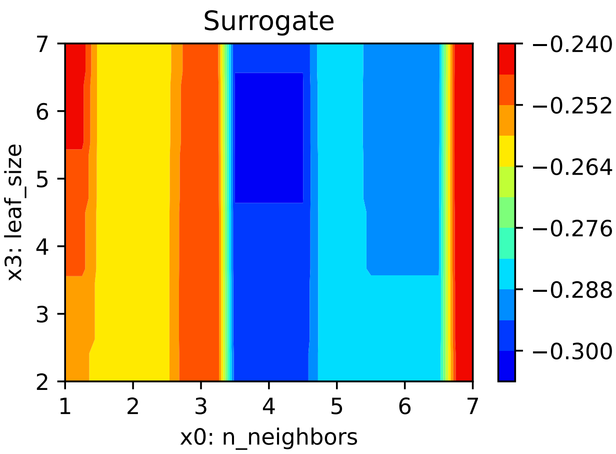
24.20.1 Detailed Hyperparameter Plots

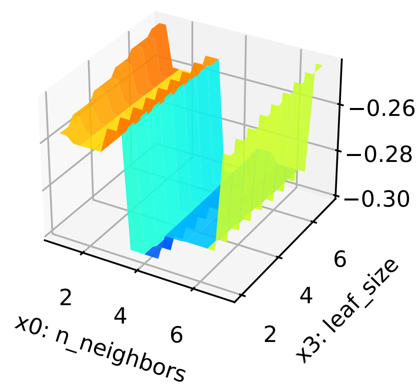
```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

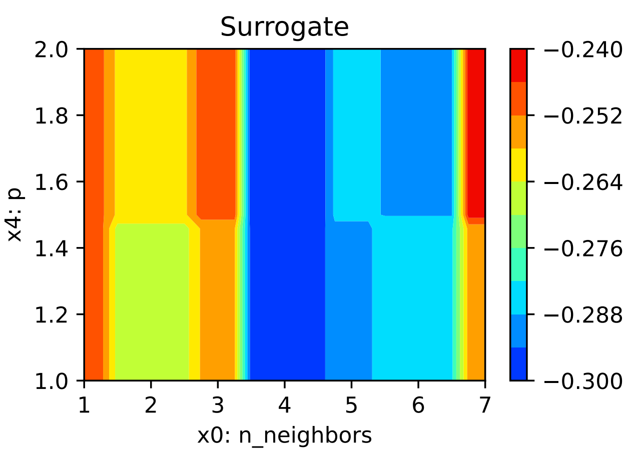
```
n_neighbors:  14.062005356823159
weights:  100.0
leaf_size:  0.03194210846917897
p:  0.026575949846363224
```

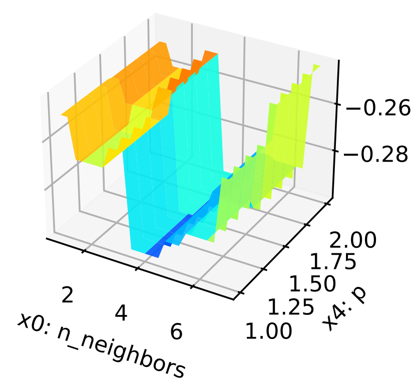

Surrogate
x1: weights
x0: n_neighbors
−0.240
−0.252
−0.264
−0.276
−0.288
−0.300

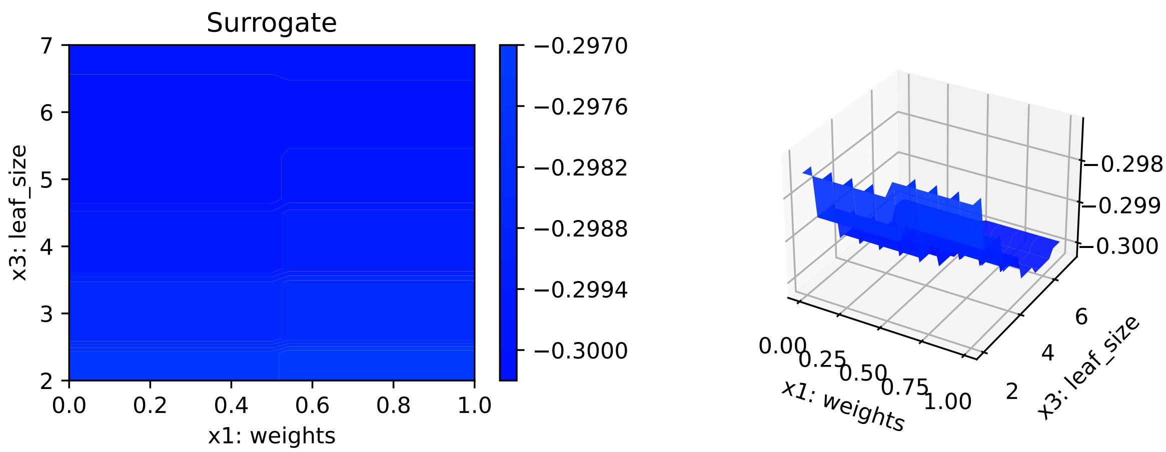

x0: n_neighbors
x1: weights

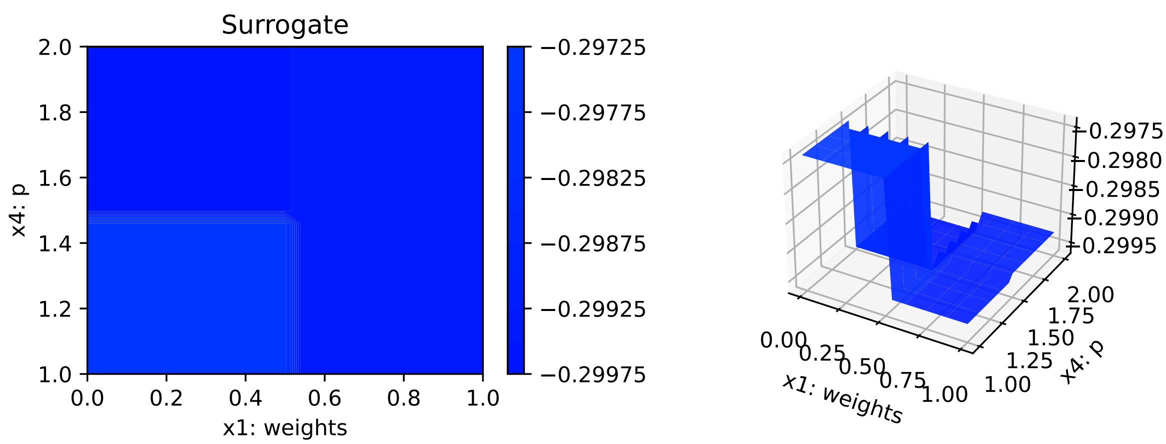

Surrogate
x3: leaf_size
x0: n_neighbors
−0.240
−0.252
−0.264
−0.276
−0.288
−0.300

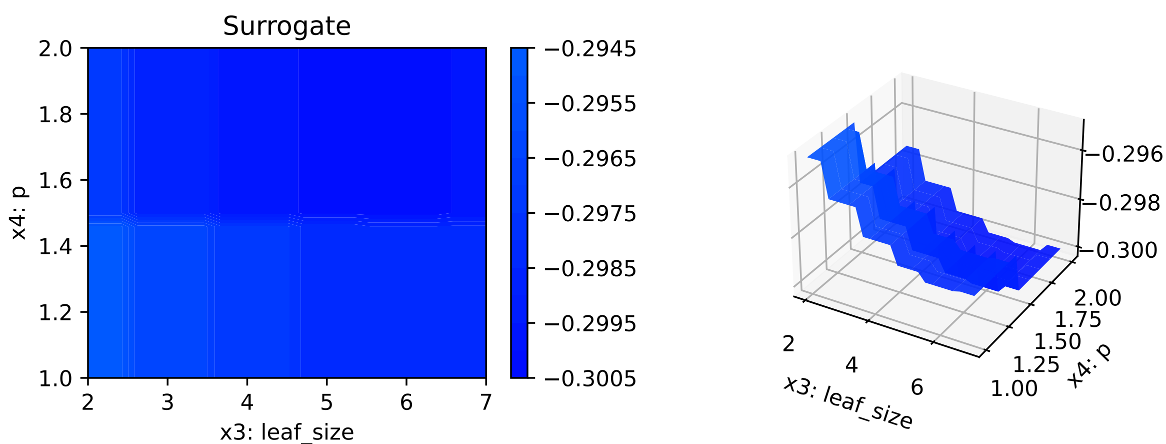

x0: n_neighbors
x3: leaf_size


Surrogate
x4: p
x0: n_neighbors
−0.240
−0.252
−0.264
−0.276
−0.288
−0.300


x0: n_neighbors
x4: p


Surrogate
x3: leaf_size
x1: weights
−0.2970
−0.2976
−0.2982
−0.2988
−0.2994
−0.3000
0.298
0.299
0.300
x3: leaf_size


Surrogate
x4: p
x1: weights
−0.29725
−0.29775
−0.29825
−0.29875
−0.29925
−0.29975
0.2975
0.2980
0.2985
0.2990
0.2995
x4: p


Surrogate
x4: p
x3: leaf_size
−0.2945
−0.2955
−0.2965
−0.2975
−0.2985
−0.2995
−0.3005
−0.296
−0.298
−0.300
x4: p

24.21 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

```
Unable to display output for mime type(s): text/html
```

24.22 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
            spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

25 HPT PyTorch: Regression

In this tutorial, we will show how `spotPython` can be integrated into the `PyTorch` training workflow for regreession tasks.

This document refers to the following software versions:

- `python`: 3.10.10
- `torch`: 2.0.1
- `torchvision`: 0.15.0

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                0.2.33
spotRiver                 0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

25.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time, initial design size and the device that is used.

```
MAX_TIME = 1
INIT_SIZE = 5
DEVICE = "cpu" # "cuda:0"
```

```
from spotPython.utils.device import getDevice
DEVICE = getDevice(DEVICE)
print(DEVICE)
```

```
cpu
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '24-torch' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(INIT_SI
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
24-torch_p040025_1min_5init_2023-06-17_02-17-21
```

25.2 Initialization of the `fun_control` Dictionary

`spotPython` uses a Python dictionary for storing the information required for the hyperparameter tuning process, which was described in Section 20.2.

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="regression",
 tensorboard_path="runs/24_spot_torch_regression",
 device=DEVICE)
```

25.3 PyTorch Data Loading

```python
# Create dataset
import pandas as pd
import numpy as np
from sklearn import datasets as sklearn_datasets
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
X, y = sklearn_datasets.make_regression(
    n_samples=1000, n_features=10, noise=1, random_state=123)
y = y.reshape(-1, 1)

# Normalize the data
X_scaler = MinMaxScaler()
X_scaled = X_scaler.fit_transform(X)
y_scaler = MinMaxScaler()
y_scaled = y_scaler.fit_transform(y)

# combine the features and target into a single dataframe named train_df
train_df = pd.DataFrame(np.hstack((X_scaled, y_scaled)))

target_column = "y"
n_samples = train_df.shape[0]
n_features = train_df.shape[1] - 1
train_df.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
X_train, X_test, y_train, y_test = train_test_split(train_df.drop(target_column,
    axis=1),
    train_df[target_column],
    random_state=42,
    test_size=0.25)
trainset = pd.DataFrame(np.hstack((X_train, np.array(y_train).reshape(-1, 1))))
testset = pd.DataFrame(np.hstack((X_test, np.array(y_test).reshape(-1, 1))))
trainset.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
testset.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train_df.shape)
print(trainset.shape)
print(testset.shape)
```

```
(1000, 11)
(750, 11)
(250, 11)
```

```
import torch
from spotPython.torch.dataframedataset import DataFrameDataset
dtype_x = torch.float32
dtype_y = torch.float32
train_df = DataFrameDataset(train_df, target_column=target_column,
    dtype_x=dtype_x, dtype_y=dtype_y)
train = DataFrameDataset(trainset, target_column=target_column,
    dtype_x=dtype_x, dtype_y=dtype_y)
test = DataFrameDataset(testset, target_column=target_column,
    dtype_x=dtype_x, dtype_y=dtype_y)
n_samples = len(train)
```

- Now we can test the data loading:

```
from spotPython.torch.traintest import create_train_val_data_loaders
trainloader, testloader = create_train_val_data_loaders(train, 2, True, 0)
for i, data in enumerate(trainloader, 0):
    inputs, labels = data
    print(inputs.shape)
    print(labels.shape)
    print(inputs)
    print(labels)
    break
```

```
torch.Size([2, 10])
torch.Size([2])
tensor([[0.4580, 0.7112, 0.6889, 0.5399, 0.2849, 0.4129, 0.3154, 0.4322, 0.8278,
         0.7327],
        [0.6717, 0.6097, 0.3278, 0.6670, 0.4975, 0.4188, 0.5481, 0.5159, 0.4404,
         0.3801]])
tensor([0.4625, 0.5764])
```

- Since this works fine, we can add the data loading to the `fun_control` dictionary:

```
# add the dataset to the fun_control
fun_control.update({"data": train_df, # full dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": target_column,})
```

25.4 The Model (Algorithm) to be Tuned

25.5 Specification of the Preprocessing Model

After the training and test data are specified and added to the fun_control dictionary, spotPython allows the specification of a data preprocessing pipeline, e.g., for the scaling of the data or for the one-hot encoding of categorical variables, see Section 20.4.1. This feature is not used here, so we do not change the default value (which is None).

25.6 Select algorithm and core_model_hyper_dict

25.6.1 Implementing a Configurable Neural Network With spotPython

spotPython includes the Net_lin_reg class which is implemented in the file netregression.py.

This class inherits from the class Net_Core which is implemented in the file netcore.py, see **?@sec-the-net-core-class-24**.

```
from torch import nn
import spotPython.torch.netcore as netcore


class Net_lin_reg(netcore.Net_Core):
    def __init__(
        self, _L_in, _L_out, l1, dropout_prob, lr_mult,
        batch_size, epochs, k_folds, patience, optimizer,
        sgd_momentum
    ):
        super(Net_lin_reg, self).__init__(
            lr_mult=lr_mult,
            batch_size=batch_size,
            epochs=epochs,
            k_folds=k_folds,
            patience=patience,
            optimizer=optimizer,
            sgd_momentum=sgd_momentum,
        )
        l2 = max(l1 // 2, 4)
        self.fc1 = nn.Linear(_L_in, l1)
        self.fc2 = nn.Linear(l1, l2)
```

```
        self.fc3 = nn.Linear(l2, _L_out)
        self.relu = nn.ReLU()
        self.softmax = nn.Softmax(dim=1)
        self.dropout1 = nn.Dropout(p=dropout_prob)
        self.dropout2 = nn.Dropout(p=dropout_prob / 2)

    def forward(self, x):
        x = self.fc1(x)
        x = self.relu(x)
        x = self.dropout1(x)
        x = self.fc2(x)
        x = self.relu(x)
        x = self.dropout2(x)
        x = self.fc3(x)
        return x
```

25.6.1.1 The Net_Core class

Net_lin_reg inherits from the class Net_Core which is implemented in the file netcore.py. This class was described in Section 20.4.3.

```
from spotPython.torch.netregression import Net_lin_reg
from spotPython.data.torch_hyper_dict import TorchHyperDict
from spotPython.hyperparameters.values import add_core_model_to_fun_control
fun_control = add_core_model_to_fun_control(core_model=Net_lin_reg,
                              fun_control=fun_control,
                              hyper_dict=TorchHyperDict,
                              filename=None)
```

25.7 The Search Space

25.7.1 Configuring the Search Space With spotPython

25.7.1.1 The hyper_dict Hyperparameters for the Selected Algorithm

spotPython uses JSON files for the specification of the hyperparameters, which were described in Section 20.5.2.

The corresponding entries for the Net_lin_reg class are shown below.

```
"Net_lin_reg":
{
    "_L_in": {
        "type": "int",
        "default": 10,
        "transform": "None",
        "lower": 10,
        "upper": 10},
    "_L_out": {
        "type": "int",
        "default": 1,
        "transform": "None",
        "lower": 1,
        "upper": 1},
    "l1": {
        "type": "int",
        "default": 3,
        "transform": "transform_power_2_int",
        "lower": 3,
        "upper": 8},
    "dropout_prob": {
        "type": "float",
        "default": 0.01,
        "transform": "None",
        "lower": 0.0,
        "upper": 0.9},
    "lr_mult": {
        "type": "float",
        "default": 1.0,
        "transform": "None",
        "lower": 0.1,
        "upper": 10.0},
    "batch_size": {
        "type": "int",
        "default": 4,
        "transform": "transform_power_2_int",
        "lower": 1,
        "upper": 4},
    "epochs": {
        "type": "int",
        "default": 4,
```

```
            "transform": "transform_power_2_int",
            "lower": 4,
            "upper": 9},
        "k_folds": {
            "type": "int",
            "default": 1,
            "transform": "None",
            "lower": 1,
            "upper": 1},
        "patience": {
            "type": "int",
            "default": 2,
            "transform": "transform_power_2_int",
            "lower": 1,
            "upper": 5
        },
        "optimizer": {
            "levels": ["Adadelta",
                       "Adagrad",
                       "Adam",
                       "AdamW",
                       "SparseAdam",
                       "Adamax",
                       "ASGD",
                       "NAdam",
                       "RAdam",
                       "RMSprop",
                       "Rprop",
                       "SGD"],
            "type": "factor",
            "default": "SGD",
            "transform": "None",
            "class_name": "torch.optim",
            "core_model_parameter_type": "str",
            "lower": 0,
            "upper": 12},
        "sgd_momentum": {
            "type": "float",
            "default": 0.0,
            "transform": "None",
            "lower": 0.0,
```

```
                "upper": 1.0}
    },
```

25.8 Modifying the Hyperparameters

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

25.8.1 Modify `hyper_dict` Hyperparameters for the Selected Algorithm aka `core_model`

25.8.1.1 Modify Hyperparameters of Type numeric and integer (boolean)

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds

fun_control = modify_hyper_parameter_bounds(fun_control, "epochs", bounds=[2, 16])
fun_control = modify_hyper_parameter_bounds(fun_control, "patience", bounds=[3, 7])
```

25.8.1.2 Modify Hyperparameter of Type factor

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
fun_control = modify_hyper_parameter_levels(fun_control, "optimizer",
    ["Adadelta", "Adagrad", "Adam", "AdamW", "Adamax", "ASGD", "NAdam"])


fun_control.update({
               "_L_in": n_features,
               "_L_out": 1,})
```

25.8.2 Optimizers

Optimizers are described in Section 20.6.

25.9 Evaluation

The evaluation procedure requires the specification of two elements:

1. the way how the data is split into a train and a test set (see Section 20.7)
2. the loss function (and a metric).

25.9.1 Loss Functions and Metrics

The key `"loss_function"` specifies the loss function which is used during the optimization, see Section 20.8.

We will use MSE loss for the regression task.

```
from torch.nn import MSELoss
loss_torch = MSELoss()
fun_control.update({"loss_function": loss_torch})
```

25.9.2 Metric

```
from torchmetrics import MeanAbsoluteError
metric_torch = MeanAbsoluteError().to(fun_control["device"])
fun_control.update({"metric_torch": metric_torch})
```

25.10 Preparing the SPOT Call

The following code passes the information about the parameter ranges and bounds to `spot`.

```
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

```python
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name         | type   | default   |   lower |   upper | transform              |
|--------------|--------|-----------|---------|---------|------------------------|
| _L_in        | int    | 10        |    10   |    10   | None                   |
| _L_out       | int    | 1         |     1   |     1   | None                   |
| l1           | int    | 3         |     3   |     8   | transform_power_2_int |
| dropout_prob | float  | 0.01      |     0   |     0.9 | None                   |
| lr_mult      | float  | 1.0       |     0.1 |    10   | None                   |
| batch_size   | int    | 4         |     1   |     4   | transform_power_2_int |
| epochs       | int    | 4         |     2   |    16   | transform_power_2_int |
| k_folds      | int    | 1         |     1   |     1   | None                   |
| patience     | int    | 2         |     3   |     7   | transform_power_2_int |
| optimizer    | factor | SGD       |     0   |     6   | None                   |
| sgd_momentum | float  | 0.0       |     0   |     1   | None                   |
```

25.11 The Objective Function `fun_torch`

The objective function `fun_torch` is selected next. It implements an interface from `PyTorch`'s training, validation, and testing methods to `spotPython`.

```python
from spotPython.fun.hypertorch import HyperTorch
fun = HyperTorch().fun_torch
```

```python
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=TorchHyperDict().load()
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
```

25.12 Starting the Hyperparameter Tuning

The `spotPython` hyperparameter tuning is started by calling the `Spot` function as described in Section 20.12.

```python
from spotPython.spot import spot
from math import inf
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
```

```python
                     upper = upper,
                     fun_evals = inf,
                     fun_repeats = 1,
                     max_time = MAX_TIME,
                     noise = False,
                     tolerance_x = np.sqrt(np.spacing(1)),
                     var_type = var_type,
                     var_name = var_name,
                     infill_criterion = "y",
                     n_points = 1,
                     seed=123,
                     log_level = 50,
                     show_models= False,
                     show_progress= True,
                     fun_control = fun_control,
                     design_control={"init_size": INIT_SIZE,
                                     "repeats": 1},
                     surrogate_control={"noise": True,
                                        "cod_type": "norm",
                                        "min_theta": -4,
                                        "max_theta": 3,
                                        "n_theta": len(var_name),
                                        "model_fun_evals": 10_000,
                                        "log_level": 50
                                        })
spot_tuner.run(X_start=X_start)
```

```
config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.7103122166156, 'lr_mult': 3.62
Epoch: 1

Loss on hold-out set: 0.043964673752749435
MeanAbsoluteError value on hold-out data: 0.16461940109729767
Epoch: 2
Loss on hold-out set: 0.03457524517158929
MeanAbsoluteError value on hold-out data: 0.14958176016807556
Epoch: 3
Loss on hold-out set: 0.029925968032330275
MeanAbsoluteError value on hold-out data: 0.13674235343933105
Epoch: 4
Loss on hold-out set: 0.02802746153534635
```

```
MeanAbsoluteError value on hold-out data: 0.13134253025054932
Epoch: 5
Loss on hold-out set: 0.02586658725416974
MeanAbsoluteError value on hold-out data: 0.12824375927448273
Epoch: 6
Loss on hold-out set: 0.024500433514875016
MeanAbsoluteError value on hold-out data: 0.12698516249656677
Epoch: 7
Loss on hold-out set: 0.024938731723906177
MeanAbsoluteError value on hold-out data: 0.1237039789557457
Epoch: 8
Loss on hold-out set: 0.021456128746075064
MeanAbsoluteError value on hold-out data: 0.11489038169384003
Epoch: 9

Loss on hold-out set: 0.021472166684505186
MeanAbsoluteError value on hold-out data: 0.11672847718000412
Epoch: 10

Loss on hold-out set: 0.022215088106397735
MeanAbsoluteError value on hold-out data: 0.11792019009590149
Epoch: 11
Loss on hold-out set: 0.020928226117240756
MeanAbsoluteError value on hold-out data: 0.11521977931261063
Epoch: 12

Loss on hold-out set: 0.018788766201683564
MeanAbsoluteError value on hold-out data: 0.10838589072227478
Epoch: 13
Loss on hold-out set: 0.01977658361858247
MeanAbsoluteError value on hold-out data: 0.10970094054937363
Epoch: 14
Loss on hold-out set: 0.02004081933563085
MeanAbsoluteError value on hold-out data: 0.11253173649311066
Epoch: 15
Loss on hold-out set: 0.017893161177390107
MeanAbsoluteError value on hold-out data: 0.10271118581295013
Epoch: 16
Loss on hold-out set: 0.01786531971179341
MeanAbsoluteError value on hold-out data: 0.10199601203203201
Epoch: 17
Loss on hold-out set: 0.015926932744485766
```

```
MeanAbsoluteError value on hold-out data: 0.09624960273504257
Epoch: 18
Loss on hold-out set: 0.01594574314444081
MeanAbsoluteError value on hold-out data: 0.10048878192901611
Epoch: 19
Loss on hold-out set: 0.015449737076108394
MeanAbsoluteError value on hold-out data: 0.09628041833639145
Epoch: 20

Loss on hold-out set: 0.013632013168382017
MeanAbsoluteError value on hold-out data: 0.08993703871965408
Epoch: 21

Loss on hold-out set: 0.01558282500819156
MeanAbsoluteError value on hold-out data: 0.09730208665132523
Epoch: 22
Loss on hold-out set: 0.01469774256877013
MeanAbsoluteError value on hold-out data: 0.09153390675783157
Epoch: 23

Loss on hold-out set: 0.01381725602244076
MeanAbsoluteError value on hold-out data: 0.08921832591295242
Epoch: 24
Loss on hold-out set: 0.013107507060723085
MeanAbsoluteError value on hold-out data: 0.08698201179504395
Epoch: 25
Loss on hold-out set: 0.013364921176904127
MeanAbsoluteError value on hold-out data: 0.08801571279764175
Epoch: 26
Loss on hold-out set: 0.013083722381117312
MeanAbsoluteError value on hold-out data: 0.08851244300603867
Epoch: 27
Loss on hold-out set: 0.016171021699464244
MeanAbsoluteError value on hold-out data: 0.10087253898382187
Epoch: 28
Loss on hold-out set: 0.012211578365072216
MeanAbsoluteError value on hold-out data: 0.08422020077705383
Epoch: 29
Loss on hold-out set: 0.01254400273932046
MeanAbsoluteError value on hold-out data: 0.08540602773427963
Epoch: 30
Loss on hold-out set: 0.012496824866454852
```

```
MeanAbsoluteError value on hold-out data: 0.08481574058532715
Epoch: 31

Loss on hold-out set: 0.012552415014636753
MeanAbsoluteError value on hold-out data: 0.0854199081659317
Epoch: 32

Loss on hold-out set: 0.014480925002748049
MeanAbsoluteError value on hold-out data: 0.09143101423978806
Epoch: 33
Loss on hold-out set: 0.010319335877858592
MeanAbsoluteError value on hold-out data: 0.07934051007032394
Epoch: 34

Loss on hold-out set: 0.011877597131962446
MeanAbsoluteError value on hold-out data: 0.08449865132570267
Epoch: 35
Loss on hold-out set: 0.012564333645921005
MeanAbsoluteError value on hold-out data: 0.08792129904031754
Epoch: 36
Loss on hold-out set: 0.011403895157855004
MeanAbsoluteError value on hold-out data: 0.08180585503578186
Epoch: 37
Loss on hold-out set: 0.011765138270627511
MeanAbsoluteError value on hold-out data: 0.08214540779590607
Epoch: 38
Loss on hold-out set: 0.012396611775712748
MeanAbsoluteError value on hold-out data: 0.08501216024160385
Epoch: 39
Loss on hold-out set: 0.012488012808669163
MeanAbsoluteError value on hold-out data: 0.08298568427562714
Epoch: 40
Loss on hold-out set: 0.012359104891258636
MeanAbsoluteError value on hold-out data: 0.08279114216566086
Epoch: 41
Loss on hold-out set: 0.009952383501896341
MeanAbsoluteError value on hold-out data: 0.0760246068239212
Epoch: 42

Loss on hold-out set: 0.011596388869771832
MeanAbsoluteError value on hold-out data: 0.07522816210985184
Epoch: 43
```

```
Loss on hold-out set: 0.0138954688598843
MeanAbsoluteError value on hold-out data: 0.08913403004407883
Epoch: 44
Loss on hold-out set: 0.009525573340636728
MeanAbsoluteError value on hold-out data: 0.07357040047645569
Epoch: 45

Loss on hold-out set: 0.010457459322519992
MeanAbsoluteError value on hold-out data: 0.07942638546228409
Epoch: 46
Loss on hold-out set: 0.01168687012365186
MeanAbsoluteError value on hold-out data: 0.08512870967388153
Epoch: 47
Loss on hold-out set: 0.010395352538724086
MeanAbsoluteError value on hold-out data: 0.07542260736227036
Epoch: 48
Loss on hold-out set: 0.014497695766438386
MeanAbsoluteError value on hold-out data: 0.09312694519758224
Epoch: 49
Loss on hold-out set: 0.01196648996617449
MeanAbsoluteError value on hold-out data: 0.07561998814344406
Epoch: 50
Loss on hold-out set: 0.008930675691532853
MeanAbsoluteError value on hold-out data: 0.07080917060375214
Epoch: 51
Loss on hold-out set: 0.011609327317656655
MeanAbsoluteError value on hold-out data: 0.08216641843318939
Epoch: 52
Loss on hold-out set: 0.010222037402471821
MeanAbsoluteError value on hold-out data: 0.07517590373754501
Epoch: 53

Loss on hold-out set: 0.011704713636151465
MeanAbsoluteError value on hold-out data: 0.07712382078170776
Epoch: 54

Loss on hold-out set: 0.011787320793557324
MeanAbsoluteError value on hold-out data: 0.0818999707698822
Epoch: 55
Loss on hold-out set: 0.010272516210342905
MeanAbsoluteError value on hold-out data: 0.07590029388666153
Epoch: 56
```

```
Loss on hold-out set: 0.013054155180916974
MeanAbsoluteError value on hold-out data: 0.08348473161458969
Epoch: 57
Loss on hold-out set: 0.011041519832552263
MeanAbsoluteError value on hold-out data: 0.0771094411611557
Epoch: 58
Loss on hold-out set: 0.012192529264690452
MeanAbsoluteError value on hold-out data: 0.08285577595233917
Epoch: 59
Loss on hold-out set: 0.011699624800760495
MeanAbsoluteError value on hold-out data: 0.08123096823692322
Epoch: 60
Loss on hold-out set: 0.01202020712049776
MeanAbsoluteError value on hold-out data: 0.08041084557771683
Epoch: 61
Loss on hold-out set: 0.013031750574315848
MeanAbsoluteError value on hold-out data: 0.0854228213429451
Epoch: 62
Loss on hold-out set: 0.011558679471674719
MeanAbsoluteError value on hold-out data: 0.08009522408246994
Epoch: 63
Loss on hold-out set: 0.01170910293493714
MeanAbsoluteError value on hold-out data: 0.081049345433712
Epoch: 64

Loss on hold-out set: 0.010476533714130423
MeanAbsoluteError value on hold-out data: 0.07118216902017593
Epoch: 65

Loss on hold-out set: 0.012009335822719885
MeanAbsoluteError value on hold-out data: 0.08487939089536667
Epoch: 66
Loss on hold-out set: 0.012355205633579508
MeanAbsoluteError value on hold-out data: 0.08028626441955566
Early stopping at epoch 65
Returned to Spot: Validation loss: 0.012355205633579508
----------------------------------------------

config: {'_L_in': 10, '_L_out': 1, 'l1': 32, 'dropout_prob': 0.19981931523998656, 'lr_mult':
Epoch: 1

Loss on hold-out set: 0.10358314490632008
```

```
MeanAbsoluteError value on hold-out data: 0.2768810987472534
Epoch: 2
Loss on hold-out set: 0.04570627575250048
MeanAbsoluteError value on hold-out data: 0.17495810985565186
Epoch: 3
Loss on hold-out set: 0.07689022351252406
MeanAbsoluteError value on hold-out data: 0.24407508969306946
Epoch: 4
Loss on hold-out set: 0.03922366542055419
MeanAbsoluteError value on hold-out data: 0.16455703973770142
Epoch: 5
Loss on hold-out set: 0.06978269431151841
MeanAbsoluteError value on hold-out data: 0.23259025812149048
Epoch: 6
Loss on hold-out set: 0.0592753724440148
MeanAbsoluteError value on hold-out data: 0.21105879545211792
Epoch: 7
Loss on hold-out set: 0.06807827478960941
MeanAbsoluteError value on hold-out data: 0.2317931056022644
Epoch: 8
Loss on hold-out set: 0.03210916311333054
MeanAbsoluteError value on hold-out data: 0.14897921681404114
Epoch: 9
Loss on hold-out set: 0.03327455499062413
MeanAbsoluteError value on hold-out data: 0.15717926621437073
Epoch: 10
Loss on hold-out set: 0.09324781439806286
MeanAbsoluteError value on hold-out data: 0.28135567903518677
Epoch: 11
Loss on hold-out set: 0.06886018459734164
MeanAbsoluteError value on hold-out data: 0.23831868171691895
Epoch: 12
Loss on hold-out set: 0.03056425699277928
MeanAbsoluteError value on hold-out data: 0.15364469587802887
Epoch: 13
Loss on hold-out set: 0.06727060048203719
MeanAbsoluteError value on hold-out data: 0.24024423956871033
Epoch: 14
Loss on hold-out set: 0.010463080332173328
MeanAbsoluteError value on hold-out data: 0.07824745029211044
Epoch: 15
Loss on hold-out set: 0.05377371393536266
MeanAbsoluteError value on hold-out data: 0.21035981178283691
```

```
Epoch: 16

Loss on hold-out set: 0.016745270818079774
MeanAbsoluteError value on hold-out data: 0.10320351272821426
Epoch: 17
Loss on hold-out set: 0.0896818500600363
MeanAbsoluteError value on hold-out data: 0.28097543120384216
Epoch: 18

Loss on hold-out set: 0.01868390473292062
MeanAbsoluteError value on hold-out data: 0.11737767606973648
Epoch: 19
Loss on hold-out set: 0.00922784916321306
MeanAbsoluteError value on hold-out data: 0.070852130651474
Epoch: 20
Loss on hold-out set: 0.011125576682388783
MeanAbsoluteError value on hold-out data: 0.08753638714551926
Epoch: 21

Loss on hold-out set: 0.01159667528822626
MeanAbsoluteError value on hold-out data: 0.08693484961986542
Epoch: 22
Loss on hold-out set: 0.015987936260276718
MeanAbsoluteError value on hold-out data: 0.10710609704256058
Epoch: 23
Loss on hold-out set: 0.020545418521291332
MeanAbsoluteError value on hold-out data: 0.12472298741340637
Epoch: 24
Loss on hold-out set: 0.05574264161680874
MeanAbsoluteError value on hold-out data: 0.21756611764431
Epoch: 25
Loss on hold-out set: 0.006078766677283535
MeanAbsoluteError value on hold-out data: 0.05770277604460716
Epoch: 26
Loss on hold-out set: 0.018360681537734836
MeanAbsoluteError value on hold-out data: 0.1193782165646553
Epoch: 27
Loss on hold-out set: 0.018473200254926558
MeanAbsoluteError value on hold-out data: 0.11486109346151352
Epoch: 28
Loss on hold-out set: 0.029718518257141113
MeanAbsoluteError value on hold-out data: 0.15800529718399048
```

```
Epoch: 29
Loss on hold-out set: 0.026331474416350063
MeanAbsoluteError value on hold-out data: 0.14762228727340698
Epoch: 30
Loss on hold-out set: 0.006450050400177899
MeanAbsoluteError value on hold-out data: 0.055831726640462875
Epoch: 31
Loss on hold-out set: 0.012952242977917194
MeanAbsoluteError value on hold-out data: 0.09367728233337402
Epoch: 32
Loss on hold-out set: 0.01421187602375683
MeanAbsoluteError value on hold-out data: 0.09401413798332214
Epoch: 33
Loss on hold-out set: 0.02041859934596639
MeanAbsoluteError value on hold-out data: 0.12841658294200897
Epoch: 34
Loss on hold-out set: 0.028058809767428198
MeanAbsoluteError value on hold-out data: 0.15378259122371674
Epoch: 35
Loss on hold-out set: 0.020633452866030366
MeanAbsoluteError value on hold-out data: 0.126885324716568
Epoch: 36

Loss on hold-out set: 0.050084852270389855
MeanAbsoluteError value on hold-out data: 0.2051909863948822
Epoch: 37
Loss on hold-out set: 0.023863766146333593
MeanAbsoluteError value on hold-out data: 0.14195218682289124
Epoch: 38

Loss on hold-out set: 0.004018373333996064
MeanAbsoluteError value on hold-out data: 0.049913786351680756
Epoch: 39
Loss on hold-out set: 0.007082185732494844
MeanAbsoluteError value on hold-out data: 0.06283550709486008
Epoch: 40
Loss on hold-out set: 0.006859898383386041
MeanAbsoluteError value on hold-out data: 0.0695873573422432
Epoch: 41

Loss on hold-out set: 0.05092171363924679
MeanAbsoluteError value on hold-out data: 0.21428008377552032
```

```
Epoch: 42
Loss on hold-out set: 0.01135926267230197
MeanAbsoluteError value on hold-out data: 0.08848273754119873
Epoch: 43
Loss on hold-out set: 0.003690724303994916
MeanAbsoluteError value on hold-out data: 0.04551507532596588
Epoch: 44
Loss on hold-out set: 0.046646705975658016
MeanAbsoluteError value on hold-out data: 0.20521807670593262
Epoch: 45
Loss on hold-out set: 0.010258822432278018
MeanAbsoluteError value on hold-out data: 0.08140717446804047
Epoch: 46
Loss on hold-out set: 0.025946613009038725
MeanAbsoluteError value on hold-out data: 0.14790713787078857
Epoch: 47
Loss on hold-out set: 0.024525919929146767
MeanAbsoluteError value on hold-out data: 0.14000001549720764
Epoch: 48
Loss on hold-out set: 0.013087617380446509
MeanAbsoluteError value on hold-out data: 0.09549346566200256
Epoch: 49
Loss on hold-out set: 0.007352411673453294
MeanAbsoluteError value on hold-out data: 0.06612381339073181
Epoch: 50
Loss on hold-out set: 0.014710819765337203
MeanAbsoluteError value on hold-out data: 0.10902388393878937
Epoch: 51
Loss on hold-out set: 0.004037088579743316
MeanAbsoluteError value on hold-out data: 0.045202966779470444
Epoch: 52
Loss on hold-out set: 0.00747766009973068
MeanAbsoluteError value on hold-out data: 0.07029120624065399
Epoch: 53
Loss on hold-out set: 0.02345978101029208
MeanAbsoluteError value on hold-out data: 0.1365056037902832
Epoch: 54
Loss on hold-out set: 0.0053914708673561875
MeanAbsoluteError value on hold-out data: 0.055202942341566086
Epoch: 55
Loss on hold-out set: 0.013419732377913437
MeanAbsoluteError value on hold-out data: 0.09904542565345764
Epoch: 56
```

```
Loss on hold-out set: 0.02844361490324924
MeanAbsoluteError value on hold-out data: 0.14912648499011993
Epoch: 57
Loss on hold-out set: 0.01525346969107264
MeanAbsoluteError value on hold-out data: 0.10432848334312439
Epoch: 58

Loss on hold-out set: 0.014284911516465638
MeanAbsoluteError value on hold-out data: 0.10663095861673355
Epoch: 59
Loss on hold-out set: 0.0072381028684934505
MeanAbsoluteError value on hold-out data: 0.06538242846727371
Epoch: 60
Loss on hold-out set: 0.015472317212506345
MeanAbsoluteError value on hold-out data: 0.10494329780340195
Epoch: 61

Loss on hold-out set: 0.023168749813186496
MeanAbsoluteError value on hold-out data: 0.1328827440738678
Epoch: 62
Loss on hold-out set: 0.003292381680742102
MeanAbsoluteError value on hold-out data: 0.04080411419272423
Epoch: 63
Loss on hold-out set: 0.0075954322360063855
MeanAbsoluteError value on hold-out data: 0.07074116915464401
Epoch: 64
Loss on hold-out set: 0.032329293556119264
MeanAbsoluteError value on hold-out data: 0.17114335298538208
Epoch: 65
Loss on hold-out set: 0.003155405026566433
MeanAbsoluteError value on hold-out data: 0.040826208889484406
Epoch: 66
Loss on hold-out set: 0.004049922348808889
MeanAbsoluteError value on hold-out data: 0.04829060286283493
Epoch: 67
Loss on hold-out set: 0.005929685577652172
MeanAbsoluteError value on hold-out data: 0.06230416148900986
Epoch: 68
Loss on hold-out set: 0.018948899434977455
MeanAbsoluteError value on hold-out data: 0.1254827082157135
Epoch: 69
Loss on hold-out set: 0.01132467234703271
```

```
MeanAbsoluteError value on hold-out data: 0.09557067602872849
Epoch: 70
Loss on hold-out set: 0.005161224496795943
MeanAbsoluteError value on hold-out data: 0.055362071841955185
Epoch: 71
Loss on hold-out set: 0.01758174245294772
MeanAbsoluteError value on hold-out data: 0.11888892948627472
Epoch: 72
Loss on hold-out set: 0.01753748580813408
MeanAbsoluteError value on hold-out data: 0.1185716912150383
Epoch: 73
Loss on hold-out set: 0.02262055089599208
MeanAbsoluteError value on hold-out data: 0.1418294757604599
Epoch: 74
Loss on hold-out set: 0.010096079130706034
MeanAbsoluteError value on hold-out data: 0.08898121863603592
Epoch: 75
Loss on hold-out set: 0.0208986338816191
MeanAbsoluteError value on hold-out data: 0.12972436845302582
Epoch: 76

Loss on hold-out set: 0.02329032544634844
MeanAbsoluteError value on hold-out data: 0.14005202054977417
Epoch: 77
Loss on hold-out set: 0.015878652614590368
MeanAbsoluteError value on hold-out data: 0.11136429756879807
Epoch: 78

Loss on hold-out set: 0.017252925832412745
MeanAbsoluteError value on hold-out data: 0.11478591710329056
Epoch: 79
Loss on hold-out set: 0.005269261800046814
MeanAbsoluteError value on hold-out data: 0.056378353387117386
Epoch: 80
Loss on hold-out set: 0.007649140015832688
MeanAbsoluteError value on hold-out data: 0.07597532123327255
Epoch: 81

Loss on hold-out set: 0.012805612022547345
MeanAbsoluteError value on hold-out data: 0.09863268584012985
Epoch: 82
Loss on hold-out set: 0.02006369814472763
```

```
MeanAbsoluteError value on hold-out data: 0.12654262781143188
Epoch: 83
Loss on hold-out set: 0.0031761517166160047
MeanAbsoluteError value on hold-out data: 0.041711367666721344
Epoch: 84
Loss on hold-out set: 0.016973078152851054
MeanAbsoluteError value on hold-out data: 0.10918568819761276
Epoch: 85
Loss on hold-out set: 0.011311387349116174
MeanAbsoluteError value on hold-out data: 0.09128645062446594
Epoch: 86
Loss on hold-out set: 0.019412015956875524
MeanAbsoluteError value on hold-out data: 0.12445447593927383
Epoch: 87
Loss on hold-out set: 0.02446592407987306
MeanAbsoluteError value on hold-out data: 0.1390930414199829
Epoch: 88
Loss on hold-out set: 0.003358811967221922
MeanAbsoluteError value on hold-out data: 0.03933732956647873
Epoch: 89
Loss on hold-out set: 0.016769461186700745
MeanAbsoluteError value on hold-out data: 0.1081303060054779
Epoch: 90
Loss on hold-out set: 0.013396066319393484
MeanAbsoluteError value on hold-out data: 0.09915189445018768
Epoch: 91
Loss on hold-out set: 0.007524091039637202
MeanAbsoluteError value on hold-out data: 0.07332272082567215
Epoch: 92
Loss on hold-out set: 0.008685216503707986
MeanAbsoluteError value on hold-out data: 0.0696951150894165
Epoch: 93
Loss on hold-out set: 0.020163642634686667
MeanAbsoluteError value on hold-out data: 0.12699933350086212
Epoch: 94
Loss on hold-out set: 0.018069875426590443
MeanAbsoluteError value on hold-out data: 0.11476275324821472
Epoch: 95
Loss on hold-out set: 0.023898591140383167
MeanAbsoluteError value on hold-out data: 0.14445029199123383
Epoch: 96

Loss on hold-out set: 0.008744145657769159
```

```
MeanAbsoluteError value on hold-out data: 0.07054957747459412
Epoch: 97
Loss on hold-out set: 0.011238312054621545
MeanAbsoluteError value on hold-out data: 0.09159389138221741
Early stopping at epoch 96
Returned to Spot: Validation loss: 0.011238312054621545
----------------------------------------------

config: {'_L_in': 10, '_L_out': 1, 'l1': 128, 'dropout_prob': 0.8582565260508446, 'lr_mult':
Epoch: 1

Loss on hold-out set: 0.07460551447545488
MeanAbsoluteError value on hold-out data: 0.21916714310646057
Epoch: 2
Loss on hold-out set: 0.04845342978156016
MeanAbsoluteError value on hold-out data: 0.1726057082414627
Epoch: 3

Loss on hold-out set: 0.045284138100420 63
MeanAbsoluteError value on hold-out data: 0.17003852128982544
Epoch: 4

Loss on hold-out set: 0.03860494334216734
MeanAbsoluteError value on hold-out data: 0.1530163586139679
Epoch: 5
Loss on hold-out set: 0.039623044124940256
MeanAbsoluteError value on hold-out data: 0.15650835633277893
Epoch: 6

Loss on hold-out set: 0.0380598059950474
MeanAbsoluteError value on hold-out data: 0.15595950186252594
Epoch: 7

Loss on hold-out set: 0.034733510608333136
MeanAbsoluteError value on hold-out data: 0.14924226701259613
Epoch: 8
Loss on hold-out set: 0.03399781122192508
MeanAbsoluteError value on hold-out data: 0.14692363142967224
Epoch: 9
```

```
Loss on hold-out set: 0.03435655223710152
MeanAbsoluteError value on hold-out data: 0.1472965031862259
Epoch: 10

Loss on hold-out set: 0.029644601897380198
MeanAbsoluteError value on hold-out data: 0.13628540933132172
Epoch: 11
Loss on hold-out set: 0.032122793882347955
MeanAbsoluteError value on hold-out data: 0.14440323412418365
Epoch: 12

Loss on hold-out set: 0.03289826862300591
MeanAbsoluteError value on hold-out data: 0.1444675624370575
Epoch: 13

Loss on hold-out set: 0.0301380449586577
MeanAbsoluteError value on hold-out data: 0.13895730674266815
Epoch: 14
Loss on hold-out set: 0.02957010092776424
MeanAbsoluteError value on hold-out data: 0.13654182851314545
Epoch: 15

Loss on hold-out set: 0.03040539940780339
MeanAbsoluteError value on hold-out data: 0.13784785568714142
Epoch: 16

Loss on hold-out set: 0.030766337599488908
MeanAbsoluteError value on hold-out data: 0.13922980427742004
Epoch: 17
Loss on hold-out set: 0.030517923798155
MeanAbsoluteError value on hold-out data: 0.13872362673282623
Epoch: 18

Loss on hold-out set: 0.029315110345875535
MeanAbsoluteError value on hold-out data: 0.13540653884410858
Epoch: 19

Loss on hold-out set: 0.0306606151706607
MeanAbsoluteError value on hold-out data: 0.13810956478118896
Epoch: 20
```

```
Loss on hold-out set: 0.03099537961856792
MeanAbsoluteError value on hold-out data: 0.14035049080848694
Epoch: 21

Loss on hold-out set: 0.028348304592527712
MeanAbsoluteError value on hold-out data: 0.13298945128917694
Epoch: 22

Loss on hold-out set: 0.031248044962703714
MeanAbsoluteError value on hold-out data: 0.13999059796333313
Epoch: 23
Loss on hold-out set: 0.030543726594963422
MeanAbsoluteError value on hold-out data: 0.1384928673505783
Epoch: 24

Loss on hold-out set: 0.030410953383834566
MeanAbsoluteError value on hold-out data: 0.13503092527389526
Epoch: 25

Loss on hold-out set: 0.030647423857832715
MeanAbsoluteError value on hold-out data: 0.13839219510555267
Epoch: 26
Loss on hold-out set: 0.030469873869127088
MeanAbsoluteError value on hold-out data: 0.13748352229595184
Epoch: 27

Loss on hold-out set: 0.029042095525073818
MeanAbsoluteError value on hold-out data: 0.13321518898010254
Epoch: 28

Loss on hold-out set: 0.03008719596483085
MeanAbsoluteError value on hold-out data: 0.13974428176879883
Epoch: 29
Loss on hold-out set: 0.029323486530435428
MeanAbsoluteError value on hold-out data: 0.13266955316066742
Epoch: 30

Loss on hold-out set: 0.029560660576583662
MeanAbsoluteError value on hold-out data: 0.13576051592826843
Epoch: 31
```

```
Loss on hold-out set: 0.029196623127839605
MeanAbsoluteError value on hold-out data: 0.1347980946302414
Epoch: 32
Loss on hold-out set: 0.029129984782872875
MeanAbsoluteError value on hold-out data: 0.13559606671333313
Epoch: 33

Loss on hold-out set: 0.02805399642429014
MeanAbsoluteError value on hold-out data: 0.13097281754016876
Epoch: 34

Loss on hold-out set: 0.02895700640947325
MeanAbsoluteError value on hold-out data: 0.13364779949188232
Epoch: 35
Loss on hold-out set: 0.03170935381286351
MeanAbsoluteError value on hold-out data: 0.13986912369728088
Epoch: 36

Loss on hold-out set: 0.02838603938105128
MeanAbsoluteError value on hold-out data: 0.13371603190898895
Epoch: 37

Loss on hold-out set: 0.02875671380267401
MeanAbsoluteError value on hold-out data: 0.13641943037509918
Epoch: 38
Loss on hold-out set: 0.028764596328061696
MeanAbsoluteError value on hold-out data: 0.13572029769420624
Epoch: 39

Loss on hold-out set: 0.029613282360660378
MeanAbsoluteError value on hold-out data: 0.13712219893932343
Epoch: 40

Loss on hold-out set: 0.029452227050593745
MeanAbsoluteError value on hold-out data: 0.1347862184047699
Epoch: 41
Loss on hold-out set: 0.03022418825729498
MeanAbsoluteError value on hold-out data: 0.13648201525211334
Epoch: 42
```

```
Loss on hold-out set: 0.029160446842724924
MeanAbsoluteError value on hold-out data: 0.1358913779258728
Epoch: 43

Loss on hold-out set: 0.02801428955135634
MeanAbsoluteError value on hold-out data: 0.1350402534008026
Epoch: 44
Loss on hold-out set: 0.029085180403781122
MeanAbsoluteError value on hold-out data: 0.1362590789794922
Epoch: 45

Loss on hold-out set: 0.02844401635481821
MeanAbsoluteError value on hold-out data: 0.13416031002998352
Epoch: 46

Loss on hold-out set: 0.029504119433258893
MeanAbsoluteError value on hold-out data: 0.13547244668006897
Epoch: 47
Loss on hold-out set: 0.029546819411868153
MeanAbsoluteError value on hold-out data: 0.1362309604883194
Epoch: 48

Loss on hold-out set: 0.02846307303996582
MeanAbsoluteError value on hold-out data: 0.13425816595554352
Epoch: 49

Loss on hold-out set: 0.02883469177245085
MeanAbsoluteError value on hold-out data: 0.1350647360086441
Epoch: 50
Loss on hold-out set: 0.028548288912376544
MeanAbsoluteError value on hold-out data: 0.13124127686023712
Epoch: 51

Loss on hold-out set: 0.03059611499462335
MeanAbsoluteError value on hold-out data: 0.1401008665561676
Epoch: 52

Loss on hold-out set: 0.029523735919453127
MeanAbsoluteError value on hold-out data: 0.13544313609600067
Epoch: 53
```

```
Loss on hold-out set: 0.02809460189550009
MeanAbsoluteError value on hold-out data: 0.13190878927707672
Epoch: 54

Loss on hold-out set: 0.029810951554051522
MeanAbsoluteError value on hold-out data: 0.13814663887023926
Epoch: 55

Loss on hold-out set: 0.027499321187594128
MeanAbsoluteError value on hold-out data: 0.12956348061561584
Epoch: 56
Loss on hold-out set: 0.028586047973367387
MeanAbsoluteError value on hold-out data: 0.1340431421995163
Epoch: 57

Loss on hold-out set: 0.027824619300857497
MeanAbsoluteError value on hold-out data: 0.13213808834552765
Epoch: 58

Loss on hold-out set: 0.029107544083623604
MeanAbsoluteError value on hold-out data: 0.1358097493648529
Epoch: 59
Loss on hold-out set: 0.028597593398105043
MeanAbsoluteError value on hold-out data: 0.1339723765850067
Epoch: 60

Loss on hold-out set: 0.029106148108839987
MeanAbsoluteError value on hold-out data: 0.13701815903186798
Epoch: 61

Loss on hold-out set: 0.028245920081826626
MeanAbsoluteError value on hold-out data: 0.13375931978225708
Epoch: 62
Loss on hold-out set: 0.028352178178053387
MeanAbsoluteError value on hold-out data: 0.13544680178165436
Epoch: 63

Loss on hold-out set: 0.029212195543174554
MeanAbsoluteError value on hold-out data: 0.13469089567661285
Epoch: 64
```

```
Loss on hold-out set: 0.02960938351289466
MeanAbsoluteError value on hold-out data: 0.13598334789276123
Epoch: 65
Loss on hold-out set: 0.028596080409364125
MeanAbsoluteError value on hold-out data: 0.1321115642786026
Epoch: 66

Loss on hold-out set: 0.028770625854716247
MeanAbsoluteError value on hold-out data: 0.13600006699562073
Epoch: 67

Loss on hold-out set: 0.028879080189508386
MeanAbsoluteError value on hold-out data: 0.1347190886735916
Epoch: 68
Loss on hold-out set: 0.028323871204144476
MeanAbsoluteError value on hold-out data: 0.13463090360164642
Epoch: 69

Loss on hold-out set: 0.02806454904314402
MeanAbsoluteError value on hold-out data: 0.13476480543613434
Epoch: 70

Loss on hold-out set: 0.02809817267921365
MeanAbsoluteError value on hold-out data: 0.13377925753593445
Epoch: 71
Loss on hold-out set: 0.02902982859639451
MeanAbsoluteError value on hold-out data: 0.13603319227695465
Epoch: 72

Loss on hold-out set: 0.02895519209346579
MeanAbsoluteError value on hold-out data: 0.13559916615486145
Epoch: 73

Loss on hold-out set: 0.02881142606609501
MeanAbsoluteError value on hold-out data: 0.13437466323375702
Epoch: 74
Loss on hold-out set: 0.027948005942744204
MeanAbsoluteError value on hold-out data: 0.13125544786453247
Epoch: 75
```

```
Loss on hold-out set: 0.028573698152298068
MeanAbsoluteError value on hold-out data: 0.13289403915405273
Epoch: 76

Loss on hold-out set: 0.029041454388958908
MeanAbsoluteError value on hold-out data: 0.1352778673171997
Epoch: 77
Loss on hold-out set: 0.027819235356182616
MeanAbsoluteError value on hold-out data: 0.13428588211536407
Epoch: 78

Loss on hold-out set: 0.028804607179405747
MeanAbsoluteError value on hold-out data: 0.1363428682088852
Epoch: 79

Loss on hold-out set: 0.028197459614220863
MeanAbsoluteError value on hold-out data: 0.13332651555538177
Epoch: 80
Loss on hold-out set: 0.02851364145768457
MeanAbsoluteError value on hold-out data: 0.13397546112537384
Epoch: 81

Loss on hold-out set: 0.027627070480181527
MeanAbsoluteError value on hold-out data: 0.13203167915344238
Epoch: 82

Loss on hold-out set: 0.027731516842201622
MeanAbsoluteError value on hold-out data: 0.13279828429222107
Epoch: 83
Loss on hold-out set: 0.02922473897963452
MeanAbsoluteError value on hold-out data: 0.13676296174526215
Epoch: 84

Loss on hold-out set: 0.028082093154080213
MeanAbsoluteError value on hold-out data: 0.13414303958415985
Epoch: 85

Loss on hold-out set: 0.030845022559612214
MeanAbsoluteError value on hold-out data: 0.14063270390033722
Epoch: 86
```

```
Loss on hold-out set: 0.028763302713923623
MeanAbsoluteError value on hold-out data: 0.13558954000473022
Epoch: 87

Loss on hold-out set: 0.02761333924155527
MeanAbsoluteError value on hold-out data: 0.1311931163072586
Epoch: 88

Loss on hold-out set: 0.028904220483867295
MeanAbsoluteError value on hold-out data: 0.13580116629600525
Epoch: 89
Loss on hold-out set: 0.028772555434067423
MeanAbsoluteError value on hold-out data: 0.13476090133190155
Epoch: 90

Loss on hold-out set: 0.029205785158846993
MeanAbsoluteError value on hold-out data: 0.13580204546451569
Epoch: 91

Loss on hold-out set: 0.026623526407856844
MeanAbsoluteError value on hold-out data: 0.12957142293453217
Epoch: 92
Loss on hold-out set: 0.027142648379832886
MeanAbsoluteError value on hold-out data: 0.1326054334640503
Epoch: 93

Loss on hold-out set: 0.027648536673283767
MeanAbsoluteError value on hold-out data: 0.13001784682273865
Epoch: 94

Loss on hold-out set: 0.029015168557913664
MeanAbsoluteError value on hold-out data: 0.13551534712314606
Epoch: 95
Loss on hold-out set: 0.028521273118870642
MeanAbsoluteError value on hold-out data: 0.13097716867923737
Epoch: 96

Loss on hold-out set: 0.029335630939074993
MeanAbsoluteError value on hold-out data: 0.13776704668998718
Epoch: 97
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```
Loss on hold-out set: 0.027158193954722557
MeanAbsoluteError value on hold-out data: 0.1319052129983902
Epoch: 98
Loss on hold-out set: 0.0272496200009482
MeanAbsoluteError value on hold-out data: 0.1317027360200882
Epoch: 99

Loss on hold-out set: 0.0289358184612441
MeanAbsoluteError value on hold-out data: 0.1338353306055069
Epoch: 100

Loss on hold-out set: 0.026784253465593794
MeanAbsoluteError value on hold-out data: 0.13001742959022522
Epoch: 101
Loss on hold-out set: 0.026424901594885645
MeanAbsoluteError value on hold-out data: 0.13005320727825165
Epoch: 102

Loss on hold-out set: 0.02907431518678398
MeanAbsoluteError value on hold-out data: 0.13634803891181946
Epoch: 103

Loss on hold-out set: 0.03009536879369989
MeanAbsoluteError value on hold-out data: 0.13788406550884247
Epoch: 104
Loss on hold-out set: 0.026720319758375504
MeanAbsoluteError value on hold-out data: 0.12965235114097595
Epoch: 105

Loss on hold-out set: 0.02919840244789763
MeanAbsoluteError value on hold-out data: 0.13708142936229706
Epoch: 106

Loss on hold-out set: 0.02915118039774825
MeanAbsoluteError value on hold-out data: 0.13603664934635162
Epoch: 107
Loss on hold-out set: 0.02813156994085148
MeanAbsoluteError value on hold-out data: 0.13416697084903717
Epoch: 108
```

```
Loss on hold-out set: 0.028323435761461346
MeanAbsoluteError value on hold-out data: 0.1354917585849762
Epoch: 109

Loss on hold-out set: 0.02818496813221524
MeanAbsoluteError value on hold-out data: 0.13284580409526825
Epoch: 110
Loss on hold-out set: 0.02740336038276534
MeanAbsoluteError value on hold-out data: 0.12996912002563477
Epoch: 111

Loss on hold-out set: 0.025928453522958535
MeanAbsoluteError value on hold-out data: 0.1289086937904358
Epoch: 112

Loss on hold-out set: 0.027779814610645794
MeanAbsoluteError value on hold-out data: 0.1328590363264084
Epoch: 113
Loss on hold-out set: 0.02762052678721375
MeanAbsoluteError value on hold-out data: 0.13380880653858185
Epoch: 114

Loss on hold-out set: 0.026701207683294873
MeanAbsoluteError value on hold-out data: 0.12854591012001038
Epoch: 115

Loss on hold-out set: 0.0279673808813277
MeanAbsoluteError value on hold-out data: 0.132940873503685
Epoch: 116
Loss on hold-out set: 0.026962467364440575
MeanAbsoluteError value on hold-out data: 0.12788060307502747
Epoch: 117

Loss on hold-out set: 0.026664690581746982
MeanAbsoluteError value on hold-out data: 0.12995721399784088
Epoch: 118

Loss on hold-out set: 0.027620809190169286
MeanAbsoluteError value on hold-out data: 0.13269765675067902
Epoch: 119
```

```
Loss on hold-out set: 0.029389905703089123
MeanAbsoluteError value on hold-out data: 0.13590899109840393
Epoch: 120

Loss on hold-out set: 0.027949779022019356
MeanAbsoluteError value on hold-out data: 0.1322057843208313
Epoch: 121

Loss on hold-out set: 0.027423639992193785
MeanAbsoluteError value on hold-out data: 0.13139261305332184
Epoch: 122
Loss on hold-out set: 0.026580427469743883
MeanAbsoluteError value on hold-out data: 0.1276712566614151
Epoch: 123

Loss on hold-out set: 0.028373535144686077
MeanAbsoluteError value on hold-out data: 0.13371406495571136
Epoch: 124

Loss on hold-out set: 0.02923442456581294
MeanAbsoluteError value on hold-out data: 0.13695849478244781
Epoch: 125
Loss on hold-out set: 0.0267853356940365
MeanAbsoluteError value on hold-out data: 0.12951572239398956
Epoch: 126

Loss on hold-out set: 0.02832558483273412
MeanAbsoluteError value on hold-out data: 0.13481631875038147
Epoch: 127

Loss on hold-out set: 0.02752840881727631
MeanAbsoluteError value on hold-out data: 0.13189640641212463
Epoch: 128
Loss on hold-out set: 0.02634231375025896
MeanAbsoluteError value on hold-out data: 0.1276904195547104
Epoch: 129

Loss on hold-out set: 0.028825410754652694
MeanAbsoluteError value on hold-out data: 0.13820546865463257
Epoch: 130
```

```
Loss on hold-out set: 0.029418292914924676
MeanAbsoluteError value on hold-out data: 0.1379919946193695
Epoch: 131
Loss on hold-out set: 0.026282870175297526
MeanAbsoluteError value on hold-out data: 0.12872891128063202
Epoch: 132

Loss on hold-out set: 0.02644502396035629
MeanAbsoluteError value on hold-out data: 0.1312778741121292
Epoch: 133

Loss on hold-out set: 0.02779166980467077
MeanAbsoluteError value on hold-out data: 0.12758614122867584
Epoch: 134
Loss on hold-out set: 0.027145518529675124
MeanAbsoluteError value on hold-out data: 0.1309465765953064
Epoch: 135

Loss on hold-out set: 0.027419741975027136
MeanAbsoluteError value on hold-out data: 0.1297135055065155
Epoch: 136

Loss on hold-out set: 0.025774691754874464
MeanAbsoluteError value on hold-out data: 0.1281321495771408
Epoch: 137
Loss on hold-out set: 0.02737753289715329
MeanAbsoluteError value on hold-out data: 0.13537272810935974
Epoch: 138

Loss on hold-out set: 0.026304647682748813
MeanAbsoluteError value on hold-out data: 0.1295831799507141
Epoch: 139

Loss on hold-out set: 0.02613725979802742
MeanAbsoluteError value on hold-out data: 0.12911783158779144
Epoch: 140
Loss on hold-out set: 0.02592486862752897
MeanAbsoluteError value on hold-out data: 0.12647701799869537
Epoch: 141
```

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Loss on hold-out set: 0.028277623148363393
MeanAbsoluteError value on hold-out data: 0.13501615822315216
Epoch: 142

Loss on hold-out set: 0.027671734947119452
MeanAbsoluteError value on hold-out data: 0.13302358984947205
Epoch: 143
Loss on hold-out set: 0.02823821618842582
MeanAbsoluteError value on hold-out data: 0.13394184410572052
Epoch: 144

Loss on hold-out set: 0.02785873716638889
MeanAbsoluteError value on hold-out data: 0.13548727333545685
Epoch: 145

Loss on hold-out set: 0.027204374478994094
MeanAbsoluteError value on hold-out data: 0.1313079446554184
Epoch: 146
Loss on hold-out set: 0.027910129851079546
MeanAbsoluteError value on hold-out data: 0.13304169476032257
Epoch: 147

Loss on hold-out set: 0.029311307997850235
MeanAbsoluteError value on hold-out data: 0.13557523488998413
Epoch: 148

Loss on hold-out set: 0.02681643718931203
MeanAbsoluteError value on hold-out data: 0.13079267740249634
Epoch: 149
Loss on hold-out set: 0.027484728677081877
MeanAbsoluteError value on hold-out data: 0.13166336715221405
Epoch: 150

Loss on hold-out set: 0.02867760328629326
MeanAbsoluteError value on hold-out data: 0.135649636387825
Epoch: 151

Loss on hold-out set: 0.02599391033843858
MeanAbsoluteError value on hold-out data: 0.12758855521678925
Epoch: 152
```

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Loss on hold-out set: 0.026479642774696308
MeanAbsoluteError value on hold-out data: 0.12867332994937897
Epoch: 153

Loss on hold-out set: 0.029475968643285645
MeanAbsoluteError value on hold-out data: 0.1381320059299469
Epoch: 154

Loss on hold-out set: 0.026230226158319662
MeanAbsoluteError value on hold-out data: 0.130685955286026
Epoch: 155
Loss on hold-out set: 0.026640283934539183
MeanAbsoluteError value on hold-out data: 0.12990529835224152
Epoch: 156

Loss on hold-out set: 0.025685831833300955
MeanAbsoluteError value on hold-out data: 0.12830814719200134
Epoch: 157

Loss on hold-out set: 0.02481762117781424
MeanAbsoluteError value on hold-out data: 0.12599602341651917
Epoch: 158
Loss on hold-out set: 0.02589138012164767
MeanAbsoluteError value on hold-out data: 0.12741750478744507
Epoch: 159

Loss on hold-out set: 0.025908316966282048
MeanAbsoluteError value on hold-out data: 0.12722285091876984
Epoch: 160

Loss on hold-out set: 0.02523860023987557
MeanAbsoluteError value on hold-out data: 0.12438566982746124
Epoch: 161
Loss on hold-out set: 0.026559137440435733
MeanAbsoluteError value on hold-out data: 0.12956039607524872
Epoch: 162

Loss on hold-out set: 0.026362853783066385
MeanAbsoluteError value on hold-out data: 0.1305115818977356
Epoch: 163
```

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Loss on hold-out set: 0.027273348169079933
MeanAbsoluteError value on hold-out data: 0.13499100506305695
Epoch: 164
Loss on hold-out set: 0.026650395404612937
MeanAbsoluteError value on hold-out data: 0.1289195418357849
Epoch: 165

Loss on hold-out set: 0.026478925001186628
MeanAbsoluteError value on hold-out data: 0.1321224570274353
Epoch: 166

Loss on hold-out set: 0.024664807236707324
MeanAbsoluteError value on hold-out data: 0.12165489047765732
Epoch: 167
Loss on hold-out set: 0.026497258583646422
MeanAbsoluteError value on hold-out data: 0.1321207731962204
Epoch: 168

Loss on hold-out set: 0.026441242949889178
MeanAbsoluteError value on hold-out data: 0.1290658861398697
Epoch: 169

Loss on hold-out set: 0.026164996156294366
MeanAbsoluteError value on hold-out data: 0.12737210094928741
Epoch: 170
Loss on hold-out set: 0.027454931618606983
MeanAbsoluteError value on hold-out data: 0.132094606757164
Epoch: 171

Loss on hold-out set: 0.026060759839213764
MeanAbsoluteError value on hold-out data: 0.12864065170288086
Epoch: 172

Loss on hold-out set: 0.026376453144475818
MeanAbsoluteError value on hold-out data: 0.12930618226528168
Epoch: 173
Loss on hold-out set: 0.02612550221039176
MeanAbsoluteError value on hold-out data: 0.12694144248962402
Epoch: 174
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Loss on hold-out set: 0.027598101719728825
MeanAbsoluteError value on hold-out data: 0.12961435317993164
Epoch: 175

Loss on hold-out set: 0.024608926007725435
MeanAbsoluteError value on hold-out data: 0.12411177158355713
Epoch: 176
Loss on hold-out set: 0.027055449349378858
MeanAbsoluteError value on hold-out data: 0.1289374977350235
Epoch: 177

Loss on hold-out set: 0.026591243838871983
MeanAbsoluteError value on hold-out data: 0.129530668258667
Epoch: 178

Loss on hold-out set: 0.02711151569082934
MeanAbsoluteError value on hold-out data: 0.1330578625202179
Epoch: 179
Loss on hold-out set: 0.02698407427824956
MeanAbsoluteError value on hold-out data: 0.13132187724113464
Epoch: 180

Loss on hold-out set: 0.02772967214132071
MeanAbsoluteError value on hold-out data: 0.1311216503381729
Epoch: 181

Loss on hold-out set: 0.026625443200852413
MeanAbsoluteError value on hold-out data: 0.1286877542734146
Epoch: 182
Loss on hold-out set: 0.026739202562542533
MeanAbsoluteError value on hold-out data: 0.12961453199386597
Epoch: 183

Loss on hold-out set: 0.025177924669183463
MeanAbsoluteError value on hold-out data: 0.12646843492984772
Epoch: 184

Loss on hold-out set: 0.025688670550686462
MeanAbsoluteError value on hold-out data: 0.12727798521518707
Epoch: 185
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Loss on hold-out set: 0.025861047178768786
MeanAbsoluteError value on hold-out data: 0.12638480961322784
Epoch: 186

Loss on hold-out set: 0.02670882215461461
MeanAbsoluteError value on hold-out data: 0.13124394416809082
Epoch: 187

Loss on hold-out set: 0.026452588583924807
MeanAbsoluteError value on hold-out data: 0.12999427318572998
Epoch: 188
Loss on hold-out set: 0.025026678175636335
MeanAbsoluteError value on hold-out data: 0.1257525235414505
Epoch: 189

Loss on hold-out set: 0.025329601726455923
MeanAbsoluteError value on hold-out data: 0.12770375609397888
Epoch: 190

Loss on hold-out set: 0.026672993696605165
MeanAbsoluteError value on hold-out data: 0.12809568643569946
Epoch: 191
Loss on hold-out set: 0.025648900040541777
MeanAbsoluteError value on hold-out data: 0.12699781358242035
Epoch: 192

Loss on hold-out set: 0.027697763646719976
MeanAbsoluteError value on hold-out data: 0.13207422196865082
Epoch: 193

Loss on hold-out set: 0.02611198028239111
MeanAbsoluteError value on hold-out data: 0.12954485416412354
Epoch: 194
Loss on hold-out set: 0.025984151837183164
MeanAbsoluteError value on hold-out data: 0.12967701256275177
Epoch: 195

Loss on hold-out set: 0.025088627406997452
MeanAbsoluteError value on hold-out data: 0.12450049072504044
Epoch: 196
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Loss on hold-out set: 0.025454476225004328
MeanAbsoluteError value on hold-out data: 0.12580186128616333
Epoch: 197
Loss on hold-out set: 0.02607713525062233
MeanAbsoluteError value on hold-out data: 0.12825292348861694
Epoch: 198

Loss on hold-out set: 0.026246194688719696
MeanAbsoluteError value on hold-out data: 0.1270068883895874
Epoch: 199

Loss on hold-out set: 0.02578205714642536
MeanAbsoluteError value on hold-out data: 0.12760508060455322
Epoch: 200
Loss on hold-out set: 0.02367855557065923
MeanAbsoluteError value on hold-out data: 0.1238710880279541
Epoch: 201

Loss on hold-out set: 0.023425467773801452
MeanAbsoluteError value on hold-out data: 0.12095228582620621
Epoch: 202

Loss on hold-out set: 0.024386231138390335
MeanAbsoluteError value on hold-out data: 0.12702105939388275
Epoch: 203
Loss on hold-out set: 0.025483652357021734
MeanAbsoluteError value on hold-out data: 0.12606477737426758
Epoch: 204

Loss on hold-out set: 0.024303358140653774
MeanAbsoluteError value on hold-out data: 0.12336204200983047
Epoch: 205

Loss on hold-out set: 0.025805364308228794
MeanAbsoluteError value on hold-out data: 0.1287146806716919
Epoch: 206
Loss on hold-out set: 0.02569168472284218
MeanAbsoluteError value on hold-out data: 0.12871374189853668
Epoch: 207
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Loss on hold-out set: 0.0270089335636294
MeanAbsoluteError value on hold-out data: 0.13083289563655853
Epoch: 208

Loss on hold-out set: 0.025735596343705158
MeanAbsoluteError value on hold-out data: 0.129078209400177
Epoch: 209
Loss on hold-out set: 0.02565860353250173
MeanAbsoluteError value on hold-out data: 0.12878179550170898
Epoch: 210

Loss on hold-out set: 0.02727938257099595
MeanAbsoluteError value on hold-out data: 0.1324509233236313
Epoch: 211

Loss on hold-out set: 0.025311237797723152
MeanAbsoluteError value on hold-out data: 0.124679334461689
Epoch: 212
Loss on hold-out set: 0.025502633605889665
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Epoch: 213

Loss on hold-out set: 0.025852312160350267
MeanAbsoluteError value on hold-out data: 0.12865670025348663
Epoch: 214

Loss on hold-out set: 0.025907610955376487
MeanAbsoluteError value on hold-out data: 0.12762120366096497
Epoch: 215
Loss on hold-out set: 0.02655923264857847
MeanAbsoluteError value on hold-out data: 0.1286872774362564
Epoch: 216

Loss on hold-out set: 0.022203312603523956
MeanAbsoluteError value on hold-out data: 0.11939553916454315
Epoch: 217

Loss on hold-out set: 0.026803047200822525
MeanAbsoluteError value on hold-out data: 0.1301177442073822
Epoch: 218
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Loss on hold-out set: 0.025525871049030684
MeanAbsoluteError value on hold-out data: 0.12988018989562988
Epoch: 219

Loss on hold-out set: 0.02441998707848446
MeanAbsoluteError value on hold-out data: 0.1225811168551445
Epoch: 220

Loss on hold-out set: 0.026593080403714945
MeanAbsoluteError value on hold-out data: 0.1292794942855835
Epoch: 221
Loss on hold-out set: 0.026060988902124032
MeanAbsoluteError value on hold-out data: 0.12874610722064972
Epoch: 222

Loss on hold-out set: 0.02390495709842071
MeanAbsoluteError value on hold-out data: 0.12305549532175064
Epoch: 223

Loss on hold-out set: 0.02461019481367354
MeanAbsoluteError value on hold-out data: 0.12473902106285095
Epoch: 224
Loss on hold-out set: 0.024706589754496234
MeanAbsoluteError value on hold-out data: 0.12450321018695831
Epoch: 225

Loss on hold-out set: 0.027290366081215326
MeanAbsoluteError value on hold-out data: 0.13121938705444336
Epoch: 226

Loss on hold-out set: 0.023191629815652655
MeanAbsoluteError value on hold-out data: 0.12011344730854034
Epoch: 227
Loss on hold-out set: 0.025307870406104483
MeanAbsoluteError value on hold-out data: 0.12788265943527222
Epoch: 228

Loss on hold-out set: 0.026422594752317917
MeanAbsoluteError value on hold-out data: 0.12871937453746796
Epoch: 229
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Loss on hold-out set: 0.02397596451537538
MeanAbsoluteError value on hold-out data: 0.12006393074989319
Epoch: 230
Loss on hold-out set: 0.025283489741123048
MeanAbsoluteError value on hold-out data: 0.12697331607341766
Epoch: 231

Loss on hold-out set: 0.022642780265202115
MeanAbsoluteError value on hold-out data: 0.12004467099905014
Epoch: 232

Loss on hold-out set: 0.0259697543704533
MeanAbsoluteError value on hold-out data: 0.1280602067708969
Epoch: 233
Loss on hold-out set: 0.024090759279206394
MeanAbsoluteError value on hold-out data: 0.12648572027683258
Epoch: 234

Loss on hold-out set: 0.02399674015265191
MeanAbsoluteError value on hold-out data: 0.12696366012096405
Epoch: 235

Loss on hold-out set: 0.023634535836123783
MeanAbsoluteError value on hold-out data: 0.12175711244344711
Epoch: 236
Loss on hold-out set: 0.02357756930194834
MeanAbsoluteError value on hold-out data: 0.12292338162660599
Epoch: 237

Loss on hold-out set: 0.025373133239396946
MeanAbsoluteError value on hold-out data: 0.125956729054451
Epoch: 238

Loss on hold-out set: 0.023172712157926677
MeanAbsoluteError value on hold-out data: 0.12224222719669342
Epoch: 239
Loss on hold-out set: 0.025043663585189887
MeanAbsoluteError value on hold-out data: 0.1260804533958435
Epoch: 240
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Loss on hold-out set: 0.025024670767500843
MeanAbsoluteError value on hold-out data: 0.12543068826198578
Epoch: 241

Loss on hold-out set: 0.024779301782652207
MeanAbsoluteError value on hold-out data: 0.12605200707912445
Epoch: 242
Loss on hold-out set: 0.02473065335356902
MeanAbsoluteError value on hold-out data: 0.12697656452655792
Epoch: 243

Loss on hold-out set: 0.02130171321313052
MeanAbsoluteError value on hold-out data: 0.11823774874210358
Epoch: 244

Loss on hold-out set: 0.025356916114954706
MeanAbsoluteError value on hold-out data: 0.12413010746240616
Epoch: 245
Loss on hold-out set: 0.023596137072696973
MeanAbsoluteError value on hold-out data: 0.12261282652616501
Epoch: 246

Loss on hold-out set: 0.02544939893753811
MeanAbsoluteError value on hold-out data: 0.12461842596530914
Epoch: 247

Loss on hold-out set: 0.0243752700338761
MeanAbsoluteError value on hold-out data: 0.12399563193321228
Epoch: 248
Loss on hold-out set: 0.023172395647125085
MeanAbsoluteError value on hold-out data: 0.12291992455720901
Epoch: 249

Loss on hold-out set: 0.02414042853556263
MeanAbsoluteError value on hold-out data: 0.12606558203697205
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Loss on hold-out set: 0.023205244134684715
MeanAbsoluteError value on hold-out data: 0.11865585297346115
Epoch: 251
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Loss on hold-out set: 0.02376201464612677
MeanAbsoluteError value on hold-out data: 0.11954574286937714
Epoch: 252

Loss on hold-out set: 0.023160580326463485
MeanAbsoluteError value on hold-out data: 0.11850564181804657
Epoch: 253

Loss on hold-out set: 0.02663478857090619
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Epoch: 254
Loss on hold-out set: 0.025066941487796916
MeanAbsoluteError value on hold-out data: 0.1257849484682083
Epoch: 255

Loss on hold-out set: 0.02402239606604174
MeanAbsoluteError value on hold-out data: 0.12531639635562897
Epoch: 256

Loss on hold-out set: 0.02587641408696072
MeanAbsoluteError value on hold-out data: 0.12790490686893463
Epoch: 257
Loss on hold-out set: 0.023714517477492335
MeanAbsoluteError value on hold-out data: 0.1218007430434227
Epoch: 258

Loss on hold-out set: 0.024003952460188886
MeanAbsoluteError value on hold-out data: 0.12391718477010727
Epoch: 259

Loss on hold-out set: 0.023691574283341954
MeanAbsoluteError value on hold-out data: 0.12141232937574387
Epoch: 260
Loss on hold-out set: 0.02579097559209913
MeanAbsoluteError value on hold-out data: 0.12742199003696442
Epoch: 261

Loss on hold-out set: 0.025269406127651262
MeanAbsoluteError value on hold-out data: 0.12557147443294525
Epoch: 262
```

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Loss on hold-out set: 0.022870261691859923
MeanAbsoluteError value on hold-out data: 0.12025829404592514
Epoch: 263
Loss on hold-out set: 0.025504075352315945
MeanAbsoluteError value on hold-out data: 0.12453912198543549
Epoch: 264

Loss on hold-out set: 0.023799418382986916
MeanAbsoluteError value on hold-out data: 0.12176179140806198
Epoch: 265

Loss on hold-out set: 0.023253296023152265
MeanAbsoluteError value on hold-out data: 0.12297533452510834
Epoch: 266
Loss on hold-out set: 0.022793959780513736
MeanAbsoluteError value on hold-out data: 0.12037362158298492
Epoch: 267

Loss on hold-out set: 0.025022824113451254
MeanAbsoluteError value on hold-out data: 0.12373019009828568
Epoch: 268

Loss on hold-out set: 0.024883047138525096
MeanAbsoluteError value on hold-out data: 0.12381049990653992
Epoch: 269
Loss on hold-out set: 0.023515685875851584
MeanAbsoluteError value on hold-out data: 0.12027378380298615
Epoch: 270

Loss on hold-out set: 0.02520746850806366
MeanAbsoluteError value on hold-out data: 0.12683312594890594
Epoch: 271

Loss on hold-out set: 0.02433769326113785
MeanAbsoluteError value on hold-out data: 0.12456334382295609
Epoch: 272
Loss on hold-out set: 0.022682532420925175
MeanAbsoluteError value on hold-out data: 0.11940126121044159
Epoch: 273
```

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Loss on hold-out set: 0.023287077196049114
MeanAbsoluteError value on hold-out data: 0.12091291695833206
Epoch: 274

Loss on hold-out set: 0.024628777420924355
MeanAbsoluteError value on hold-out data: 0.12641878426074982
Epoch: 275
Loss on hold-out set: 0.023625517780407487
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Epoch: 276

Loss on hold-out set: 0.022983165862484999
MeanAbsoluteError value on hold-out data: 0.11762239038944244
Epoch: 277

Loss on hold-out set: 0.024218800479138734
MeanAbsoluteError value on hold-out data: 0.12218176573514938
Epoch: 278
Loss on hold-out set: 0.02347389650453503
MeanAbsoluteError value on hold-out data: 0.12235009670257568
Epoch: 279

Loss on hold-out set: 0.023130635656028364
MeanAbsoluteError value on hold-out data: 0.1223967894911766
Epoch: 280

Loss on hold-out set: 0.021814358319582727
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Loss on hold-out set: 0.02565000177991654
MeanAbsoluteError value on hold-out data: 0.12968185544013977
Epoch: 282

Loss on hold-out set: 0.02207267861551372
MeanAbsoluteError value on hold-out data: 0.12001791596412659
Epoch: 283

Loss on hold-out set: 0.024137296797319626
MeanAbsoluteError value on hold-out data: 0.12397164851427078
Epoch: 284
```

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Loss on hold-out set: 0.025674861415172927
MeanAbsoluteError value on hold-out data: 0.1251799762248993
Epoch: 285

Loss on hold-out set: 0.02376667124015512
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Epoch: 286

Loss on hold-out set: 0.022536755734230005
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Loss on hold-out set: 0.02375378352754827
MeanAbsoluteError value on hold-out data: 0.12338553369045258
Epoch: 288

Loss on hold-out set: 0.02432165173093381
MeanAbsoluteError value on hold-out data: 0.1238040030002594
Epoch: 289

Loss on hold-out set: 0.0209715115090512
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Epoch: 290
Loss on hold-out set: 0.022280089923879132
MeanAbsoluteError value on hold-out data: 0.11685258150100708
Epoch: 291

Loss on hold-out set: 0.022877216852163353
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Epoch: 292

Loss on hold-out set: 0.02297693463464384
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Epoch: 293
Loss on hold-out set: 0.022488975085143467
MeanAbsoluteError value on hold-out data: 0.12061212956905365
Epoch: 294

Loss on hold-out set: 0.02166886329689684
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Epoch: 295
```

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Loss on hold-out set: 0.02186026386991216
MeanAbsoluteError value on hold-out data: 0.11626537144184113
Epoch: 296
Loss on hold-out set: 0.021602073324417385
MeanAbsoluteError value on hold-out data: 0.11773517727851868
Epoch: 297

Loss on hold-out set: 0.024070357726498817
MeanAbsoluteError value on hold-out data: 0.12369733303785324
Epoch: 298

Loss on hold-out set: 0.021613104011533626
MeanAbsoluteError value on hold-out data: 0.11690850555896759
Epoch: 299
Loss on hold-out set: 0.021494192565369302
MeanAbsoluteError value on hold-out data: 0.11490728706121445
Epoch: 300

Loss on hold-out set: 0.022350293631558694
MeanAbsoluteError value on hold-out data: 0.11619317531585693
Epoch: 301

Loss on hold-out set: 0.02345531308747013
MeanAbsoluteError value on hold-out data: 0.12234409153461456
Epoch: 302
Loss on hold-out set: 0.02120142904963965
MeanAbsoluteError value on hold-out data: 0.11404215544462204
Epoch: 303

Loss on hold-out set: 0.023065823578702595
MeanAbsoluteError value on hold-out data: 0.11832281947135925
Epoch: 304

Loss on hold-out set: 0.024210701836855152
MeanAbsoluteError value on hold-out data: 0.12037365883588791
Epoch: 305
Loss on hold-out set: 0.021315216001239604
MeanAbsoluteError value on hold-out data: 0.11559107154607773
Epoch: 306
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Loss on hold-out set: 0.023618942866063055
MeanAbsoluteError value on hold-out data: 0.121085524559021
Epoch: 307

Loss on hold-out set: 0.023296744183123035
MeanAbsoluteError value on hold-out data: 0.12047813087701797
Epoch: 308
Loss on hold-out set: 0.021482032587664436
MeanAbsoluteError value on hold-out data: 0.11691849678754807
Epoch: 309

Loss on hold-out set: 0.0222550209108158
MeanAbsoluteError value on hold-out data: 0.1192181259393692
Epoch: 310

Loss on hold-out set: 0.022187997870108424
MeanAbsoluteError value on hold-out data: 0.11848987638950348
Epoch: 311
Loss on hold-out set: 0.023176210720231818
MeanAbsoluteError value on hold-out data: 0.11903791129589081
Epoch: 312

Loss on hold-out set: 0.023965667545756634
MeanAbsoluteError value on hold-out data: 0.12291338294744492
Epoch: 313

Loss on hold-out set: 0.021834660695555531
MeanAbsoluteError value on hold-out data: 0.1184380054473877
Epoch: 314
Loss on hold-out set: 0.024716821138669427
MeanAbsoluteError value on hold-out data: 0.12493439018726349
Epoch: 315

Loss on hold-out set: 0.022048836627060766
MeanAbsoluteError value on hold-out data: 0.11945636570453644
Epoch: 316

Loss on hold-out set: 0.022739311339876923
MeanAbsoluteError value on hold-out data: 0.12020442634820938
Epoch: 317
```

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Loss on hold-out set: 0.02348342392096432
MeanAbsoluteError value on hold-out data: 0.12158940732479095
Epoch: 318

Loss on hold-out set: 0.022815232534776443
MeanAbsoluteError value on hold-out data: 0.1217254102230072
Epoch: 319

Loss on hold-out set: 0.021193554375931855
MeanAbsoluteError value on hold-out data: 0.11637532711029053
Epoch: 320
Loss on hold-out set: 0.025192869742616798
MeanAbsoluteError value on hold-out data: 0.12626756727695465
Epoch: 321

Loss on hold-out set: 0.023526099549538534
MeanAbsoluteError value on hold-out data: 0.12155939638614655
Epoch: 322

Loss on hold-out set: 0.022585083289886825
MeanAbsoluteError value on hold-out data: 0.12009255588054657
Epoch: 323
Loss on hold-out set: 0.022826618192339082
MeanAbsoluteError value on hold-out data: 0.1202939972281456
Epoch: 324

Loss on hold-out set: 0.022955412562393272
MeanAbsoluteError value on hold-out data: 0.12180103361606598
Epoch: 325

Loss on hold-out set: 0.02125116255260461
MeanAbsoluteError value on hold-out data: 0.11514317989349365
Epoch: 326
Loss on hold-out set: 0.0260293224970034
MeanAbsoluteError value on hold-out data: 0.12938839197158813
Epoch: 327

Loss on hold-out set: 0.021801442443296157
MeanAbsoluteError value on hold-out data: 0.11762300878763199
Epoch: 328
```

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Loss on hold-out set: 0.022963959299765215
MeanAbsoluteError value on hold-out data: 0.12000567466020584
Epoch: 329
Loss on hold-out set: 0.02037189434287332
MeanAbsoluteError value on hold-out data: 0.11567804962396622
Epoch: 330

Loss on hold-out set: 0.023049136975993558
MeanAbsoluteError value on hold-out data: 0.11937634646892548
Epoch: 331

Loss on hold-out set: 0.020783156316774694
MeanAbsoluteError value on hold-out data: 0.11415033787488937
Epoch: 332
Loss on hold-out set: 0.023417149094602793
MeanAbsoluteError value on hold-out data: 0.12102439999580383
Epoch: 333

Loss on hold-out set: 0.020951212666647432
MeanAbsoluteError value on hold-out data: 0.1169891506433487
Epoch: 334

Loss on hold-out set: 0.02447519323429636
MeanAbsoluteError value on hold-out data: 0.12277745455503464
Epoch: 335
Loss on hold-out set: 0.021362044790354653
MeanAbsoluteError value on hold-out data: 0.11556335538625717
Epoch: 336

Loss on hold-out set: 0.02107658035931915
MeanAbsoluteError value on hold-out data: 0.11754865199327469
Epoch: 337

Loss on hold-out set: 0.020416744019215307
MeanAbsoluteError value on hold-out data: 0.11500153690576553
Epoch: 338
Loss on hold-out set: 0.021173651931700684
MeanAbsoluteError value on hold-out data: 0.11641766875982285
Epoch: 339
```

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Loss on hold-out set: 0.020713909214658
MeanAbsoluteError value on hold-out data: 0.11317944526672363
Epoch: 340

Loss on hold-out set: 0.02106523928368309
MeanAbsoluteError value on hold-out data: 0.11284496635198593
Epoch: 341
Loss on hold-out set: 0.023090037487897157
MeanAbsoluteError value on hold-out data: 0.11767570674419403
Epoch: 342

Loss on hold-out set: 0.02155256628670031
MeanAbsoluteError value on hold-out data: 0.11721258610486984
Epoch: 343

Loss on hold-out set: 0.021596925172877188
MeanAbsoluteError value on hold-out data: 0.11461963504552841
Epoch: 344
Loss on hold-out set: 0.02085778438214523
MeanAbsoluteError value on hold-out data: 0.11683546751737595
Epoch: 345

Loss on hold-out set: 0.022091370527584028
MeanAbsoluteError value on hold-out data: 0.11847928166389465
Epoch: 346

Loss on hold-out set: 0.022376917250415622
MeanAbsoluteError value on hold-out data: 0.12012218683958054
Epoch: 347
Loss on hold-out set: 0.021514149838112645
MeanAbsoluteError value on hold-out data: 0.11764441430568695
Epoch: 348

Loss on hold-out set: 0.021423198656120804
MeanAbsoluteError value on hold-out data: 0.11518388241529465
Epoch: 349

Loss on hold-out set: 0.022139535640599207
MeanAbsoluteError value on hold-out data: 0.11889006197452545
Epoch: 350
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Loss on hold-out set: 0.0243472598962641
MeanAbsoluteError value on hold-out data: 0.1227441057562828
Epoch: 351

Loss on hold-out set: 0.021100853853228425
MeanAbsoluteError value on hold-out data: 0.1164931207895279
Epoch: 352

Loss on hold-out set: 0.02136878789043597
MeanAbsoluteError value on hold-out data: 0.1151675432920456
Epoch: 353
Loss on hold-out set: 0.021661331414118953
MeanAbsoluteError value on hold-out data: 0.11652417480945587
Epoch: 354

Loss on hold-out set: 0.02036885449871382
MeanAbsoluteError value on hold-out data: 0.11176211386919022
Epoch: 355

Loss on hold-out set: 0.021486118440434437
MeanAbsoluteError value on hold-out data: 0.11436615139245987
Epoch: 356
Loss on hold-out set: 0.02070883801265154
MeanAbsoluteError value on hold-out data: 0.11599880456924438
Epoch: 357

Loss on hold-out set: 0.020644333352101966
MeanAbsoluteError value on hold-out data: 0.11665916442871094
Epoch: 358

Loss on hold-out set: 0.02343095804040786
MeanAbsoluteError value on hold-out data: 0.1228240579366684
Epoch: 359
Loss on hold-out set: 0.019886836268318196
MeanAbsoluteError value on hold-out data: 0.11220048367977142
Epoch: 360

Loss on hold-out set: 0.019617884618037353
MeanAbsoluteError value on hold-out data: 0.11155718564987183
Epoch: 361
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Loss on hold-out set: 0.0205154155535274l7
MeanAbsoluteError value on hold-out data: 0.1150815561413765
Epoch: 362
Loss on hold-out set: 0.019635081371986114
MeanAbsoluteError value on hold-out data: 0.11107230931520462
Epoch: 363

Loss on hold-out set: 0.022487004902213812
MeanAbsoluteError value on hold-out data: 0.11723802238702774
Epoch: 364

Loss on hold-out set: 0.02326418548943669
MeanAbsoluteError value on hold-out data: 0.11693861335515976
Epoch: 365
Loss on hold-out set: 0.020908955655177124
MeanAbsoluteError value on hold-out data: 0.11730239540338516
Epoch: 366

Loss on hold-out set: 0.022140763461842048
MeanAbsoluteError value on hold-out data: 0.11892449855804443
Epoch: 367

Loss on hold-out set: 0.019202462089354715
MeanAbsoluteError value on hold-out data: 0.1093532145023346
Epoch: 368
Loss on hold-out set: 0.021342739165459836
MeanAbsoluteError value on hold-out data: 0.1145443469285965
Epoch: 369

Loss on hold-out set: 0.020540146139877227
MeanAbsoluteError value on hold-out data: 0.11615023016929626
Epoch: 370

Loss on hold-out set: 0.020039195241358054
MeanAbsoluteError value on hold-out data: 0.1108023077249527
Epoch: 371
Loss on hold-out set: 0.020910480089005434
MeanAbsoluteError value on hold-out data: 0.11502692848443985
Epoch: 372
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Loss on hold-out set: 0.02037635531880369
MeanAbsoluteError value on hold-out data: 0.11364709585905075
Epoch: 373

Loss on hold-out set: 0.02224675480159931
MeanAbsoluteError value on hold-out data: 0.120032399892807
Epoch: 374
Loss on hold-out set: 0.02075021250580903
MeanAbsoluteError value on hold-out data: 0.1159338504076004
Epoch: 375

Loss on hold-out set: 0.020368458575418722
MeanAbsoluteError value on hold-out data: 0.11595185846090317
Epoch: 376

Loss on hold-out set: 0.022677492000705873
MeanAbsoluteError value on hold-out data: 0.12179142981767654
Epoch: 377
Loss on hold-out set: 0.020281007608718937
MeanAbsoluteError value on hold-out data: 0.11330784857273102
Epoch: 378

Loss on hold-out set: 0.01869549409641574
MeanAbsoluteError value on hold-out data: 0.10903666168451309
Epoch: 379

Loss on hold-out set: 0.02120484758341263
MeanAbsoluteError value on hold-out data: 0.11657560616731644
Epoch: 380
Loss on hold-out set: 0.019007633938626894
MeanAbsoluteError value on hold-out data: 0.10919929295778275
Epoch: 381

Loss on hold-out set: 0.022012553488699873
MeanAbsoluteError value on hold-out data: 0.1190103143453598
Epoch: 382

Loss on hold-out set: 0.019868367507272826
MeanAbsoluteError value on hold-out data: 0.11081236600875854
Epoch: 383
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Loss on hold-out set: 0.019580841209772187
MeanAbsoluteError value on hold-out data: 0.11178646236658096
Epoch: 384

Loss on hold-out set: 0.020360083472914993
MeanAbsoluteError value on hold-out data: 0.1143244206905365
Epoch: 385

Loss on hold-out set: 0.020683465616408889
MeanAbsoluteError value on hold-out data: 0.11481764167547226
Epoch: 386
Loss on hold-out set: 0.018914410803360322
MeanAbsoluteError value on hold-out data: 0.10845156013965607
Epoch: 387

Loss on hold-out set: 0.021315116096969948
MeanAbsoluteError value on hold-out data: 0.11579775810241699
Epoch: 388

Loss on hold-out set: 0.019743226538970097
MeanAbsoluteError value on hold-out data: 0.11350993067026138
Epoch: 389
Loss on hold-out set: 0.021796139419651202
MeanAbsoluteError value on hold-out data: 0.11896892637014389
Epoch: 390

Loss on hold-out set: 0.018642796289107884
MeanAbsoluteError value on hold-out data: 0.10876856744289398
Epoch: 391

Loss on hold-out set: 0.021689227704773658
MeanAbsoluteError value on hold-out data: 0.11878364533185959
Epoch: 392
Loss on hold-out set: 0.020439188707096035
MeanAbsoluteError value on hold-out data: 0.11437056213617325
Epoch: 393

Loss on hold-out set: 0.020897159464123738
MeanAbsoluteError value on hold-out data: 0.11305976659059525
Epoch: 394
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Loss on hold-out set: 0.020417108122589223
MeanAbsoluteError value on hold-out data: 0.11462229490280151
Epoch: 395
Loss on hold-out set: 0.019938146656398505
MeanAbsoluteError value on hold-out data: 0.11241818964481354
Epoch: 396

Loss on hold-out set: 0.018974714270346664
MeanAbsoluteError value on hold-out data: 0.11100472509860992
Epoch: 397

Loss on hold-out set: 0.020020125025439484
MeanAbsoluteError value on hold-out data: 0.11185102164745331
Epoch: 398
Loss on hold-out set: 0.019260778196815712
MeanAbsoluteError value on hold-out data: 0.10789725184440613
Epoch: 399

Loss on hold-out set: 0.020829922459767357
MeanAbsoluteError value on hold-out data: 0.1151348277926445
Epoch: 400

Loss on hold-out set: 0.020437747963102269
MeanAbsoluteError value on hold-out data: 0.11621898412704468
Epoch: 401
Loss on hold-out set: 0.0186998927333237
MeanAbsoluteError value on hold-out data: 0.10586108267307281
Epoch: 402

Loss on hold-out set: 0.019579104232155562
MeanAbsoluteError value on hold-out data: 0.10899149626493454
Epoch: 403

Loss on hold-out set: 0.018316468989717788
MeanAbsoluteError value on hold-out data: 0.10423478484153748
Epoch: 404
Loss on hold-out set: 0.019180927600925001
MeanAbsoluteError value on hold-out data: 0.10842560976743698
Epoch: 405
```

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Loss on hold-out set: 0.019224660518909028
MeanAbsoluteError value on hold-out data: 0.11273227632045746
Epoch: 406

Loss on hold-out set: 0.021167378009510383
MeanAbsoluteError value on hold-out data: 0.11599525809288025
Epoch: 407
Loss on hold-out set: 0.019370811290961378
MeanAbsoluteError value on hold-out data: 0.10770206153392792
Epoch: 408

Loss on hold-out set: 0.02149322220463849
MeanAbsoluteError value on hold-out data: 0.11392013728618622
Epoch: 409

Loss on hold-out set: 0.019997540886512677
MeanAbsoluteError value on hold-out data: 0.11165710538625717
Epoch: 410
Loss on hold-out set: 0.019740657188667684
MeanAbsoluteError value on hold-out data: 0.11028547585010529
Epoch: 411

Loss on hold-out set: 0.020005711450745974
MeanAbsoluteError value on hold-out data: 0.10686836391687393
Epoch: 412

Loss on hold-out set: 0.01799865103443153
MeanAbsoluteError value on hold-out data: 0.10651163756847382
Epoch: 413
Loss on hold-out set: 0.01795370862450606
MeanAbsoluteError value on hold-out data: 0.1086636334657669
Epoch: 414

Loss on hold-out set: 0.020637896410626126
MeanAbsoluteError value on hold-out data: 0.11229347437620163
Epoch: 415

Loss on hold-out set: 0.018660273077548483
MeanAbsoluteError value on hold-out data: 0.11018902063369751
Epoch: 416
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Loss on hold-out set: 0.01911070067076556
MeanAbsoluteError value on hold-out data: 0.11033540219068527
Epoch: 417

Loss on hold-out set: 0.019730388060922147
MeanAbsoluteError value on hold-out data: 0.11096329987049103
Epoch: 418

Loss on hold-out set: 0.019313022303200946
MeanAbsoluteError value on hold-out data: 0.11074395477771759
Epoch: 419
Loss on hold-out set: 0.01943029817819479
MeanAbsoluteError value on hold-out data: 0.11044301092624664
Epoch: 420

Loss on hold-out set: 0.018276425848307555
MeanAbsoluteError value on hold-out data: 0.10671604424715042
Epoch: 421

Loss on hold-out set: 0.020144463035976515
MeanAbsoluteError value on hold-out data: 0.11169534176588058
Epoch: 422
Loss on hold-out set: 0.019994347535296886
MeanAbsoluteError value on hold-out data: 0.11240357905626297
Epoch: 423

Loss on hold-out set: 0.021115252984212324
MeanAbsoluteError value on hold-out data: 0.11615242063999176
Epoch: 424

Loss on hold-out set: 0.0172691673329003
MeanAbsoluteError value on hold-out data: 0.10518458485603333
Epoch: 425
Loss on hold-out set: 0.019964893251502264
MeanAbsoluteError value on hold-out data: 0.11180390417575836
Epoch: 426

Loss on hold-out set: 0.020456001797574574
MeanAbsoluteError value on hold-out data: 0.11551360785961151
Epoch: 427
```

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Loss on hold-out set: 0.019073269250802695
MeanAbsoluteError value on hold-out data: 0.11077236384153366
Epoch: 428
Loss on hold-out set: 0.01857194714587725
MeanAbsoluteError value on hold-out data: 0.10778414458036423
Epoch: 429

Loss on hold-out set: 0.018684408625267677
MeanAbsoluteError value on hold-out data: 0.1079961284995079
Epoch: 430

Loss on hold-out set: 0.021384976008800245
MeanAbsoluteError value on hold-out data: 0.11490755528211594
Epoch: 431
Loss on hold-out set: 0.01851039316005578
MeanAbsoluteError value on hold-out data: 0.10609693080186844
Epoch: 432

Loss on hold-out set: 0.01932955234282417
MeanAbsoluteError value on hold-out data: 0.11214958131313324
Epoch: 433

Loss on hold-out set: 0.019559097831637094
MeanAbsoluteError value on hold-out data: 0.10937211662530899
Epoch: 434
Loss on hold-out set: 0.016814118216376905
MeanAbsoluteError value on hold-out data: 0.10278509557247162
Epoch: 435

Loss on hold-out set: 0.018800947796795905
MeanAbsoluteError value on hold-out data: 0.10831163823604584
Epoch: 436

Loss on hold-out set: 0.019345992743117223
MeanAbsoluteError value on hold-out data: 0.10967107117176056
Epoch: 437
Loss on hold-out set: 0.01970208506832326
MeanAbsoluteError value on hold-out data: 0.10969953238964081
Epoch: 438
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Loss on hold-out set: 0.019805615458802397
MeanAbsoluteError value on hold-out data: 0.10884751379489899
Epoch: 439

Loss on hold-out set: 0.019589981991254415
MeanAbsoluteError value on hold-out data: 0.1114167645573616
Epoch: 440
Loss on hold-out set: 0.019055808779036548
MeanAbsoluteError value on hold-out data: 0.1053457036614418
Epoch: 441

Loss on hold-out set: 0.019648898442877302
MeanAbsoluteError value on hold-out data: 0.10967100411653519
Epoch: 442

Loss on hold-out set: 0.01695695518263771
MeanAbsoluteError value on hold-out data: 0.10141943395137787
Epoch: 443
Loss on hold-out set: 0.017414086835148435
MeanAbsoluteError value on hold-out data: 0.1028439998626709
Epoch: 444

Loss on hold-out set: 0.020149070023738506
MeanAbsoluteError value on hold-out data: 0.11107775568962097
Epoch: 445

Loss on hold-out set: 0.019098695946934943
MeanAbsoluteError value on hold-out data: 0.11079592257738113
Epoch: 446
Loss on hold-out set: 0.018488880035292823
MeanAbsoluteError value on hold-out data: 0.1072242334485054
Epoch: 447

Loss on hold-out set: 0.019702730668116904
MeanAbsoluteError value on hold-out data: 0.1105409786105156
Epoch: 448

Loss on hold-out set: 0.020001475729901963
MeanAbsoluteError value on hold-out data: 0.11175501346588135
Epoch: 449
```

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Loss on hold-out set: 0.02016076220565689
MeanAbsoluteError value on hold-out data: 0.11041431128978729
Epoch: 450

Loss on hold-out set: 0.022701401956825674
MeanAbsoluteError value on hold-out data: 0.1205759048461914
Epoch: 451

Loss on hold-out set: 0.018272283879140712
MeanAbsoluteError value on hold-out data: 0.10643761605024338
Epoch: 452
Loss on hold-out set: 0.019769994807090067
MeanAbsoluteError value on hold-out data: 0.1081695556640625
Epoch: 453

Loss on hold-out set: 0.020937997093157416
MeanAbsoluteError value on hold-out data: 0.11432021111249924
Epoch: 454

Loss on hold-out set: 0.019073948432633187
MeanAbsoluteError value on hold-out data: 0.11235091090202332
Epoch: 455
Loss on hold-out set: 0.019406531497709996
MeanAbsoluteError value on hold-out data: 0.10940096527338028
Epoch: 456

Loss on hold-out set: 0.019874457298671284
MeanAbsoluteError value on hold-out data: 0.1085488349199295
Epoch: 457

Loss on hold-out set: 0.019135946134871726
MeanAbsoluteError value on hold-out data: 0.11009500920772552
Epoch: 458
Loss on hold-out set: 0.01798375133095154
MeanAbsoluteError value on hold-out data: 0.10756096988916397
Epoch: 459

Loss on hold-out set: 0.019400522605574223
MeanAbsoluteError value on hold-out data: 0.10945338010787964
Epoch: 460
```

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Loss on hold-out set: 0.01905948478146456
MeanAbsoluteError value on hold-out data: 0.10832280665636063
Epoch: 461
Loss on hold-out set: 0.017849190785733906
MeanAbsoluteError value on hold-out data: 0.10486284643411636
Epoch: 462

Loss on hold-out set: 0.01796396668428012
MeanAbsoluteError value on hold-out data: 0.10742323845624924
Epoch: 463

Loss on hold-out set: 0.017593972053485535
MeanAbsoluteError value on hold-out data: 0.10828951746225357
Epoch: 464
Loss on hold-out set: 0.018494111231460313
MeanAbsoluteError value on hold-out data: 0.10250356793403625
Epoch: 465

Loss on hold-out set: 0.018155079574983878
MeanAbsoluteError value on hold-out data: 0.10733899474143982
Epoch: 466

Loss on hold-out set: 0.017046632999942326
MeanAbsoluteError value on hold-out data: 0.10289021581411362
Epoch: 467
Loss on hold-out set: 0.018224553676651947
MeanAbsoluteError value on hold-out data: 0.10445176810026169
Epoch: 468

Loss on hold-out set: 0.01877320629908354
MeanAbsoluteError value on hold-out data: 0.10748794674873352
Epoch: 469

Loss on hold-out set: 0.01839910726955471
MeanAbsoluteError value on hold-out data: 0.10452454537153244
Epoch: 470
Loss on hold-out set: 0.018760357536763573
MeanAbsoluteError value on hold-out data: 0.10909974575042725
Epoch: 471
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Loss on hold-out set: 0.018354644244194251
MeanAbsoluteError value on hold-out data: 0.10729235410690308
Epoch: 472

Loss on hold-out set: 0.017468334412551485
MeanAbsoluteError value on hold-out data: 0.10449889302253723
Epoch: 473
Loss on hold-out set: 0.018073373632699563
MeanAbsoluteError value on hold-out data: 0.10655996203422546
Epoch: 474

Loss on hold-out set: 0.017405827047064736
MeanAbsoluteError value on hold-out data: 0.10583611577749252
Epoch: 475

Loss on hold-out set: 0.01843599436765847
MeanAbsoluteError value on hold-out data: 0.10611886531114578
Epoch: 476
Loss on hold-out set: 0.016325112015474586
MeanAbsoluteError value on hold-out data: 0.0999550148844719
Epoch: 477

Loss on hold-out set: 0.018814083756975984
MeanAbsoluteError value on hold-out data: 0.10873335599899292
Epoch: 478

Loss on hold-out set: 0.019013591102363232
MeanAbsoluteError value on hold-out data: 0.10770750790834427
Epoch: 479
Loss on hold-out set: 0.018384335881564767
MeanAbsoluteError value on hold-out data: 0.10541354864835739
Epoch: 480

Loss on hold-out set: 0.016402386276749895
MeanAbsoluteError value on hold-out data: 0.101139597594738
Epoch: 481

Loss on hold-out set: 0.016694126336127133
MeanAbsoluteError value on hold-out data: 0.1025342345237732
Epoch: 482
```

```
Loss on hold-out set: 0.019513995666929986
MeanAbsoluteError value on hold-out data: 0.10905670374631882
Epoch: 483

Loss on hold-out set: 0.018828267178614622
MeanAbsoluteError value on hold-out data: 0.10850570350885391
Epoch: 484

Loss on hold-out set: 0.017309462863583272
MeanAbsoluteError value on hold-out data: 0.10473349690437317
Epoch: 485
Loss on hold-out set: 0.019409644620803496
MeanAbsoluteError value on hold-out data: 0.1072702631354332
Epoch: 486

Loss on hold-out set: 0.017866716385469772
MeanAbsoluteError value on hold-out data: 0.10271264612674713
Epoch: 487

Loss on hold-out set: 0.019253276894936184
MeanAbsoluteError value on hold-out data: 0.1093553826212883
Epoch: 488
Loss on hold-out set: 0.016928450983056488
MeanAbsoluteError value on hold-out data: 0.10481323301792145
Epoch: 489

Loss on hold-out set: 0.01787539878656389
MeanAbsoluteError value on hold-out data: 0.10146129131317139
Epoch: 490

Loss on hold-out set: 0.017425144201358003
MeanAbsoluteError value on hold-out data: 0.10425080358982086
Epoch: 491
Loss on hold-out set: 0.015998446017377623
MeanAbsoluteError value on hold-out data: 0.10031945258378983
Epoch: 492

Loss on hold-out set: 0.01872862643286377
MeanAbsoluteError value on hold-out data: 0.10937055200338364
Epoch: 493
```

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Loss on hold-out set: 0.016335683162372636
MeanAbsoluteError value on hold-out data: 0.10268326848745346
Epoch: 494
Loss on hold-out set: 0.01795410514503601
MeanAbsoluteError value on hold-out data: 0.10500068962574005
Epoch: 495

Loss on hold-out set: 0.017115583001965813
MeanAbsoluteError value on hold-out data: 0.10424461960792542
Epoch: 496

Loss on hold-out set: 0.016508086277050703
MeanAbsoluteError value on hold-out data: 0.10017570853233337
Epoch: 497
Loss on hold-out set: 0.017239121555558085
MeanAbsoluteError value on hold-out data: 0.10368676483631134
Epoch: 498

Loss on hold-out set: 0.019114759842826363
MeanAbsoluteError value on hold-out data: 0.10863170772790909
Epoch: 499

Loss on hold-out set: 0.01652283004281344
MeanAbsoluteError value on hold-out data: 0.09895376116037369
Epoch: 500
Loss on hold-out set: 0.017566612585663582
MeanAbsoluteError value on hold-out data: 0.10684506595134735
Epoch: 501

Loss on hold-out set: 0.017646236415263652
MeanAbsoluteError value on hold-out data: 0.10639377683401108
Epoch: 502

Loss on hold-out set: 0.019046939696224095
MeanAbsoluteError value on hold-out data: 0.10897490382194519
Epoch: 503
Loss on hold-out set: 0.017920064353190053
MeanAbsoluteError value on hold-out data: 0.10629644989967346
Epoch: 504
```

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Loss on hold-out set: 0.016313291793727938
MeanAbsoluteError value on hold-out data: 0.10080287605524063
Epoch: 505

Loss on hold-out set: 0.01673793128808029
MeanAbsoluteError value on hold-out data: 0.10522197932004929
Epoch: 506
Loss on hold-out set: 0.016411064657440876
MeanAbsoluteError value on hold-out data: 0.10163898766040802
Epoch: 507

Loss on hold-out set: 0.017251833835519696
MeanAbsoluteError value on hold-out data: 0.10468511283397675
Epoch: 508

Loss on hold-out set: 0.01574955665904175
MeanAbsoluteError value on hold-out data: 0.09923212975263596
Epoch: 509
Loss on hold-out set: 0.018608735530773024
MeanAbsoluteError value on hold-out data: 0.10724110901355743
Epoch: 510

Loss on hold-out set: 0.015805470690102085
MeanAbsoluteError value on hold-out data: 0.09668012708425522
Epoch: 511

Loss on hold-out set: 0.01588751633942593
MeanAbsoluteError value on hold-out data: 0.1023000180721283
Epoch: 512
Loss on hold-out set: 0.016303127535799527
MeanAbsoluteError value on hold-out data: 0.0971493124961853
Epoch: 513

Loss on hold-out set: 0.01607892481963063
MeanAbsoluteError value on hold-out data: 0.10252609103918076
Epoch: 514

Loss on hold-out set: 0.01554880190155624
MeanAbsoluteError value on hold-out data: 0.0990661233663559
Epoch: 515
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Loss on hold-out set: 0.016819833732054878
MeanAbsoluteError value on hold-out data: 0.10548047721385956
Epoch: 516

Loss on hold-out set: 0.016247869379731127
MeanAbsoluteError value on hold-out data: 0.10018632560968399
Epoch: 517

Loss on hold-out set: 0.016615621481711664
MeanAbsoluteError value on hold-out data: 0.10200747847557068
Epoch: 518
Loss on hold-out set: 0.017479609804819725
MeanAbsoluteError value on hold-out data: 0.10639297217130661
Epoch: 519

Loss on hold-out set: 0.015567554010873815
MeanAbsoluteError value on hold-out data: 0.09694402664899826
Epoch: 520

Loss on hold-out set: 0.019439180881430124
MeanAbsoluteError value on hold-out data: 0.10916917026042938
Epoch: 521
Loss on hold-out set: 0.018955913571213994
MeanAbsoluteError value on hold-out data: 0.10488100349903107
Epoch: 522

Loss on hold-out set: 0.017738717071941513
MeanAbsoluteError value on hold-out data: 0.10315421223640442
Epoch: 523

Loss on hold-out set: 0.016963598466924548
MeanAbsoluteError value on hold-out data: 0.09994049370288849
Epoch: 524
Loss on hold-out set: 0.017447596179457226
MeanAbsoluteError value on hold-out data: 0.10272818803787231
Epoch: 525

Loss on hold-out set: 0.017565161229407142
MeanAbsoluteError value on hold-out data: 0.10463123023509979
Epoch: 526
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Loss on hold-out set: 0.01815434637214518
MeanAbsoluteError value on hold-out data: 0.10452712327241898
Epoch: 527
Loss on hold-out set: 0.017937938949277546
MeanAbsoluteError value on hold-out data: 0.10464468598365784
Epoch: 528

Loss on hold-out set: 0.017711927992568235
MeanAbsoluteError value on hold-out data: 0.1019037663936615
Epoch: 529

Loss on hold-out set: 0.016981469159363768
MeanAbsoluteError value on hold-out data: 0.10169155150651932
Epoch: 530
Loss on hold-out set: 0.01762350808979439
MeanAbsoluteError value on hold-out data: 0.10396043956279755
Epoch: 531

Loss on hold-out set: 0.017813044348343587
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Epoch: 532

Loss on hold-out set: 0.01742456764768576
MeanAbsoluteError value on hold-out data: 0.1035332977771759
Epoch: 533
Loss on hold-out set: 0.01772427222157906
MeanAbsoluteError value on hold-out data: 0.10539279878139496
Epoch: 534

Loss on hold-out set: 0.0172159089394457
MeanAbsoluteError value on hold-out data: 0.10338856279850006
Epoch: 535

Loss on hold-out set: 0.015964498211130072
MeanAbsoluteError value on hold-out data: 0.09949742257595062
Epoch: 536
Loss on hold-out set: 0.015067003981239396
MeanAbsoluteError value on hold-out data: 0.09732868522405624
Epoch: 537
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Loss on hold-out set: 0.015942957538160652
MeanAbsoluteError value on hold-out data: 0.09868930280208588
Epoch: 538

Loss on hold-out set: 0.015543677681707778
MeanAbsoluteError value on hold-out data: 0.09728006273508072
Epoch: 539
Loss on hold-out set: 0.014041522494153469
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Epoch: 540

Loss on hold-out set: 0.014551647330032816
MeanAbsoluteError value on hold-out data: 0.0975605770945549
Epoch: 541

Loss on hold-out set: 0.01642444496304961
MeanAbsoluteError value on hold-out data: 0.10135261714458466
Epoch: 542
Loss on hold-out set: 0.01675642498320182
MeanAbsoluteError value on hold-out data: 0.10356827825307846
Epoch: 543

Loss on hold-out set: 0.01776157785692097
MeanAbsoluteError value on hold-out data: 0.1016935482621193
Epoch: 544

Loss on hold-out set: 0.016905136019680262
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Epoch: 545
Loss on hold-out set: 0.016632952447689604
MeanAbsoluteError value on hold-out data: 0.10075230151414871
Epoch: 546

Loss on hold-out set: 0.01668867617971652
MeanAbsoluteError value on hold-out data: 0.09970147162675858
Epoch: 547

Loss on hold-out set: 0.015114129361851763
MeanAbsoluteError value on hold-out data: 0.0976153090596199
Epoch: 548
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Loss on hold-out set: 0.015900074061610214
MeanAbsoluteError value on hold-out data: 0.09778150171041489
Epoch: 549

Loss on hold-out set: 0.015357558590961466
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Epoch: 550

Loss on hold-out set: 0.016631054903900804
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Epoch: 551
Loss on hold-out set: 0.016712734594766517
MeanAbsoluteError value on hold-out data: 0.10143938660621643
Epoch: 552

Loss on hold-out set: 0.015978487977020752
MeanAbsoluteError value on hold-out data: 0.09965751320123672
Epoch: 553

Loss on hold-out set: 0.015470853184427445
MeanAbsoluteError value on hold-out data: 0.09518783539533615
Epoch: 554
Loss on hold-out set: 0.015414722947219465
MeanAbsoluteError value on hold-out data: 0.09693841636180878
Epoch: 555

Loss on hold-out set: 0.016470493960174887
MeanAbsoluteError value on hold-out data: 0.10044296085834503
Epoch: 556

Loss on hold-out set: 0.01819937021842634
MeanAbsoluteError value on hold-out data: 0.100677989423275
Epoch: 557
Loss on hold-out set: 0.016679225205540812
MeanAbsoluteError value on hold-out data: 0.10457596182823181
Epoch: 558

Loss on hold-out set: 0.015648002783806684
MeanAbsoluteError value on hold-out data: 0.10006475448608398
Epoch: 559
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Loss on hold-out set: 0.015766111152869494
MeanAbsoluteError value on hold-out data: 0.09524800628423691
Epoch: 560
Loss on hold-out set: 0.017862349769081146
MeanAbsoluteError value on hold-out data: 0.10689782351255417
Epoch: 561

Loss on hold-out set: 0.017264890793449013
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Epoch: 562

Loss on hold-out set: 0.015539189699496395
MeanAbsoluteError value on hold-out data: 0.09658663719892502
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Loss on hold-out set: 0.016197417599129647
MeanAbsoluteError value on hold-out data: 0.09922459721565247
Epoch: 564

Loss on hold-out set: 0.01686867742408746
MeanAbsoluteError value on hold-out data: 0.10412243753671646
Epoch: 565

Loss on hold-out set: 0.015385888682916023
MeanAbsoluteError value on hold-out data: 0.09667789191007614
Epoch: 566
Loss on hold-out set: 0.016852508911591332
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Epoch: 567

Loss on hold-out set: 0.016251302119647638
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Epoch: 568

Loss on hold-out set: 0.014151104087359272
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Epoch: 569
Loss on hold-out set: 0.014847672669008412
MeanAbsoluteError value on hold-out data: 0.09450365602970123
Epoch: 570
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Loss on hold-out set: 0.017563162548855557
MeanAbsoluteError value on hold-out data: 0.09952954202890396
Epoch: 571

Loss on hold-out set: 0.015445310617845582
MeanAbsoluteError value on hold-out data: 0.09627535939216614
Epoch: 572
Loss on hold-out set: 0.01563971385071151
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Epoch: 573

Loss on hold-out set: 0.01600195668044762
MeanAbsoluteError value on hold-out data: 0.09607841074466705
Epoch: 574

Loss on hold-out set: 0.01573104676379444
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Epoch: 575
Loss on hold-out set: 0.015539633191559309
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Epoch: 576

Loss on hold-out set: 0.014676295649405802
MeanAbsoluteError value on hold-out data: 0.09612414985895157
Epoch: 577

Loss on hold-out set: 0.014187812411043221
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Epoch: 578
Loss on hold-out set: 0.01783756614181281
MeanAbsoluteError value on hold-out data: 0.10228567570447922
Epoch: 579

Loss on hold-out set: 0.013926840537363509
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Epoch: 580

Loss on hold-out set: 0.015773600916436408
MeanAbsoluteError value on hold-out data: 0.09965692460536957
Epoch: 581
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Loss on hold-out set: 0.015452079826645785
MeanAbsoluteError value on hold-out data: 0.09670154750347137
Epoch: 582

Loss on hold-out set: 0.017562595059862362
MeanAbsoluteError value on hold-out data: 0.1049421951174736
Epoch: 583

Loss on hold-out set: 0.014790887043084998
MeanAbsoluteError value on hold-out data: 0.09416337311267853
Epoch: 584
Loss on hold-out set: 0.013988622460407593
MeanAbsoluteError value on hold-out data: 0.09342028200626373
Epoch: 585

Loss on hold-out set: 0.014349652516539208
MeanAbsoluteError value on hold-out data: 0.09327273070812225
Epoch: 586

Loss on hold-out set: 0.015920346275088378
MeanAbsoluteError value on hold-out data: 0.100106380879879
Epoch: 587
Loss on hold-out set: 0.01669734256705851
MeanAbsoluteError value on hold-out data: 0.10388587415218353
Epoch: 588

Loss on hold-out set: 0.016245275258309752
MeanAbsoluteError value on hold-out data: 0.1019294336438179
Epoch: 589

Loss on hold-out set: 0.014551795682054945
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Epoch: 590
Loss on hold-out set: 0.014506625432792741
MeanAbsoluteError value on hold-out data: 0.09417205303907394
Epoch: 591

Loss on hold-out set: 0.016077617244736758
MeanAbsoluteError value on hold-out data: 0.09915128350257874
Epoch: 592
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Loss on hold-out set: 0.01602826901517498
MeanAbsoluteError value on hold-out data: 0.10192860662937164
Epoch: 593
Loss on hold-out set: 0.015071554247924723
MeanAbsoluteError value on hold-out data: 0.0983138307929039
Epoch: 594

Loss on hold-out set: 0.01508201346975208
MeanAbsoluteError value on hold-out data: 0.09792789071798325
Epoch: 595

Loss on hold-out set: 0.015845450100314337
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Epoch: 596
Loss on hold-out set: 0.016830352150027466
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Epoch: 597

Loss on hold-out set: 0.01657996921184046
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Epoch: 598

Loss on hold-out set: 0.018320817435063266
MeanAbsoluteError value on hold-out data: 0.10598766803741455
Epoch: 599
Loss on hold-out set: 0.01409965001443349
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Epoch: 600

Loss on hold-out set: 0.015035610392045177
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Epoch: 601

Loss on hold-out set: 0.014474701975414063
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Epoch: 602
Loss on hold-out set: 0.015453488124985598
MeanAbsoluteError value on hold-out data: 0.09650345891714096
Epoch: 603
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Loss on hold-out set: 0.01581506666456941
MeanAbsoluteError value on hold-out data: 0.0957801565527916
Epoch: 604

Loss on hold-out set: 0.016118908204395363
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Epoch: 605
Loss on hold-out set: 0.016133354779158254
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Epoch: 606

Loss on hold-out set: 0.015302271695272793
MeanAbsoluteError value on hold-out data: 0.09714047610759735
Epoch: 607

Loss on hold-out set: 0.013352986418661505
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Epoch: 608
Loss on hold-out set: 0.014705725436118276
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Epoch: 609

Loss on hold-out set: 0.015198393799073529
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Epoch: 610

Loss on hold-out set: 0.015540570590746938
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Epoch: 611
Loss on hold-out set: 0.015455112637549367
MeanAbsoluteError value on hold-out data: 0.09582477807998657
Epoch: 612

Loss on hold-out set: 0.014669735584757291
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Epoch: 613

Loss on hold-out set: 0.01593473931653231
MeanAbsoluteError value on hold-out data: 0.09788976609706879
Epoch: 614
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Loss on hold-out set: 0.013701136173779863
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Epoch: 615

Loss on hold-out set: 0.01467815500126259
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Epoch: 616

Loss on hold-out set: 0.014587762753265754
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Epoch: 617
Loss on hold-out set: 0.01511803072450372
MeanAbsoluteError value on hold-out data: 0.09713563323020935
Epoch: 618

Loss on hold-out set: 0.014031270383869317
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Epoch: 619

Loss on hold-out set: 0.014058530865368084
MeanAbsoluteError value on hold-out data: 0.09325023740530014
Epoch: 620
Loss on hold-out set: 0.01165904240886448
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Epoch: 621

Loss on hold-out set: 0.013977521318787088
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Epoch: 622

Loss on hold-out set: 0.01511316868069116
MeanAbsoluteError value on hold-out data: 0.09454777836799622
Epoch: 623
Loss on hold-out set: 0.015002745608314095
MeanAbsoluteError value on hold-out data: 0.09503614157438278
Epoch: 624

Loss on hold-out set: 0.014840312638455847
MeanAbsoluteError value on hold-out data: 0.0957617536187172
Epoch: 625
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Loss on hold-out set: 0.015422445090177159
MeanAbsoluteError value on hold-out data: 0.09822384268045425
Epoch: 626
Loss on hold-out set: 0.015779077961560688
MeanAbsoluteError value on hold-out data: 0.09608050435781479
Epoch: 627

Loss on hold-out set: 0.014807908633617141
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Epoch: 628

Loss on hold-out set: 0.014556043280802745
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Epoch: 629
Loss on hold-out set: 0.01600221216242062
MeanAbsoluteError value on hold-out data: 0.10126055777072906
Epoch: 630

Loss on hold-out set: 0.014509166325771428
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Epoch: 631

Loss on hold-out set: 0.015272784109135197
MeanAbsoluteError value on hold-out data: 0.09733447432518005
Epoch: 632
Loss on hold-out set: 0.015733729725713297
MeanAbsoluteError value on hold-out data: 0.09639370441436768
Epoch: 633

Loss on hold-out set: 0.014096802192919616
MeanAbsoluteError value on hold-out data: 0.09419728070497513
Epoch: 634

Loss on hold-out set: 0.014654951035239113
MeanAbsoluteError value on hold-out data: 0.0957341268658638
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Loss on hold-out set: 0.014329065272177104
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Epoch: 636
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Loss on hold-out set: 0.01477379056426192
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Epoch: 637

Loss on hold-out set: 0.016709475855459458
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Epoch: 638
Loss on hold-out set: 0.014857266073886422
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Epoch: 639

Loss on hold-out set: 0.013550542866190275
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Epoch: 640

Loss on hold-out set: 0.013569903345342027
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Epoch: 641
Loss on hold-out set: 0.01488484850153327
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Epoch: 642

Loss on hold-out set: 0.01356367669638227
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Epoch: 643

Loss on hold-out set: 0.014853662873232072
MeanAbsoluteError value on hold-out data: 0.09602480381727219
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Loss on hold-out set: 0.01633089258506516
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Epoch: 645

Loss on hold-out set: 0.015457792508580799
MeanAbsoluteError value on hold-out data: 0.09915337711572647
Epoch: 646

Loss on hold-out set: 0.014566411510507653
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Epoch: 647
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Loss on hold-out set: 0.01490591799976149
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Epoch: 648

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MeanAbsoluteError value on hold-out data: 0.09222816675901413
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Loss on hold-out set: 0.015549251034826739
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Epoch: 650
Loss on hold-out set: 0.01437398687194218
MeanAbsoluteError value on hold-out data: 0.09274104982614517
Epoch: 651

Loss on hold-out set: 0.013900273990584537
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Epoch: 652

Loss on hold-out set: 0.01528316971938087
MeanAbsoluteError value on hold-out data: 0.0946761965751648
Epoch: 653
Loss on hold-out set: 0.012927545782052524
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Epoch: 654

Loss on hold-out set: 0.014360781187327424
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Epoch: 655

Loss on hold-out set: 0.012681393337697956
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Epoch: 656
Loss on hold-out set: 0.013287689643523967
MeanAbsoluteError value on hold-out data: 0.09085865318775177
Epoch: 657

Loss on hold-out set: 0.01258061191692832
MeanAbsoluteError value on hold-out data: 0.08699407428503036
Epoch: 658
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Loss on hold-out set: 0.01393461704448176
MeanAbsoluteError value on hold-out data: 0.08872909843921661
Epoch: 659
Loss on hold-out set: 0.013684906074110282
MeanAbsoluteError value on hold-out data: 0.09256549179553986
Epoch: 660

Loss on hold-out set: 0.01431050056780805
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Epoch: 661

Loss on hold-out set: 0.012922549423553089
MeanAbsoluteError value on hold-out data: 0.09037728607654572
Epoch: 662
Loss on hold-out set: 0.01348151766161512
MeanAbsoluteError value on hold-out data: 0.09134715050458908
Epoch: 663

Loss on hold-out set: 0.012086584390587329
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Epoch: 664

Loss on hold-out set: 0.014263238631368342
MeanAbsoluteError value on hold-out data: 0.09321952611207962
Epoch: 665
Loss on hold-out set: 0.014598089960733585
MeanAbsoluteError value on hold-out data: 0.09235823154449463
Epoch: 666

Loss on hold-out set: 0.01460354361954766
MeanAbsoluteError value on hold-out data: 0.09550747275352478
Epoch: 667

Loss on hold-out set: 0.014896265894834263
MeanAbsoluteError value on hold-out data: 0.09369943290948868
Epoch: 668
Loss on hold-out set: 0.014218682091462445
MeanAbsoluteError value on hold-out data: 0.09511623531579971
Epoch: 669
```

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Loss on hold-out set: 0.013734217589523442
MeanAbsoluteError value on hold-out data: 0.09153085201978683
Epoch: 670

Loss on hold-out set: 0.016342520564503502
MeanAbsoluteError value on hold-out data: 0.10052680224180222
Epoch: 671
Loss on hold-out set: 0.013259290386728632
MeanAbsoluteError value on hold-out data: 0.08863037079572678
Epoch: 672

Loss on hold-out set: 0.015437392806391776
MeanAbsoluteError value on hold-out data: 0.09927630424499512
Epoch: 673

Loss on hold-out set: 0.015133140523685142
MeanAbsoluteError value on hold-out data: 0.09610424935817719
Epoch: 674
Loss on hold-out set: 0.01224482253646632
MeanAbsoluteError value on hold-out data: 0.08288715034723282
Epoch: 675

Loss on hold-out set: 0.012882793504565294
MeanAbsoluteError value on hold-out data: 0.08711256831884384
Epoch: 676

Loss on hold-out set: 0.013527038416553599
MeanAbsoluteError value on hold-out data: 0.09073268622159958
Epoch: 677
Loss on hold-out set: 0.013210346166209395
MeanAbsoluteError value on hold-out data: 0.09029712527990341
Epoch: 678

Loss on hold-out set: 0.013906400328948318
MeanAbsoluteError value on hold-out data: 0.09163986146450043
Epoch: 679

Loss on hold-out set: 0.01247040244289868
MeanAbsoluteError value on hold-out data: 0.08765751123428345
Epoch: 680
```

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Loss on hold-out set: 0.01318630345763874
MeanAbsoluteError value on hold-out data: 0.08883168548345566
Epoch: 681

Loss on hold-out set: 0.013649444801073211
MeanAbsoluteError value on hold-out data: 0.0932684913277626
Epoch: 682

Loss on hold-out set: 0.013291262611019192
MeanAbsoluteError value on hold-out data: 0.0871022418141365
Epoch: 683
Loss on hold-out set: 0.01445298403792549
MeanAbsoluteError value on hold-out data: 0.09469656646251678
Epoch: 684

Loss on hold-out set: 0.013832887771576452
MeanAbsoluteError value on hold-out data: 0.09007678925991058
Epoch: 685

Loss on hold-out set: 0.01272112884549036
MeanAbsoluteError value on hold-out data: 0.08759532123804092
Epoch: 686
Loss on hold-out set: 0.015304249932451058
MeanAbsoluteError value on hold-out data: 0.09381774812936783
Epoch: 687

Loss on hold-out set: 0.015047155484001753
MeanAbsoluteError value on hold-out data: 0.09336500614881516
Epoch: 688

Loss on hold-out set: 0.013201099016005174
MeanAbsoluteError value on hold-out data: 0.0886252373456955
Epoch: 689
Loss on hold-out set: 0.012643601216429184
MeanAbsoluteError value on hold-out data: 0.08863086998462677
Epoch: 690

Loss on hold-out set: 0.012731224526651203
MeanAbsoluteError value on hold-out data: 0.08803972601890564
Epoch: 691
```

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Loss on hold-out set: 0.014712495260149202
MeanAbsoluteError value on hold-out data: 0.0930987074971199
Epoch: 692
Loss on hold-out set: 0.015109362610335969
MeanAbsoluteError value on hold-out data: 0.09261055290699005
Epoch: 693

Loss on hold-out set: 0.01274038686339433
MeanAbsoluteError value on hold-out data: 0.08731617033481598
Epoch: 694

Loss on hold-out set: 0.01348415752787209
MeanAbsoluteError value on hold-out data: 0.09108549356460571
Epoch: 695
Loss on hold-out set: 0.012216553959588055
MeanAbsoluteError value on hold-out data: 0.08626237511634827
Epoch: 696

Loss on hold-out set: 0.013724211943723882
MeanAbsoluteError value on hold-out data: 0.09414254873991013
Epoch: 697

Loss on hold-out set: 0.014574426771384121
MeanAbsoluteError value on hold-out data: 0.09255022555589676
Epoch: 698
Loss on hold-out set: 0.013789630330575165
MeanAbsoluteError value on hold-out data: 0.08985623717308044
Epoch: 699

Loss on hold-out set: 0.01321655807171434
MeanAbsoluteError value on hold-out data: 0.08901600539684296
Epoch: 700

Loss on hold-out set: 0.014627046011573839
MeanAbsoluteError value on hold-out data: 0.0902458131313324
Epoch: 701
Loss on hold-out set: 0.01425952055620049
MeanAbsoluteError value on hold-out data: 0.09083569049835205
Epoch: 702
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Loss on hold-out set: 0.012775320112511205
MeanAbsoluteError value on hold-out data: 0.08823573589324951
Epoch: 703

Loss on hold-out set: 0.014700035259641784
MeanAbsoluteError value on hold-out data: 0.0908830314874649
Epoch: 704
Loss on hold-out set: 0.014802121576697877
MeanAbsoluteError value on hold-out data: 0.09376129508018494
Epoch: 705

Loss on hold-out set: 0.014337499959898803
MeanAbsoluteError value on hold-out data: 0.09468299150466919
Epoch: 706

Loss on hold-out set: 0.012350101420015563
MeanAbsoluteError value on hold-out data: 0.08713865280151367
Epoch: 707
Loss on hold-out set: 0.012711425279388398
MeanAbsoluteError value on hold-out data: 0.08691292256116867
Epoch: 708

Loss on hold-out set: 0.013836053392345397
MeanAbsoluteError value on hold-out data: 0.09160690754652023
Epoch: 709

Loss on hold-out set: 0.012502469502408834
MeanAbsoluteError value on hold-out data: 0.08879640698432922
Epoch: 710
Loss on hold-out set: 0.012986520789272617
MeanAbsoluteError value on hold-out data: 0.08759292960166931
Epoch: 711

Loss on hold-out set: 0.015044022960937582
MeanAbsoluteError value on hold-out data: 0.09452371299266815
Epoch: 712

Loss on hold-out set: 0.011657407127980452
MeanAbsoluteError value on hold-out data: 0.08472084999084473
Epoch: 713
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Loss on hold-out set: 0.011235689398387573
MeanAbsoluteError value on hold-out data: 0.08267323672771454
Epoch: 714

Loss on hold-out set: 0.013600347689983512
MeanAbsoluteError value on hold-out data: 0.08894886076450348
Epoch: 715

Loss on hold-out set: 0.012105938689492177
MeanAbsoluteError value on hold-out data: 0.08732347935438156
Epoch: 716
Loss on hold-out set: 0.013396061607539499
MeanAbsoluteError value on hold-out data: 0.09140992164611816
Epoch: 717

Loss on hold-out set: 0.0137459191531525
MeanAbsoluteError value on hold-out data: 0.09257806837558746
Epoch: 718

Loss on hold-out set: 0.012546073122842548
MeanAbsoluteError value on hold-out data: 0.08790873736143112
Epoch: 719
Loss on hold-out set: 0.012935333127285654
MeanAbsoluteError value on hold-out data: 0.08458225429058075
Epoch: 720

Loss on hold-out set: 0.011632198863657408
MeanAbsoluteError value on hold-out data: 0.08467762172222137
Epoch: 721

Loss on hold-out set: 0.012363596545983456
MeanAbsoluteError value on hold-out data: 0.08509377390146255
Epoch: 722
Loss on hold-out set: 0.014148826817884886
MeanAbsoluteError value on hold-out data: 0.093085877597332
Epoch: 723

Loss on hold-out set: 0.012433768993784442
MeanAbsoluteError value on hold-out data: 0.08823707699775696
Epoch: 724
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Loss on hold-out set: 0.012464704282222286
MeanAbsoluteError value on hold-out data: 0.08326540142297745
Epoch: 725
Loss on hold-out set: 0.014542841403114532
MeanAbsoluteError value on hold-out data: 0.09195412695407867
Epoch: 726

Loss on hold-out set: 0.012963014993219986
MeanAbsoluteError value on hold-out data: 0.08787815272808075
Epoch: 727

Loss on hold-out set: 0.01403247791546164
MeanAbsoluteError value on hold-out data: 0.08939296007156372
Epoch: 728
Loss on hold-out set: 0.013391595064216139
MeanAbsoluteError value on hold-out data: 0.0901135504245758
Epoch: 729

Loss on hold-out set: 0.013021728320575979
MeanAbsoluteError value on hold-out data: 0.0840332955121994
Epoch: 730

Loss on hold-out set: 0.012802714221082473
MeanAbsoluteError value on hold-out data: 0.08867868781089783
Epoch: 731
Loss on hold-out set: 0.013237925821595126
MeanAbsoluteError value on hold-out data: 0.08729298412799835
Epoch: 732

Loss on hold-out set: 0.012203150826341396
MeanAbsoluteError value on hold-out data: 0.0852484405040741
Epoch: 733

Loss on hold-out set: 0.01409699086162315
MeanAbsoluteError value on hold-out data: 0.08657993376255035
Epoch: 734
Loss on hold-out set: 0.014035576392780058
MeanAbsoluteError value on hold-out data: 0.08997902274131775
Epoch: 735
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Loss on hold-out set: 0.013304283588416486
MeanAbsoluteError value on hold-out data: 0.09051342308521271
Epoch: 736

Loss on hold-out set: 0.014046679926735427
MeanAbsoluteError value on hold-out data: 0.0925561934709549
Epoch: 737
Loss on hold-out set: 0.011600449130100969
MeanAbsoluteError value on hold-out data: 0.08491187542676926
Epoch: 738

Loss on hold-out set: 0.01349445105510919
MeanAbsoluteError value on hold-out data: 0.09145883470773697
Epoch: 739

Loss on hold-out set: 0.010566577164302846
MeanAbsoluteError value on hold-out data: 0.08124136924743652
Epoch: 740
Loss on hold-out set: 0.013249498401758803
MeanAbsoluteError value on hold-out data: 0.08734458684921265
Epoch: 741

Loss on hold-out set: 0.011289018845891405
MeanAbsoluteError value on hold-out data: 0.08463779091835022
Epoch: 742

Loss on hold-out set: 0.011670880715458527
MeanAbsoluteError value on hold-out data: 0.08585558831691742
Epoch: 743
Loss on hold-out set: 0.01192299812094158
MeanAbsoluteError value on hold-out data: 0.08283703029155731
Epoch: 744

Loss on hold-out set: 0.013263272891223702
MeanAbsoluteError value on hold-out data: 0.08958327025175095
Epoch: 745

Loss on hold-out set: 0.01259216743289168
MeanAbsoluteError value on hold-out data: 0.08946237713098526
Epoch: 746
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Loss on hold-out set: 0.010962449468267247
MeanAbsoluteError value on hold-out data: 0.08047328889369965
Epoch: 747

Loss on hold-out set: 0.013950307039776818
MeanAbsoluteError value on hold-out data: 0.09224717319011688
Epoch: 748

Loss on hold-out set: 0.012725316789583304
MeanAbsoluteError value on hold-out data: 0.08794053643941879
Epoch: 749
Loss on hold-out set: 0.013753730803024762
MeanAbsoluteError value on hold-out data: 0.09046129137277603
Epoch: 750

Loss on hold-out set: 0.013275847716431598
MeanAbsoluteError value on hold-out data: 0.08802768588066101
Epoch: 751

Loss on hold-out set: 0.01263671110937139
MeanAbsoluteError value on hold-out data: 0.08865486085414886
Epoch: 752
Loss on hold-out set: 0.012653600910319559
MeanAbsoluteError value on hold-out data: 0.08785820752382278
Epoch: 753

Loss on hold-out set: 0.011357308911101427
MeanAbsoluteError value on hold-out data: 0.08242348581552505
Epoch: 754

Loss on hold-out set: 0.012486287038724791
MeanAbsoluteError value on hold-out data: 0.08605941385030746
Epoch: 755
Loss on hold-out set: 0.015035675091930899
MeanAbsoluteError value on hold-out data: 0.09502170234918594
Epoch: 756

Loss on hold-out set: 0.012586769370136608
MeanAbsoluteError value on hold-out data: 0.08835557103157043
Epoch: 757
```

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Loss on hold-out set: 0.011356409099777616
MeanAbsoluteError value on hold-out data: 0.08227486908435822
Epoch: 758
Loss on hold-out set: 0.013893006234405524
MeanAbsoluteError value on hold-out data: 0.09020248800516129
Epoch: 759

Loss on hold-out set: 0.012152334756780571
MeanAbsoluteError value on hold-out data: 0.084882453083992
Epoch: 760

Loss on hold-out set: 0.012519141711794267
MeanAbsoluteError value on hold-out data: 0.08717131614685059
Epoch: 761
Loss on hold-out set: 0.011562469255222823
MeanAbsoluteError value on hold-out data: 0.08301559835672379
Epoch: 762

Loss on hold-out set: 0.011627005284147647
MeanAbsoluteError value on hold-out data: 0.0822850838303566
Epoch: 763

Loss on hold-out set: 0.013561953390259684
MeanAbsoluteError value on hold-out data: 0.08740372210741043
Epoch: 764
Loss on hold-out set: 0.011336874153439567
MeanAbsoluteError value on hold-out data: 0.08026584982872009
Epoch: 765

Loss on hold-out set: 0.012369941143115284
MeanAbsoluteError value on hold-out data: 0.08800870180130005
Epoch: 766

Loss on hold-out set: 0.012732557277049637
MeanAbsoluteError value on hold-out data: 0.08890172094106674
Epoch: 767
Loss on hold-out set: 0.012204208210799455
MeanAbsoluteError value on hold-out data: 0.08551806211471558
Epoch: 768
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Loss on hold-out set: 0.012626854710166906
MeanAbsoluteError value on hold-out data: 0.08787168562412262
Epoch: 769

Loss on hold-out set: 0.012531858416641626
MeanAbsoluteError value on hold-out data: 0.08560790121555328
Epoch: 770
Loss on hold-out set: 0.012608914262285302
MeanAbsoluteError value on hold-out data: 0.08789979666471481
Epoch: 771

Loss on hold-out set: 0.012175513604694667
MeanAbsoluteError value on hold-out data: 0.08791116625070572
Epoch: 772

Loss on hold-out set: 0.013099316488875742
MeanAbsoluteError value on hold-out data: 0.08863489329814911
Epoch: 773
Loss on hold-out set: 0.013537896115837307
MeanAbsoluteError value on hold-out data: 0.08974085003137589
Epoch: 774

Loss on hold-out set: 0.012502023851993727
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Epoch: 775

Loss on hold-out set: 0.012313999776451964
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Epoch: 776
Loss on hold-out set: 0.011260079903258884
MeanAbsoluteError value on hold-out data: 0.08092668652534485
Epoch: 777

Loss on hold-out set: 0.011411377942422404
MeanAbsoluteError value on hold-out data: 0.0808485597372055
Epoch: 778

Loss on hold-out set: 0.012977309989941309
MeanAbsoluteError value on hold-out data: 0.08744536340236664
Epoch: 779
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Loss on hold-out set: 0.012457807153492838
MeanAbsoluteError value on hold-out data: 0.08328290283679962
Epoch: 780

Loss on hold-out set: 0.011451511291525093
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Epoch: 781

Loss on hold-out set: 0.011950397163939972
MeanAbsoluteError value on hold-out data: 0.08406277000904083
Epoch: 782
Loss on hold-out set: 0.011502560873680826
MeanAbsoluteError value on hold-out data: 0.08230368047952652
Epoch: 783

Loss on hold-out set: 0.011180205837348089
MeanAbsoluteError value on hold-out data: 0.0819452702999115
Epoch: 784

Loss on hold-out set: 0.011571310421083277
MeanAbsoluteError value on hold-out data: 0.08649612218141556
Epoch: 785
Loss on hold-out set: 0.012881500588361329
MeanAbsoluteError value on hold-out data: 0.0861847847700119
Epoch: 786

Loss on hold-out set: 0.012108865688423976
MeanAbsoluteError value on hold-out data: 0.08227813988924026
Epoch: 787

Loss on hold-out set: 0.01255813938709707
MeanAbsoluteError value on hold-out data: 0.08603553473949432
Epoch: 788
Loss on hold-out set: 0.011161312837696944
MeanAbsoluteError value on hold-out data: 0.08222150057554245
Epoch: 789

Loss on hold-out set: 0.011923438124504172
MeanAbsoluteError value on hold-out data: 0.08607087284326553
Epoch: 790
```

```
Loss on hold-out set: 0.011938977228928706
MeanAbsoluteError value on hold-out data: 0.08717851340770721
Epoch: 791
Loss on hold-out set: 0.013572028415995495
MeanAbsoluteError value on hold-out data: 0.08930019289255142
Epoch: 792

Loss on hold-out set: 0.011760531625865649
MeanAbsoluteError value on hold-out data: 0.0824320837855339
Epoch: 793

Loss on hold-out set: 0.013053571828835023
MeanAbsoluteError value on hold-out data: 0.08885597437620163
Epoch: 794
Loss on hold-out set: 0.012386736524203266
MeanAbsoluteError value on hold-out data: 0.08355417847633362
Epoch: 795

Loss on hold-out set: 0.012233806816439027
MeanAbsoluteError value on hold-out data: 0.08389709144830704
Epoch: 796

Loss on hold-out set: 0.01264769484550925
MeanAbsoluteError value on hold-out data: 0.08776209503412247
Epoch: 797
Loss on hold-out set: 0.014490431399608497
MeanAbsoluteError value on hold-out data: 0.09010812640190125
Epoch: 798

Loss on hold-out set: 0.010761176118085131
MeanAbsoluteError value on hold-out data: 0.08011528104543686
Epoch: 799

Loss on hold-out set: 0.012000334099636044
MeanAbsoluteError value on hold-out data: 0.08464542031288147
Epoch: 800
Loss on hold-out set: 0.010357865008797186
MeanAbsoluteError value on hold-out data: 0.08067206293344498
Epoch: 801
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Loss on hold-out set: 0.012048521595618998
MeanAbsoluteError value on hold-out data: 0.08503985404968262
Epoch: 802

Loss on hold-out set: 0.011277190071077468
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Epoch: 803
Loss on hold-out set: 0.011754163628650834
MeanAbsoluteError value on hold-out data: 0.08532029390335083
Epoch: 804

Loss on hold-out set: 0.011707378152273848
MeanAbsoluteError value on hold-out data: 0.08390554785728455
Epoch: 805

Loss on hold-out set: 0.012212011087352342
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Epoch: 806
Loss on hold-out set: 0.012498114999035389
MeanAbsoluteError value on hold-out data: 0.08575763553380966
Epoch: 807

Loss on hold-out set: 0.012913571900207898
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Epoch: 808

Loss on hold-out set: 0.012098721834869744
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Epoch: 809
Loss on hold-out set: 0.011152371004815602
MeanAbsoluteError value on hold-out data: 0.08148984611034393
Epoch: 810

Loss on hold-out set: 0.012089414709189441
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Epoch: 811

Loss on hold-out set: 0.010609691201049523
MeanAbsoluteError value on hold-out data: 0.0793781578540802
Epoch: 812
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Loss on hold-out set: 0.013490606250161363
MeanAbsoluteError value on hold-out data: 0.08697226643562317
Epoch: 813

Loss on hold-out set: 0.011964702616884704
MeanAbsoluteError value on hold-out data: 0.08248436450958252
Epoch: 814

Loss on hold-out set: 0.011984639649696571
MeanAbsoluteError value on hold-out data: 0.08263735473155975
Epoch: 815
Loss on hold-out set: 0.01084867354951598
MeanAbsoluteError value on hold-out data: 0.08218921720981598
Epoch: 816

Loss on hold-out set: 0.01244965796698428
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Epoch: 817

Loss on hold-out set: 0.012621153972140746
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Epoch: 818
Loss on hold-out set: 0.011170837762765586
MeanAbsoluteError value on hold-out data: 0.08195691555738449
Epoch: 819

Loss on hold-out set: 0.010242390295995088
MeanAbsoluteError value on hold-out data: 0.07501169294118881
Epoch: 820

Loss on hold-out set: 0.011777982733231813
MeanAbsoluteError value on hold-out data: 0.08426183462142944
Epoch: 821
Loss on hold-out set: 0.011972209158708816
MeanAbsoluteError value on hold-out data: 0.08065351843833923
Epoch: 822

Loss on hold-out set: 0.010421844099716205
MeanAbsoluteError value on hold-out data: 0.07622716575860977
Epoch: 823
```

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Loss on hold-out set: 0.013220155157699386
MeanAbsoluteError value on hold-out data: 0.08627309650182724
Epoch: 824
Loss on hold-out set: 0.013359996119203667
MeanAbsoluteError value on hold-out data: 0.09135977178812027
Epoch: 825

Loss on hold-out set: 0.01199086207721848
MeanAbsoluteError value on hold-out data: 0.08189936727285385
Epoch: 826

Loss on hold-out set: 0.01105456021734426
MeanAbsoluteError value on hold-out data: 0.07976293563842773
Epoch: 827
Loss on hold-out set: 0.010423620112778736
MeanAbsoluteError value on hold-out data: 0.07961120456457138
Epoch: 828

Loss on hold-out set: 0.011218004723389944
MeanAbsoluteError value on hold-out data: 0.07981065660715103
Epoch: 829

Loss on hold-out set: 0.010968996925657847
MeanAbsoluteError value on hold-out data: 0.08102231472730637
Epoch: 830
Loss on hold-out set: 0.011137827083681865
MeanAbsoluteError value on hold-out data: 0.08071498572826385
Epoch: 831

Loss on hold-out set: 0.012029929731118803
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Epoch: 832

Loss on hold-out set: 0.012001719089457765
MeanAbsoluteError value on hold-out data: 0.08422146737575531
Epoch: 833
Loss on hold-out set: 0.012077170057236799
MeanAbsoluteError value on hold-out data: 0.08585459738969803
Epoch: 834
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Loss on hold-out set: 0.010210105228882943
MeanAbsoluteError value on hold-out data: 0.07663607597351074
Epoch: 835

Loss on hold-out set: 0.012765356402621062
MeanAbsoluteError value on hold-out data: 0.0846935585141182
Epoch: 836
Loss on hold-out set: 0.011586861013201997
MeanAbsoluteError value on hold-out data: 0.08514168113470078
Epoch: 837

Loss on hold-out set: 0.011151756523856117
MeanAbsoluteError value on hold-out data: 0.08265072852373123
Epoch: 838

Loss on hold-out set: 0.012486282032671927
MeanAbsoluteError value on hold-out data: 0.0839204266667366
Epoch: 839
Loss on hold-out set: 0.010572723705117824
MeanAbsoluteError value on hold-out data: 0.07981853187084198
Epoch: 840

Loss on hold-out set: 0.01255846069200743
MeanAbsoluteError value on hold-out data: 0.08480942994356155
Epoch: 841

Loss on hold-out set: 0.01076823450866262
MeanAbsoluteError value on hold-out data: 0.07884037494659424
Epoch: 842
Loss on hold-out set: 0.012028595104202395
MeanAbsoluteError value on hold-out data: 0.08112446218729019
Epoch: 843

Loss on hold-out set: 0.012259522410749924
MeanAbsoluteError value on hold-out data: 0.0833299309015274
Epoch: 844

Loss on hold-out set: 0.012293935950195494
MeanAbsoluteError value on hold-out data: 0.08373833447694778
Epoch: 845
```

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Loss on hold-out set: 0.011291630158593762
MeanAbsoluteError value on hold-out data: 0.081919364631176
Epoch: 846

Loss on hold-out set: 0.011294056409557622
MeanAbsoluteError value on hold-out data: 0.08149783313274384
Epoch: 847

Loss on hold-out set: 0.010670019000366059
MeanAbsoluteError value on hold-out data: 0.07926541566848755
Epoch: 848
Loss on hold-out set: 0.01230319602007512
MeanAbsoluteError value on hold-out data: 0.08425014466047287
Epoch: 849

Loss on hold-out set: 0.01083051063658786
MeanAbsoluteError value on hold-out data: 0.07920687645673752
Epoch: 850

Loss on hold-out set: 0.010363127559782394
MeanAbsoluteError value on hold-out data: 0.07841289788484573
Epoch: 851
Loss on hold-out set: 0.010072192514223085
MeanAbsoluteError value on hold-out data: 0.07410680502653122
Epoch: 852

Loss on hold-out set: 0.010279562657718391
MeanAbsoluteError value on hold-out data: 0.07477105408906937
Epoch: 853

Loss on hold-out set: 0.010846589439849291
MeanAbsoluteError value on hold-out data: 0.08004190027713776
Epoch: 854
Loss on hold-out set: 0.01099010043835733
MeanAbsoluteError value on hold-out data: 0.07997359335422516
Epoch: 855

Loss on hold-out set: 0.011071779516169045
MeanAbsoluteError value on hold-out data: 0.07916133850812912
Epoch: 856
```

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Loss on hold-out set: 0.012691507314752926
MeanAbsoluteError value on hold-out data: 0.08172242343425751
Epoch: 857
Loss on hold-out set: 0.009940426803877927
MeanAbsoluteError value on hold-out data: 0.07495184242725372
Epoch: 858

Loss on hold-out set: 0.01251771736346806
MeanAbsoluteError value on hold-out data: 0.08726448565721512
Epoch: 859

Loss on hold-out set: 0.010472437192620419
MeanAbsoluteError value on hold-out data: 0.07703165709972382
Epoch: 860
Loss on hold-out set: 0.010443457255605608
MeanAbsoluteError value on hold-out data: 0.07886314392089844
Epoch: 861

Loss on hold-out set: 0.011681455817961251
MeanAbsoluteError value on hold-out data: 0.08216250687837601
Epoch: 862

Loss on hold-out set: 0.013974317610894408
MeanAbsoluteError value on hold-out data: 0.08958712220191956
Epoch: 863
Loss on hold-out set: 0.01089927799198146
MeanAbsoluteError value on hold-out data: 0.07957014441490173
Epoch: 864

Loss on hold-out set: 0.010894766964920564
MeanAbsoluteError value on hold-out data: 0.07779132574796677
Epoch: 865

Loss on hold-out set: 0.012231129219386882
MeanAbsoluteError value on hold-out data: 0.08444193005561829
Epoch: 866
Loss on hold-out set: 0.011909912752647264
MeanAbsoluteError value on hold-out data: 0.0803740918636322
Epoch: 867
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Loss on hold-out set: 0.00965155557511025
MeanAbsoluteError value on hold-out data: 0.07446232438087463
Epoch: 868

Loss on hold-out set: 0.011378743269051483
MeanAbsoluteError value on hold-out data: 0.08351527899503708
Epoch: 869
Loss on hold-out set: 0.012960535860377907
MeanAbsoluteError value on hold-out data: 0.08603967726230621
Epoch: 870

Loss on hold-out set: 0.010523223480316422
MeanAbsoluteError value on hold-out data: 0.0780780091881752
Epoch: 871

Loss on hold-out set: 0.010281034144281876
MeanAbsoluteError value on hold-out data: 0.07585296034812927
Epoch: 872
Loss on hold-out set: 0.011536362630916603
MeanAbsoluteError value on hold-out data: 0.0834391862154007
Epoch: 873

Loss on hold-out set: 0.011613426630198471
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Epoch: 874

Loss on hold-out set: 0.013158803896706862
MeanAbsoluteError value on hold-out data: 0.08761236816644669
Epoch: 875
Loss on hold-out set: 0.010334851447793577
MeanAbsoluteError value on hold-out data: 0.07888723909854889
Epoch: 876

Loss on hold-out set: 0.010652441104975879
MeanAbsoluteError value on hold-out data: 0.07869382202625275
Epoch: 877

Loss on hold-out set: 0.010923101076914464
MeanAbsoluteError value on hold-out data: 0.08008649200201035
Epoch: 878
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Loss on hold-out set: 0.011654035824528806
MeanAbsoluteError value on hold-out data: 0.08154154568910599
Epoch: 879

Loss on hold-out set: 0.010599687915989003
MeanAbsoluteError value on hold-out data: 0.07704054564237595
Epoch: 880

Loss on hold-out set: 0.010593209045982804
MeanAbsoluteError value on hold-out data: 0.07616398483514786
Epoch: 881
Loss on hold-out set: 0.011297327078452024
MeanAbsoluteError value on hold-out data: 0.08008179068565369
Epoch: 882

Loss on hold-out set: 0.012818842702320884
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Epoch: 883

Loss on hold-out set: 0.011403568136496081
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Epoch: 884
Loss on hold-out set: 0.009296016003081603
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Epoch: 885

Loss on hold-out set: 0.010309624649768617
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Epoch: 886

Loss on hold-out set: 0.010520919856620216
MeanAbsoluteError value on hold-out data: 0.07875441014766693
Epoch: 887
Loss on hold-out set: 0.011748523640477893
MeanAbsoluteError value on hold-out data: 0.07888000458478928
Epoch: 888

Loss on hold-out set: 0.009837052184799784
MeanAbsoluteError value on hold-out data: 0.07532542198896408
Epoch: 889
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Loss on hold-out set: 0.009815488533386088
MeanAbsoluteError value on hold-out data: 0.07399434596300125
Epoch: 890
Loss on hold-out set: 0.010228912676490533
MeanAbsoluteError value on hold-out data: 0.079363152384758
Epoch: 891

Loss on hold-out set: 0.010457604135396347
MeanAbsoluteError value on hold-out data: 0.07821693271398544
Epoch: 892

Loss on hold-out set: 0.009354324731514983
MeanAbsoluteError value on hold-out data: 0.07127799093723297
Epoch: 893
Loss on hold-out set: 0.011279911138505365
MeanAbsoluteError value on hold-out data: 0.0795518010854721
Epoch: 894

Loss on hold-out set: 0.010221205364020231
MeanAbsoluteError value on hold-out data: 0.07754063606262207
Epoch: 895

Loss on hold-out set: 0.010506279673724445
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Epoch: 896
Loss on hold-out set: 0.009268699432962725
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Epoch: 897

Loss on hold-out set: 0.010444649571933648
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Epoch: 898

Loss on hold-out set: 0.009947843398646607
MeanAbsoluteError value on hold-out data: 0.07516754418611526
Epoch: 899
Loss on hold-out set: 0.011507693281697963
MeanAbsoluteError value on hold-out data: 0.08003173023462296
Epoch: 900
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Loss on hold-out set: 0.010582835534733022
MeanAbsoluteError value on hold-out data: 0.0777437686920166
Epoch: 901

Loss on hold-out set: 0.010837489615878439
MeanAbsoluteError value on hold-out data: 0.07969188690185547
Epoch: 902
Loss on hold-out set: 0.009632011383982899
MeanAbsoluteError value on hold-out data: 0.07446824759244919
Epoch: 903

Loss on hold-out set: 0.011563167420730073
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Epoch: 904

Loss on hold-out set: 0.011548360876937901
MeanAbsoluteError value on hold-out data: 0.08204109966754913
Epoch: 905
Loss on hold-out set: 0.011290753532666713
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Epoch: 906

Loss on hold-out set: 0.009786605982820523
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Epoch: 907

Loss on hold-out set: 0.010173431404934187
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Epoch: 908
Loss on hold-out set: 0.010591513735853368
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Epoch: 909

Loss on hold-out set: 0.009808487134359894
MeanAbsoluteError value on hold-out data: 0.07365819811820984
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Loss on hold-out set: 0.010770416129914034
MeanAbsoluteError value on hold-out data: 0.07900591939687729
Epoch: 911
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Loss on hold-out set: 0.01044701663791784
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Epoch: 912

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Epoch: 913

Loss on hold-out set: 0.010841358591351309
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Epoch: 914
Loss on hold-out set: 0.010268224392763538
MeanAbsoluteError value on hold-out data: 0.07870779186487198
Epoch: 915

Loss on hold-out set: 0.010115042418625915
MeanAbsoluteError value on hold-out data: 0.07803353667259216
Epoch: 916

Loss on hold-out set: 0.008532184674719853
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Epoch: 917
Loss on hold-out set: 0.01184425324393184
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Epoch: 918

Loss on hold-out set: 0.011654391586441003
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Epoch: 919

Loss on hold-out set: 0.011271168020903133
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Epoch: 920
Loss on hold-out set: 0.011201812428577493
MeanAbsoluteError value on hold-out data: 0.08022148162126541
Epoch: 921

Loss on hold-out set: 0.010540635115030455
MeanAbsoluteError value on hold-out data: 0.07880537211894989
Epoch: 922
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Loss on hold-out set: 0.011239120441578052
MeanAbsoluteError value on hold-out data: 0.07978955656290054
Epoch: 923
Loss on hold-out set: 0.011506976629340594
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Epoch: 924

Loss on hold-out set: 0.010092509481679978
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Epoch: 925

Loss on hold-out set: 0.010325431214320512
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Epoch: 926
Loss on hold-out set: 0.010793940428605613
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Epoch: 927

Loss on hold-out set: 0.010938878100520062
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Epoch: 928

Loss on hold-out set: 0.010565976260234795
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Loss on hold-out set: 0.00967380122684214
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Epoch: 930

Loss on hold-out set: 0.010876146113035551
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Epoch: 931

Loss on hold-out set: 0.010061199156055712
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Epoch: 932
Loss on hold-out set: 0.009821009795911474
MeanAbsoluteError value on hold-out data: 0.07455424219369888
Epoch: 933
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Loss on hold-out set: 0.010002024930824215
MeanAbsoluteError value on hold-out data: 0.07587635517120361
Epoch: 934

Loss on hold-out set: 0.011298003224461 96
MeanAbsoluteError value on hold-out data: 0.08141518384218216
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Loss on hold-out set: 0.01066030892446482
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Epoch: 936

Loss on hold-out set: 0.009964286240089375
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Epoch: 937

Loss on hold-out set: 0.00931739617510175
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Epoch: 938
Loss on hold-out set: 0.009748321147879437
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Epoch: 939

Loss on hold-out set: 0.010150639437682307
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Loss on hold-out set: 0.010908213639437841
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Epoch: 942

Loss on hold-out set: 0.010553390971035697
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Epoch: 943

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Epoch: 944
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Loss on hold-out set: 0.01043209292895502
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Epoch: 945

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Epoch: 946

Loss on hold-out set: 0.01067965086188148
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Loss on hold-out set: 0.010321474574138846
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Epoch: 948

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Loss on hold-out set: 0.010054067125486957
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Loss on hold-out set: 0.010195181326416787
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Loss on hold-out set: 0.009803097379941998
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Epoch: 952

Loss on hold-out set: 0.009233000486853295
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Epoch: 953
Loss on hold-out set: 0.010765911210376847
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Epoch: 954

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Loss on hold-out set: 0.010406090975308568
MeanAbsoluteError value on hold-out data: 0.08115773648023605
Epoch: 956
Loss on hold-out set: 0.01028298560542074
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Epoch: 957

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Epoch: 958

Loss on hold-out set: 0.010366151751756357
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Loss on hold-out set: 0.012781157962648042
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Loss on hold-out set: 0.011916668237475581
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Epoch: 961

Loss on hold-out set: 0.00937242145374815
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Epoch: 962
Loss on hold-out set: 0.00938447217401972
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Epoch: 963

Loss on hold-out set: 0.011190579106187214
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Epoch: 964

Loss on hold-out set: 0.011516710433546299
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Epoch: 965
Loss on hold-out set: 0.01040013180154953
MeanAbsoluteError value on hold-out data: 0.07716669887304306
Epoch: 966
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Loss on hold-out set: 0.008673201506414l4
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Epoch: 967

Loss on hold-out set: 0.010476253818330103
MeanAbsoluteError value on hold-out data: 0.07735367864370346
Epoch: 968
Loss on hold-out set: 0.008017128499939947
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Loss on hold-out set: 0.010181804305151067
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Epoch: 970

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Loss on hold-out set: 0.008912336273839779
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Epoch: 972

Loss on hold-out set: 0.0102005900302053
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Loss on hold-out set: 0.010105598901379078
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Loss on hold-out set: 0.010165939129304509
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Loss on hold-out set: 0.010691978577330398
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Loss on hold-out set: 0.010306397685781121
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Epoch: 977
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Loss on hold-out set: 0.011079969528946094
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Loss on hold-out set: 0.009894329460694428
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Loss on hold-out set: 0.011955982340999375
MeanAbsoluteError value on hold-out data: 0.08118919283151627
Epoch: 981

Loss on hold-out set: 0.010727505604444547
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Loss on hold-out set: 0.009406191572452371
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Loss on hold-out set: 0.009051177835838947
MeanAbsoluteError value on hold-out data: 0.07398620247840881
Epoch: 984

Loss on hold-out set: 0.009030472595404716
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Epoch: 985

Loss on hold-out set: 0.008233589374964746
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Loss on hold-out set: 0.009518739900546885
MeanAbsoluteError value on hold-out data: 0.07171015441417694
Epoch: 987

Loss on hold-out set: 0.010120526629519493
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Epoch: 988
```

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Loss on hold-out set: 0.008151337351591792
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Epoch: 989
Loss on hold-out set: 0.010260261130800549
MeanAbsoluteError value on hold-out data: 0.07762278616428375
Epoch: 990

Loss on hold-out set: 0.01043171938205584
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Epoch: 991

Loss on hold-out set: 0.00982216380346775
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Loss on hold-out set: 0.01010935024426241
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Epoch: 993

Loss on hold-out set: 0.008737561553207342
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Epoch: 994

Loss on hold-out set: 0.009949234955759797
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Loss on hold-out set: 0.009714007097184852
MeanAbsoluteError value on hold-out data: 0.0733596682548523
Epoch: 996

Loss on hold-out set: 0.009559327386474858
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Loss on hold-out set: 0.010821051050685733
MeanAbsoluteError value on hold-out data: 0.0761180967092514
Epoch: 998
Loss on hold-out set: 0.008182128822760811
MeanAbsoluteError value on hold-out data: 0.07177567481994629
Epoch: 999
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Loss on hold-out set: 0.009650884251071452
MeanAbsoluteError value on hold-out data: 0.07583362609148026
Epoch: 1000

Loss on hold-out set: 0.00912706283906194
MeanAbsoluteError value on hold-out data: 0.07308671623468399
Epoch: 1001
Loss on hold-out set: 0.010716556181647926
MeanAbsoluteError value on hold-out data: 0.07828537374734879
Epoch: 1002

Loss on hold-out set: 0.009907118007946943
MeanAbsoluteError value on hold-out data: 0.07324421405792236
Epoch: 1003

Loss on hold-out set: 0.009838409919090433
MeanAbsoluteError value on hold-out data: 0.07358106970787048
Epoch: 1004
Loss on hold-out set: 0.010388645592756802
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Epoch: 1005

Loss on hold-out set: 0.009185194188806539
MeanAbsoluteError value on hold-out data: 0.07450535893440247
Epoch: 1006

Loss on hold-out set: 0.008411338384078893
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Epoch: 1007
Loss on hold-out set: 0.009633201221295167
MeanAbsoluteError value on hold-out data: 0.0718674436211586
Epoch: 1008

Loss on hold-out set: 0.011217695318046027
MeanAbsoluteError value on hold-out data: 0.07735791802406311
Epoch: 1009

Loss on hold-out set: 0.01162674711032499
MeanAbsoluteError value on hold-out data: 0.07945922017097473
Epoch: 1010
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Loss on hold-out set: 0.008846016512555555
MeanAbsoluteError value on hold-out data: 0.06883455067873001
Epoch: 1011

Loss on hold-out set: 0.008285254152942798
MeanAbsoluteError value on hold-out data: 0.06843537092208862
Epoch: 1012

Loss on hold-out set: 0.00964612061627122
MeanAbsoluteError value on hold-out data: 0.07599431276321411
Epoch: 1013
Loss on hold-out set: 0.009484323369433697
MeanAbsoluteError value on hold-out data: 0.07027170807123184
Epoch: 1014

Loss on hold-out set: 0.009578314667627031
MeanAbsoluteError value on hold-out data: 0.07641306519508362
Epoch: 1015

Loss on hold-out set: 0.010662721924757838
MeanAbsoluteError value on hold-out data: 0.07776158303022385
Epoch: 1016
Loss on hold-out set: 0.007217271433946734
MeanAbsoluteError value on hold-out data: 0.06332535296678543
Epoch: 1017

Loss on hold-out set: 0.008700098197950866
MeanAbsoluteError value on hold-out data: 0.0720493346452713
Epoch: 1018

Loss on hold-out set: 0.008277756240465048
MeanAbsoluteError value on hold-out data: 0.06784182041883469
Epoch: 1019
Loss on hold-out set: 0.009649743342403478
MeanAbsoluteError value on hold-out data: 0.07595877349376678
Epoch: 1020

Loss on hold-out set: 0.008516939247298676
MeanAbsoluteError value on hold-out data: 0.07148423790931702
Epoch: 1021
```

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Loss on hold-out set: 0.010241656722513048
MeanAbsoluteError value on hold-out data: 0.07793035358190536
Epoch: 1022
Loss on hold-out set: 0.009823777997383635
MeanAbsoluteError value on hold-out data: 0.07462351769208908
Epoch: 1023

Loss on hold-out set: 0.009423660920438124
MeanAbsoluteError value on hold-out data: 0.07253091782331467
Epoch: 1024

Loss on hold-out set: 0.009192634538740094
MeanAbsoluteError value on hold-out data: 0.07182789593935013
Epoch: 1025
Loss on hold-out set: 0.009999075095668861
MeanAbsoluteError value on hold-out data: 0.07422878593206406
Epoch: 1026

Loss on hold-out set: 0.009226348859228892
MeanAbsoluteError value on hold-out data: 0.07527128607034683
Epoch: 1027

Loss on hold-out set: 0.010406050200690515
MeanAbsoluteError value on hold-out data: 0.07627156376838684
Epoch: 1028
Loss on hold-out set: 0.010075316214885485
MeanAbsoluteError value on hold-out data: 0.07464103400707245
Epoch: 1029

Loss on hold-out set: 0.007891473443911915
MeanAbsoluteError value on hold-out data: 0.06669881194829941
Epoch: 1030

Loss on hold-out set: 0.008361747662565904
MeanAbsoluteError value on hold-out data: 0.06913010030984879
Epoch: 1031
Loss on hold-out set: 0.010360191175811148
MeanAbsoluteError value on hold-out data: 0.07625839859247208
Epoch: 1032
```

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Loss on hold-out set: 0.010315031463057 19
MeanAbsoluteError value on hold-out data: 0.07602520287036896
Epoch: 1033

Loss on hold-out set: 0.009611024976547923
MeanAbsoluteError value on hold-out data: 0.07293060421943665
Epoch: 1034
Loss on hold-out set: 0.010580128295041505
MeanAbsoluteError value on hold-out data: 0.076787069439888
Epoch: 1035

Loss on hold-out set: 0.009018206400869531
MeanAbsoluteError value on hold-out data: 0.07100393623113632
Epoch: 1036

Loss on hold-out set: 0.009403651445229191
MeanAbsoluteError value on hold-out data: 0.0737273097038269
Epoch: 1037
Loss on hold-out set: 0.010048537792560335
MeanAbsoluteError value on hold-out data: 0.07389655709266663
Epoch: 1038

Loss on hold-out set: 0.010088774586401996
MeanAbsoluteError value on hold-out data: 0.07545366883277893
Epoch: 1039

Loss on hold-out set: 0.009775095523582421
MeanAbsoluteError value on hold-out data: 0.07541853189468384
Epoch: 1040
Loss on hold-out set: 0.008889759014600714
MeanAbsoluteError value on hold-out data: 0.0708453580737114
Epoch: 1041

Loss on hold-out set: 0.010219978818766625
MeanAbsoluteError value on hold-out data: 0.07419796288013458
Epoch: 1042

Loss on hold-out set: 0.009880568968086815
MeanAbsoluteError value on hold-out data: 0.07288051396608353
Epoch: 1043
```

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Loss on hold-out set: 0.011080761257738535
MeanAbsoluteError value on hold-out data: 0.07829643040895462
Epoch: 1044

Loss on hold-out set: 0.008091812065940758
MeanAbsoluteError value on hold-out data: 0.06954268366098404
Epoch: 1045

Loss on hold-out set: 0.008772912261047167
MeanAbsoluteError value on hold-out data: 0.07180771976709366
Epoch: 1046
Loss on hold-out set: 0.008859732435133386
MeanAbsoluteError value on hold-out data: 0.07139207422733307
Epoch: 1047

Loss on hold-out set: 0.008815640879111014
MeanAbsoluteError value on hold-out data: 0.07062304764986038
Epoch: 1048

Loss on hold-out set: 0.01132335652577846
MeanAbsoluteError value on hold-out data: 0.07565022259950638
Epoch: 1049
Loss on hold-out set: 0.00939050525469914
MeanAbsoluteError value on hold-out data: 0.07399527728557587
Epoch: 1050

Loss on hold-out set: 0.009878753488998578
MeanAbsoluteError value on hold-out data: 0.07475496828556061
Epoch: 1051

Loss on hold-out set: 0.009710960324446205
MeanAbsoluteError value on hold-out data: 0.07543466240167618
Epoch: 1052
Loss on hold-out set: 0.00892301554427983
MeanAbsoluteError value on hold-out data: 0.07179003208875656
Epoch: 1053

Loss on hold-out set: 0.009736922347631965
MeanAbsoluteError value on hold-out data: 0.07380545139312744
Epoch: 1054
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Loss on hold-out set: 0.0092491903732783
MeanAbsoluteError value on hold-out data: 0.07312756031751633
Epoch: 1055
Loss on hold-out set: 0.008550533707457363
MeanAbsoluteError value on hold-out data: 0.07293356209993362
Epoch: 1056

Loss on hold-out set: 0.007820393180782047
MeanAbsoluteError value on hold-out data: 0.06611477583646774
Epoch: 1057

Loss on hold-out set: 0.009465605585476928
MeanAbsoluteError value on hold-out data: 0.07438766956329346
Epoch: 1058
Loss on hold-out set: 0.008748791293401155
MeanAbsoluteError value on hold-out data: 0.07045375555753708
Epoch: 1059

Loss on hold-out set: 0.009945157617985388
MeanAbsoluteError value on hold-out data: 0.07420968264341354
Epoch: 1060

Loss on hold-out set: 0.008139968255903417
MeanAbsoluteError value on hold-out data: 0.06938647478818893
Epoch: 1061
Loss on hold-out set: 0.009619896358150679
MeanAbsoluteError value on hold-out data: 0.07387065142393112
Epoch: 1062

Loss on hold-out set: 0.00873696406307308
MeanAbsoluteError value on hold-out data: 0.0688306987285614
Epoch: 1063

Loss on hold-out set: 0.00993291041663421
MeanAbsoluteError value on hold-out data: 0.07488460838794708
Epoch: 1064
Loss on hold-out set: 0.008945063465566817
MeanAbsoluteError value on hold-out data: 0.07078840583562851
Epoch: 1065
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Loss on hold-out set: 0.008711627673328622
MeanAbsoluteError value on hold-out data: 0.07060685008764267
Epoch: 1066

Loss on hold-out set: 0.008561781568641891
MeanAbsoluteError value on hold-out data: 0.06929024308919907
Epoch: 1067
Loss on hold-out set: 0.008214414951895984
MeanAbsoluteError value on hold-out data: 0.06702414900064468
Epoch: 1068

Loss on hold-out set: 0.009931575574058419
MeanAbsoluteError value on hold-out data: 0.07615899294614792
Epoch: 1069

Loss on hold-out set: 0.009602983864994408
MeanAbsoluteError value on hold-out data: 0.07511761039495468
Epoch: 1070
Loss on hold-out set: 0.0098953451329362
MeanAbsoluteError value on hold-out data: 0.07667653262615204
Epoch: 1071

Loss on hold-out set: 0.009126651286302755
MeanAbsoluteError value on hold-out data: 0.07067342847585678
Epoch: 1072

Loss on hold-out set: 0.010318759431344611
MeanAbsoluteError value on hold-out data: 0.07730618119239807
Epoch: 1073
Loss on hold-out set: 0.010471213706690225
MeanAbsoluteError value on hold-out data: 0.07590189576148987
Epoch: 1074

Loss on hold-out set: 0.008800882281636101
MeanAbsoluteError value on hold-out data: 0.07114902883768082
Epoch: 1075

Loss on hold-out set: 0.009353867709311696
MeanAbsoluteError value on hold-out data: 0.07263924926519394
Epoch: 1076
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Loss on hold-out set: 0.008832087196836558
MeanAbsoluteError value on hold-out data: 0.06964792311191559
Epoch: 1077

Loss on hold-out set: 0.009188366533101847
MeanAbsoluteError value on hold-out data: 0.0714731216430664
Epoch: 1078

Loss on hold-out set: 0.009181160608736718
MeanAbsoluteError value on hold-out data: 0.07047182321548462
Epoch: 1079
Loss on hold-out set: 0.009498757796294133
MeanAbsoluteError value on hold-out data: 0.07344841957092285
Epoch: 1080

Loss on hold-out set: 0.008557316851353487
MeanAbsoluteError value on hold-out data: 0.07155515998601913
Epoch: 1081

Loss on hold-out set: 0.008030338069996408
MeanAbsoluteError value on hold-out data: 0.06721904128789902
Epoch: 1082
Loss on hold-out set: 0.009663828139006606
MeanAbsoluteError value on hold-out data: 0.07340537756681442
Epoch: 1083

Loss on hold-out set: 0.009420075867528794
MeanAbsoluteError value on hold-out data: 0.07412054389715195
Epoch: 1084

Loss on hold-out set: 0.007339031155133853
MeanAbsoluteError value on hold-out data: 0.061981841921806335
Epoch: 1085
Loss on hold-out set: 0.00862485642838692
MeanAbsoluteError value on hold-out data: 0.06806190311908722
Epoch: 1086

Loss on hold-out set: 0.009537378611178914
MeanAbsoluteError value on hold-out data: 0.07404476404190063
Epoch: 1087
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Loss on hold-out set: 0.010180315926166562
MeanAbsoluteError value on hold-out data: 0.07655861228704453
Epoch: 1088
Loss on hold-out set: 0.009133365655883002
MeanAbsoluteError value on hold-out data: 0.07191671431064606
Epoch: 1089

Loss on hold-out set: 0.00852411797910463
MeanAbsoluteError value on hold-out data: 0.07059183716773987
Epoch: 1090

Loss on hold-out set: 0.00938878176422198
MeanAbsoluteError value on hold-out data: 0.07358210533857346
Epoch: 1091
Loss on hold-out set: 0.00906544773747252
MeanAbsoluteError value on hold-out data: 0.07083588093519211
Epoch: 1092

Loss on hold-out set: 0.008790796837492962
MeanAbsoluteError value on hold-out data: 0.07012681663036346
Epoch: 1093

Loss on hold-out set: 0.010065884564925605
MeanAbsoluteError value on hold-out data: 0.07472621649503708
Epoch: 1094
Loss on hold-out set: 0.008000439703755547
MeanAbsoluteError value on hold-out data: 0.06648498773574829
Epoch: 1095

Loss on hold-out set: 0.009174952413353215
MeanAbsoluteError value on hold-out data: 0.07231061160564423
Epoch: 1096

Loss on hold-out set: 0.010053324766934869
MeanAbsoluteError value on hold-out data: 0.07465694099664688
Epoch: 1097
Loss on hold-out set: 0.00808137076136821
MeanAbsoluteError value on hold-out data: 0.06709711998701096
Epoch: 1098
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Loss on hold-out set: 0.008454783550308397
MeanAbsoluteError value on hold-out data: 0.0688961073756218
Epoch: 1099

Loss on hold-out set: 0.009306110496254405
MeanAbsoluteError value on hold-out data: 0.07427926361560822
Epoch: 1100
Loss on hold-out set: 0.006792551067010208
MeanAbsoluteError value on hold-out data: 0.06518638879060745
Epoch: 1101

Loss on hold-out set: 0.009198063347733598
MeanAbsoluteError value on hold-out data: 0.07423388212919235
Epoch: 1102

Loss on hold-out set: 0.008409070245952534
MeanAbsoluteError value on hold-out data: 0.06964217871427536
Epoch: 1103
Loss on hold-out set: 0.00818041606674645
MeanAbsoluteError value on hold-out data: 0.06649273633956909
Epoch: 1104

Loss on hold-out set: 0.008971287027331224
MeanAbsoluteError value on hold-out data: 0.06982367485761642
Epoch: 1105

Loss on hold-out set: 0.009388445785055714
MeanAbsoluteError value on hold-out data: 0.07098671048879623
Epoch: 1106
Loss on hold-out set: 0.0068605373699756455
MeanAbsoluteError value on hold-out data: 0.0640764832496643
Epoch: 1107

Loss on hold-out set: 0.008425824782910544
MeanAbsoluteError value on hold-out data: 0.06858105212450027
Epoch: 1108

Loss on hold-out set: 0.008070706909081005
MeanAbsoluteError value on hold-out data: 0.06551647931337357
Epoch: 1109
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Loss on hold-out set: 0.009335527852878537
MeanAbsoluteError value on hold-out data: 0.07233378291130066
Epoch: 1110

Loss on hold-out set: 0.010041815983180035
MeanAbsoluteError value on hold-out data: 0.07490262389183044
Epoch: 1111

Loss on hold-out set: 0.008929026578856187
MeanAbsoluteError value on hold-out data: 0.07152480632066727
Epoch: 1112
Loss on hold-out set: 0.008562988617274338
MeanAbsoluteError value on hold-out data: 0.06933259218931198
Epoch: 1113

Loss on hold-out set: 0.0074074555888819305
MeanAbsoluteError value on hold-out data: 0.06555876135826111
Epoch: 1114

Loss on hold-out set: 0.009590534053034692
MeanAbsoluteError value on hold-out data: 0.0740642175078392
Epoch: 1115
Loss on hold-out set: 0.00880714894393653
MeanAbsoluteError value on hold-out data: 0.0688495859503746
Epoch: 1116

Loss on hold-out set: 0.008805242826609857
MeanAbsoluteError value on hold-out data: 0.06981164216995239
Epoch: 1117

Loss on hold-out set: 0.00832295069466151
MeanAbsoluteError value on hold-out data: 0.06967481970787048
Epoch: 1118
Loss on hold-out set: 0.009437114859065333
MeanAbsoluteError value on hold-out data: 0.07387483865022659
Epoch: 1119

Loss on hold-out set: 0.00955485915694832
MeanAbsoluteError value on hold-out data: 0.072490394115448
Epoch: 1120
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Loss on hold-out set: 0.010583259429249665
MeanAbsoluteError value on hold-out data: 0.07534657418727875
Epoch: 1121
Loss on hold-out set: 0.008934303183365652
MeanAbsoluteError value on hold-out data: 0.0677257552742958
Epoch: 1122

Loss on hold-out set: 0.008879193018995769
MeanAbsoluteError value on hold-out data: 0.07102786749601364
Epoch: 1123

Loss on hold-out set: 0.010829343579813818
MeanAbsoluteError value on hold-out data: 0.0751388743519783
Epoch: 1124
Loss on hold-out set: 0.00878629470069427
MeanAbsoluteError value on hold-out data: 0.06940235197544098
Epoch: 1125

Loss on hold-out set: 0.008969111334115118
MeanAbsoluteError value on hold-out data: 0.07088224589824677
Epoch: 1126

Loss on hold-out set: 0.008986068352326886
MeanAbsoluteError value on hold-out data: 0.07087385654449463
Epoch: 1127
Loss on hold-out set: 0.00859248276740497
MeanAbsoluteError value on hold-out data: 0.07027353346347809
Epoch: 1128

Loss on hold-out set: 0.008003122117070233
MeanAbsoluteError value on hold-out data: 0.06744179874658585
Epoch: 1129

Loss on hold-out set: 0.010681594672635129
MeanAbsoluteError value on hold-out data: 0.07720866799354553
Epoch: 1130
Loss on hold-out set: 0.008458246989430335
MeanAbsoluteError value on hold-out data: 0.06706796586513519
Epoch: 1131
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Loss on hold-out set: 0.007637952650547959
MeanAbsoluteError value on hold-out data: 0.06559109687805176
Epoch: 1132

Loss on hold-out set: 0.010183028756746353
MeanAbsoluteError value on hold-out data: 0.07453413307666779
Epoch: 1133
Loss on hold-out set: 0.007653796148066855
MeanAbsoluteError value on hold-out data: 0.06735790520906448
Epoch: 1134

Loss on hold-out set: 0.008246045076793962
MeanAbsoluteError value on hold-out data: 0.0663498193025589
Epoch: 1135

Loss on hold-out set: 0.010214301569722011
MeanAbsoluteError value on hold-out data: 0.07505565881729126
Epoch: 1136
Loss on hold-out set: 0.0081361420321385
MeanAbsoluteError value on hold-out data: 0.06643901020288467
Epoch: 1137

Loss on hold-out set: 0.008740704683126144
MeanAbsoluteError value on hold-out data: 0.07083291560411453
Epoch: 1138

Loss on hold-out set: 0.007452114204716054
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Epoch: 1139
Loss on hold-out set: 0.008931478943801873
MeanAbsoluteError value on hold-out data: 0.07030972838401794
Epoch: 1140

Loss on hold-out set: 0.008774057270541865
MeanAbsoluteError value on hold-out data: 0.06796817481517792
Epoch: 1141

Loss on hold-out set: 0.007859472716081655
MeanAbsoluteError value on hold-out data: 0.06794437021017075
Epoch: 1142
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Loss on hold-out set: 0.009735451510665977
MeanAbsoluteError value on hold-out data: 0.0705607607960701
Epoch: 1143

Loss on hold-out set: 0.008391522763364872
MeanAbsoluteError value on hold-out data: 0.06699078530073166
Epoch: 1144

Loss on hold-out set: 0.009386867494152587
MeanAbsoluteError value on hold-out data: 0.07138597965240479
Epoch: 1145
Loss on hold-out set: 0.008391298288867498
MeanAbsoluteError value on hold-out data: 0.07077102363109589
Epoch: 1146

Loss on hold-out set: 0.009817929269969076
MeanAbsoluteError value on hold-out data: 0.07485375553369522
Epoch: 1147

Loss on hold-out set: 0.008345677940621197
MeanAbsoluteError value on hold-out data: 0.07076768577098846
Epoch: 1148
Loss on hold-out set: 0.00831050931656743
MeanAbsoluteError value on hold-out data: 0.06824981421232224
Epoch: 1149

Loss on hold-out set: 0.008652559292992615
MeanAbsoluteError value on hold-out data: 0.07083601504564285
Epoch: 1150

Loss on hold-out set: 0.009235299070108643
MeanAbsoluteError value on hold-out data: 0.07505596429109573
Epoch: 1151
Loss on hold-out set: 0.008496426367006886
MeanAbsoluteError value on hold-out data: 0.06939230859279633
Epoch: 1152

Loss on hold-out set: 0.007658829406864243
MeanAbsoluteError value on hold-out data: 0.06557686626911163
Epoch: 1153
```

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Loss on hold-out set: 0.008382206104773407
MeanAbsoluteError value on hold-out data: 0.06811054795980453
Epoch: 1154
Loss on hold-out set: 0.01005546793404695
MeanAbsoluteError value on hold-out data: 0.07421477884054184
Epoch: 1155

Loss on hold-out set: 0.009368026835193935
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Epoch: 1156

Loss on hold-out set: 0.009328704419846569
MeanAbsoluteError value on hold-out data: 0.07232312858104706
Epoch: 1157
Loss on hold-out set: 0.00933034279266091
MeanAbsoluteError value on hold-out data: 0.07090383023023605
Epoch: 1158

Loss on hold-out set: 0.009445872578999115
MeanAbsoluteError value on hold-out data: 0.07063309103250504
Epoch: 1159

Loss on hold-out set: 0.008920346830079022
MeanAbsoluteError value on hold-out data: 0.06963171809911728
Epoch: 1160
Loss on hold-out set: 0.009148508298464246
MeanAbsoluteError value on hold-out data: 0.06996498256921768
Epoch: 1161

Loss on hold-out set: 0.0088229536318795
MeanAbsoluteError value on hold-out data: 0.06818490475416183
Epoch: 1162

Loss on hold-out set: 0.008404941485556872
MeanAbsoluteError value on hold-out data: 0.06712689995765686
Epoch: 1163
Loss on hold-out set: 0.009607670428522397
MeanAbsoluteError value on hold-out data: 0.07050688564777374
Epoch: 1164
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Loss on hold-out set: 0.008412505658488953
MeanAbsoluteError value on hold-out data: 0.06914941221475601
Epoch: 1165

Loss on hold-out set: 0.008645733121763139
MeanAbsoluteError value on hold-out data: 0.07017820328474045
Epoch: 1166
Loss on hold-out set: 0.008471321580873336
MeanAbsoluteError value on hold-out data: 0.07033852487802505
Epoch: 1167

Loss on hold-out set: 0.009415298104667423
MeanAbsoluteError value on hold-out data: 0.0722128227353096
Epoch: 1168

Loss on hold-out set: 0.00843144770453364
MeanAbsoluteError value on hold-out data: 0.07104511559009552
Epoch: 1169
Loss on hold-out set: 0.008214181482423252
MeanAbsoluteError value on hold-out data: 0.06703028827905655
Epoch: 1170

Loss on hold-out set: 0.008802647651161047
MeanAbsoluteError value on hold-out data: 0.07051248848438263
Epoch: 1171

Loss on hold-out set: 0.008755956332782564
MeanAbsoluteError value on hold-out data: 0.06833022087812424
Epoch: 1172
Loss on hold-out set: 0.008295059134937522
MeanAbsoluteError value on hold-out data: 0.06647574156522751
Epoch: 1173

Loss on hold-out set: 0.0079073536224314
MeanAbsoluteError value on hold-out data: 0.06783609092235565
Epoch: 1174

Loss on hold-out set: 0.008435333040591407
MeanAbsoluteError value on hold-out data: 0.06955870985984802
Epoch: 1175
```

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Loss on hold-out set: 0.009558073541278038
MeanAbsoluteError value on hold-out data: 0.07265479862689972
Epoch: 1176

Loss on hold-out set: 0.007753455554194549
MeanAbsoluteError value on hold-out data: 0.06577705591917038
Epoch: 1177

Loss on hold-out set: 0.008717229603935266
MeanAbsoluteError value on hold-out data: 0.06785859167575836
Epoch: 1178
Loss on hold-out set: 0.008767723584205668
MeanAbsoluteError value on hold-out data: 0.06994222849607468
Epoch: 1179

Loss on hold-out set: 0.008544527110061609
MeanAbsoluteError value on hold-out data: 0.07178708910942078
Epoch: 1180

Loss on hold-out set: 0.008720811089927642
MeanAbsoluteError value on hold-out data: 0.0724770799279213
Epoch: 1181
Loss on hold-out set: 0.010015781530290344
MeanAbsoluteError value on hold-out data: 0.07563281804323196
Epoch: 1182

Loss on hold-out set: 0.00860157194683173
MeanAbsoluteError value on hold-out data: 0.0686519593000412
Epoch: 1183

Loss on hold-out set: 0.008697128838781888
MeanAbsoluteError value on hold-out data: 0.06970146298408508
Epoch: 1184
Loss on hold-out set: 0.009071577782654761
MeanAbsoluteError value on hold-out data: 0.07012033462524414
Epoch: 1185

Loss on hold-out set: 0.006984067561970733
MeanAbsoluteError value on hold-out data: 0.0635938048362732
Epoch: 1186
```

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Loss on hold-out set: 0.00824881270166467
MeanAbsoluteError value on hold-out data: 0.06755801290273666
Epoch: 1187
Loss on hold-out set: 0.007713539902955139
MeanAbsoluteError value on hold-out data: 0.06735295802354813
Epoch: 1188

Loss on hold-out set: 0.008031024196807266
MeanAbsoluteError value on hold-out data: 0.06817354261875153
Epoch: 1189

Loss on hold-out set: 0.007342259818833554
MeanAbsoluteError value on hold-out data: 0.06402499228715897
Epoch: 1190
Loss on hold-out set: 0.009921952663353295
MeanAbsoluteError value on hold-out data: 0.0725163072347641
Epoch: 1191

Loss on hold-out set: 0.008350108254429263
MeanAbsoluteError value on hold-out data: 0.06813184171915054
Epoch: 1192

Loss on hold-out set: 0.009557674991471383
MeanAbsoluteError value on hold-out data: 0.07423099130392075
Epoch: 1193
Loss on hold-out set: 0.009378203949745511
MeanAbsoluteError value on hold-out data: 0.07321120798587799
Epoch: 1194

Loss on hold-out set: 0.008952130074758315
MeanAbsoluteError value on hold-out data: 0.07341716438531876
Epoch: 1195

Loss on hold-out set: 0.007743666767006895
MeanAbsoluteError value on hold-out data: 0.0690046027302742
Epoch: 1196
Loss on hold-out set: 0.008487465540116925
MeanAbsoluteError value on hold-out data: 0.06872623413801193
Epoch: 1197
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Loss on hold-out set: 0.009614190726376062
MeanAbsoluteError value on hold-out data: 0.07241252064704895
Epoch: 1198

Loss on hold-out set: 0.008581281299157126
MeanAbsoluteError value on hold-out data: 0.06836096942424774
Epoch: 1199
Loss on hold-out set: 0.008008612831084368
MeanAbsoluteError value on hold-out data: 0.06825843453407288
Epoch: 1200

Loss on hold-out set: 0.008381572050978624
MeanAbsoluteError value on hold-out data: 0.06775447726249695
Epoch: 1201

Loss on hold-out set: 0.008364219841071947
MeanAbsoluteError value on hold-out data: 0.06856677681207657
Epoch: 1202
Loss on hold-out set: 0.007858951347128216
MeanAbsoluteError value on hold-out data: 0.06779040396213531
Epoch: 1203

Loss on hold-out set: 0.008339869895595863
MeanAbsoluteError value on hold-out data: 0.0689382553100586
Epoch: 1204

Loss on hold-out set: 0.009498852084889223
MeanAbsoluteError value on hold-out data: 0.07102641463279724
Epoch: 1205
Loss on hold-out set: 0.0074943757064829695
MeanAbsoluteError value on hold-out data: 0.06559628248214722
Epoch: 1206

Loss on hold-out set: 0.008595117792089392
MeanAbsoluteError value on hold-out data: 0.06987079977989197
Epoch: 1207

Loss on hold-out set: 0.006699674487317679
MeanAbsoluteError value on hold-out data: 0.06156397610902786
Epoch: 1208
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Loss on hold-out set: 0.008314190293313005
MeanAbsoluteError value on hold-out data: 0.0690171867609024
Epoch: 1209

Loss on hold-out set: 0.008201075872736207
MeanAbsoluteError value on hold-out data: 0.06749993562698364
Epoch: 1210

Loss on hold-out set: 0.009367302496387614
MeanAbsoluteError value on hold-out data: 0.07282624393701553
Epoch: 1211
Loss on hold-out set: 0.00763075044308304
MeanAbsoluteError value on hold-out data: 0.0641491562128067
Epoch: 1212

Loss on hold-out set: 0.007827546988749722
MeanAbsoluteError value on hold-out data: 0.0666855052113533
Epoch: 1213

Loss on hold-out set: 0.007817297593937837
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Epoch: 1214
Loss on hold-out set: 0.008668427634393083
MeanAbsoluteError value on hold-out data: 0.0704454556107521
Epoch: 1215

Loss on hold-out set: 0.010938182887675793
MeanAbsoluteError value on hold-out data: 0.07867881655693054
Epoch: 1216

Loss on hold-out set: 0.00764924514995073
MeanAbsoluteError value on hold-out data: 0.06727448850870132
Epoch: 1217
Loss on hold-out set: 0.008349350141288596
MeanAbsoluteError value on hold-out data: 0.0662500336766243
Epoch: 1218

Loss on hold-out set: 0.009827800256192253
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Epoch: 1219
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Loss on hold-out set: 0.007647950482787564
MeanAbsoluteError value on hold-out data: 0.06270056217908859
Epoch: 1220
Loss on hold-out set: 0.009354215196049153
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Epoch: 1221

Loss on hold-out set: 0.008099023086494224
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Epoch: 1222

Loss on hold-out set: 0.007730175809374486
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Epoch: 1223
Loss on hold-out set: 0.007506818181855124
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Epoch: 1224

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Epoch: 1225

Loss on hold-out set: 0.009691596644212647
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Epoch: 1226
Loss on hold-out set: 0.007688775489077671
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Epoch: 1227

Loss on hold-out set: 0.007624005511582557
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Epoch: 1228

Loss on hold-out set: 0.008283264166481482
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Epoch: 1230

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Loss on hold-out set: 0.006936068758313922
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Epoch: 1231

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Loss on hold-out set: 0.00816418248990279
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Epoch: 1233

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Epoch: 1234

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Epoch: 1235
Loss on hold-out set: 0.009844494672652217
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Epoch: 1236

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Epoch: 1237

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Epoch: 1238
Loss on hold-out set: 0.006595121857947864
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Epoch: 1239

Loss on hold-out set: 0.008998978640690136
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Epoch: 1240

Loss on hold-out set: 0.007834784858641797
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Epoch: 1241
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Loss on hold-out set: 0.006340425134794714
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Epoch: 1242

Loss on hold-out set: 0.0074508562734263255
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Epoch: 1243

Loss on hold-out set: 0.008628501046235517
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Epoch: 1244
Loss on hold-out set: 0.009131686763187949
MeanAbsoluteError value on hold-out data: 0.06946006417274475
Epoch: 1245

Loss on hold-out set: 0.007531671591432314
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Epoch: 1246

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Epoch: 1247
Loss on hold-out set: 0.006929076089851757
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Epoch: 1248

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Epoch: 1249

Loss on hold-out set: 0.007359806268371661
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Epoch: 1250
Loss on hold-out set: 0.006557406021453668
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Epoch: 1251

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Epoch: 1252
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Loss on hold-out set: 0.008289241969760042
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Loss on hold-out set: 0.007600485634745079
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Epoch: 1254

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Epoch: 1255

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Epoch: 1256
Loss on hold-out set: 0.0078272739428697
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Epoch: 1257

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Epoch: 1258

Loss on hold-out set: 0.008196221885312601
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Epoch: 1260

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Epoch: 1261

Loss on hold-out set: 0.009713419490362868
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Epoch: 1262
Loss on hold-out set: 0.008247185684012948
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Epoch: 1263
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Epoch: 1264

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Epoch: 1265
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Epoch: 1266

Loss on hold-out set: 0.009684189053295995
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Epoch: 1267

Loss on hold-out set: 0.007967341782108027
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Epoch: 1268
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Loss on hold-out set: 0.008684776815449975
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Epoch: 1272

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Epoch: 1274
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Loss on hold-out set: 0.008238318087072306
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Epoch: 1275

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Epoch: 1276

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Epoch: 1277
Loss on hold-out set: 0.008428520695031997
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Epoch: 1278

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Epoch: 1279

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Epoch: 1281

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Epoch: 1282

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Epoch: 1283
Loss on hold-out set: 0.007524606088760872
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Epoch: 1284

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Epoch: 1285

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Loss on hold-out set: 0.00870996311666507
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Epoch: 1287

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Epoch: 1288

Loss on hold-out set: 0.007333086821211812
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Epoch: 1289
Loss on hold-out set: 0.008152675470761702
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Epoch: 1290

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Epoch: 1291

Loss on hold-out set: 0.008828558676759713
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Epoch: 1292
Loss on hold-out set: 0.0077141097704407
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Epoch: 1293

Loss on hold-out set: 0.007982649015918166
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Epoch: 1294

Loss on hold-out set: 0.00673412378025508
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Loss on hold-out set: 0.006630316778464476
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Epoch: 1296
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Loss on hold-out set: 0.008851497067116725
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Loss on hold-out set: 0.008349605204493855
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Epoch: 1299

Loss on hold-out set: 0.007537556123606919
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Epoch: 1300

Loss on hold-out set: 0.007757186491847582
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Epoch: 1301
Loss on hold-out set: 0.006805430507471707
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Epoch: 1302

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Epoch: 1303

Loss on hold-out set: 0.007608592513982633
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Loss on hold-out set: 0.008371355095805484
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Epoch: 1305

Loss on hold-out set: 0.0074182542401346535
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Epoch: 1306

Loss on hold-out set: 0.007910246996592226
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Epoch: 1307
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Epoch: 1309

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Epoch: 1310
Loss on hold-out set: 0.007188992291121394
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Epoch: 1311

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Epoch: 1312

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Loss on hold-out set: 0.007860805670934496
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Epoch: 1314

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Epoch: 1315

Loss on hold-out set: 0.007595169902015186
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Epoch: 1316
Loss on hold-out set: 0.006688640009282001
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Epoch: 1317

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Epoch: 1318

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Loss on hold-out set: 0.007410726531476636
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Epoch: 1319
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Epoch: 1321

Loss on hold-out set: 0.0069184582148439705
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Epoch: 1322
Loss on hold-out set: 0.006689244865669935
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Epoch: 1323

Loss on hold-out set: 0.007612262438973024
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Epoch: 1324

Loss on hold-out set: 0.0072054688022763005
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Loss on hold-out set: 0.007744980783924499
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Epoch: 1326

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Epoch: 1327

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Loss on hold-out set: 0.008161324687607703
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Epoch: 1329
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Loss on hold-out set: 0.00880666381441794
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Epoch: 1330

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Epoch: 1331
Loss on hold-out set: 0.0073701089763198975
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Epoch: 1332

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Epoch: 1333

Loss on hold-out set: 0.008238957010610951
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Epoch: 1334
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Epoch: 1335

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Epoch: 1336

Loss on hold-out set: 0.0066788845565558105
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Epoch: 1337
Loss on hold-out set: 0.007274228880369264
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Epoch: 1338

Loss on hold-out set: 0.008557847652603716
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Epoch: 1339

Loss on hold-out set: 0.007186230814271116
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Epoch: 1340
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Loss on hold-out set: 0.006984890546397462
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Epoch: 1341

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MeanAbsoluteError value on hold-out data: 0.06492621451616287
Epoch: 1342

Loss on hold-out set: 0.007091336585356961
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Epoch: 1343
Loss on hold-out set: 0.00655343522237672
MeanAbsoluteError value on hold-out data: 0.06131889298558235
Epoch: 1344

Loss on hold-out set: 0.008630287040044399
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Epoch: 1345

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Epoch: 1346
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Epoch: 1347

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Epoch: 1348

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Epoch: 1349
Loss on hold-out set: 0.007927619227521063
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Epoch: 1350

Loss on hold-out set: 0.006896469500643434
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Epoch: 1351
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Loss on hold-out set: 0.008014811832824004
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Loss on hold-out set: 0.007258108522679928
MeanAbsoluteError value on hold-out data: 0.0623306967318058
Epoch: 1353

Loss on hold-out set: 0.007617782301458646
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Epoch: 1354

Loss on hold-out set: 0.008313155201760007
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Epoch: 1355
Loss on hold-out set: 0.007914449097176354
MeanAbsoluteError value on hold-out data: 0.06587100774049759
Epoch: 1356

Loss on hold-out set: 0.006483034883664611
MeanAbsoluteError value on hold-out data: 0.06174354627728462
Epoch: 1357

Loss on hold-out set: 0.0066842894591051544
MeanAbsoluteError value on hold-out data: 0.06267368048429489
Epoch: 1358
Loss on hold-out set: 0.007326528524178381
MeanAbsoluteError value on hold-out data: 0.06394001096487045
Epoch: 1359

Loss on hold-out set: 0.006603053730117002
MeanAbsoluteError value on hold-out data: 0.061263274401426315
Epoch: 1360

Loss on hold-out set: 0.007108181298341757
MeanAbsoluteError value on hold-out data: 0.0643259584903717
Epoch: 1361
Loss on hold-out set: 0.007781778689192531
MeanAbsoluteError value on hold-out data: 0.06525319069623947
Epoch: 1362
```

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Loss on hold-out set: 0.008662146897662145
MeanAbsoluteError value on hold-out data: 0.06885534524917603
Epoch: 1363

Loss on hold-out set: 0.007358902703266115
MeanAbsoluteError value on hold-out data: 0.06325393915176392
Epoch: 1364
Loss on hold-out set: 0.0070046823201240236
MeanAbsoluteError value on hold-out data: 0.064714215695858
Epoch: 1365

Loss on hold-out set: 0.008247275913017802
MeanAbsoluteError value on hold-out data: 0.06829921901226044
Epoch: 1366

Loss on hold-out set: 0.008358056524642355
MeanAbsoluteError value on hold-out data: 0.06540332734584808
Epoch: 1367
Loss on hold-out set: 0.007428606998200848
MeanAbsoluteError value on hold-out data: 0.06237946078181267
Epoch: 1368

Loss on hold-out set: 0.007923007236969776
MeanAbsoluteError value on hold-out data: 0.06732971966266632
Epoch: 1369

Loss on hold-out set: 0.008218733565760583
MeanAbsoluteError value on hold-out data: 0.06505877524614334
Epoch: 1370
Loss on hold-out set: 0.00712614745386721
MeanAbsoluteError value on hold-out data: 0.061705056577920914
Epoch: 1371

Loss on hold-out set: 0.006870662028183385
MeanAbsoluteError value on hold-out data: 0.06405352801084518
Epoch: 1372

Loss on hold-out set: 0.007105933139609988
MeanAbsoluteError value on hold-out data: 0.06279445439577103
Epoch: 1373
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Loss on hold-out set: 0.007733155405465671
MeanAbsoluteError value on hold-out data: 0.06457499414682388
Epoch: 1374

Loss on hold-out set: 0.006857377260797269
MeanAbsoluteError value on hold-out data: 0.06143409013748169
Epoch: 1375

Loss on hold-out set: 0.008391483900292466
MeanAbsoluteError value on hold-out data: 0.06630788743495941
Epoch: 1376
Loss on hold-out set: 0.008358539177716012
MeanAbsoluteError value on hold-out data: 0.0658782422542572
Epoch: 1377

Loss on hold-out set: 0.007385100672900459
MeanAbsoluteError value on hold-out data: 0.062242839485406876
Epoch: 1378

Loss on hold-out set: 0.008254377940793346
MeanAbsoluteError value on hold-out data: 0.06494715064764023
Epoch: 1379
Loss on hold-out set: 0.007783082814906569
MeanAbsoluteError value on hold-out data: 0.06639442592859268
Epoch: 1380

Loss on hold-out set: 0.007087824009686301
MeanAbsoluteError value on hold-out data: 0.06113814562559128
Epoch: 1381

Loss on hold-out set: 0.007399430495109603
MeanAbsoluteError value on hold-out data: 0.06340007483959198
Epoch: 1382
Loss on hold-out set: 0.008581610799992631
MeanAbsoluteError value on hold-out data: 0.06660348176956177
Epoch: 1383

Loss on hold-out set: 0.007319721425665194
MeanAbsoluteError value on hold-out data: 0.06249247118830681
Epoch: 1384
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Loss on hold-out set: 0.007531948941814335
MeanAbsoluteError value on hold-out data: 0.06292761117219925
Epoch: 1385
Loss on hold-out set: 0.008206925879728336
MeanAbsoluteError value on hold-out data: 0.06636926531791687
Epoch: 1386

Loss on hold-out set: 0.007894851239980199
MeanAbsoluteError value on hold-out data: 0.06458236277103424
Epoch: 1387

Loss on hold-out set: 0.006284844869393662
MeanAbsoluteError value on hold-out data: 0.061613570898771286
Epoch: 1388
Loss on hold-out set: 0.006462574525551948
MeanAbsoluteError value on hold-out data: 0.06111278012394905
Epoch: 1389

Loss on hold-out set: 0.008479775569758203
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Epoch: 1390

Loss on hold-out set: 0.008006435266051994
MeanAbsoluteError value on hold-out data: 0.06224217265844345
Epoch: 1391
Loss on hold-out set: 0.007971743283220955
MeanAbsoluteError value on hold-out data: 0.06623521447181702
Epoch: 1392

Loss on hold-out set: 0.007226064206139806
MeanAbsoluteError value on hold-out data: 0.06163494288921356
Epoch: 1393

Loss on hold-out set: 0.006865804736517021
MeanAbsoluteError value on hold-out data: 0.06435486674308777
Epoch: 1394
Loss on hold-out set: 0.007685404599978938
MeanAbsoluteError value on hold-out data: 0.06195046007633209
Epoch: 1395
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Loss on hold-out set: 0.006218564410495067
MeanAbsoluteError value on hold-out data: 0.058701470494270325
Epoch: 1396

Loss on hold-out set: 0.008331840886142649
MeanAbsoluteError value on hold-out data: 0.06372050940990448
Epoch: 1397
Loss on hold-out set: 0.008115247020129269
MeanAbsoluteError value on hold-out data: 0.06677833944559097
Epoch: 1398

Loss on hold-out set: 0.007940049557018937
MeanAbsoluteError value on hold-out data: 0.06590113043785095
Epoch: 1399

Loss on hold-out set: 0.007850448577773932
MeanAbsoluteError value on hold-out data: 0.06464444845914841
Epoch: 1400
Loss on hold-out set: 0.008508982939999138
MeanAbsoluteError value on hold-out data: 0.06389335542917252
Epoch: 1401

Loss on hold-out set: 0.007842026965057206
MeanAbsoluteError value on hold-out data: 0.0640438050031662
Epoch: 1402

Loss on hold-out set: 0.0071830387469162815
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Epoch: 1403
Loss on hold-out set: 0.006606762517258176
MeanAbsoluteError value on hold-out data: 0.05599531903862953
Epoch: 1404

Loss on hold-out set: 0.006741788264231824
MeanAbsoluteError value on hold-out data: 0.061625588685274124
Epoch: 1405

Loss on hold-out set: 0.007380830594629515
MeanAbsoluteError value on hold-out data: 0.06464558094739914
Epoch: 1406
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Loss on hold-out set: 0.007213042916919221
MeanAbsoluteError value on hold-out data: 0.06141640990972519
Epoch: 1407

Loss on hold-out set: 0.0073089603210488956
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Epoch: 1408

Loss on hold-out set: 0.007687727598169923
MeanAbsoluteError value on hold-out data: 0.06430992484092712
Epoch: 1409
Loss on hold-out set: 0.006221667806385085
MeanAbsoluteError value on hold-out data: 0.05906667560338974
Epoch: 1410

Loss on hold-out set: 0.007422675352305911
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Epoch: 1411

Loss on hold-out set: 0.007240428739251002
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Epoch: 1412
Loss on hold-out set: 0.008778710663051848
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Epoch: 1413

Loss on hold-out set: 0.00858460784211881
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Epoch: 1414

Loss on hold-out set: 0.007810273283539572
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Epoch: 1415
Loss on hold-out set: 0.008619891580929106
MeanAbsoluteError value on hold-out data: 0.06565258651971817
Epoch: 1416

Loss on hold-out set: 0.007153326858868544
MeanAbsoluteError value on hold-out data: 0.06220056489109993
Epoch: 1417
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Loss on hold-out set: 0.008059145712080256
MeanAbsoluteError value on hold-out data: 0.06420379877090454
Epoch: 1418
Loss on hold-out set: 0.006745355818117484
MeanAbsoluteError value on hold-out data: 0.06165168061852455
Epoch: 1419

Loss on hold-out set: 0.0065414021932034905
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Epoch: 1420

Loss on hold-out set: 0.006411326247010341
MeanAbsoluteError value on hold-out data: 0.059080760926008224
Epoch: 1421
Loss on hold-out set: 0.005785970497696932
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Epoch: 1422

Loss on hold-out set: 0.008874818987069375
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Epoch: 1423

Loss on hold-out set: 0.006769767181964805
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Loss on hold-out set: 0.007019345253126327
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Epoch: 1425

Loss on hold-out set: 0.006187229693653838
MeanAbsoluteError value on hold-out data: 0.05931633710861206
Epoch: 1426

Loss on hold-out set: 0.007304570008776257
MeanAbsoluteError value on hold-out data: 0.061462484300136566
Epoch: 1427
Loss on hold-out set: 0.0071983207778642585
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Epoch: 1428
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Loss on hold-out set: 0.006404472777358023
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Epoch: 1429

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Epoch: 1430
Loss on hold-out set: 0.006465543766559373
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Epoch: 1431

Loss on hold-out set: 0.006609214644945496
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Epoch: 1432

Loss on hold-out set: 0.008093652029589673
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Epoch: 1433
Loss on hold-out set: 0.0073651220281317365
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Epoch: 1434

Loss on hold-out set: 0.007322313942337739
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Epoch: 1435

Loss on hold-out set: 0.007296190278405751
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Epoch: 1436
Loss on hold-out set: 0.005828591074987344
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Epoch: 1437

Loss on hold-out set: 0.007271736268273041
MeanAbsoluteError value on hold-out data: 0.06329134106636047
Epoch: 1438

Loss on hold-out set: 0.007792155535523004
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Epoch: 1439
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Loss on hold-out set: 0.00777885840767946
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Epoch: 1440

Loss on hold-out set: 0.006892244705771494
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Epoch: 1441

Loss on hold-out set: 0.00765185728298699
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Loss on hold-out set: 0.007636073041964361
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Epoch: 1443

Loss on hold-out set: 0.0064267131962697024
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Epoch: 1444

Loss on hold-out set: 0.006490412162590171
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Epoch: 1445
Loss on hold-out set: 0.006371585867467123
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Epoch: 1446

Loss on hold-out set: 0.006562064957809828
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Epoch: 1447

Loss on hold-out set: 0.0066721087262885705
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Epoch: 1448
Loss on hold-out set: 0.006361101144769539
MeanAbsoluteError value on hold-out data: 0.05920891463756561
Epoch: 1449

Loss on hold-out set: 0.006440053026329527
MeanAbsoluteError value on hold-out data: 0.05804181471467018
Epoch: 1450
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Loss on hold-out set: 0.006691107144863508
MeanAbsoluteError value on hold-out data: 0.05928557738661766
Epoch: 1451
Loss on hold-out set: 0.008395419380867679
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Epoch: 1452

Loss on hold-out set: 0.007052991284266076
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Epoch: 1453

Loss on hold-out set: 0.007437970945975394
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Epoch: 1454
Loss on hold-out set: 0.00710897910247392
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Epoch: 1455

Loss on hold-out set: 0.007515263631345684
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Epoch: 1456

Loss on hold-out set: 0.006579714627854022
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Epoch: 1457
Loss on hold-out set: 0.007703386271186901
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Epoch: 1458

Loss on hold-out set: 0.007095821674538456
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Epoch: 1459

Loss on hold-out set: 0.008361163678394708
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Loss on hold-out set: 0.0075494432095850545
MeanAbsoluteError value on hold-out data: 0.06178963929414749
Epoch: 1461
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Loss on hold-out set: 0.006199578500891221
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Epoch: 1462

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Loss on hold-out set: 0.006415026676093021
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Epoch: 1464

Loss on hold-out set: 0.008076324455808692
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Epoch: 1465

Loss on hold-out set: 0.009491247767311204
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Epoch: 1466
Loss on hold-out set: 0.007091664151715425
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Epoch: 1467

Loss on hold-out set: 0.007225897055268433
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Epoch: 1468

Loss on hold-out set: 0.007577548528618839
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Epoch: 1469
Loss on hold-out set: 0.006875788047667205
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Epoch: 1471

Loss on hold-out set: 0.007226885998146221
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Epoch: 1472
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Loss on hold-out set: 0.005886048365355236
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Epoch: 1473

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Loss on hold-out set: 0.005596206783520756
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Epoch: 1475
Loss on hold-out set: 0.008200326602127462
MeanAbsoluteError value on hold-out data: 0.06633046269416809
Epoch: 1476

Loss on hold-out set: 0.006380769976834321
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Epoch: 1477

Loss on hold-out set: 0.0075031223544647216
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Epoch: 1478
Loss on hold-out set: 0.00740346053064665
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Epoch: 1479

Loss on hold-out set: 0.0071286875759445445
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Epoch: 1480

Loss on hold-out set: 0.007380493624950759
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Epoch: 1481
Loss on hold-out set: 0.00582885891932771
MeanAbsoluteError value on hold-out data: 0.055595189332962036
Epoch: 1482

Loss on hold-out set: 0.006993286341219876
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Epoch: 1483
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Loss on hold-out set: 0.007800525697229356
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Loss on hold-out set: 0.005657681269816142
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Epoch: 1485

Loss on hold-out set: 0.006552927500027484
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Epoch: 1486

Loss on hold-out set: 0.009098660614436085
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Epoch: 1487
Loss on hold-out set: 0.005650373089689916
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Epoch: 1488

Loss on hold-out set: 0.007112137752055787
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Epoch: 1489

Loss on hold-out set: 0.006544608821665558
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Epoch: 1491

Loss on hold-out set: 0.007863978905540232
MeanAbsoluteError value on hold-out data: 0.06471371650695801
Epoch: 1492

Loss on hold-out set: 0.009094568343369242
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Epoch: 1493
Loss on hold-out set: 0.006451749167365506
MeanAbsoluteError value on hold-out data: 0.06099960207939148
Epoch: 1494
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Loss on hold-out set: 0.007758231621943802
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Epoch: 1495

Loss on hold-out set: 0.00700119554225239
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Loss on hold-out set: 0.007090543452892841
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Epoch: 1497

Loss on hold-out set: 0.008346914640545341
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Epoch: 1498

Loss on hold-out set: 0.005784704675579633
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Loss on hold-out set: 0.006582887208520939
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Epoch: 1500

Loss on hold-out set: 0.006753036150500217
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Epoch: 1501

Loss on hold-out set: 0.00675853636629957
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Loss on hold-out set: 0.00754761629725787
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Epoch: 1503

Loss on hold-out set: 0.007621652714703183
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Epoch: 1504

Loss on hold-out set: 0.007283981043862392
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Epoch: 1505
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Loss on hold-out set: 0.0070228694832136776
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Epoch: 1506

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Epoch: 1507

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Loss on hold-out set: 0.007229966614810716
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Epoch: 1509

Loss on hold-out set: 0.007049170448638809
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Epoch: 1510

Loss on hold-out set: 0.007080492478077455
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Epoch: 1511
Loss on hold-out set: 0.006393863037028495
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Epoch: 1512

Loss on hold-out set: 0.007725934241292028
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Epoch: 1513

Loss on hold-out set: 0.007046471319072225
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Epoch: 1514
Loss on hold-out set: 0.006318623253246187
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Epoch: 1515

Loss on hold-out set: 0.006729081450935155
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Epoch: 1516
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Loss on hold-out set: 0.006523465390928323
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Epoch: 1517
Loss on hold-out set: 0.00821042177437145
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Epoch: 1518

Loss on hold-out set: 0.006698185523461386
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Epoch: 1519

Loss on hold-out set: 0.006052415509475395
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Epoch: 1520
Loss on hold-out set: 0.007330691502405292
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Epoch: 1521

Loss on hold-out set: 0.006206689365402174
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Epoch: 1522

Loss on hold-out set: 0.0075099323186683855
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Epoch: 1523
Loss on hold-out set: 0.006849106066680785
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Epoch: 1524

Loss on hold-out set: 0.005985183810335002
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Epoch: 1525

Loss on hold-out set: 0.0077385533502301014
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Epoch: 1526
Loss on hold-out set: 0.006901280821305894
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Epoch: 1527
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Loss on hold-out set: 0.006645474609504163
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Epoch: 1528

Loss on hold-out set: 0.007267867245779295
MeanAbsoluteError value on hold-out data: 0.062191709876060486
Epoch: 1529
Loss on hold-out set: 0.00787862096065074
MeanAbsoluteError value on hold-out data: 0.06303820013999939
Epoch: 1530

Loss on hold-out set: 0.006578098914469592
MeanAbsoluteError value on hold-out data: 0.06062893569469452
Epoch: 1531

Loss on hold-out set: 0.006871372763465236
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Epoch: 1532
Loss on hold-out set: 0.006238535994610477
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Epoch: 1533

Loss on hold-out set: 0.007060955895722146
MeanAbsoluteError value on hold-out data: 0.06182407960295677
Epoch: 1534

Loss on hold-out set: 0.0070925388446327516
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Epoch: 1535
Loss on hold-out set: 0.006252422351041484
MeanAbsoluteError value on hold-out data: 0.0559881217777729
Epoch: 1536

Loss on hold-out set: 0.00640259734223946
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Epoch: 1537

Loss on hold-out set: 0.006591043162237232
MeanAbsoluteError value on hold-out data: 0.06028216704726219
Epoch: 1538
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Loss on hold-out set: 0.00677350006129321
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Epoch: 1539

Loss on hold-out set: 0.006299272128890152
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Epoch: 1540

Loss on hold-out set: 0.00708640747795774
MeanAbsoluteError value on hold-out data: 0.06118406355381012
Epoch: 1541
Loss on hold-out set: 0.006810380644504524
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Epoch: 1542

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Epoch: 1543

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Epoch: 1544
Loss on hold-out set: 0.00881009957221977
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Epoch: 1546

Loss on hold-out set: 0.006170626819481792
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Loss on hold-out set: 0.0061107685729803055
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Epoch: 1549
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Epoch: 1551

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Epoch: 1552

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Epoch: 1554

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Epoch: 1555

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Epoch: 1557

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Epoch: 1558

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Epoch: 1559
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Epoch: 1560

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Epoch: 1564

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Epoch: 1566

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Epoch: 1567

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Epoch: 1571
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Epoch: 1582

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Epoch: 1597

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Loss on hold-out set: 0.006941287029782567
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Epoch: 1696

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Epoch: 1699

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Epoch: 1700
Loss on hold-out set: 0.0055219498938701385
MeanAbsoluteError value on hold-out data: 0.053920257836580276
Epoch: 1701

Loss on hold-out set: 0.00686576398324784
MeanAbsoluteError value on hold-out data: 0.05967068299651146
Epoch: 1702

Loss on hold-out set: 0.00597583918972911
MeanAbsoluteError value on hold-out data: 0.055749353021383286
Epoch: 1703
```

Loss on hold-out set: 0.005154892094506067
MeanAbsoluteError value on hold-out data: 0.05109861493110657
Epoch: 1704

Loss on hold-out set: 0.006120604847237701
MeanAbsoluteError value on hold-out data: 0.05614132434129715
Epoch: 1705

Loss on hold-out set: 0.0059326324386347554
MeanAbsoluteError value on hold-out data: 0.05425235629081726
Epoch: 1706
Loss on hold-out set: 0.006615492759992776
MeanAbsoluteError value on hold-out data: 0.05897782742977142
Epoch: 1707

Loss on hold-out set: 0.005569042404737654
MeanAbsoluteError value on hold-out data: 0.05428854003548622
Epoch: 1708

Loss on hold-out set: 0.0057222803004424345
MeanAbsoluteError value on hold-out data: 0.05695905163884163
Epoch: 1709
Loss on hold-out set: 0.005843598905271392
MeanAbsoluteError value on hold-out data: 0.05586063489317894
Epoch: 1710

Loss on hold-out set: 0.005992990551394541
MeanAbsoluteError value on hold-out data: 0.05550844222307205
Epoch: 1711

Loss on hold-out set: 0.006868467712086689
MeanAbsoluteError value on hold-out data: 0.059085674583911896
Epoch: 1712
Loss on hold-out set: 0.0065426972446342305
MeanAbsoluteError value on hold-out data: 0.056544940918684006
Epoch: 1713

Loss on hold-out set: 0.006558137488997697
MeanAbsoluteError value on hold-out data: 0.059762001037597656
Epoch: 1714

```
Loss on hold-out set: 0.0056510724933832536
MeanAbsoluteError value on hold-out data: 0.05463450774550438
Epoch: 1715
Loss on hold-out set: 0.008383621389833328
MeanAbsoluteError value on hold-out data: 0.06257998943328857
Epoch: 1716

Loss on hold-out set: 0.006866435280098813
MeanAbsoluteError value on hold-out data: 0.057118818163871765
Epoch: 1717

Loss on hold-out set: 0.006061400160821601
MeanAbsoluteError value on hold-out data: 0.05568140745162964
Epoch: 1718
Loss on hold-out set: 0.005614600420352265
MeanAbsoluteError value on hold-out data: 0.05522312968969345
Epoch: 1719

Loss on hold-out set: 0.006520061830766887
MeanAbsoluteError value on hold-out data: 0.057971514761447906
Epoch: 1720

Loss on hold-out set: 0.005209759732499606
MeanAbsoluteError value on hold-out data: 0.05295043811202049
Epoch: 1721
Loss on hold-out set: 0.006978941200383512
MeanAbsoluteError value on hold-out data: 0.059238251298666
Epoch: 1722

Loss on hold-out set: 0.0067867015430965695
MeanAbsoluteError value on hold-out data: 0.05671313777565956
Epoch: 1723

Loss on hold-out set: 0.006052495049959058
MeanAbsoluteError value on hold-out data: 0.05678609386086464
Epoch: 1724
Loss on hold-out set: 0.006332770120437392
MeanAbsoluteError value on hold-out data: 0.05896444246172905
Epoch: 1725
```

Loss on hold-out set: 0.0068039093087039265
MeanAbsoluteError value on hold-out data: 0.05814708024263382
Epoch: 1726

Loss on hold-out set: 0.007530075782206798
MeanAbsoluteError value on hold-out data: 0.06181536242365837
Epoch: 1727
Loss on hold-out set: 0.006161592973088167
MeanAbsoluteError value on hold-out data: 0.05597614124417305
Epoch: 1728
Loss on hold-out set: 0.006441901724113753
MeanAbsoluteError value on hold-out data: 0.05566837266087532
Epoch: 1729

Loss on hold-out set: 0.0058146877177447705
MeanAbsoluteError value on hold-out data: 0.05628964677453041
Epoch: 1730
Loss on hold-out set: 0.005425228837489916
MeanAbsoluteError value on hold-out data: 0.05460214614868164
Epoch: 1731
Loss on hold-out set: 0.006064305688303193
MeanAbsoluteError value on hold-out data: 0.05608842894434929
Epoch: 1732

Loss on hold-out set: 0.005942103194259593
MeanAbsoluteError value on hold-out data: 0.05491594225168228
Epoch: 1733
Loss on hold-out set: 0.005024040746769363
MeanAbsoluteError value on hold-out data: 0.052087027579545975
Epoch: 1734
Loss on hold-out set: 0.006036093917961504
MeanAbsoluteError value on hold-out data: 0.057707518339157104
Epoch: 1735

Loss on hold-out set: 0.0061059099494135205
MeanAbsoluteError value on hold-out data: 0.05698241665959358
Epoch: 1736
Loss on hold-out set: 0.00670886995720745
MeanAbsoluteError value on hold-out data: 0.058912113308906555
Epoch: 1737
Loss on hold-out set: 0.0057879623712142345

```
MeanAbsoluteError value on hold-out data: 0.05577396973967552
Epoch: 1738

Loss on hold-out set: 0.006112623529012732
MeanAbsoluteError value on hold-out data: 0.0548589713871479
Epoch: 1739
Loss on hold-out set: 0.006100422519424076
MeanAbsoluteError value on hold-out data: 0.0565519705414772
Epoch: 1740
Loss on hold-out set: 0.0062295155370278125
MeanAbsoluteError value on hold-out data: 0.056590691208839417
Epoch: 1741

Loss on hold-out set: 0.0064630491746114176
MeanAbsoluteError value on hold-out data: 0.058018092066049576
Epoch: 1742
Loss on hold-out set: 0.006240328096343243
MeanAbsoluteError value on hold-out data: 0.05739434063434601
Epoch: 1743
Loss on hold-out set: 0.0060354229746758395
MeanAbsoluteError value on hold-out data: 0.05704532563686371
Epoch: 1744

Loss on hold-out set: 0.006037247465486265
MeanAbsoluteError value on hold-out data: 0.05564393848180771
Epoch: 1745
Loss on hold-out set: 0.006901932074615615
MeanAbsoluteError value on hold-out data: 0.059136707335710526
Epoch: 1746
Loss on hold-out set: 0.005883924993552985
MeanAbsoluteError value on hold-out data: 0.05528636276721954
Epoch: 1747

Loss on hold-out set: 0.0066131032416979
MeanAbsoluteError value on hold-out data: 0.05744460970163345
Epoch: 1748
Loss on hold-out set: 0.0060295839111010234
MeanAbsoluteError value on hold-out data: 0.05610233172774315
Epoch: 1749
Loss on hold-out set: 0.006108455927181543
MeanAbsoluteError value on hold-out data: 0.05655127391219139
Epoch: 1750
```

```
Loss on hold-out set: 0.006033279592146149
MeanAbsoluteError value on hold-out data: 0.05744301527738571
Epoch: 1751
Loss on hold-out set: 0.005430869198795942
MeanAbsoluteError value on hold-out data: 0.05437426269054413
Epoch: 1752
Loss on hold-out set: 0.005743478076443959
MeanAbsoluteError value on hold-out data: 0.053918395191431046
Epoch: 1753

Loss on hold-out set: 0.006988439586342945
MeanAbsoluteError value on hold-out data: 0.060492172837257385
Epoch: 1754
Loss on hold-out set: 0.0059334382341694435
MeanAbsoluteError value on hold-out data: 0.05391823500394821
Epoch: 1755
Loss on hold-out set: 0.006597397188691806
MeanAbsoluteError value on hold-out data: 0.05883814021945
Epoch: 1756

Loss on hold-out set: 0.006720187464028035
MeanAbsoluteError value on hold-out data: 0.05537288635969162
Epoch: 1757
Loss on hold-out set: 0.006820769899592657
MeanAbsoluteError value on hold-out data: 0.05950827896595001
Epoch: 1758
Loss on hold-out set: 0.005659407088563361
MeanAbsoluteError value on hold-out data: 0.05339352414011955
Epoch: 1759

Loss on hold-out set: 0.006595341095429225
MeanAbsoluteError value on hold-out data: 0.05837630107998848
Epoch: 1760
Loss on hold-out set: 0.005437722753898319
MeanAbsoluteError value on hold-out data: 0.05287674441933632
Epoch: 1761
Loss on hold-out set: 0.005496210678993521
MeanAbsoluteError value on hold-out data: 0.054206181317567825
Epoch: 1762

Loss on hold-out set: 0.005419561333437742
```

```
MeanAbsoluteError value on hold-out data: 0.05381790176033974
Epoch: 1763
Loss on hold-out set: 0.0065651935887702465
MeanAbsoluteError value on hold-out data: 0.05903308093547821
Epoch: 1764
Loss on hold-out set: 0.006082197227685052
MeanAbsoluteError value on hold-out data: 0.05648597702383995
Epoch: 1765

Loss on hold-out set: 0.00518262856353734
MeanAbsoluteError value on hold-out data: 0.052867092192173004
Epoch: 1766
Loss on hold-out set: 0.005556871224131707
MeanAbsoluteError value on hold-out data: 0.05607254058122635
Epoch: 1767
Loss on hold-out set: 0.006521700532005828
MeanAbsoluteError value on hold-out data: 0.058716438710689545
Epoch: 1768

Loss on hold-out set: 0.005169023163131593
MeanAbsoluteError value on hold-out data: 0.05257111415266991
Epoch: 1769
Loss on hold-out set: 0.005089446075313996
MeanAbsoluteError value on hold-out data: 0.054739538580179214
Epoch: 1770
Loss on hold-out set: 0.005902955202724721
MeanAbsoluteError value on hold-out data: 0.056499626487493515
Epoch: 1771

Loss on hold-out set: 0.005832178200992833
MeanAbsoluteError value on hold-out data: 0.056227583438158035
Epoch: 1772
Loss on hold-out set: 0.006412134277052246
MeanAbsoluteError value on hold-out data: 0.05742207169532776
Epoch: 1773
Loss on hold-out set: 0.0061094959499738855
MeanAbsoluteError value on hold-out data: 0.05500059202313423
Epoch: 1774

Loss on hold-out set: 0.004843553352742068
MeanAbsoluteError value on hold-out data: 0.05186297371983528
```

```
Epoch: 1775
Loss on hold-out set: 0.005217601246161697
MeanAbsoluteError value on hold-out data: 0.050799764692783356
Epoch: 1776
Loss on hold-out set: 0.005719793613558674
MeanAbsoluteError value on hold-out data: 0.0532372370362818
Epoch: 1777

Loss on hold-out set: 0.005504991604326884
MeanAbsoluteError value on hold-out data: 0.054696325212717056
Epoch: 1778
Loss on hold-out set: 0.004993574655127304
MeanAbsoluteError value on hold-out data: 0.05158587917685509
Epoch: 1779
Loss on hold-out set: 0.005602652903186633
MeanAbsoluteError value on hold-out data: 0.05388707295060158
Epoch: 1780

Loss on hold-out set: 0.006576967816945398
MeanAbsoluteError value on hold-out data: 0.05805924907326698
Epoch: 1781
Loss on hold-out set: 0.006398894528780753
MeanAbsoluteError value on hold-out data: 0.058203041553497314
Epoch: 1782
Loss on hold-out set: 0.00604238176580111
MeanAbsoluteError value on hold-out data: 0.05649702623486519
Epoch: 1783

Loss on hold-out set: 0.006319113708426206
MeanAbsoluteError value on hold-out data: 0.0580112598836422
Epoch: 1784
Loss on hold-out set: 0.005259015433784195
MeanAbsoluteError value on hold-out data: 0.05319150164723396
Epoch: 1785
Loss on hold-out set: 0.005542116774947014
MeanAbsoluteError value on hold-out data: 0.0550716407597065
Epoch: 1786

Loss on hold-out set: 0.006882190570568127
MeanAbsoluteError value on hold-out data: 0.058325767517089844
Epoch: 1787
```

```
Loss on hold-out set: 0.005666227502042602
MeanAbsoluteError value on hold-out data: 0.0540219247341156
Epoch: 1788
Loss on hold-out set: 0.0063742112688790565
MeanAbsoluteError value on hold-out data: 0.05675206333398819
Epoch: 1789

Loss on hold-out set: 0.0052298556790901785
MeanAbsoluteError value on hold-out data: 0.051108889281749725
Epoch: 1790
Loss on hold-out set: 0.005657465085605508
MeanAbsoluteError value on hold-out data: 0.05046210438013077
Epoch: 1791
Loss on hold-out set: 0.005858053654251307
MeanAbsoluteError value on hold-out data: 0.054228998720645905
Epoch: 1792

Loss on hold-out set: 0.006269605457467454
MeanAbsoluteError value on hold-out data: 0.05593542754650116
Early stopping at epoch 1791
Returned to Spot: Validation loss: 0.006269605457467454
----------------------------------------------

config: {'_L_in': 10, '_L_out': 1, 'l1': 16, 'dropout_prob': 0.1773189149831582, 'lr_mult': 9
Epoch: 1
Loss on hold-out set: 0.03108395350165665
MeanAbsoluteError value on hold-out data: 0.13979753851890564
Epoch: 2
Loss on hold-out set: 0.029856409284596642
MeanAbsoluteError value on hold-out data: 0.13459670543670654
Epoch: 3
Loss on hold-out set: 0.023168638630304484
MeanAbsoluteError value on hold-out data: 0.12064463645219803
Epoch: 4
Loss on hold-out set: 0.021339265120526155
MeanAbsoluteError value on hold-out data: 0.11408503353595734
Returned to Spot: Validation loss: 0.021339265120526155
----------------------------------------------

config: {'_L_in': 10, '_L_out': 1, 'l1': 32, 'dropout_prob': 0.3840970624671163, 'lr_mult': 4
Epoch: 1
Loss on hold-out set: 0.028092310996726155
```

```
MeanAbsoluteError value on hold-out data: 0.13432064652442932
Epoch: 2
Loss on hold-out set: 0.023099353990370507
MeanAbsoluteError value on hold-out data: 0.12068716436624527
Epoch: 3
Loss on hold-out set: 0.023178815253471072
MeanAbsoluteError value on hold-out data: 0.12330807000398636
Epoch: 4

Loss on hold-out set: 0.020628881518189843
MeanAbsoluteError value on hold-out data: 0.11460810154676437
Epoch: 5
Loss on hold-out set: 0.01913658717009974
MeanAbsoluteError value on hold-out data: 0.10817889869213104
Epoch: 6
Loss on hold-out set: 0.015494997625386244
MeanAbsoluteError value on hold-out data: 0.09850440174341202
Epoch: 7
Loss on hold-out set: 0.01454726848628764
MeanAbsoluteError value on hold-out data: 0.09568692743778229
Epoch: 8
Loss on hold-out set: 0.01336163766437063
MeanAbsoluteError value on hold-out data: 0.09203585982322693
Epoch: 9
Loss on hold-out set: 0.011160664297150154
MeanAbsoluteError value on hold-out data: 0.08411747962236404
Epoch: 10
Loss on hold-out set: 0.011387258375945845
MeanAbsoluteError value on hold-out data: 0.07915222644805908
Epoch: 11
Loss on hold-out set: 0.012169253828592207
MeanAbsoluteError value on hold-out data: 0.087555892765522
Epoch: 12
Loss on hold-out set: 0.010965750068671218
MeanAbsoluteError value on hold-out data: 0.08494852483272552
Epoch: 13
Loss on hold-out set: 0.009092247426068704
MeanAbsoluteError value on hold-out data: 0.07504165917634964
Epoch: 14
Loss on hold-out set: 0.008145817380864173
MeanAbsoluteError value on hold-out data: 0.07196590304374695
Epoch: 15
```

```
Loss on hold-out set: 0.007214438982038318
MeanAbsoluteError value on hold-out data: 0.06794630736112595
Epoch: 16
Loss on hold-out set: 0.006401205435395241
MeanAbsoluteError value on hold-out data: 0.06295067071914673
Epoch: 17
Loss on hold-out set: 0.006773266022240645
MeanAbsoluteError value on hold-out data: 0.06270939856767654
Epoch: 18
Loss on hold-out set: 0.006492427158120431
MeanAbsoluteError value on hold-out data: 0.06104327365756035
Epoch: 19
Loss on hold-out set: 0.006362752183217947
MeanAbsoluteError value on hold-out data: 0.05959262326359749
Epoch: 20
Loss on hold-out set: 0.006192004105909483
MeanAbsoluteError value on hold-out data: 0.06347131729125977
Epoch: 21
Loss on hold-out set: 0.005392973393961591
MeanAbsoluteError value on hold-out data: 0.05644865706562996
Epoch: 22
Loss on hold-out set: 0.005809521008478968
MeanAbsoluteError value on hold-out data: 0.05718793347477913
Epoch: 23
Loss on hold-out set: 0.00513685051670396
MeanAbsoluteError value on hold-out data: 0.054564375430345535
Epoch: 24
Loss on hold-out set: 0.007194349640294125
MeanAbsoluteError value on hold-out data: 0.06659453362226486
Epoch: 25
Loss on hold-out set: 0.0050626466124269525
MeanAbsoluteError value on hold-out data: 0.052767980843782425
Epoch: 26

Loss on hold-out set: 0.005964157315534784
MeanAbsoluteError value on hold-out data: 0.05761843919754028
Epoch: 27
Loss on hold-out set: 0.004205082166376279
MeanAbsoluteError value on hold-out data: 0.04865239933133125
Epoch: 28
Loss on hold-out set: 0.005206418536162298
MeanAbsoluteError value on hold-out data: 0.05505737289786339
```

```
Epoch: 29
Loss on hold-out set: 0.0036415084997363585
MeanAbsoluteError value on hold-out data: 0.04479679837822914
Epoch: 30
Loss on hold-out set: 0.004483987417188473
MeanAbsoluteError value on hold-out data: 0.04758676141500473
Epoch: 31
Loss on hold-out set: 0.005990774465700318
MeanAbsoluteError value on hold-out data: 0.061434585601091385
Epoch: 32
Loss on hold-out set: 0.004927276560154401
MeanAbsoluteError value on hold-out data: 0.0538155622780323
Epoch: 33
Loss on hold-out set: 0.0038000896487287
MeanAbsoluteError value on hold-out data: 0.043611735105514526
Epoch: 34
Loss on hold-out set: 0.006366186275906665
MeanAbsoluteError value on hold-out data: 0.06048452481627464
Epoch: 35
Loss on hold-out set: 0.0044216115447373965
MeanAbsoluteError value on hold-out data: 0.048491038382053375
Epoch: 36
Loss on hold-out set: 0.00464631014773132
MeanAbsoluteError value on hold-out data: 0.053104646503925323
Epoch: 37

Loss on hold-out set: 0.0042621537607996475
MeanAbsoluteError value on hold-out data: 0.05261274054646492
Epoch: 38
Loss on hold-out set: 0.005370241914581703
MeanAbsoluteError value on hold-out data: 0.058759905397892
Epoch: 39
Loss on hold-out set: 0.004078732297976354
MeanAbsoluteError value on hold-out data: 0.046267591416835785
Epoch: 40
Loss on hold-out set: 0.005203436383070718
MeanAbsoluteError value on hold-out data: 0.05417736619710922
Epoch: 41
Loss on hold-out set: 0.004627176162198578
MeanAbsoluteError value on hold-out data: 0.05195195972919464
Epoch: 42
Loss on hold-out set: 0.004207102146832959
```

```
MeanAbsoluteError value on hold-out data: 0.04724271968007088
Epoch: 43
Loss on hold-out set: 0.004317741924559844
MeanAbsoluteError value on hold-out data: 0.048612192273139954
Epoch: 44
Loss on hold-out set: 0.003785909674326448
MeanAbsoluteError value on hold-out data: 0.04218163713812828
Epoch: 45
Loss on hold-out set: 0.004270921687987682
MeanAbsoluteError value on hold-out data: 0.04523957148194313
Epoch: 46
Loss on hold-out set: 0.003079241451096574
MeanAbsoluteError value on hold-out data: 0.03955801576375961
Epoch: 47
Loss on hold-out set: 0.0049245629634242505
MeanAbsoluteError value on hold-out data: 0.050603777170181274
Epoch: 48

Loss on hold-out set: 0.005297243193796787
MeanAbsoluteError value on hold-out data: 0.05514548718929291
Epoch: 49
Loss on hold-out set: 0.004805923488579299
MeanAbsoluteError value on hold-out data: 0.05262114107608795
Epoch: 50
Loss on hold-out set: 0.004855719422553911
MeanAbsoluteError value on hold-out data: 0.05262672156095505
Epoch: 51
Loss on hold-out set: 0.004595812056274889
MeanAbsoluteError value on hold-out data: 0.04804007336497307
Epoch: 52
Loss on hold-out set: 0.003483214026537577
MeanAbsoluteError value on hold-out data: 0.040377844125032425
Epoch: 53
Loss on hold-out set: 0.0038249910193323892
MeanAbsoluteError value on hold-out data: 0.04293591529130936
Epoch: 54
Loss on hold-out set: 0.0035075524187720333
MeanAbsoluteError value on hold-out data: 0.04399890825152397
Epoch: 55
Loss on hold-out set: 0.0036449701231169073
MeanAbsoluteError value on hold-out data: 0.0443449467420578
Epoch: 56
```

```
Loss on hold-out set: 0.0033622199476475976
MeanAbsoluteError value on hold-out data: 0.04063126817345619
Epoch: 57
Loss on hold-out set: 0.004024630397907458
MeanAbsoluteError value on hold-out data: 0.04145378619432449
Epoch: 58
Loss on hold-out set: 0.004941483022105929
MeanAbsoluteError value on hold-out data: 0.055099405348300934
Epoch: 59

Loss on hold-out set: 0.004603927614976112
MeanAbsoluteError value on hold-out data: 0.04991842433810234
Epoch: 60
Loss on hold-out set: 0.005534595901783752
MeanAbsoluteError value on hold-out data: 0.061141517013311386
Epoch: 61
Loss on hold-out set: 0.0033166984189608086
MeanAbsoluteError value on hold-out data: 0.04273485019803047
Epoch: 62
Loss on hold-out set: 0.003228607381491824
MeanAbsoluteError value on hold-out data: 0.04275544732809067
Epoch: 63
Loss on hold-out set: 0.005014563000785481
MeanAbsoluteError value on hold-out data: 0.049218323081731796
Epoch: 64
Loss on hold-out set: 0.005263070719880297
MeanAbsoluteError value on hold-out data: 0.05755065754055977
Epoch: 65
Loss on hold-out set: 0.003532255227726541
MeanAbsoluteError value on hold-out data: 0.043874144554138184
Epoch: 66
Loss on hold-out set: 0.004071612620272821
MeanAbsoluteError value on hold-out data: 0.047189876437187195
Epoch: 67
Loss on hold-out set: 0.0037450894443808416
MeanAbsoluteError value on hold-out data: 0.047390904277563095
Epoch: 68
Loss on hold-out set: 0.004296807970508541
MeanAbsoluteError value on hold-out data: 0.047867998480796814
Epoch: 69
Loss on hold-out set: 0.004003263345159786
MeanAbsoluteError value on hold-out data: 0.04533475264906883
```

```
Epoch: 70
Loss on hold-out set: 0.003268264610884025
MeanAbsoluteError value on hold-out data: 0.03957972675561905
Epoch: 71


Loss on hold-out set: 0.0036410559719354894
MeanAbsoluteError value on hold-out data: 0.04482315853238106
Epoch: 72
Loss on hold-out set: 0.004530005696180619
MeanAbsoluteError value on hold-out data: 0.04769998788833618
Epoch: 73
Loss on hold-out set: 0.0036487796735998833
MeanAbsoluteError value on hold-out data: 0.0461231991648674
Epoch: 74
Loss on hold-out set: 0.004026349710521141
MeanAbsoluteError value on hold-out data: 0.04698650538921356
Epoch: 75
Loss on hold-out set: 0.004225322606017519
MeanAbsoluteError value on hold-out data: 0.047552723437547684
Epoch: 76
Loss on hold-out set: 0.005206073099735046
MeanAbsoluteError value on hold-out data: 0.05376986786723137
Epoch: 77
Loss on hold-out set: 0.004006386517032392
MeanAbsoluteError value on hold-out data: 0.043821778148412704
Epoch: 78
Loss on hold-out set: 0.005241909922915511
MeanAbsoluteError value on hold-out data: 0.04854344204068184
Epoch: 79
Loss on hold-out set: 0.0040434181144902185
MeanAbsoluteError value on hold-out data: 0.045710522681474686
Epoch: 80
Loss on hold-out set: 0.006117022296070661
MeanAbsoluteError value on hold-out data: 0.06251635402441025
Epoch: 81
Loss on hold-out set: 0.006742436867697458
MeanAbsoluteError value on hold-out data: 0.06353610008955002
Epoch: 82


Loss on hold-out set: 0.0043805325748460175
MeanAbsoluteError value on hold-out data: 0.04646935686469078
Epoch: 83
```

```
Loss on hold-out set: 0.0034658889428675664
MeanAbsoluteError value on hold-out data: 0.044836632907390594
Epoch: 84
Loss on hold-out set: 0.004062147343862115
MeanAbsoluteError value on hold-out data: 0.045172933489084244
Epoch: 85
Loss on hold-out set: 0.006030665208144407
MeanAbsoluteError value on hold-out data: 0.0550721175968647
Epoch: 86
Loss on hold-out set: 0.004890154182871093
MeanAbsoluteError value on hold-out data: 0.04521860182285309
Epoch: 87
Loss on hold-out set: 0.00436650199117139
MeanAbsoluteError value on hold-out data: 0.04981920123100281
Epoch: 88
Loss on hold-out set: 0.004805736940684973
MeanAbsoluteError value on hold-out data: 0.048832278698682785
Epoch: 89
Loss on hold-out set: 0.004437177913036737
MeanAbsoluteError value on hold-out data: 0.04486740007996559
Epoch: 90
Loss on hold-out set: 0.004549278583573668
MeanAbsoluteError value on hold-out data: 0.051092419773340225
Epoch: 91
Loss on hold-out set: 0.004552874890290887
MeanAbsoluteError value on hold-out data: 0.050133366137742996
Epoch: 92
Loss on hold-out set: 0.0038445634502415104
MeanAbsoluteError value on hold-out data: 0.04325396195054054
Epoch: 93

Loss on hold-out set: 0.0030326223396083436
MeanAbsoluteError value on hold-out data: 0.04049954563379288
Epoch: 94
Loss on hold-out set: 0.004867403780257231
MeanAbsoluteError value on hold-out data: 0.05176795274019241
Epoch: 95
Loss on hold-out set: 0.004536337649609011
MeanAbsoluteError value on hold-out data: 0.04860428720712662
Epoch: 96
Loss on hold-out set: 0.00306158776526756
MeanAbsoluteError value on hold-out data: 0.03957994654774666
```

```
Epoch: 97
Loss on hold-out set: 0.004460591887197408
MeanAbsoluteError value on hold-out data: 0.047789763659238815
Epoch: 98
Loss on hold-out set: 0.004246654583288259
MeanAbsoluteError value on hold-out data: 0.04622720927000046
Epoch: 99
Loss on hold-out set: 0.004734919002083571
MeanAbsoluteError value on hold-out data: 0.05161454156041145
Epoch: 100
Loss on hold-out set: 0.004128901257277711
MeanAbsoluteError value on hold-out data: 0.04639066383242607
Epoch: 101
Loss on hold-out set: 0.004471753405309037
MeanAbsoluteError value on hold-out data: 0.04842916131019592
Epoch: 102
Loss on hold-out set: 0.0039039990913711095
MeanAbsoluteError value on hold-out data: 0.047502268105745316
Epoch: 103
Loss on hold-out set: 0.0034461641534060043
MeanAbsoluteError value on hold-out data: 0.0398809053003788
Epoch: 104
Loss on hold-out set: 0.0055759542983172365
MeanAbsoluteError value on hold-out data: 0.05693627521395683
Epoch: 105

Loss on hold-out set: 0.00581756492120851
MeanAbsoluteError value on hold-out data: 0.055988140404224396
Epoch: 106
Loss on hold-out set: 0.004294538573288408
MeanAbsoluteError value on hold-out data: 0.04527606815099716
Epoch: 107
Loss on hold-out set: 0.0039794151410828095
MeanAbsoluteError value on hold-out data: 0.04548513516783714
Epoch: 108
Loss on hold-out set: 0.00445365577960681
MeanAbsoluteError value on hold-out data: 0.04895598068833351
Epoch: 109
Loss on hold-out set: 0.003953264171478192
MeanAbsoluteError value on hold-out data: 0.04481235519051552
Epoch: 110
Loss on hold-out set: 0.004346655652625486
```

```
MeanAbsoluteError value on hold-out data: 0.05026005208492279
Epoch: 111
Loss on hold-out set: 0.00444616222069415
MeanAbsoluteError value on hold-out data: 0.04451599344611168
Epoch: 112
Loss on hold-out set: 0.004743774638642974
MeanAbsoluteError value on hold-out data: 0.04576140269637108
Epoch: 113
Loss on hold-out set: 0.0037965284718666226
MeanAbsoluteError value on hold-out data: 0.04351956024765968
Epoch: 114
Loss on hold-out set: 0.004753229775049381
MeanAbsoluteError value on hold-out data: 0.05366820469498634
Epoch: 115
Loss on hold-out set: 0.003093012090845916
MeanAbsoluteError value on hold-out data: 0.04271671175956726
Epoch: 116
Loss on hold-out set: 0.003751190973592824
MeanAbsoluteError value on hold-out data: 0.045372650027275085
Epoch: 117

Loss on hold-out set: 0.003701142377011772
MeanAbsoluteError value on hold-out data: 0.044228143990039825
Epoch: 118
Loss on hold-out set: 0.0037935633981281795
MeanAbsoluteError value on hold-out data: 0.04101856052875519
Epoch: 119
Loss on hold-out set: 0.0035920889594739207
MeanAbsoluteError value on hold-out data: 0.048097338527441025
Epoch: 120
Loss on hold-out set: 0.004640096256288847
MeanAbsoluteError value on hold-out data: 0.05291040241718292
Epoch: 121
Loss on hold-out set: 0.0037868364995933676
MeanAbsoluteError value on hold-out data: 0.04441355541348457
Epoch: 122
Loss on hold-out set: 0.004408916881258942
MeanAbsoluteError value on hold-out data: 0.04791993647813797
Epoch: 123
Loss on hold-out set: 0.003805169002398064
MeanAbsoluteError value on hold-out data: 0.049591969698667526
Epoch: 124
```

```
Loss on hold-out set: 0.003653524812666307
MeanAbsoluteError value on hold-out data: 0.04356307163834572
Epoch: 125
Loss on hold-out set: 0.002829914793102561
MeanAbsoluteError value on hold-out data: 0.037797700613737106
Epoch: 126
Loss on hold-out set: 0.0033836348080321364
MeanAbsoluteError value on hold-out data: 0.043331217020750046
Epoch: 127
Loss on hold-out set: 0.004067454821013503
MeanAbsoluteError value on hold-out data: 0.04592638835310936
Epoch: 128

Loss on hold-out set: 0.00292617482850083
MeanAbsoluteError value on hold-out data: 0.04023493081331253
Epoch: 129
Loss on hold-out set: 0.005047255937059067
MeanAbsoluteError value on hold-out data: 0.04794159531593323
Epoch: 130
Loss on hold-out set: 0.004413857121682285
MeanAbsoluteError value on hold-out data: 0.05171943083405495
Epoch: 131
Loss on hold-out set: 0.003955122248091931
MeanAbsoluteError value on hold-out data: 0.042680419981479645
Epoch: 132
Loss on hold-out set: 0.005305402402116574
MeanAbsoluteError value on hold-out data: 0.04886878281831741
Epoch: 133
Loss on hold-out set: 0.004133184566039984
MeanAbsoluteError value on hold-out data: 0.049209196120500565
Epoch: 134
Loss on hold-out set: 0.0024960765716203147
MeanAbsoluteError value on hold-out data: 0.037657883018255234
Epoch: 135
Loss on hold-out set: 0.00407335371480593
MeanAbsoluteError value on hold-out data: 0.04853399097919464
Epoch: 136
Loss on hold-out set: 0.004479891445953399
MeanAbsoluteError value on hold-out data: 0.04382752254605293
Epoch: 137
Loss on hold-out set: 0.004052676076657678
MeanAbsoluteError value on hold-out data: 0.04890184849500656
```

```
Epoch: 138
Loss on hold-out set: 0.003937156830369004
MeanAbsoluteError value on hold-out data: 0.041236668825149536
Epoch: 139
Loss on hold-out set: 0.004714234304724653
MeanAbsoluteError value on hold-out data: 0.048354823142290115
Epoch: 140

Loss on hold-out set: 0.006621354734402542
MeanAbsoluteError value on hold-out data: 0.06283194571733475
Epoch: 141
Loss on hold-out set: 0.004254520495458947
MeanAbsoluteError value on hold-out data: 0.04399476200342178
Epoch: 142
Loss on hold-out set: 0.0032215248555937585
MeanAbsoluteError value on hold-out data: 0.039903104305267334
Epoch: 143
Loss on hold-out set: 0.0037292612986148973
MeanAbsoluteError value on hold-out data: 0.041451528668403625
Epoch: 144
Loss on hold-out set: 0.003954046302456654
MeanAbsoluteError value on hold-out data: 0.04048844799399376
Epoch: 145
Loss on hold-out set: 0.004530099374517847
MeanAbsoluteError value on hold-out data: 0.045373234897851944
Epoch: 146
Loss on hold-out set: 0.002749326845667766
MeanAbsoluteError value on hold-out data: 0.03910341486334801
Epoch: 147
Loss on hold-out set: 0.003401900277056388
MeanAbsoluteError value on hold-out data: 0.041274234652519226
Epoch: 148
Loss on hold-out set: 0.004296285751287972
MeanAbsoluteError value on hold-out data: 0.04476640000939369
Epoch: 149
Loss on hold-out set: 0.0034092275814864
MeanAbsoluteError value on hold-out data: 0.040559735149145126
Epoch: 150
Loss on hold-out set: 0.004892932421123413
MeanAbsoluteError value on hold-out data: 0.04675183445215225
Epoch: 151
Loss on hold-out set: 0.004939361692920916
```

```
MeanAbsoluteError value on hold-out data: 0.054196521639823914
Epoch: 152

Loss on hold-out set: 0.0037321262773873875
MeanAbsoluteError value on hold-out data: 0.04197756573557854
Epoch: 153
Loss on hold-out set: 0.005563835720654185
MeanAbsoluteError value on hold-out data: 0.05383012816309929
Epoch: 154
Loss on hold-out set: 0.00505844026185131
MeanAbsoluteError value on hold-out data: 0.049374017864465714
Epoch: 155
Loss on hold-out set: 0.005729540952750922
MeanAbsoluteError value on hold-out data: 0.055850666016340256
Epoch: 156
Loss on hold-out set: 0.00447508656285017
MeanAbsoluteError value on hold-out data: 0.050545621663331985
Epoch: 157
Loss on hold-out set: 0.0032286526448411963
MeanAbsoluteError value on hold-out data: 0.04122339189052582
Epoch: 158
Loss on hold-out set: 0.005266002014794044
MeanAbsoluteError value on hold-out data: 0.053341343998909
Epoch: 159
Loss on hold-out set: 0.003632486987809994
MeanAbsoluteError value on hold-out data: 0.04347092658281326
Epoch: 160
Loss on hold-out set: 0.003916412253410702
MeanAbsoluteError value on hold-out data: 0.04609092324972153
Epoch: 161
Loss on hold-out set: 0.005544954996654077
MeanAbsoluteError value on hold-out data: 0.057865582406520844
Epoch: 162
Loss on hold-out set: 0.004117903397663643
MeanAbsoluteError value on hold-out data: 0.04042133316397667
Epoch: 163

Loss on hold-out set: 0.0038196565950975605
MeanAbsoluteError value on hold-out data: 0.04757344722747803
Epoch: 164
Loss on hold-out set: 0.003749075327313652
MeanAbsoluteError value on hold-out data: 0.04537241905927658
```

```
Epoch: 165
Loss on hold-out set: 0.003236346379516793
MeanAbsoluteError value on hold-out data: 0.039822205901145935
Epoch: 166
Loss on hold-out set: 0.004744388285632196
MeanAbsoluteError value on hold-out data: 0.05179304629564285
Epoch: 167
Loss on hold-out set: 0.003499457269514862
MeanAbsoluteError value on hold-out data: 0.043386369943618774
Epoch: 168
Loss on hold-out set: 0.0031643090880702643
MeanAbsoluteError value on hold-out data: 0.03922136873006821
Epoch: 169
Loss on hold-out set: 0.003125078925605569
MeanAbsoluteError value on hold-out data: 0.04158106446266174
Epoch: 170
Loss on hold-out set: 0.004364724012128518
MeanAbsoluteError value on hold-out data: 0.044490694999694824
Epoch: 171
Loss on hold-out set: 0.004146035324083641
MeanAbsoluteError value on hold-out data: 0.04234122857451439
Epoch: 172
Loss on hold-out set: 0.004593205178695682
MeanAbsoluteError value on hold-out data: 0.05483212694525719
Epoch: 173
Loss on hold-out set: 0.005194415200477172
MeanAbsoluteError value on hold-out data: 0.05397013947367668
Epoch: 174
Loss on hold-out set: 0.004756652391638215
MeanAbsoluteError value on hold-out data: 0.0494881235063076
Epoch: 175

Loss on hold-out set: 0.004827795537207031
MeanAbsoluteError value on hold-out data: 0.05267047882080078
Epoch: 176
Loss on hold-out set: 0.004325839519304664
MeanAbsoluteError value on hold-out data: 0.05025424808263779
Epoch: 177
Loss on hold-out set: 0.003623516924562864
MeanAbsoluteError value on hold-out data: 0.04509085416793823
Epoch: 178
Loss on hold-out set: 0.0040048098522483516
```

```
MeanAbsoluteError value on hold-out data: 0.04346651956439018
Epoch: 179
Loss on hold-out set: 0.0034367941430230673
MeanAbsoluteError value on hold-out data: 0.04375312104821205
Epoch: 180
Loss on hold-out set: 0.00458847956944833
MeanAbsoluteError value on hold-out data: 0.053029876202344894
Epoch: 181
Loss on hold-out set: 0.0035392361065820104
MeanAbsoluteError value on hold-out data: 0.0403442308306694
Epoch: 182
Loss on hold-out set: 0.0035927685706778185
MeanAbsoluteError value on hold-out data: 0.04196459800004959
Epoch: 183
Loss on hold-out set: 0.00493177856888475
MeanAbsoluteError value on hold-out data: 0.05022526532411575
Epoch: 184
Loss on hold-out set: 0.003902429252201201
MeanAbsoluteError value on hold-out data: 0.0442359521985054
Epoch: 185
Loss on hold-out set: 0.003980229648540875
MeanAbsoluteError value on hold-out data: 0.04589516669511795
Epoch: 186

Loss on hold-out set: 0.004823275029928864
MeanAbsoluteError value on hold-out data: 0.05627521499991417
Epoch: 187
Loss on hold-out set: 0.003572638790692987
MeanAbsoluteError value on hold-out data: 0.043333057314157486
Epoch: 188
Loss on hold-out set: 0.0030406179208320714
MeanAbsoluteError value on hold-out data: 0.03775323927402496
Epoch: 189
Loss on hold-out set: 0.0052066134521737695
MeanAbsoluteError value on hold-out data: 0.0529417023062706
Epoch: 190
Loss on hold-out set: 0.004955323495730562
MeanAbsoluteError value on hold-out data: 0.04802355542778969
Epoch: 191
Loss on hold-out set: 0.0035204342719608625
MeanAbsoluteError value on hold-out data: 0.0438949391245842
Epoch: 192
```

```
Loss on hold-out set: 0.0035985162417330827
MeanAbsoluteError value on hold-out data: 0.045809391885995865
Epoch: 193
Loss on hold-out set: 0.004421806197282613
MeanAbsoluteError value on hold-out data: 0.045771948993206024
Epoch: 194
Loss on hold-out set: 0.004570708086248487
MeanAbsoluteError value on hold-out data: 0.042340073734521866
Epoch: 195
Loss on hold-out set: 0.005318562097320529
MeanAbsoluteError value on hold-out data: 0.051876768469810486
Epoch: 196
Loss on hold-out set: 0.0036561738923314565
MeanAbsoluteError value on hold-out data: 0.04322274029254913
Epoch: 197

Loss on hold-out set: 0.004278669274706198
MeanAbsoluteError value on hold-out data: 0.04435229301452637
Epoch: 198
Loss on hold-out set: 0.00582533759619477
MeanAbsoluteError value on hold-out data: 0.047210510820150375
Early stopping at epoch 197
Returned to Spot: Validation loss: 0.00582533759619477
----------------------------------------------


config: {'_L_in': 10, '_L_out': 1, 'l1': 32, 'dropout_prob': 0.5024396248295631, 'lr_mult': 3
Epoch: 1
Loss on hold-out set: 0.050470124390956606
MeanAbsoluteError value on hold-out data: 0.17807205021381378
Epoch: 2
Loss on hold-out set: 0.03601070603747901
MeanAbsoluteError value on hold-out data: 0.15177612006664276
Epoch: 3
Loss on hold-out set: 0.03247427913409315
MeanAbsoluteError value on hold-out data: 0.1461077779531479
Epoch: 4
Loss on hold-out set: 0.03281747073082155
MeanAbsoluteError value on hold-out data: 0.14249537885189056
Epoch: 5
Loss on hold-out set: 0.028822745980792923
MeanAbsoluteError value on hold-out data: 0.13796882331371307
```

```
Epoch: 6
Loss on hold-out set: 0.03260573703109434
MeanAbsoluteError value on hold-out data: 0.14170528948307037
Epoch: 7
Loss on hold-out set: 0.025819227356757773
MeanAbsoluteError value on hold-out data: 0.1280757039785385
Epoch: 8
Loss on hold-out set: 0.022321242391818055
MeanAbsoluteError value on hold-out data: 0.11730899661779404
Epoch: 9
Loss on hold-out set: 0.023289143107831478
MeanAbsoluteError value on hold-out data: 0.12215057015419006
Epoch: 10
Loss on hold-out set: 0.0204285596203255
MeanAbsoluteError value on hold-out data: 0.1124904602766037
Epoch: 11
```

```
Loss on hold-out set: 0.020540171688863712
MeanAbsoluteError value on hold-out data: 0.10956305265426636
Epoch: 12
Loss on hold-out set: 0.019289409815284767
MeanAbsoluteError value on hold-out data: 0.107833631336689
Epoch: 13
Loss on hold-out set: 0.018602809133498294
MeanAbsoluteError value on hold-out data: 0.10800498723983765
Epoch: 14
Loss on hold-out set: 0.017937725814255446
MeanAbsoluteError value on hold-out data: 0.10735669732093811
Epoch: 15
Loss on hold-out set: 0.018462630442196603
MeanAbsoluteError value on hold-out data: 0.10794353485107422
Epoch: 16
Loss on hold-out set: 0.01792873552461204
MeanAbsoluteError value on hold-out data: 0.10508924722671509
Epoch: 17
Loss on hold-out set: 0.0174692713434955
MeanAbsoluteError value on hold-out data: 0.10353229194879532
Epoch: 18
Loss on hold-out set: 0.011569002857676855
MeanAbsoluteError value on hold-out data: 0.08291202783584595
Epoch: 19
Loss on hold-out set: 0.014114443194366208
```

```
MeanAbsoluteError value on hold-out data: 0.09242282062768936
Epoch: 20
Loss on hold-out set: 0.014918881198881488
MeanAbsoluteError value on hold-out data: 0.09452228248119354
Epoch: 21
Loss on hold-out set: 0.013620662876698924
MeanAbsoluteError value on hold-out data: 0.09022883325815201
Epoch: 22


Loss on hold-out set: 0.01258805290011591
MeanAbsoluteError value on hold-out data: 0.08951456844806671
Epoch: 23
Loss on hold-out set: 0.012073873281846509
MeanAbsoluteError value on hold-out data: 0.07984800636768341
Epoch: 24
Loss on hold-out set: 0.011882753485176516
MeanAbsoluteError value on hold-out data: 0.08235832303762436
Epoch: 25
Loss on hold-out set: 0.013867262040117853
MeanAbsoluteError value on hold-out data: 0.08875955641269684
Epoch: 26
Loss on hold-out set: 0.012255948992740167
MeanAbsoluteError value on hold-out data: 0.08518532663583755
Epoch: 27
Loss on hold-out set: 0.00877406416877516
MeanAbsoluteError value on hold-out data: 0.07090409100055695
Epoch: 28
Loss on hold-out set: 0.01268413979069967
MeanAbsoluteError value on hold-out data: 0.0826491042971611
Epoch: 29
Loss on hold-out set: 0.010402007117303774
MeanAbsoluteError value on hold-out data: 0.07597597688436508
Epoch: 30
Loss on hold-out set: 0.008978866239838106
MeanAbsoluteError value on hold-out data: 0.06964496523141861
Epoch: 31
Loss on hold-out set: 0.009986447740199142
MeanAbsoluteError value on hold-out data: 0.07277239859104156
Epoch: 32
Loss on hold-out set: 0.009238560298016589
MeanAbsoluteError value on hold-out data: 0.07148826867341995
Epoch: 33
```

```
Loss on hold-out set: 0.012843787241236944
MeanAbsoluteError value on hold-out data: 0.08804646134376526
Epoch: 34
Loss on hold-out set: 0.009613420802021497
MeanAbsoluteError value on hold-out data: 0.07301539182662964
Epoch: 35
Loss on hold-out set: 0.010670826130080968
MeanAbsoluteError value on hold-out data: 0.0770464539527893
Epoch: 36
Loss on hold-out set: 0.011226198072300145
MeanAbsoluteError value on hold-out data: 0.07987027615308762
Epoch: 37
Loss on hold-out set: 0.008988888293970376
MeanAbsoluteError value on hold-out data: 0.06941476464271545
Epoch: 38
Loss on hold-out set: 0.009318303782492876
MeanAbsoluteError value on hold-out data: 0.07116278260946274
Epoch: 39
Loss on hold-out set: 0.008628377114961805
MeanAbsoluteError value on hold-out data: 0.06694087386131287
Epoch: 40
Loss on hold-out set: 0.008706729344435428
MeanAbsoluteError value on hold-out data: 0.07008085399866104
Epoch: 41
Loss on hold-out set: 0.008995590431272592
MeanAbsoluteError value on hold-out data: 0.07342194765806198
Epoch: 42
Loss on hold-out set: 0.007944453460176623
MeanAbsoluteError value on hold-out data: 0.06532423198223114
Epoch: 43
Loss on hold-out set: 0.008809009413725059
MeanAbsoluteError value on hold-out data: 0.068943090736866
Epoch: 44

Loss on hold-out set: 0.00899052964891062
MeanAbsoluteError value on hold-out data: 0.07061433047056198
Epoch: 45
Loss on hold-out set: 0.009272568568121642
MeanAbsoluteError value on hold-out data: 0.06981483846902847
Epoch: 46
Loss on hold-out set: 0.008160707020004722
MeanAbsoluteError value on hold-out data: 0.06833045929670334
```

```
Epoch: 47
Loss on hold-out set: 0.011261523658360698
MeanAbsoluteError value on hold-out data: 0.08555145561695099
Epoch: 48
Loss on hold-out set: 0.008319198971883835
MeanAbsoluteError value on hold-out data: 0.06725790351629257
Epoch: 49
Loss on hold-out set: 0.00837178488482574
MeanAbsoluteError value on hold-out data: 0.06785359233617783
Epoch: 50
Loss on hold-out set: 0.008295496374270633
MeanAbsoluteError value on hold-out data: 0.06612477451562881
Epoch: 51
Loss on hold-out set: 0.008677417798408945
MeanAbsoluteError value on hold-out data: 0.06760222464799881
Epoch: 52
Loss on hold-out set: 0.009365415479375147
MeanAbsoluteError value on hold-out data: 0.06751319020986557
Epoch: 53
Loss on hold-out set: 0.009556002795426665
MeanAbsoluteError value on hold-out data: 0.07309623062610626
Epoch: 54
Loss on hold-out set: 0.01072998921154067
MeanAbsoluteError value on hold-out data: 0.07638177275657654
Epoch: 55

Loss on hold-out set: 0.00882365483190178
MeanAbsoluteError value on hold-out data: 0.06872469931840897
Epoch: 56
Loss on hold-out set: 0.00885928447946514
MeanAbsoluteError value on hold-out data: 0.06767798960208893
Epoch: 57
Loss on hold-out set: 0.009184036354877446
MeanAbsoluteError value on hold-out data: 0.07122014462947845
Epoch: 58
Loss on hold-out set: 0.009047846983824121
MeanAbsoluteError value on hold-out data: 0.07172136008739471
Epoch: 59
Loss on hold-out set: 0.006881109938197034
MeanAbsoluteError value on hold-out data: 0.06042802706360817
Epoch: 60
Loss on hold-out set: 0.007326112781332708
```

```
MeanAbsoluteError value on hold-out data: 0.06468020379543304
Epoch: 61
Loss on hold-out set: 0.008377776263698348
MeanAbsoluteError value on hold-out data: 0.06650520861148834
Epoch: 62
Loss on hold-out set: 0.0064735396054426304
MeanAbsoluteError value on hold-out data: 0.06055958569049835
Epoch: 63
Loss on hold-out set: 0.009274255481279014
MeanAbsoluteError value on hold-out data: 0.0731026828289032
Epoch: 64
Loss on hold-out set: 0.007167861476773396
MeanAbsoluteError value on hold-out data: 0.06274034082889557
Epoch: 65
Loss on hold-out set: 0.00769210905204282
MeanAbsoluteError value on hold-out data: 0.0645519495010376
Epoch: 66

Loss on hold-out set: 0.008774549853497822
MeanAbsoluteError value on hold-out data: 0.07175951451063156
Epoch: 67
Loss on hold-out set: 0.008149756608824981
MeanAbsoluteError value on hold-out data: 0.07083823531866074
Epoch: 68
Loss on hold-out set: 0.008657651545945555
MeanAbsoluteError value on hold-out data: 0.06864617764949799
Epoch: 69
Loss on hold-out set: 0.007155844874336924
MeanAbsoluteError value on hold-out data: 0.06295986473560333
Epoch: 70
Loss on hold-out set: 0.007905008660408816
MeanAbsoluteError value on hold-out data: 0.06464080512523651
Epoch: 71
Loss on hold-out set: 0.007297929517287565
MeanAbsoluteError value on hold-out data: 0.06290733069181442
Epoch: 72
Loss on hold-out set: 0.007222465925702923
MeanAbsoluteError value on hold-out data: 0.059914473444223404
Epoch: 73
Loss on hold-out set: 0.006866331926032312
MeanAbsoluteError value on hold-out data: 0.05885935574769974
Epoch: 74
```

```
Loss on hold-out set: 0.006374180018227841
MeanAbsoluteError value on hold-out data: 0.057746771723032
Epoch: 75
Loss on hold-out set: 0.008911963460329724
MeanAbsoluteError value on hold-out data: 0.07084521651268005
Epoch: 76
Loss on hold-out set: 0.009284821406349932
MeanAbsoluteError value on hold-out data: 0.0684407576918602
Epoch: 77
Loss on hold-out set: 0.0070731605948439165
MeanAbsoluteError value on hold-out data: 0.0609641894698143
Epoch: 78


Loss on hold-out set: 0.00836748980586172
MeanAbsoluteError value on hold-out data: 0.06661433726549149
Epoch: 79
Loss on hold-out set: 0.007799681934748629
MeanAbsoluteError value on hold-out data: 0.06560824066400528
Epoch: 80
Loss on hold-out set: 0.007729386996575876
MeanAbsoluteError value on hold-out data: 0.06514577567577362
Epoch: 81
Loss on hold-out set: 0.007438299362547696
MeanAbsoluteError value on hold-out data: 0.06334252655506134
Epoch: 82
Loss on hold-out set: 0.007638543930002733
MeanAbsoluteError value on hold-out data: 0.06335311383008957
Epoch: 83
Loss on hold-out set: 0.007286363756161575
MeanAbsoluteError value on hold-out data: 0.0634523332118988
Epoch: 84
Loss on hold-out set: 0.0074886863493654685
MeanAbsoluteError value on hold-out data: 0.06436996161937714
Epoch: 85
Loss on hold-out set: 0.006560557650549239
MeanAbsoluteError value on hold-out data: 0.057015229016542435
Epoch: 86
Loss on hold-out set: 0.007760563179066307
MeanAbsoluteError value on hold-out data: 0.06461501121520996
Epoch: 87
Loss on hold-out set: 0.008299630362001298
MeanAbsoluteError value on hold-out data: 0.0673133134841919
```

```
Epoch: 88
Loss on hold-out set: 0.007209504363249596
MeanAbsoluteError value on hold-out data: 0.062024738639593124
Epoch: 89

Loss on hold-out set: 0.007002823967731705
MeanAbsoluteError value on hold-out data: 0.06090136989951134
Epoch: 90
Loss on hold-out set: 0.007172173495698524
MeanAbsoluteError value on hold-out data: 0.06304875016212463
Epoch: 91
Loss on hold-out set: 0.006927721520983859
MeanAbsoluteError value on hold-out data: 0.06042618304491043
Epoch: 92
Loss on hold-out set: 0.006421305514921091
MeanAbsoluteError value on hold-out data: 0.05948494002223015
Epoch: 93
Loss on hold-out set: 0.008548022462300173
MeanAbsoluteError value on hold-out data: 0.06844713538885117
Epoch: 94
Loss on hold-out set: 0.006860493483193415
MeanAbsoluteError value on hold-out data: 0.061843905597925186
Epoch: 95
Loss on hold-out set: 0.008249971402907058
MeanAbsoluteError value on hold-out data: 0.06756110489368439
Epoch: 96
Loss on hold-out set: 0.006660442716613608
MeanAbsoluteError value on hold-out data: 0.060900554060935974
Epoch: 97
Loss on hold-out set: 0.006168763407530557
MeanAbsoluteError value on hold-out data: 0.057699985802173615
Epoch: 98
Loss on hold-out set: 0.007762475337490048
MeanAbsoluteError value on hold-out data: 0.06609514355659485
Epoch: 99
Loss on hold-out set: 0.0070596868386737215
MeanAbsoluteError value on hold-out data: 0.06447027623653412
Epoch: 100

Loss on hold-out set: 0.0075899940321074895
MeanAbsoluteError value on hold-out data: 0.06459175795316696
Epoch: 101
```

```
Loss on hold-out set: 0.007070564003171105
MeanAbsoluteError value on hold-out data: 0.06198669970035553
Epoch: 102
Loss on hold-out set: 0.008526944543087953
MeanAbsoluteError value on hold-out data: 0.0706968605518341
Epoch: 103
Loss on hold-out set: 0.006022206192076402
MeanAbsoluteError value on hold-out data: 0.05757788196206093
Epoch: 104
Loss on hold-out set: 0.006953138184096468
MeanAbsoluteError value on hold-out data: 0.05800177901983261
Epoch: 105
Loss on hold-out set: 0.007306089456266675
MeanAbsoluteError value on hold-out data: 0.06321341544389725
Epoch: 106
Loss on hold-out set: 0.007281408409318446
MeanAbsoluteError value on hold-out data: 0.0604221485555172
Epoch: 107
Loss on hold-out set: 0.008263429645203837
MeanAbsoluteError value on hold-out data: 0.06619958579540253
Epoch: 108
Loss on hold-out set: 0.008097791082323775
MeanAbsoluteError value on hold-out data: 0.06276820600032806
Epoch: 109
Loss on hold-out set: 0.00661478394728252
MeanAbsoluteError value on hold-out data: 0.058800093829631805
Epoch: 110
Loss on hold-out set: 0.007237213896587491
MeanAbsoluteError value on hold-out data: 0.06232794374227524
Epoch: 111

Loss on hold-out set: 0.006812104317328991
MeanAbsoluteError value on hold-out data: 0.06110675632953644
Epoch: 112
Loss on hold-out set: 0.008569127973475444
MeanAbsoluteError value on hold-out data: 0.06871097534894943
Epoch: 113
Loss on hold-out set: 0.00844656745903194
MeanAbsoluteError value on hold-out data: 0.06949253380298615
Epoch: 114
Loss on hold-out set: 0.007184358526597191
MeanAbsoluteError value on hold-out data: 0.06329521536827087
```

```
Epoch: 115
Loss on hold-out set: 0.010895859738076595
MeanAbsoluteError value on hold-out data: 0.0758163258433342
Epoch: 116
Loss on hold-out set: 0.0077151287481875015
MeanAbsoluteError value on hold-out data: 0.06486725807189941
Epoch: 117
Loss on hold-out set: 0.00796783310483749
MeanAbsoluteError value on hold-out data: 0.06621547788381577
Epoch: 118
Loss on hold-out set: 0.006886198534630239
MeanAbsoluteError value on hold-out data: 0.06242235749959946
Epoch: 119
Loss on hold-out set: 0.008198462815734706
MeanAbsoluteError value on hold-out data: 0.0664718970656395
Epoch: 120
Loss on hold-out set: 0.008630308303461214
MeanAbsoluteError value on hold-out data: 0.06665659695863724
Epoch: 121
Loss on hold-out set: 0.007907008136451048
MeanAbsoluteError value on hold-out data: 0.0659835934638977
Epoch: 122

Loss on hold-out set: 0.008115676384860356
MeanAbsoluteError value on hold-out data: 0.06707029789686203
Epoch: 123
Loss on hold-out set: 0.007927093835621091
MeanAbsoluteError value on hold-out data: 0.0661000981926918
Epoch: 124
Loss on hold-out set: 0.007040957252396957
MeanAbsoluteError value on hold-out data: 0.06049250438809395
Epoch: 125
Loss on hold-out set: 0.0073642725045302585
MeanAbsoluteError value on hold-out data: 0.062469482421875
Epoch: 126
Loss on hold-out set: 0.007248463619218551
MeanAbsoluteError value on hold-out data: 0.06258191168308258
Epoch: 127
Loss on hold-out set: 0.008780343715395583
MeanAbsoluteError value on hold-out data: 0.07223600149154663
Epoch: 128
Loss on hold-out set: 0.008274598013438089
```

```
MeanAbsoluteError value on hold-out data: 0.06262227147817612
Epoch: 129
Loss on hold-out set: 0.0076478965837802546
MeanAbsoluteError value on hold-out data: 0.06306392699480057
Epoch: 130
Loss on hold-out set: 0.009197980317127841
MeanAbsoluteError value on hold-out data: 0.06900815665721893
Epoch: 131
Loss on hold-out set: 0.007517752914664973
MeanAbsoluteError value on hold-out data: 0.06515169888734818
Epoch: 132
Loss on hold-out set: 0.007508938451983819
MeanAbsoluteError value on hold-out data: 0.06331051141023636
Epoch: 133

Loss on hold-out set: 0.007149828999229756
MeanAbsoluteError value on hold-out data: 0.06037142500281334
Epoch: 134
Loss on hold-out set: 0.007780029410863982
MeanAbsoluteError value on hold-out data: 0.0657438412308693
Epoch: 135
Loss on hold-out set: 0.008552523630082999
MeanAbsoluteError value on hold-out data: 0.067693330347538
Epoch: 136
Loss on hold-out set: 0.008346226115367915
MeanAbsoluteError value on hold-out data: 0.06543468683958054
Epoch: 137
Loss on hold-out set: 0.006877635072573628
MeanAbsoluteError value on hold-out data: 0.0599597729742527
Epoch: 138
Loss on hold-out set: 0.007204368845314572
MeanAbsoluteError value on hold-out data: 0.06215723603963852
Epoch: 139
Loss on hold-out set: 0.0066263836189663335
MeanAbsoluteError value on hold-out data: 0.06045914441347122
Epoch: 140
Loss on hold-out set: 0.007239281040567316
MeanAbsoluteError value on hold-out data: 0.06453172117471695
Epoch: 141
Loss on hold-out set: 0.008144252909053313
MeanAbsoluteError value on hold-out data: 0.06384187191724777
Epoch: 142
```

```
Loss on hold-out set: 0.007825984533778146
MeanAbsoluteError value on hold-out data: 0.06755706667900085
Epoch: 143
Loss on hold-out set: 0.006828775451714635
MeanAbsoluteError value on hold-out data: 0.0609930157661438
Epoch: 144

Loss on hold-out set: 0.007252873310598692
MeanAbsoluteError value on hold-out data: 0.06262336671352386
Epoch: 145
Loss on hold-out set: 0.006658693980793224
MeanAbsoluteError value on hold-out data: 0.06071668118238449
Epoch: 146
Loss on hold-out set: 0.007081299131785177
MeanAbsoluteError value on hold-out data: 0.0657845214009285
Epoch: 147
Loss on hold-out set: 0.007184591573221903
MeanAbsoluteError value on hold-out data: 0.06581216305494308
Epoch: 148
Loss on hold-out set: 0.0070598654075231596
MeanAbsoluteError value on hold-out data: 0.06048393249511719
Epoch: 149
Loss on hold-out set: 0.007078109234020016
MeanAbsoluteError value on hold-out data: 0.061179932206869125
Epoch: 150
Loss on hold-out set: 0.00885006361702261
MeanAbsoluteError value on hold-out data: 0.07082995772361755
Epoch: 151
Loss on hold-out set: 0.007263360839141042
MeanAbsoluteError value on hold-out data: 0.06145415082573891
Epoch: 152
Loss on hold-out set: 0.008965293570470653
MeanAbsoluteError value on hold-out data: 0.07290235161781311
Epoch: 153
Loss on hold-out set: 0.007569456687442174
MeanAbsoluteError value on hold-out data: 0.06480922549962997
Epoch: 154
Loss on hold-out set: 0.006701299304902358
MeanAbsoluteError value on hold-out data: 0.05759432539343834
Epoch: 155

Loss on hold-out set: 0.006194476255730383
```

```
MeanAbsoluteError value on hold-out data: 0.05580461025238037
Epoch: 156
Loss on hold-out set: 0.006300278611505698
MeanAbsoluteError value on hold-out data: 0.06089280918240547
Epoch: 157
Loss on hold-out set: 0.00718516934246413
MeanAbsoluteError value on hold-out data: 0.06373962759971619
Epoch: 158
Loss on hold-out set: 0.00852537279838304
MeanAbsoluteError value on hold-out data: 0.07068679481744766
Epoch: 159
Loss on hold-out set: 0.009561024909520424
MeanAbsoluteError value on hold-out data: 0.07372558861970901
Epoch: 160
Loss on hold-out set: 0.007593845228640069
MeanAbsoluteError value on hold-out data: 0.06593287736177444
Epoch: 161
Loss on hold-out set: 0.009625600862292279
MeanAbsoluteError value on hold-out data: 0.07203835248947144
Epoch: 162
Loss on hold-out set: 0.007898458334813384
MeanAbsoluteError value on hold-out data: 0.06462537497282028
Epoch: 163
Loss on hold-out set: 0.009371988239428518
MeanAbsoluteError value on hold-out data: 0.07262814044952393
Epoch: 164
Loss on hold-out set: 0.011397682574553121
MeanAbsoluteError value on hold-out data: 0.07625946402549744
Epoch: 165
Loss on hold-out set: 0.008499902201277254
MeanAbsoluteError value on hold-out data: 0.06812672317028046
Epoch: 166

Loss on hold-out set: 0.008246088256495759
MeanAbsoluteError value on hold-out data: 0.06428951770067215
Epoch: 167
Loss on hold-out set: 0.0075145893007222755
MeanAbsoluteError value on hold-out data: 0.062496788799762726
Early stopping at epoch 166
Returned to Spot: Validation loss: 0.0075145893007222755
----------------------------------------------
spotPython tuning: 0.00582533759619477 [#---------] 5.56%
```

```
config: {'_L_in': 10, '_L_out': 1, 'l1': 32, 'dropout_prob': 0.2026133975959994, 'lr_mult': 6
Epoch: 1
Loss on hold-out set: 0.03400613820964569
MeanAbsoluteError value on hold-out data: 0.14520570635795593
Epoch: 2
Loss on hold-out set: 0.031046170055081968
MeanAbsoluteError value on hold-out data: 0.14310187101364136
Epoch: 3
Loss on hold-out set: 0.028257542583895356
MeanAbsoluteError value on hold-out data: 0.13254953920841217
Epoch: 4
Loss on hold-out set: 0.024030488450080156
MeanAbsoluteError value on hold-out data: 0.12535563111305237
Epoch: 5
Loss on hold-out set: 0.02164625837222526
MeanAbsoluteError value on hold-out data: 0.11853860318660736
Epoch: 6
Loss on hold-out set: 0.019624427892267704
MeanAbsoluteError value on hold-out data: 0.11028194427490234
Epoch: 7
Loss on hold-out set: 0.014697436868262134
MeanAbsoluteError value on hold-out data: 0.09563151746988297
Epoch: 8
Loss on hold-out set: 0.018391621617698355
MeanAbsoluteError value on hold-out data: 0.10978391021490097
Epoch: 9
Loss on hold-out set: 0.012283420965296069
MeanAbsoluteError value on hold-out data: 0.0881105288863182
Epoch: 10
Loss on hold-out set: 0.009672655791387354
MeanAbsoluteError value on hold-out data: 0.07658044993877411
Epoch: 11

Loss on hold-out set: 0.00984161504005131
MeanAbsoluteError value on hold-out data: 0.07624074071645737
Epoch: 12
Loss on hold-out set: 0.00893402450693477
MeanAbsoluteError value on hold-out data: 0.07482166588306427
Epoch: 13
Loss on hold-out set: 0.013060604228245976
MeanAbsoluteError value on hold-out data: 0.09511081874370575
```

```
Epoch: 14
Loss on hold-out set: 0.00856683538662956
MeanAbsoluteError value on hold-out data: 0.07061094790697098
Epoch: 15
Loss on hold-out set: 0.007520541168847366
MeanAbsoluteError value on hold-out data: 0.0655604898929596
Epoch: 16
Loss on hold-out set: 0.007524355853858747
MeanAbsoluteError value on hold-out data: 0.07024111598730087
Epoch: 17
Loss on hold-out set: 0.005923599265148177
MeanAbsoluteError value on hold-out data: 0.06194005161523819
Epoch: 18
Loss on hold-out set: 0.007725930313187602
MeanAbsoluteError value on hold-out data: 0.07246582955121994
Epoch: 19
Loss on hold-out set: 0.006696593353377753
MeanAbsoluteError value on hold-out data: 0.06288081407546997
Epoch: 20
Loss on hold-out set: 0.004661816895302189
MeanAbsoluteError value on hold-out data: 0.050559621304273605
Epoch: 21
Loss on hold-out set: 0.005518573011565758
MeanAbsoluteError value on hold-out data: 0.05625903978943825
Epoch: 22

Loss on hold-out set: 0.005591704727665178
MeanAbsoluteError value on hold-out data: 0.05503354221582413
Epoch: 23
Loss on hold-out set: 0.007689196604156965
MeanAbsoluteError value on hold-out data: 0.07103711366653442
Epoch: 24
Loss on hold-out set: 0.004366138508837474
MeanAbsoluteError value on hold-out data: 0.0482633002102375
Epoch: 25
Loss on hold-out set: 0.004262475304513876
MeanAbsoluteError value on hold-out data: 0.05084257945418358
Epoch: 26
Loss on hold-out set: 0.006072682772738565
MeanAbsoluteError value on hold-out data: 0.06247696653008461
Epoch: 27
Loss on hold-out set: 0.0038584035324962123
```

```
MeanAbsoluteError value on hold-out data: 0.04320518672466278
Epoch: 28
Loss on hold-out set: 0.004858833377702946
MeanAbsoluteError value on hold-out data: 0.051999226212501526
Epoch: 29
Loss on hold-out set: 0.00469295194335772
MeanAbsoluteError value on hold-out data: 0.049663230776786804
Epoch: 30
Loss on hold-out set: 0.0034943260773281125
MeanAbsoluteError value on hold-out data: 0.045313410460948944
Epoch: 31
Loss on hold-out set: 0.004130605818078804
MeanAbsoluteError value on hold-out data: 0.04802298545837402
Epoch: 32
Loss on hold-out set: 0.004559438269720168
MeanAbsoluteError value on hold-out data: 0.05107174813747406
Returned to Spot: Validation loss: 0.004559438269720168
----------------------------------------------

spotPython tuning: 0.004559438269720168 [#---------] 7.49%


config: {'_L_in': 10, '_L_out': 1, 'l1': 32, 'dropout_prob': 0.2660657118545304, 'lr_mult': 
Epoch: 1
Loss on hold-out set: 0.034216654879090036
MeanAbsoluteError value on hold-out data: 0.14693577587604523
Epoch: 2

Loss on hold-out set: 0.025325379230229084
MeanAbsoluteError value on hold-out data: 0.13119006156921387
Epoch: 3
Loss on hold-out set: 0.02291230710321351
MeanAbsoluteError value on hold-out data: 0.12185821682214737
Epoch: 4
Loss on hold-out set: 0.022636219908140208
MeanAbsoluteError value on hold-out data: 0.11924497038125992
Epoch: 5
Loss on hold-out set: 0.01364366533112173
MeanAbsoluteError value on hold-out data: 0.0937623381614685
Epoch: 6
Loss on hold-out set: 0.014039714661377826
MeanAbsoluteError value on hold-out data: 0.09385853260755539
```

```
Epoch: 7
Loss on hold-out set: 0.013234313271057448
MeanAbsoluteError value on hold-out data: 0.08973128348588943
Epoch: 8
Loss on hold-out set: 0.010020065832098848
MeanAbsoluteError value on hold-out data: 0.07636108994483948
Epoch: 9
Loss on hold-out set: 0.010273036620530644
MeanAbsoluteError value on hold-out data: 0.07752132415771484
Epoch: 10
Loss on hold-out set: 0.01173015285626446
MeanAbsoluteError value on hold-out data: 0.08563963323831558
Epoch: 11

Loss on hold-out set: 0.008817421664532862
MeanAbsoluteError value on hold-out data: 0.07039077579975128
Epoch: 12
Loss on hold-out set: 0.008496952987594628
MeanAbsoluteError value on hold-out data: 0.06839146465063095
Epoch: 13

Loss on hold-out set: 0.007447149849643833
MeanAbsoluteError value on hold-out data: 0.06738825142383575
Epoch: 14
Loss on hold-out set: 0.010391035834082255
MeanAbsoluteError value on hold-out data: 0.08275046944618225
Epoch: 15
Loss on hold-out set: 0.007254319173577977
MeanAbsoluteError value on hold-out data: 0.06407683342695236
Epoch: 16
Loss on hold-out set: 0.009191848719063657
MeanAbsoluteError value on hold-out data: 0.0730736032128334
Epoch: 17
Loss on hold-out set: 0.013321997772436589
MeanAbsoluteError value on hold-out data: 0.0898430272936821
Epoch: 18
Loss on hold-out set: 0.006042351400920827
MeanAbsoluteError value on hold-out data: 0.05872870236635208
Epoch: 19
Loss on hold-out set: 0.00798242524462311
MeanAbsoluteError value on hold-out data: 0.06800194829702377
Epoch: 20
```

```
Loss on hold-out set: 0.006259287814732249
MeanAbsoluteError value on hold-out data: 0.06046339496970177
Epoch: 21
Loss on hold-out set: 0.007979778554535619
MeanAbsoluteError value on hold-out data: 0.07119809836149216
Epoch: 22

Loss on hold-out set: 0.0070871383206012025
MeanAbsoluteError value on hold-out data: 0.06243225187063217
Epoch: 23
Loss on hold-out set: 0.005045106368733717
MeanAbsoluteError value on hold-out data: 0.054598916321992874
Epoch: 24

Loss on hold-out set: 0.005469063845291538
MeanAbsoluteError value on hold-out data: 0.05582140013575554
Epoch: 25
Loss on hold-out set: 0.004847672597909542
MeanAbsoluteError value on hold-out data: 0.05190100520849228
Epoch: 26
Loss on hold-out set: 0.0056662493290404155
MeanAbsoluteError value on hold-out data: 0.05380058288574219
Epoch: 27
Loss on hold-out set: 0.005822748702485114
MeanAbsoluteError value on hold-out data: 0.058908212929964066
Epoch: 28
Loss on hold-out set: 0.005223167329524203
MeanAbsoluteError value on hold-out data: 0.05305027961730957
Epoch: 29
Loss on hold-out set: 0.0055947798751539695
MeanAbsoluteError value on hold-out data: 0.05735326185822487
Epoch: 30
Loss on hold-out set: 0.00557397744284428
MeanAbsoluteError value on hold-out data: 0.05504255369305611
Epoch: 31
Loss on hold-out set: 0.0043589117137200544
MeanAbsoluteError value on hold-out data: 0.052770376205444336
Epoch: 32
Loss on hold-out set: 0.006100786157491568
MeanAbsoluteError value on hold-out data: 0.0654432401061058
Epoch: 33
```

```
Loss on hold-out set: 0.007361489593198425
MeanAbsoluteError value on hold-out data: 0.06741079688072205
Epoch: 34
Loss on hold-out set: 0.003408449665202122
MeanAbsoluteError value on hold-out data: 0.04070235788822174
Epoch: 35

Loss on hold-out set: 0.009930268928751741
MeanAbsoluteError value on hold-out data: 0.08791081607341766
Epoch: 36
Loss on hold-out set: 0.005609873829311446
MeanAbsoluteError value on hold-out data: 0.06094655394554138
Epoch: 37
Loss on hold-out set: 0.00375837870983799
MeanAbsoluteError value on hold-out data: 0.04489162936806679
Epoch: 38
Loss on hold-out set: 0.0036441282197636994
MeanAbsoluteError value on hold-out data: 0.04786458984017372
Epoch: 39
Loss on hold-out set: 0.003716028773372895
MeanAbsoluteError value on hold-out data: 0.04377983883023262
Epoch: 40
Loss on hold-out set: 0.00382391991106009
MeanAbsoluteError value on hold-out data: 0.046395689249038696
Epoch: 41
Loss on hold-out set: 0.003410620679221067
MeanAbsoluteError value on hold-out data: 0.0445447713136673
Epoch: 42
Loss on hold-out set: 0.0030573194334896185
MeanAbsoluteError value on hold-out data: 0.03972190245985985
Epoch: 43
Loss on hold-out set: 0.0024900220244154824
MeanAbsoluteError value on hold-out data: 0.03439086303114891
Epoch: 44

Loss on hold-out set: 0.003818957732475706
MeanAbsoluteError value on hold-out data: 0.045377183705568314
Epoch: 45
Loss on hold-out set: 0.0031145396657704717
MeanAbsoluteError value on hold-out data: 0.04349050670862198
Epoch: 46
```

```
Loss on hold-out set: 0.0032513768911533254
MeanAbsoluteError value on hold-out data: 0.040067434310913086
Epoch: 47
Loss on hold-out set: 0.003458113676874506
MeanAbsoluteError value on hold-out data: 0.0424153134226799
Epoch: 48
Loss on hold-out set: 0.003293816799812607
MeanAbsoluteError value on hold-out data: 0.04253015294671059
Epoch: 49
Loss on hold-out set: 0.005402761964911693
MeanAbsoluteError value on hold-out data: 0.057392578572034836
Epoch: 50
Loss on hold-out set: 0.004313362321179164
MeanAbsoluteError value on hold-out data: 0.049444735050201416
Epoch: 51
Loss on hold-out set: 0.004292901265312378
MeanAbsoluteError value on hold-out data: 0.05035444721579552
Epoch: 52
Loss on hold-out set: 0.0035835472640189294
MeanAbsoluteError value on hold-out data: 0.04500536620616913
Epoch: 53
Loss on hold-out set: 0.00452160728654187
MeanAbsoluteError value on hold-out data: 0.050420574843883514
Epoch: 54
Loss on hold-out set: 0.003911866811042847
MeanAbsoluteError value on hold-out data: 0.0434948205947876
Epoch: 55

Loss on hold-out set: 0.0043456989438518095
MeanAbsoluteError value on hold-out data: 0.05119287222623825
Epoch: 56
Loss on hold-out set: 0.0032606032634104943
MeanAbsoluteError value on hold-out data: 0.04062287136912346
Epoch: 57

Loss on hold-out set: 0.005132492282427847
MeanAbsoluteError value on hold-out data: 0.052653368562459946
Epoch: 58
Loss on hold-out set: 0.003872923592816254
MeanAbsoluteError value on hold-out data: 0.04543415084481239
Epoch: 59
Loss on hold-out set: 0.004535127437281373
```

```
MeanAbsoluteError value on hold-out data: 0.051870714873075485
Epoch: 60
Loss on hold-out set: 0.0039206529679512115
MeanAbsoluteError value on hold-out data: 0.0460781529545784
Epoch: 61
Loss on hold-out set: 0.0045663288665788344
MeanAbsoluteError value on hold-out data: 0.05688254162669182
Epoch: 62
Loss on hold-out set: 0.0032783736272617
MeanAbsoluteError value on hold-out data: 0.045551903545856476
Epoch: 63
Loss on hold-out set: 0.003701638101024161
MeanAbsoluteError value on hold-out data: 0.04660610482096672
Epoch: 64
Loss on hold-out set: 0.0033715408345941747
MeanAbsoluteError value on hold-out data: 0.04134143143892288
Returned to Spot: Validation loss: 0.0033715408345941747
----------------------------------------------


spotPython tuning: 0.0033715408345941747 [#---------] 10.19%


config: {'_L_in': 10, '_L_out': 1, 'l1': 32, 'dropout_prob': 0.6846315734479901, 'lr_mult': 9
Epoch: 1
Loss on hold-out set: 0.04741452435815805
MeanAbsoluteError value on hold-out data: 0.17464739084243774
Epoch: 2
Loss on hold-out set: 0.035002258692034764
MeanAbsoluteError value on hold-out data: 0.14467781782150269
Epoch: 3
Loss on hold-out set: 0.03459489254869128
MeanAbsoluteError value on hold-out data: 0.14581754803657532
Epoch: 4
Loss on hold-out set: 0.033752666547355294
MeanAbsoluteError value on hold-out data: 0.14382052421569824
Epoch: 5
Loss on hold-out set: 0.03293967467585677
MeanAbsoluteError value on hold-out data: 0.14204788208007812
Epoch: 6
Loss on hold-out set: 0.0315151156269406
MeanAbsoluteError value on hold-out data: 0.1381780058145523
Epoch: 7
```

```
Loss on hold-out set: 0.030889931232913545
MeanAbsoluteError value on hold-out data: 0.13814030587673187
Epoch: 8
Loss on hold-out set: 0.03149947594532645
MeanAbsoluteError value on hold-out data: 0.1390954852104187
Epoch: 9
Loss on hold-out set: 0.02966604412435309
MeanAbsoluteError value on hold-out data: 0.13418711721897125
Epoch: 10
Loss on hold-out set: 0.030391907000816183
MeanAbsoluteError value on hold-out data: 0.1357744336128235
Epoch: 11

Loss on hold-out set: 0.029847443704248258
MeanAbsoluteError value on hold-out data: 0.13477472960948944
Epoch: 12
Loss on hold-out set: 0.030595411595545317
MeanAbsoluteError value on hold-out data: 0.1358727663755417
Epoch: 13
Loss on hold-out set: 0.0287583671681779
MeanAbsoluteError value on hold-out data: 0.13240918517112732
Epoch: 14
Loss on hold-out set: 0.029515586842439677
MeanAbsoluteError value on hold-out data: 0.1335160881280899
Epoch: 15
Loss on hold-out set: 0.028206571838573405
MeanAbsoluteError value on hold-out data: 0.1316160261631012
Epoch: 16
Loss on hold-out set: 0.029332517192846064
MeanAbsoluteError value on hold-out data: 0.13345178961753845
Epoch: 17
Loss on hold-out set: 0.02877174227155353
MeanAbsoluteError value on hold-out data: 0.13319946825504303
Epoch: 18
Loss on hold-out set: 0.030799745441120314
MeanAbsoluteError value on hold-out data: 0.13722334802150726
Epoch: 19
Loss on hold-out set: 0.030564939468412808
MeanAbsoluteError value on hold-out data: 0.13546429574489594
Epoch: 20
Loss on hold-out set: 0.03222399734352764
MeanAbsoluteError value on hold-out data: 0.14015622437000275
```

```
Epoch: 21
Loss on hold-out set: 0.02692595016407339
MeanAbsoluteError value on hold-out data: 0.13029880821704865
Epoch: 22

Loss on hold-out set: 0.02697994357808248
MeanAbsoluteError value on hold-out data: 0.1271815299987793
Epoch: 23
Loss on hold-out set: 0.02791626834751744
MeanAbsoluteError value on hold-out data: 0.13053689897060394
Epoch: 24
Loss on hold-out set: 0.027572339572208494
MeanAbsoluteError value on hold-out data: 0.1285332292318344
Epoch: 25
Loss on hold-out set: 0.026530189121043997
MeanAbsoluteError value on hold-out data: 0.12604179978370667
Epoch: 26
Loss on hold-out set: 0.02895760333998815
MeanAbsoluteError value on hold-out data: 0.13346052169799805
Epoch: 27
Loss on hold-out set: 0.028557268167404753
MeanAbsoluteError value on hold-out data: 0.12861591577529907
Epoch: 28
Loss on hold-out set: 0.027199747506529093
MeanAbsoluteError value on hold-out data: 0.12752147018909454
Epoch: 29
Loss on hold-out set: 0.026236536875857336
MeanAbsoluteError value on hold-out data: 0.12384569644927979
Epoch: 30
Loss on hold-out set: 0.02511841523166942
MeanAbsoluteError value on hold-out data: 0.12130822241306305
Epoch: 31
Loss on hold-out set: 0.028661163866912063
MeanAbsoluteError value on hold-out data: 0.13200776278972626
Epoch: 32
Loss on hold-out set: 0.03196024926575391
MeanAbsoluteError value on hold-out data: 0.13912107050418854
Epoch: 33
Loss on hold-out set: 0.03212969081084195
MeanAbsoluteError value on hold-out data: 0.13943471014499664
Epoch: 34

Loss on hold-out set: 0.0321355536089916
```

```
MeanAbsoluteError value on hold-out data: 0.1394459754228592
Epoch: 35
Loss on hold-out set: 0.03213549694536548
MeanAbsoluteError value on hold-out data: 0.13944590091705322
Epoch: 36
Loss on hold-out set: 0.03213525898019342
MeanAbsoluteError value on hold-out data: 0.13944540917873383
Epoch: 37
Loss on hold-out set: 0.032133729148067926
MeanAbsoluteError value on hold-out data: 0.13944074511528015
Epoch: 38
Loss on hold-out set: 0.03213027989687888
MeanAbsoluteError value on hold-out data: 0.13943904638290405
Epoch: 39
Loss on hold-out set: 0.03213008262805248
MeanAbsoluteError value on hold-out data: 0.139438658952713
Epoch: 40
Loss on hold-out set: 0.03213110144593214
MeanAbsoluteError value on hold-out data: 0.13943979144096375
Epoch: 41
Loss on hold-out set: 0.03213424551741857
MeanAbsoluteError value on hold-out data: 0.13944344222545624
Epoch: 42
Loss on hold-out set: 0.03212945869094447
MeanAbsoluteError value on hold-out data: 0.13943487405776978
Epoch: 43
Loss on hold-out set: 0.03213390817032441
MeanAbsoluteError value on hold-out data: 0.1394428014755249
Epoch: 44
Loss on hold-out set: 0.03212924471958295
MeanAbsoluteError value on hold-out data: 0.13943704962730408
Epoch: 45

Loss on hold-out set: 0.032123812082174574
MeanAbsoluteError value on hold-out data: 0.13943034410476685
Epoch: 46
Loss on hold-out set: 0.03213350069218952
MeanAbsoluteError value on hold-out data: 0.1394420564174652
Epoch: 47
Loss on hold-out set: 0.03212355308871912
MeanAbsoluteError value on hold-out data: 0.13942986726760864
Epoch: 48
```

```
Loss on hold-out set: 0.032128728423757774
MeanAbsoluteError value on hold-out data: 0.13943606615066528
Epoch: 49
Loss on hold-out set: 0.032128619495779276
MeanAbsoluteError value on hold-out data: 0.13943587243556976
Epoch: 50
Loss on hold-out set: 0.032128510861902645
MeanAbsoluteError value on hold-out data: 0.13943566381931305
Epoch: 51
Loss on hold-out set: 0.032132947143461356
MeanAbsoluteError value on hold-out data: 0.13944095373153687
Epoch: 52
Loss on hold-out set: 0.032132853925424185
MeanAbsoluteError value on hold-out data: 0.13944081962108612
Epoch: 53
Loss on hold-out set: 0.03213277071910469
MeanAbsoluteError value on hold-out data: 0.1394406259059906
Epoch: 54
Loss on hold-out set: 0.032126858046180325
MeanAbsoluteError value on hold-out data: 0.13943076133728027
Epoch: 55
Loss on hold-out set: 0.03213130955976483
MeanAbsoluteError value on hold-out data: 0.13943606615066528
Epoch: 56

Loss on hold-out set: 0.0321325337097637
MeanAbsoluteError value on hold-out data: 0.13944019377231598
Epoch: 57
Loss on hold-out set: 0.032132467107945366
MeanAbsoluteError value on hold-out data: 0.13944004476070404
Epoch: 58
Loss on hold-out set: 0.03213240403534943
MeanAbsoluteError value on hold-out data: 0.13943995535373688
Epoch: 59
Loss on hold-out set: 0.032122519663780144
MeanAbsoluteError value on hold-out data: 0.13942785561084747
Epoch: 60
Loss on hold-out set: 0.03212896252884284
MeanAbsoluteError value on hold-out data: 0.13943564891815186
Epoch: 61
Loss on hold-out set: 0.03212769871185485
MeanAbsoluteError value on hold-out data: 0.1394341140985489
```

```
Epoch: 62
Loss on hold-out set: 0.032132171572333106
MeanAbsoluteError value on hold-out data: 0.13943947851657867
Epoch: 63
Loss on hold-out set: 0.03212231324103318
MeanAbsoluteError value on hold-out data: 0.13942745327949524
Epoch: 64
Loss on hold-out set: 0.03213207867290629
MeanAbsoluteError value on hold-out data: 0.13943929970264435
Epoch: 65
Loss on hold-out set: 0.032132042204274944
MeanAbsoluteError value on hold-out data: 0.13943925499916077
Epoch: 66
Loss on hold-out set: 0.03213200621355913
MeanAbsoluteError value on hold-out data: 0.1394391655921936
Epoch: 67


Loss on hold-out set: 0.03213197039440274
MeanAbsoluteError value on hold-out data: 0.13943909108638763
Epoch: 68
Loss on hold-out set: 0.03213062682679217
MeanAbsoluteError value on hold-out data: 0.13943475484848022
Epoch: 69
Loss on hold-out set: 0.032131892200069206
MeanAbsoluteError value on hold-out data: 0.1394389569759369
Epoch: 70
Loss on hold-out set: 0.032122043843724225
MeanAbsoluteError value on hold-out data: 0.13942696154117584
Epoch: 71
Loss on hold-out set: 0.03213183019359253
MeanAbsoluteError value on hold-out data: 0.13943882286548615
Epoch: 72
Loss on hold-out set: 0.03212597377990421
MeanAbsoluteError value on hold-out data: 0.1394290328025818
Epoch: 73
Loss on hold-out set: 0.03213178360295531
MeanAbsoluteError value on hold-out data: 0.13943873345851898
Epoch: 74
Loss on hold-out set: 0.032127213456030736
MeanAbsoluteError value on hold-out data: 0.13943319022655487
Epoch: 75
Loss on hold-out set: 0.03213172169451259
```

```
MeanAbsoluteError value on hold-out data: 0.13943862915039062
Epoch: 76
Loss on hold-out set: 0.03213170662179197
MeanAbsoluteError value on hold-out data: 0.13943859934806824
Epoch: 77
Loss on hold-out set: 0.03212186411072157
MeanAbsoluteError value on hold-out data: 0.1394266039133072
Epoch: 78

Loss on hold-out set: 0.03213035802994119
MeanAbsoluteError value on hold-out data: 0.13943424820899963
Epoch: 79
Loss on hold-out set: 0.03212702444656507
MeanAbsoluteError value on hold-out data: 0.1394301801919937
Epoch: 80
Loss on hold-out set: 0.032130316524815405
MeanAbsoluteError value on hold-out data: 0.13943415880203247
Epoch: 81
Loss on hold-out set: 0.03212828459953399
MeanAbsoluteError value on hold-out data: 0.13943436741828918
Epoch: 82
Loss on hold-out set: 0.03213158206965186
MeanAbsoluteError value on hold-out data: 0.13943834602832794
Epoch: 83
Loss on hold-out set: 0.032131571506493185
MeanAbsoluteError value on hold-out data: 0.13943833112716675
Epoch: 84
Loss on hold-out set: 0.03212572548440412
MeanAbsoluteError value on hold-out data: 0.13942857086658478
Epoch: 85
Loss on hold-out set: 0.032131546434309134
MeanAbsoluteError value on hold-out data: 0.13943830132484436
Epoch: 86
Loss on hold-out set: 0.03213153487855667
MeanAbsoluteError value on hold-out data: 0.13943827152252197
Epoch: 87
Loss on hold-out set: 0.032131525357008764
MeanAbsoluteError value on hold-out data: 0.13943827152252197
Epoch: 88
Loss on hold-out set: 0.03212698050284464
MeanAbsoluteError value on hold-out data: 0.13943271338939667
Epoch: 89
```

```
Loss on hold-out set: 0.03213149988043465
MeanAbsoluteError value on hold-out data: 0.1394381821155548
Epoch: 90
Loss on hold-out set: 0.032131489145716556
MeanAbsoluteError value on hold-out data: 0.13943815231323242
Epoch: 91
Loss on hold-out set: 0.03212694438958639
MeanAbsoluteError value on hold-out data: 0.1394326388835907
Epoch: 92
Loss on hold-out set: 0.032128144631554424
MeanAbsoluteError value on hold-out data: 0.1394340842962265
Epoch: 93
Loss on hold-out set: 0.03213015647212926
MeanAbsoluteError value on hold-out data: 0.1394338458776474
Epoch: 94
Loss on hold-out set: 0.032131453828984184
MeanAbsoluteError value on hold-out data: 0.13943809270858765
Early stopping at epoch 93
Returned to Spot: Validation loss: 0.032131453828984184
----------------------------------------------

spotPython tuning: 0.0033715408345941747 [#---------] 13.88%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.2576035684240782, 'lr_mult':
Epoch: 1

Loss on hold-out set: 0.01981863720146449
MeanAbsoluteError value on hold-out data: 0.11494001001119614
Epoch: 2
Loss on hold-out set: 0.011897941077079036
MeanAbsoluteError value on hold-out data: 0.08730315417051315
Epoch: 3
Loss on hold-out set: 0.0150933145042999
MeanAbsoluteError value on hold-out data: 0.09698834270238876
Epoch: 4
Loss on hold-out set: 0.012568332000611056
MeanAbsoluteError value on hold-out data: 0.09095406532287598
Epoch: 5
Loss on hold-out set: 0.008141712965688816
MeanAbsoluteError value on hold-out data: 0.071320541203022
Epoch: 6
```

```
Loss on hold-out set: 0.010629213004569081
MeanAbsoluteError value on hold-out data: 0.08393390476703644
Epoch: 7
Loss on hold-out set: 0.006559332152583489
MeanAbsoluteError value on hold-out data: 0.06581134349107742
Epoch: 8
Loss on hold-out set: 0.0059472299242196115
MeanAbsoluteError value on hold-out data: 0.05874725431203842
Epoch: 9
Loss on hold-out set: 0.005547656613328543
MeanAbsoluteError value on hold-out data: 0.05980849638581276
Epoch: 10
Loss on hold-out set: 0.005393451134870319
MeanAbsoluteError value on hold-out data: 0.05971060320734978
Epoch: 11

Loss on hold-out set: 0.008896671388739426
MeanAbsoluteError value on hold-out data: 0.07464531809091568
Epoch: 12

Loss on hold-out set: 0.004592179682252831
MeanAbsoluteError value on hold-out data: 0.05200802534818649
Epoch: 13
Loss on hold-out set: 0.004540216940528664
MeanAbsoluteError value on hold-out data: 0.05249963328242302
Epoch: 14
Loss on hold-out set: 0.0035288056364822153
MeanAbsoluteError value on hold-out data: 0.0447932593524456
Epoch: 15
Loss on hold-out set: 0.0035732745094911047
MeanAbsoluteError value on hold-out data: 0.04703221842646599
Epoch: 16
Loss on hold-out set: 0.0037947652224255236
MeanAbsoluteError value on hold-out data: 0.04965134710073471
Epoch: 17
Loss on hold-out set: 0.0038332372358509978
MeanAbsoluteError value on hold-out data: 0.050110358744859695
Epoch: 18
Loss on hold-out set: 0.00389784170884492
MeanAbsoluteError value on hold-out data: 0.0474441796541214
Epoch: 19
Loss on hold-out set: 0.0061022779340610695
```

```
MeanAbsoluteError value on hold-out data: 0.063740573823452
Epoch: 20
Loss on hold-out set: 0.00442984327367556
MeanAbsoluteError value on hold-out data: 0.050503913313150406
Epoch: 21
Loss on hold-out set: 0.0023109869798645377
MeanAbsoluteError value on hold-out data: 0.037086620926856995
Epoch: 22

Loss on hold-out set: 0.005218398463177054
MeanAbsoluteError value on hold-out data: 0.05799587070941925
Epoch: 23

Loss on hold-out set: 0.0027599850658780747
MeanAbsoluteError value on hold-out data: 0.041782792657613754
Epoch: 24
Loss on hold-out set: 0.0036572864812210596
MeanAbsoluteError value on hold-out data: 0.04575818404555321
Epoch: 25
Loss on hold-out set: 0.003168653146866219
MeanAbsoluteError value on hold-out data: 0.04063217341899872
Epoch: 26
Loss on hold-out set: 0.0025226298986174363
MeanAbsoluteError value on hold-out data: 0.04039029777050018
Epoch: 27
Loss on hold-out set: 0.0029176551891539836
MeanAbsoluteError value on hold-out data: 0.04158281907439232
Epoch: 28
Loss on hold-out set: 0.0033721833667521807
MeanAbsoluteError value on hold-out data: 0.044639576226472855
Epoch: 29
Loss on hold-out set: 0.004085377817605867
MeanAbsoluteError value on hold-out data: 0.05054996535181999
Epoch: 30
Loss on hold-out set: 0.0033440133671607136
MeanAbsoluteError value on hold-out data: 0.042902130633592606
Epoch: 31
Loss on hold-out set: 0.0029200293253157533
MeanAbsoluteError value on hold-out data: 0.04008043184876442
Epoch: 32
Loss on hold-out set: 0.005292998960756354
MeanAbsoluteError value on hold-out data: 0.062437184154987335
```

```
Epoch: 33

Loss on hold-out set: 0.003452520410064608
MeanAbsoluteError value on hold-out data: 0.04713166505098343
Epoch: 34

Loss on hold-out set: 0.0035524381183725047
MeanAbsoluteError value on hold-out data: 0.045391444116830826
Epoch: 35
Loss on hold-out set: 0.003923889839298729
MeanAbsoluteError value on hold-out data: 0.04848587512969971
Epoch: 36
Loss on hold-out set: 0.0026834354277142617
MeanAbsoluteError value on hold-out data: 0.037134233862161636
Epoch: 37
Loss on hold-out set: 0.0033127498157371426
MeanAbsoluteError value on hold-out data: 0.04569213464856148
Epoch: 38
Loss on hold-out set: 0.002168618285060419
MeanAbsoluteError value on hold-out data: 0.036372363567352295
Epoch: 39
Loss on hold-out set: 0.0041830396910786235
MeanAbsoluteError value on hold-out data: 0.05362831801176071
Epoch: 40
Loss on hold-out set: 0.0037874598224573817
MeanAbsoluteError value on hold-out data: 0.048676952719688416
Epoch: 41
Loss on hold-out set: 0.005050460011453221
MeanAbsoluteError value on hold-out data: 0.05677267536520958
Epoch: 42
Loss on hold-out set: 0.002468997885252496
MeanAbsoluteError value on hold-out data: 0.03586467728018761
Epoch: 43
Loss on hold-out set: 0.0025317781439394152
MeanAbsoluteError value on hold-out data: 0.03865037113428116
Epoch: 44

Loss on hold-out set: 0.006314361232063292
MeanAbsoluteError value on hold-out data: 0.06335130333900452
Epoch: 45
```

```
Loss on hold-out set: 0.0029851496457060996
MeanAbsoluteError value on hold-out data: 0.037545476108789444
Epoch: 46
Loss on hold-out set: 0.00309690814097657
MeanAbsoluteError value on hold-out data: 0.04255102947354317
Epoch: 47
Loss on hold-out set: 0.0032491813043107917
MeanAbsoluteError value on hold-out data: 0.04611777514219284
Epoch: 48
Loss on hold-out set: 0.0025809525334472326
MeanAbsoluteError value on hold-out data: 0.03896542638540268
Epoch: 49
Loss on hold-out set: 0.004376028566376159
MeanAbsoluteError value on hold-out data: 0.055993061512708664
Epoch: 50
Loss on hold-out set: 0.00251388773751004
MeanAbsoluteError value on hold-out data: 0.037322357296943665
Epoch: 51
Loss on hold-out set: 0.002485003765047479
MeanAbsoluteError value on hold-out data: 0.03755370154976845
Epoch: 52
Loss on hold-out set: 0.0038842762817359088
MeanAbsoluteError value on hold-out data: 0.04943898320198059
Epoch: 53
Loss on hold-out set: 0.002819689214352126
MeanAbsoluteError value on hold-out data: 0.04002705216407776
Epoch: 54
Loss on hold-out set: 0.003150255799195484
MeanAbsoluteError value on hold-out data: 0.0412205345928669
Epoch: 55

Loss on hold-out set: 0.004577517224549267
MeanAbsoluteError value on hold-out data: 0.05707288160920143
Epoch: 56

Loss on hold-out set: 0.0046486816289344505
MeanAbsoluteError value on hold-out data: 0.05285707861185074
Epoch: 57
Loss on hold-out set: 0.002744659689549161
MeanAbsoluteError value on hold-out data: 0.03837516903877258
Epoch: 58
Loss on hold-out set: 0.0026197731801259672
```

```
MeanAbsoluteError value on hold-out data: 0.035833459347486496
Epoch: 59
Loss on hold-out set: 0.005354417340928002
MeanAbsoluteError value on hold-out data: 0.06074425205588341
Epoch: 60
Loss on hold-out set: 0.0035676102132511964
MeanAbsoluteError value on hold-out data: 0.04405000060796738
Epoch: 61
Loss on hold-out set: 0.002597865466285791
MeanAbsoluteError value on hold-out data: 0.038159023970365524
Epoch: 62
Loss on hold-out set: 0.00897203281668848
MeanAbsoluteError value on hold-out data: 0.07512146234512329
Epoch: 63
Loss on hold-out set: 0.004582383458527099
MeanAbsoluteError value on hold-out data: 0.057821568101644516
Epoch: 64
Loss on hold-out set: 0.0028055036244423767
MeanAbsoluteError value on hold-out data: 0.037251561880111694
Epoch: 65
Loss on hold-out set: 0.003292671158162289
MeanAbsoluteError value on hold-out data: 0.04303732141852379
Epoch: 66

Loss on hold-out set: 0.002913681900520858
MeanAbsoluteError value on hold-out data: 0.03958820179104805
Epoch: 67

Loss on hold-out set: 0.0029543067794293165
MeanAbsoluteError value on hold-out data: 0.03981312736868858
Epoch: 68
Loss on hold-out set: 0.0038160836863282478
MeanAbsoluteError value on hold-out data: 0.04644129052758217
Epoch: 69
Loss on hold-out set: 0.002241340631275977
MeanAbsoluteError value on hold-out data: 0.035370685160160065
Epoch: 70
Loss on hold-out set: 0.0034927215287768234
MeanAbsoluteError value on hold-out data: 0.04305800423026085
Epoch: 71
Loss on hold-out set: 0.002538725352343662
MeanAbsoluteError value on hold-out data: 0.03734755516052246
```

```
Epoch: 72
Loss on hold-out set: 0.002334417121203028
MeanAbsoluteError value on hold-out data: 0.03605089336633682
Epoch: 73
Loss on hold-out set: 0.0030916276262264305
MeanAbsoluteError value on hold-out data: 0.04247426241636276
Epoch: 74
Loss on hold-out set: 0.002515677197248136
MeanAbsoluteError value on hold-out data: 0.03719357028603554
Epoch: 75
Loss on hold-out set: 0.0033574665002034684
MeanAbsoluteError value on hold-out data: 0.04390190914273262
Epoch: 76
Loss on hold-out set: 0.005570734918460642
MeanAbsoluteError value on hold-out data: 0.0540875643491745
Epoch: 77

Loss on hold-out set: 0.005511864465293719
MeanAbsoluteError value on hold-out data: 0.05897476151585579
Epoch: 78

Loss on hold-out set: 0.004396417006654174
MeanAbsoluteError value on hold-out data: 0.05254365876317024
Epoch: 79
Loss on hold-out set: 0.01865011086001208
MeanAbsoluteError value on hold-out data: 0.11935851722955704
Epoch: 80
Loss on hold-out set: 0.004609444068352643
MeanAbsoluteError value on hold-out data: 0.05624527111649513
Epoch: 81
Loss on hold-out set: 0.004251298714447522
MeanAbsoluteError value on hold-out data: 0.04870216175913811
Epoch: 82
Loss on hold-out set: 0.003158675973138184
MeanAbsoluteError value on hold-out data: 0.04287692531943321
Epoch: 83
Loss on hold-out set: 0.004258072129328196
MeanAbsoluteError value on hold-out data: 0.0504845455288887
Epoch: 84
Loss on hold-out set: 0.0036395907403570355
MeanAbsoluteError value on hold-out data: 0.04030673950910568
Epoch: 85
```

```
Loss on hold-out set: 0.003395715472594786
MeanAbsoluteError value on hold-out data: 0.04279724508523941
Epoch: 86
Loss on hold-out set: 0.0031292191032614362
MeanAbsoluteError value on hold-out data: 0.04251135513186455
Epoch: 87
Loss on hold-out set: 0.00376920985734997
MeanAbsoluteError value on hold-out data: 0.04454898089170456
Epoch: 88

Loss on hold-out set: 0.004618239221408179
MeanAbsoluteError value on hold-out data: 0.055268045514822006
Epoch: 89

Loss on hold-out set: 0.005229508488953702
MeanAbsoluteError value on hold-out data: 0.060447897762060165
Epoch: 90
Loss on hold-out set: 0.0029776650235841147
MeanAbsoluteError value on hold-out data: 0.038024693727493286
Epoch: 91
Loss on hold-out set: 0.00398110471953834
MeanAbsoluteError value on hold-out data: 0.04904411360621452
Epoch: 92
Loss on hold-out set: 0.004072509591519759
MeanAbsoluteError value on hold-out data: 0.04705517739057541
Epoch: 93
Loss on hold-out set: 0.0030192973239249305
MeanAbsoluteError value on hold-out data: 0.04300365597009659
Epoch: 94
Loss on hold-out set: 0.0028351624817955063
MeanAbsoluteError value on hold-out data: 0.03540614992380142
Epoch: 95
Loss on hold-out set: 0.004607491532193595
MeanAbsoluteError value on hold-out data: 0.05625348538160324
Epoch: 96
Loss on hold-out set: 0.0034080938065400054
MeanAbsoluteError value on hold-out data: 0.04292634502053261
Epoch: 97
Loss on hold-out set: 0.0029686996927729956
MeanAbsoluteError value on hold-out data: 0.04013003408908844
Epoch: 98
Loss on hold-out set: 0.002721866407419408
```

```
MeanAbsoluteError value on hold-out data: 0.03717365115880966
Epoch: 99

Loss on hold-out set: 0.003143094974802807
MeanAbsoluteError value on hold-out data: 0.04080019146203995
Epoch: 100

Loss on hold-out set: 0.0030863297410848502
MeanAbsoluteError value on hold-out data: 0.04356948286294937
Epoch: 101
Loss on hold-out set: 0.003257405215041026
MeanAbsoluteError value on hold-out data: 0.04130682349205017
Epoch: 102
Loss on hold-out set: 0.00330472608268457
MeanAbsoluteError value on hold-out data: 0.041464466601610184
Early stopping at epoch 101
Returned to Spot: Validation loss: 0.00330472608268457
----------------------------------------------

spotPython tuning: 0.00330472608268457 [##--------] 18.27%


config: {'_L_in': 10, '_L_out': 1, 'l1': 16, 'dropout_prob': 0.2621091976301025, 'lr_mult': 
Epoch: 1
Loss on hold-out set: 0.04169420769291097
MeanAbsoluteError value on hold-out data: 0.16461974382400513
Epoch: 2
Loss on hold-out set: 0.03862540389558202
MeanAbsoluteError value on hold-out data: 0.1552935689687729
Epoch: 3
Loss on hold-out set: 0.03153471441596354
MeanAbsoluteError value on hold-out data: 0.14373654127120972
Epoch: 4
Loss on hold-out set: 0.032361355732734264
MeanAbsoluteError value on hold-out data: 0.15015225112438202
Epoch: 5
Loss on hold-out set: 0.027352044162781614
MeanAbsoluteError value on hold-out data: 0.1351567655801773
Epoch: 6
Loss on hold-out set: 0.02390363854111025
MeanAbsoluteError value on hold-out data: 0.12404276430606842
```

```
Epoch: 7
Loss on hold-out set: 0.022672708323960632
MeanAbsoluteError value on hold-out data: 0.12397060543298721
Epoch: 8
Loss on hold-out set: 0.01970179919398537
MeanAbsoluteError value on hold-out data: 0.11506226658821106
Returned to Spot: Validation loss: 0.01970179919398537
----------------------------------------------

spotPython tuning: 0.00330472608268457 [##--------] 19.10%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.40818689932116814, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.04214267001340264
MeanAbsoluteError value on hold-out data: 0.16585470736026764
Epoch: 2
Loss on hold-out set: 0.029286462053852647
MeanAbsoluteError value on hold-out data: 0.1376143842935562
Epoch: 3
Loss on hold-out set: 0.024914527753073918
MeanAbsoluteError value on hold-out data: 0.12755680084228516
Epoch: 4
Loss on hold-out set: 0.021420803999430256
MeanAbsoluteError value on hold-out data: 0.11906438320875168
Epoch: 5
Loss on hold-out set: 0.017799917314397663
MeanAbsoluteError value on hold-out data: 0.10845498740673065
Epoch: 6
Loss on hold-out set: 0.01887884036343741
MeanAbsoluteError value on hold-out data: 0.111204594373703
Epoch: 7
Loss on hold-out set: 0.01618810950190221
MeanAbsoluteError value on hold-out data: 0.10079630464315414
Epoch: 8
Loss on hold-out set: 0.013256641411173501
MeanAbsoluteError value on hold-out data: 0.09002143144607544
Epoch: 9
Loss on hold-out set: 0.010603331421550951
MeanAbsoluteError value on hold-out data: 0.08253297209739685
Epoch: 10
Loss on hold-out set: 0.014457617371686195
```

```
MeanAbsoluteError value on hold-out data: 0.0944565013051033
Epoch: 11

Loss on hold-out set: 0.009679800766446678
MeanAbsoluteError value on hold-out data: 0.0756080225110054
Epoch: 12
Loss on hold-out set: 0.010167055438566757
MeanAbsoluteError value on hold-out data: 0.0795348584651947
Epoch: 13
Loss on hold-out set: 0.008975221521196593
MeanAbsoluteError value on hold-out data: 0.07389388978481293
Epoch: 14
Loss on hold-out set: 0.008056372244793334
MeanAbsoluteError value on hold-out data: 0.06884083151817322
Epoch: 15
Loss on hold-out set: 0.008098279041740554
MeanAbsoluteError value on hold-out data: 0.07083864510059357
Epoch: 16
Loss on hold-out set: 0.006573376506199374
MeanAbsoluteError value on hold-out data: 0.06085790693759918
Epoch: 17
Loss on hold-out set: 0.009401378215682743
MeanAbsoluteError value on hold-out data: 0.0734940692782402
Epoch: 18
Loss on hold-out set: 0.008577068985782955
MeanAbsoluteError value on hold-out data: 0.07182034850120544
Epoch: 19
Loss on hold-out set: 0.008372537050347188
MeanAbsoluteError value on hold-out data: 0.07329828292131424
Epoch: 20
Loss on hold-out set: 0.005474214454328543
MeanAbsoluteError value on hold-out data: 0.05772119015455246
Epoch: 21
Loss on hold-out set: 0.008572895784470203
MeanAbsoluteError value on hold-out data: 0.07136869430541992
Epoch: 22

Loss on hold-out set: 0.006569562931728892
MeanAbsoluteError value on hold-out data: 0.06314229220151901
Epoch: 23
Loss on hold-out set: 0.006146106427829517
MeanAbsoluteError value on hold-out data: 0.06038757786154747
```

```
Epoch: 24
Loss on hold-out set: 0.006871528614091834
MeanAbsoluteError value on hold-out data: 0.0626259371638298
Epoch: 25
Loss on hold-out set: 0.005801141095090364
MeanAbsoluteError value on hold-out data: 0.058815423399209976
Epoch: 26
Loss on hold-out set: 0.007017560634075811
MeanAbsoluteError value on hold-out data: 0.0614873431622982
Epoch: 27
Loss on hold-out set: 0.006038011287608625
MeanAbsoluteError value on hold-out data: 0.058782316744327545
Epoch: 28
Loss on hold-out set: 0.007951190094708613
MeanAbsoluteError value on hold-out data: 0.06956641376018524
Epoch: 29
Loss on hold-out set: 0.006369675209402646
MeanAbsoluteError value on hold-out data: 0.0626107007265091
Epoch: 30
Loss on hold-out set: 0.004843360516947302
MeanAbsoluteError value on hold-out data: 0.05328918620944023
Epoch: 31
Loss on hold-out set: 0.006868896702623093
MeanAbsoluteError value on hold-out data: 0.06050989776849747
Epoch: 32
Loss on hold-out set: 0.01086512056645006
MeanAbsoluteError value on hold-out data: 0.08428962528705597
Epoch: 33

Loss on hold-out set: 0.005696569014904334
MeanAbsoluteError value on hold-out data: 0.05573122203350067
Epoch: 34
Loss on hold-out set: 0.00565724245480899
MeanAbsoluteError value on hold-out data: 0.055949509143829346
Epoch: 35
Loss on hold-out set: 0.006613227207899878
MeanAbsoluteError value on hold-out data: 0.05766964703798294
Epoch: 36
Loss on hold-out set: 0.004585905729694978
MeanAbsoluteError value on hold-out data: 0.04975193366408348
Epoch: 37
Loss on hold-out set: 0.004608624090906233
```

```
MeanAbsoluteError value on hold-out data: 0.04887665435671806
Epoch: 38
Loss on hold-out set: 0.0063438595695372085
MeanAbsoluteError value on hold-out data: 0.06232820451259613
Epoch: 39
Loss on hold-out set: 0.006251683137011959
MeanAbsoluteError value on hold-out data: 0.058938167989254
Epoch: 40
Loss on hold-out set: 0.0062841700549286445
MeanAbsoluteError value on hold-out data: 0.06128505617380142
Epoch: 41
Loss on hold-out set: 0.0053031839852337725
MeanAbsoluteError value on hold-out data: 0.0541139617562294
Epoch: 42
Loss on hold-out set: 0.004998700682527239
MeanAbsoluteError value on hold-out data: 0.052969250828027725
Epoch: 43
Loss on hold-out set: 0.006469235810647278
MeanAbsoluteError value on hold-out data: 0.061194103211164474
Epoch: 44

Loss on hold-out set: 0.005225851477773272
MeanAbsoluteError value on hold-out data: 0.05507697910070419
Epoch: 45
Loss on hold-out set: 0.006287869727729182
MeanAbsoluteError value on hold-out data: 0.062375545501708984
Epoch: 46
Loss on hold-out set: 0.005357134207626682
MeanAbsoluteError value on hold-out data: 0.05414737015962601
Epoch: 47
Loss on hold-out set: 0.004820251276741098
MeanAbsoluteError value on hold-out data: 0.05113683268427849
Epoch: 48
Loss on hold-out set: 0.005273596538341065
MeanAbsoluteError value on hold-out data: 0.056504663079977036
Epoch: 49
Loss on hold-out set: 0.006914053375734703
MeanAbsoluteError value on hold-out data: 0.06349816918373108
Epoch: 50
Loss on hold-out set: 0.0077366920120671
MeanAbsoluteError value on hold-out data: 0.06866881251335144
Epoch: 51
```

```
Loss on hold-out set: 0.004761875043378065
MeanAbsoluteError value on hold-out data: 0.048671796917915344
Epoch: 52
Loss on hold-out set: 0.005879824187631081
MeanAbsoluteError value on hold-out data: 0.057749900966882706
Epoch: 53
Loss on hold-out set: 0.004015251654843604
MeanAbsoluteError value on hold-out data: 0.04720759764313698
Epoch: 54
Loss on hold-out set: 0.007014215274370815
MeanAbsoluteError value on hold-out data: 0.06967305392026901
Epoch: 55


Loss on hold-out set: 0.006343881375965123
MeanAbsoluteError value on hold-out data: 0.06004033237695694
Epoch: 56
Loss on hold-out set: 0.00624831625579023
MeanAbsoluteError value on hold-out data: 0.05789445713162422
Epoch: 57
Loss on hold-out set: 0.00620817521427709
MeanAbsoluteError value on hold-out data: 0.06078079715371132
Epoch: 58
Loss on hold-out set: 0.008351152398206881
MeanAbsoluteError value on hold-out data: 0.0683307871222496
Epoch: 59
Loss on hold-out set: 0.00759831259002615
MeanAbsoluteError value on hold-out data: 0.06665003299713135
Epoch: 60
Loss on hold-out set: 0.005303958391059974
MeanAbsoluteError value on hold-out data: 0.05851808562874794
Epoch: 61
Loss on hold-out set: 0.004715024165833663
MeanAbsoluteError value on hold-out data: 0.052878085523843765
Epoch: 62
Loss on hold-out set: 0.004335160970712374
MeanAbsoluteError value on hold-out data: 0.051179371774196625
Epoch: 63
Loss on hold-out set: 0.007383728614322057
MeanAbsoluteError value on hold-out data: 0.06822129338979721
Epoch: 64
Loss on hold-out set: 0.007664650393723461
MeanAbsoluteError value on hold-out data: 0.06908740103244781
```

```
Epoch: 65
Loss on hold-out set: 0.008666956273373216
MeanAbsoluteError value on hold-out data: 0.07320857048034668
Epoch: 66

Loss on hold-out set: 0.004182496487996296
MeanAbsoluteError value on hold-out data: 0.04902254045009613
Epoch: 67
Loss on hold-out set: 0.0057710159269749725
MeanAbsoluteError value on hold-out data: 0.05844420567154884
Epoch: 68
Loss on hold-out set: 0.005165260490397678
MeanAbsoluteError value on hold-out data: 0.056376248598098755
Epoch: 69
Loss on hold-out set: 0.0050801354518625885
MeanAbsoluteError value on hold-out data: 0.05406659469008446
Epoch: 70
Loss on hold-out set: 0.004686730308764565
MeanAbsoluteError value on hold-out data: 0.05071186274290085
Epoch: 71
Loss on hold-out set: 0.007338432152449202
MeanAbsoluteError value on hold-out data: 0.06534424424171448
Epoch: 72
Loss on hold-out set: 0.009042247437479856
MeanAbsoluteError value on hold-out data: 0.07670677453279495
Epoch: 73
Loss on hold-out set: 0.006162544798203989
MeanAbsoluteError value on hold-out data: 0.05693412199616432
Epoch: 74
Loss on hold-out set: 0.0048500922689287875
MeanAbsoluteError value on hold-out data: 0.05513016879558563
Epoch: 75
Loss on hold-out set: 0.004515241277036502
MeanAbsoluteError value on hold-out data: 0.05098497495055199
Epoch: 76
Loss on hold-out set: 0.005828702935679375
MeanAbsoluteError value on hold-out data: 0.059622783213853836
Epoch: 77

Loss on hold-out set: 0.005300212031120043
MeanAbsoluteError value on hold-out data: 0.05317738652229309
Epoch: 78
```

```
Loss on hold-out set: 0.007291614289371003
MeanAbsoluteError value on hold-out data: 0.06799906492233276
Epoch: 79
Loss on hold-out set: 0.0043604996294322376
MeanAbsoluteError value on hold-out data: 0.049652595072984695
Epoch: 80
Loss on hold-out set: 0.004558259771377044
MeanAbsoluteError value on hold-out data: 0.0511452816426754
Epoch: 81
Loss on hold-out set: 0.005074201960508761
MeanAbsoluteError value on hold-out data: 0.05654614791274071
Epoch: 82
Loss on hold-out set: 0.007314653699531367
MeanAbsoluteError value on hold-out data: 0.06669323146343231
Epoch: 83
Loss on hold-out set: 0.007998542412870416
MeanAbsoluteError value on hold-out data: 0.06857366859912872
Epoch: 84
Loss on hold-out set: 0.005643771181655067
MeanAbsoluteError value on hold-out data: 0.05666587874293327
Epoch: 85
Loss on hold-out set: 0.008847307092142537
MeanAbsoluteError value on hold-out data: 0.07432076334953308
Early stopping at epoch 84
Returned to Spot: Validation loss: 0.008847307092142537
----------------------------------------------

spotPython tuning: 0.00330472608268457 [##--------] 22.84%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.18896141691583188, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.027361383784170214
MeanAbsoluteError value on hold-out data: 0.13171257078647614
Epoch: 2
Loss on hold-out set: 0.021630833660693544
MeanAbsoluteError value on hold-out data: 0.11648482084274292
Epoch: 3
Loss on hold-out set: 0.018735304143966028
MeanAbsoluteError value on hold-out data: 0.11072732508182526
Epoch: 4
Loss on hold-out set: 0.014565826540714815
```

```
MeanAbsoluteError value on hold-out data: 0.09979194402694702
Epoch: 5
Loss on hold-out set: 0.009183025777977156
MeanAbsoluteError value on hold-out data: 0.07605650275945663
Epoch: 6
Loss on hold-out set: 0.00776428808335607
MeanAbsoluteError value on hold-out data: 0.06864971667528152
Epoch: 7
Loss on hold-out set: 0.008929032535218684
MeanAbsoluteError value on hold-out data: 0.07226916402578354
Epoch: 8
Loss on hold-out set: 0.006858241903644644
MeanAbsoluteError value on hold-out data: 0.06576499342918396
Epoch: 9
Loss on hold-out set: 0.006952535569373714
MeanAbsoluteError value on hold-out data: 0.062410928308963776
Epoch: 10
Loss on hold-out set: 0.005279112276376078
MeanAbsoluteError value on hold-out data: 0.053810324519872665
Epoch: 11

Loss on hold-out set: 0.007088162309771992
MeanAbsoluteError value on hold-out data: 0.06368423253297806
Epoch: 12
Loss on hold-out set: 0.005320115665917432
MeanAbsoluteError value on hold-out data: 0.055342692881822586
Epoch: 13
Loss on hold-out set: 0.004370179422518336
MeanAbsoluteError value on hold-out data: 0.050778355449438095
Epoch: 14
Loss on hold-out set: 0.003355659186031277
MeanAbsoluteError value on hold-out data: 0.04371907562017441
Epoch: 15
Loss on hold-out set: 0.0039213988256003515
MeanAbsoluteError value on hold-out data: 0.04919445514678955
Epoch: 16
Loss on hold-out set: 0.004210095864867694
MeanAbsoluteError value on hold-out data: 0.04664817079901695
Epoch: 17
Loss on hold-out set: 0.004111775990551044
MeanAbsoluteError value on hold-out data: 0.04632958397269249
Epoch: 18
```

```
Loss on hold-out set: 0.0026872121103990233
MeanAbsoluteError value on hold-out data: 0.04247596114873886
Epoch: 19
Loss on hold-out set: 0.00319960146627732
MeanAbsoluteError value on hold-out data: 0.04348386451601982
Epoch: 20
Loss on hold-out set: 0.003426275125667943
MeanAbsoluteError value on hold-out data: 0.04790043085813522
Epoch: 21
Loss on hold-out set: 0.00300784845833397
MeanAbsoluteError value on hold-out data: 0.04095061123371124
Epoch: 22

Loss on hold-out set: 0.00380508031536776
MeanAbsoluteError value on hold-out data: 0.04757943004369736
Epoch: 23
Loss on hold-out set: 0.002925494621434298
MeanAbsoluteError value on hold-out data: 0.039873600006103516
Epoch: 24
Loss on hold-out set: 0.002741292961505487
MeanAbsoluteError value on hold-out data: 0.038380421698093414
Epoch: 25
Loss on hold-out set: 0.0029263688882469737
MeanAbsoluteError value on hold-out data: 0.04324047639966011
Epoch: 26
Loss on hold-out set: 0.0031330011429657276
MeanAbsoluteError value on hold-out data: 0.04130670055747032
Epoch: 27
Loss on hold-out set: 0.0034565950596803113
MeanAbsoluteError value on hold-out data: 0.04817923158407211
Epoch: 28
Loss on hold-out set: 0.0025145822529386926
MeanAbsoluteError value on hold-out data: 0.03777209669351578
Epoch: 29
Loss on hold-out set: 0.002779155894562504
MeanAbsoluteError value on hold-out data: 0.034894756972789764
Epoch: 30
Loss on hold-out set: 0.004846207239959193
MeanAbsoluteError value on hold-out data: 0.05781843885779381
Epoch: 31
Loss on hold-out set: 0.0024986921336293513
MeanAbsoluteError value on hold-out data: 0.03501586243510246
```

```
Epoch: 32
Loss on hold-out set: 0.0026520595435469752
MeanAbsoluteError value on hold-out data: 0.04021143540740013
Epoch: 33

Loss on hold-out set: 0.005919475053240986
MeanAbsoluteError value on hold-out data: 0.06445014476776123
Epoch: 34
Loss on hold-out set: 0.0023154564367264116
MeanAbsoluteError value on hold-out data: 0.036544881761074066
Epoch: 35
Loss on hold-out set: 0.0027742159421139056
MeanAbsoluteError value on hold-out data: 0.04002147540450096
Epoch: 36
Loss on hold-out set: 0.0025344290157878085
MeanAbsoluteError value on hold-out data: 0.04139378294348717
Epoch: 37
Loss on hold-out set: 0.002587944628382837
MeanAbsoluteError value on hold-out data: 0.035459812730550766
Epoch: 38
Loss on hold-out set: 0.002516481588827446
MeanAbsoluteError value on hold-out data: 0.035058386623859406
Epoch: 39
Loss on hold-out set: 0.002661991047237902
MeanAbsoluteError value on hold-out data: 0.04149200767278671
Epoch: 40
Loss on hold-out set: 0.0018248948751869122
MeanAbsoluteError value on hold-out data: 0.03343534097075462
Epoch: 41
Loss on hold-out set: 0.0027210143759332007
MeanAbsoluteError value on hold-out data: 0.0411047637462616
Epoch: 42
Loss on hold-out set: 0.003778307833463738
MeanAbsoluteError value on hold-out data: 0.05047232285141945
Epoch: 43
Loss on hold-out set: 0.002559347471105866
MeanAbsoluteError value on hold-out data: 0.040758002549409866
Epoch: 44

Loss on hold-out set: 0.001824467758476538
MeanAbsoluteError value on hold-out data: 0.03445206210017204
Epoch: 45
```

```
Loss on hold-out set: 0.0028098772860463022
MeanAbsoluteError value on hold-out data: 0.03947457671165466
Epoch: 46
Loss on hold-out set: 0.0021333357405015512
MeanAbsoluteError value on hold-out data: 0.03324061259627342
Epoch: 47
Loss on hold-out set: 0.002815892407517439
MeanAbsoluteError value on hold-out data: 0.03882218897342682
Epoch: 48
Loss on hold-out set: 0.0022007352863989867
MeanAbsoluteError value on hold-out data: 0.033673178404569626
Epoch: 49
Loss on hold-out set: 0.0023585501736593678
MeanAbsoluteError value on hold-out data: 0.03682622313499451
Epoch: 50
Loss on hold-out set: 0.004422442567853355
MeanAbsoluteError value on hold-out data: 0.054269954562187195
Epoch: 51
Loss on hold-out set: 0.0022452110095304975
MeanAbsoluteError value on hold-out data: 0.037363987416028976
Epoch: 52
Loss on hold-out set: 0.0026065899644316616
MeanAbsoluteError value on hold-out data: 0.041358768939971924
Epoch: 53
Loss on hold-out set: 0.0026664882408160913
MeanAbsoluteError value on hold-out data: 0.03932225704193115
Epoch: 54
Loss on hold-out set: 0.001962576890946366
MeanAbsoluteError value on hold-out data: 0.03034629486501217
Epoch: 55

Loss on hold-out set: 0.0017173482031610451
MeanAbsoluteError value on hold-out data: 0.030273355543613434
Epoch: 56
Loss on hold-out set: 0.002148353031340153
MeanAbsoluteError value on hold-out data: 0.03531617298722267
Epoch: 57
Loss on hold-out set: 0.001876730729188574
MeanAbsoluteError value on hold-out data: 0.03060854971408844
Epoch: 58
Loss on hold-out set: 0.0023733700601089943
MeanAbsoluteError value on hold-out data: 0.03274914249777794
```

```
Epoch: 59
Loss on hold-out set: 0.0036410636507513885
MeanAbsoluteError value on hold-out data: 0.05042547360062599
Epoch: 60
Loss on hold-out set: 0.001645388263951693
MeanAbsoluteError value on hold-out data: 0.030496155843138695
Epoch: 61
Loss on hold-out set: 0.0017685890259025129
MeanAbsoluteError value on hold-out data: 0.03177117556333542
Epoch: 62
Loss on hold-out set: 0.002416214198762502
MeanAbsoluteError value on hold-out data: 0.035185132175683975
Epoch: 63
Loss on hold-out set: 0.0025140721569952896
MeanAbsoluteError value on hold-out data: 0.036894891411066055
Epoch: 64
Loss on hold-out set: 0.003198677119431331
MeanAbsoluteError value on hold-out data: 0.044034142047166824
Epoch: 65
Loss on hold-out set: 0.002204683446938074
MeanAbsoluteError value on hold-out data: 0.034277092665433884
Epoch: 66

Loss on hold-out set: 0.00205720374958075
MeanAbsoluteError value on hold-out data: 0.03060687705874443
Epoch: 67
Loss on hold-out set: 0.0014443959340784012
MeanAbsoluteError value on hold-out data: 0.029539145529270172
Epoch: 68
Loss on hold-out set: 0.0016085165077942964
MeanAbsoluteError value on hold-out data: 0.029261192306876183
Epoch: 69
Loss on hold-out set: 0.0017365631341051898
MeanAbsoluteError value on hold-out data: 0.029943453148007393
Epoch: 70
Loss on hold-out set: 0.0016311681584308022
MeanAbsoluteError value on hold-out data: 0.030794408172369003
Epoch: 71
Loss on hold-out set: 0.001999325684185973
MeanAbsoluteError value on hold-out data: 0.031427521258592606
Epoch: 72
Loss on hold-out set: 0.0018599576662956295
```

```
MeanAbsoluteError value on hold-out data: 0.030925508588552475
Epoch: 73
Loss on hold-out set: 0.0026151158534431537
MeanAbsoluteError value on hold-out data: 0.037580303847789764
Epoch: 74
Loss on hold-out set: 0.0026385063354514146
MeanAbsoluteError value on hold-out data: 0.04295384883880615
Epoch: 75
Loss on hold-out set: 0.0019516021887906582
MeanAbsoluteError value on hold-out data: 0.031342536211013794
Epoch: 76
Loss on hold-out set: 0.0029409344271315555
MeanAbsoluteError value on hold-out data: 0.04372072592377663
Epoch: 77

Loss on hold-out set: 0.0021448773500436034
MeanAbsoluteError value on hold-out data: 0.03352189436554909
Epoch: 78
Loss on hold-out set: 0.0021606346410025204
MeanAbsoluteError value on hold-out data: 0.033477164804935455
Epoch: 79
Loss on hold-out set: 0.0033485384468038225
MeanAbsoluteError value on hold-out data: 0.04780745878815651
Epoch: 80
Loss on hold-out set: 0.0022393202349408775
MeanAbsoluteError value on hold-out data: 0.033356960862874985
Epoch: 81
Loss on hold-out set: 0.0016326314584339822
MeanAbsoluteError value on hold-out data: 0.03030870109796524
Epoch: 82
Loss on hold-out set: 0.002374962787143886
MeanAbsoluteError value on hold-out data: 0.03488507494330406
Epoch: 83
Loss on hold-out set: 0.0016200141100470272
MeanAbsoluteError value on hold-out data: 0.03020249679684639
Epoch: 84
Loss on hold-out set: 0.0021681291530656287
MeanAbsoluteError value on hold-out data: 0.034253135323524475
Epoch: 85
Loss on hold-out set: 0.0030477054334417182
MeanAbsoluteError value on hold-out data: 0.04261542856693268
Epoch: 86
```

```
Loss on hold-out set: 0.001999409368421
MeanAbsoluteError value on hold-out data: 0.031246036291122437
Epoch: 87
Loss on hold-out set: 0.0017345979523318085
MeanAbsoluteError value on hold-out data: 0.031707845628261566
Epoch: 88

Loss on hold-out set: 0.0030263429706744653
MeanAbsoluteError value on hold-out data: 0.04056528955698013
Epoch: 89
Loss on hold-out set: 0.00379397763294707
MeanAbsoluteError value on hold-out data: 0.05104415491223335
Epoch: 90
Loss on hold-out set: 0.0021002973463557857
MeanAbsoluteError value on hold-out data: 0.03519728034734726
Epoch: 91
Loss on hold-out set: 0.0020717993343408268
MeanAbsoluteError value on hold-out data: 0.03491196781396866
Epoch: 92
Loss on hold-out set: 0.0021158115720793015
MeanAbsoluteError value on hold-out data: 0.034951694309711456
Epoch: 93
Loss on hold-out set: 0.004050961680293672
MeanAbsoluteError value on hold-out data: 0.051503561437129974
Epoch: 94
Loss on hold-out set: 0.0024544723334991815
MeanAbsoluteError value on hold-out data: 0.036110769957304
Epoch: 95
Loss on hold-out set: 0.003906509552555355
MeanAbsoluteError value on hold-out data: 0.05186497047543526
Epoch: 96
Loss on hold-out set: 0.002039802049311172
MeanAbsoluteError value on hold-out data: 0.03323538228869438
Epoch: 97
Loss on hold-out set: 0.0030235575548814317
MeanAbsoluteError value on hold-out data: 0.046948689967393875
Epoch: 98
Loss on hold-out set: 0.004488818797797553
MeanAbsoluteError value on hold-out data: 0.05652737244963646
Epoch: 99

Loss on hold-out set: 0.002188610600760991
```

```
MeanAbsoluteError value on hold-out data: 0.03906301036477089
Epoch: 100
Loss on hold-out set: 0.0020571956579499926
MeanAbsoluteError value on hold-out data: 0.029575541615486145
Epoch: 101
Loss on hold-out set: 0.0053337343576315204
MeanAbsoluteError value on hold-out data: 0.06146196275949478
Epoch: 102
Loss on hold-out set: 0.0025391782125409102
MeanAbsoluteError value on hold-out data: 0.03888293355703354
Epoch: 103
Loss on hold-out set: 0.001995690443436615
MeanAbsoluteError value on hold-out data: 0.03120354935526848
Epoch: 104
Loss on hold-out set: 0.001782098590506633
MeanAbsoluteError value on hold-out data: 0.028594814240932465
Epoch: 105
Loss on hold-out set: 0.0035674071925888328
MeanAbsoluteError value on hold-out data: 0.04974503815174103
Epoch: 106
Loss on hold-out set: 0.0020896712988982664
MeanAbsoluteError value on hold-out data: 0.0330144539475441
Epoch: 107
Loss on hold-out set: 0.0029268856252249527
MeanAbsoluteError value on hold-out data: 0.044360142201185226
Epoch: 108
Loss on hold-out set: 0.0018736370839178562
MeanAbsoluteError value on hold-out data: 0.035281892865896225
Epoch: 109
Loss on hold-out set: 0.002531984683867593
MeanAbsoluteError value on hold-out data: 0.037447333335876465
Epoch: 110

Loss on hold-out set: 0.002361470865588145
MeanAbsoluteError value on hold-out data: 0.0370982401072979
Epoch: 111
Loss on hold-out set: 0.002384488228831048
MeanAbsoluteError value on hold-out data: 0.03615148738026619
Epoch: 112
Loss on hold-out set: 0.0017754240489969227
MeanAbsoluteError value on hold-out data: 0.03137815371155739
Epoch: 113
```

```
Loss on hold-out set: 0.002191958072025476
MeanAbsoluteError value on hold-out data: 0.03216499462723732
Epoch: 114
Loss on hold-out set: 0.0023454723567211708
MeanAbsoluteError value on hold-out data: 0.03922886773943901
Epoch: 115
Loss on hold-out set: 0.002082788577689299
MeanAbsoluteError value on hold-out data: 0.03228477016091347
Epoch: 116
Loss on hold-out set: 0.0037815464066194467
MeanAbsoluteError value on hold-out data: 0.04940767213702202
Epoch: 117
Loss on hold-out set: 0.00280026717748689
MeanAbsoluteError value on hold-out data: 0.043022237718105316
Epoch: 118
Loss on hold-out set: 0.0040875328765986
MeanAbsoluteError value on hold-out data: 0.05207975208759308
Epoch: 119
Loss on hold-out set: 0.00185422954688731
MeanAbsoluteError value on hold-out data: 0.03419170901179314
Epoch: 120
Loss on hold-out set: 0.0017170322918039012
MeanAbsoluteError value on hold-out data: 0.030522610992193222
Epoch: 121

Loss on hold-out set: 0.003452683339434627
MeanAbsoluteError value on hold-out data: 0.0466160848736763
Epoch: 122
Loss on hold-out set: 0.0018937988574371527
MeanAbsoluteError value on hold-out data: 0.030356088653206825
Epoch: 123
Loss on hold-out set: 0.002358153362078347
MeanAbsoluteError value on hold-out data: 0.03724316135048866
Epoch: 124
Loss on hold-out set: 0.0020744170079093523
MeanAbsoluteError value on hold-out data: 0.03246781602501869
Epoch: 125
Loss on hold-out set: 0.0060155802976193
MeanAbsoluteError value on hold-out data: 0.06737660616636276
Epoch: 126
Loss on hold-out set: 0.0040675816034260945
MeanAbsoluteError value on hold-out data: 0.04979932680726051
```

```
Epoch: 127
Loss on hold-out set: 0.0021618706247720277
MeanAbsoluteError value on hold-out data: 0.03080006316304207
Epoch: 128
Loss on hold-out set: 0.0021188985265325755
MeanAbsoluteError value on hold-out data: 0.03346443921327591
Epoch: 129
Loss on hold-out set: 0.0021342431795538254
MeanAbsoluteError value on hold-out data: 0.03392518684267998
Epoch: 130
Loss on hold-out set: 0.0031401463876184273
MeanAbsoluteError value on hold-out data: 0.044936422258615494
Epoch: 131
Loss on hold-out set: 0.00226078798847371
MeanAbsoluteError value on hold-out data: 0.035387005656957626
Early stopping at epoch 130
Returned to Spot: Validation loss: 0.00226078798847371
----------------------------------------------

spotPython tuning: 0.00226078798847371 [###-------] 27.96%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.15383242966465482, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.023561536555031414
MeanAbsoluteError value on hold-out data: 0.12075135856866837
Epoch: 2
Loss on hold-out set: 0.017959450071334447
MeanAbsoluteError value on hold-out data: 0.1030152291059494
Epoch: 3
Loss on hold-out set: 0.01254392619930992
MeanAbsoluteError value on hold-out data: 0.09084662050008774
Epoch: 4
Loss on hold-out set: 0.010972432838140153
MeanAbsoluteError value on hold-out data: 0.08287503570318222
Epoch: 5
Loss on hold-out set: 0.008628189499416438
MeanAbsoluteError value on hold-out data: 0.07185991108417511
Epoch: 6
Loss on hold-out set: 0.009279225297321222
MeanAbsoluteError value on hold-out data: 0.07811646163463593
Epoch: 7
```

```
Loss on hold-out set: 0.007593933272322542
MeanAbsoluteError value on hold-out data: 0.07204072922468185
Epoch: 8
Loss on hold-out set: 0.009026015820716957
MeanAbsoluteError value on hold-out data: 0.0792652815580368
Epoch: 9
Loss on hold-out set: 0.004825264184833749
MeanAbsoluteError value on hold-out data: 0.05258910357952118
Epoch: 10
Loss on hold-out set: 0.004566551506286487
MeanAbsoluteError value on hold-out data: 0.0530582033097744
Epoch: 11

Loss on hold-out set: 0.004320224036315554
MeanAbsoluteError value on hold-out data: 0.05050837621092796
Epoch: 12
Loss on hold-out set: 0.003678437210558178
MeanAbsoluteError value on hold-out data: 0.0453408844769001
Epoch: 13
Loss on hold-out set: 0.003652621949042537
MeanAbsoluteError value on hold-out data: 0.04722355678677559
Epoch: 14
Loss on hold-out set: 0.004469759308880097
MeanAbsoluteError value on hold-out data: 0.051671210676431656
Epoch: 15
Loss on hold-out set: 0.003491821144339874
MeanAbsoluteError value on hold-out data: 0.04283298924565315
Epoch: 16
Loss on hold-out set: 0.0039033735443617366
MeanAbsoluteError value on hold-out data: 0.045836638659238815
Returned to Spot: Validation loss: 0.0039033735443617366
----------------------------------------------

spotPython tuning: 0.0022607879884737l [###-------] 29.59%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.12556862416372097, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.022332680430018195
MeanAbsoluteError value on hold-out data: 0.1176949217915535
Epoch: 2
Loss on hold-out set: 0.02189695675808348
```

```
MeanAbsoluteError value on hold-out data: 0.11973762512207031
Epoch: 3
Loss on hold-out set: 0.024026414992189722
MeanAbsoluteError value on hold-out data: 0.13297396898269653
Epoch: 4
Loss on hold-out set: 0.010048854691711696
MeanAbsoluteError value on hold-out data: 0.08116573095321655
Epoch: 5
Loss on hold-out set: 0.008644656210794653
MeanAbsoluteError value on hold-out data: 0.06973440200090408
Epoch: 6
Loss on hold-out set: 0.00981830202018548
MeanAbsoluteError value on hold-out data: 0.08150336146354675
Epoch: 7
Loss on hold-out set: 0.0069384837682407935
MeanAbsoluteError value on hold-out data: 0.0673244297504425
Epoch: 8
Loss on hold-out set: 0.0060720566298665575
MeanAbsoluteError value on hold-out data: 0.0653056725859642
Epoch: 9
Loss on hold-out set: 0.005599562890558063
MeanAbsoluteError value on hold-out data: 0.05977192521095276
Epoch: 10
Loss on hold-out set: 0.005495393103429754
MeanAbsoluteError value on hold-out data: 0.059735190123319626
Epoch: 11

Loss on hold-out set: 0.004361182533964319
MeanAbsoluteError value on hold-out data: 0.05182596296072006
Epoch: 12
Loss on hold-out set: 0.0048553950756812765
MeanAbsoluteError value on hold-out data: 0.05468901991844177
Epoch: 13
Loss on hold-out set: 0.007230893739401118
MeanAbsoluteError value on hold-out data: 0.06996529549360275
Epoch: 14
Loss on hold-out set: 0.004782315901186513
MeanAbsoluteError value on hold-out data: 0.05223995819687843
Epoch: 15
Loss on hold-out set: 0.0031376849587295987
MeanAbsoluteError value on hold-out data: 0.04365056753158569
Epoch: 16
```

```
Loss on hold-out set: 0.003947321500163525
MeanAbsoluteError value on hold-out data: 0.04561232775449753
Epoch: 17
Loss on hold-out set: 0.0038972053796322527
MeanAbsoluteError value on hold-out data: 0.05228563770651817
Epoch: 18
Loss on hold-out set: 0.0022453887948741843
MeanAbsoluteError value on hold-out data: 0.03716268017888069
Epoch: 19
Loss on hold-out set: 0.0025690688298230895
MeanAbsoluteError value on hold-out data: 0.038091011345386505
Epoch: 20
Loss on hold-out set: 0.002822673711067948
MeanAbsoluteError value on hold-out data: 0.04153558239340782
Epoch: 21
Loss on hold-out set: 0.0039398516620215522
MeanAbsoluteError value on hold-out data: 0.046677879989147186
Epoch: 22
```

```
Loss on hold-out set: 0.003091499592349129
MeanAbsoluteError value on hold-out data: 0.0425727479159832
Epoch: 23
Loss on hold-out set: 0.002880736021324992
MeanAbsoluteError value on hold-out data: 0.039282843470573425
Epoch: 24
Loss on hold-out set: 0.0024668533809936457
MeanAbsoluteError value on hold-out data: 0.036979857832193375
Epoch: 25
Loss on hold-out set: 0.0030365977451621896
MeanAbsoluteError value on hold-out data: 0.0441352017223835
Epoch: 26
Loss on hold-out set: 0.002498446807485858
MeanAbsoluteError value on hold-out data: 0.036815185099840164
Epoch: 27
Loss on hold-out set: 0.0019928790681756495
MeanAbsoluteError value on hold-out data: 0.032724250108003616
Epoch: 28
Loss on hold-out set: 0.001917404255149641
MeanAbsoluteError value on hold-out data: 0.03368031233549118
Epoch: 29
Loss on hold-out set: 0.0021218643516093785
MeanAbsoluteError value on hold-out data: 0.035225432366132736
```

```
Epoch: 30
Loss on hold-out set: 0.003064188747023428
MeanAbsoluteError value on hold-out data: 0.04344600439071655
Epoch: 31
Loss on hold-out set: 0.0018781742064196518
MeanAbsoluteError value on hold-out data: 0.03214261680841446
Epoch: 32
Loss on hold-out set: 0.0016465680344385635
MeanAbsoluteError value on hold-out data: 0.03094075433909893
Epoch: 33

Loss on hold-out set: 0.0025405046709286246
MeanAbsoluteError value on hold-out data: 0.03509466350078583
Epoch: 34
Loss on hold-out set: 0.0033713338443225153
MeanAbsoluteError value on hold-out data: 0.0476582869887352
Epoch: 35
Loss on hold-out set: 0.0022715531154780797
MeanAbsoluteError value on hold-out data: 0.039048679172992706
Epoch: 36
Loss on hold-out set: 0.0022443651894144224
MeanAbsoluteError value on hold-out data: 0.03582415357232094
Epoch: 37
Loss on hold-out set: 0.0015937731039134394
MeanAbsoluteError value on hold-out data: 0.028343768790364265
Epoch: 38
Loss on hold-out set: 0.0020270079043448754
MeanAbsoluteError value on hold-out data: 0.03686133772134781
Epoch: 39
Loss on hold-out set: 0.001271690382150394
MeanAbsoluteError value on hold-out data: 0.02792784757912159
Epoch: 40
Loss on hold-out set: 0.001764095188455509
MeanAbsoluteError value on hold-out data: 0.02980571985244751
Epoch: 41
Loss on hold-out set: 0.003292183920980039
MeanAbsoluteError value on hold-out data: 0.05053209885954857
Epoch: 42
Loss on hold-out set: 0.0017742191373958792
MeanAbsoluteError value on hold-out data: 0.031752053648233414
Epoch: 43
Loss on hold-out set: 0.0016886212879877636
```

```
MeanAbsoluteError value on hold-out data: 0.030651511624455452
Epoch: 44

Loss on hold-out set: 0.003004135015592175
MeanAbsoluteError value on hold-out data: 0.04644618183374405
Epoch: 45
Loss on hold-out set: 0.0016599550811071439
MeanAbsoluteError value on hold-out data: 0.02963796630501747
Epoch: 46
Loss on hold-out set: 0.0018466441270950447
MeanAbsoluteError value on hold-out data: 0.03323324769735336
Epoch: 47
Loss on hold-out set: 0.004307634111395792
MeanAbsoluteError value on hold-out data: 0.058667246252298355
Epoch: 48
Loss on hold-out set: 0.00459673682742409
MeanAbsoluteError value on hold-out data: 0.05920946225523949
Epoch: 49
Loss on hold-out set: 0.0031142785477353946
MeanAbsoluteError value on hold-out data: 0.047004494816064835
Epoch: 50
Loss on hold-out set: 0.0015014076286062941
MeanAbsoluteError value on hold-out data: 0.029625196009874344
Epoch: 51
Loss on hold-out set: 0.00181155409556691
MeanAbsoluteError value on hold-out data: 0.030478935688734055
Epoch: 52
Loss on hold-out set: 0.003676174628229714
MeanAbsoluteError value on hold-out data: 0.050177883356809616
Epoch: 53
Loss on hold-out set: 0.0012875335209843655
MeanAbsoluteError value on hold-out data: 0.026684625074267387
Epoch: 54
Loss on hold-out set: 0.0022221505887022146
MeanAbsoluteError value on hold-out data: 0.03927456960082054
Epoch: 55

Loss on hold-out set: 0.0014145757522783242
MeanAbsoluteError value on hold-out data: 0.02745887078344822
Epoch: 56
Loss on hold-out set: 0.001456875092883006
MeanAbsoluteError value on hold-out data: 0.028047218918800354
```

```
Epoch: 57
Loss on hold-out set: 0.0016239574692199792
MeanAbsoluteError value on hold-out data: 0.030313150957226753
Epoch: 58
Loss on hold-out set: 0.002595124859669197
MeanAbsoluteError value on hold-out data: 0.04023157060146332
Epoch: 59
Loss on hold-out set: 0.0018529673336735485
MeanAbsoluteError value on hold-out data: 0.033833663910627365
Epoch: 60
Loss on hold-out set: 0.0013124390718171764
MeanAbsoluteError value on hold-out data: 0.027734609320759773
Epoch: 61
Loss on hold-out set: 0.002523718573349087
MeanAbsoluteError value on hold-out data: 0.04052353277802467
Epoch: 62
Loss on hold-out set: 0.0010530285615363698
MeanAbsoluteError value on hold-out data: 0.025564394891262054
Epoch: 63
Loss on hold-out set: 0.0033997301545337236
MeanAbsoluteError value on hold-out data: 0.05134018138051033
Epoch: 64
Loss on hold-out set: 0.0028530647702466106
MeanAbsoluteError value on hold-out data: 0.046069078147411346
Epoch: 65
Loss on hold-out set: 0.0023138264629156574
MeanAbsoluteError value on hold-out data: 0.03795686736702919
Epoch: 66

Loss on hold-out set: 0.0012186587064206833
MeanAbsoluteError value on hold-out data: 0.026640024036169052
Epoch: 67
Loss on hold-out set: 0.0027889894891383223
MeanAbsoluteError value on hold-out data: 0.03982187807559967
Epoch: 68
Loss on hold-out set: 0.0034300541370420865
MeanAbsoluteError value on hold-out data: 0.049169715493917465
Epoch: 69
Loss on hold-out set: 0.0013231640052828496
MeanAbsoluteError value on hold-out data: 0.025844553485512733
Epoch: 70
Loss on hold-out set: 0.0010810586597807216
```

```
MeanAbsoluteError value on hold-out data: 0.023887164890766144
Epoch: 71
Loss on hold-out set: 0.0014347922589973007
MeanAbsoluteError value on hold-out data: 0.028131337836384773
Epoch: 72
Loss on hold-out set: 0.0014569019737169391
MeanAbsoluteError value on hold-out data: 0.028302857652306557
Epoch: 73
Loss on hold-out set: 0.0020315493579561774
MeanAbsoluteError value on hold-out data: 0.036576010286808014
Epoch: 74
Loss on hold-out set: 0.0013884146694755671
MeanAbsoluteError value on hold-out data: 0.028099533170461655
Epoch: 75
Loss on hold-out set: 0.0012499433264326256
MeanAbsoluteError value on hold-out data: 0.026933999732136726
Epoch: 76
Loss on hold-out set: 0.0027842925812460876
MeanAbsoluteError value on hold-out data: 0.04417446628212929
Epoch: 77

Loss on hold-out set: 0.0019079750353213105
MeanAbsoluteError value on hold-out data: 0.032539572566747665
Epoch: 78
Loss on hold-out set: 0.0011616159229704767
MeanAbsoluteError value on hold-out data: 0.026666812598705292
Epoch: 79
Loss on hold-out set: 0.0032880201960276616
MeanAbsoluteError value on hold-out data: 0.04844748601317406
Epoch: 80
Loss on hold-out set: 0.0010698284887966064
MeanAbsoluteError value on hold-out data: 0.024642925709486008
Epoch: 81
Loss on hold-out set: 0.0016882319928539034
MeanAbsoluteError value on hold-out data: 0.02923911064863205
Epoch: 82
Loss on hold-out set: 0.0012042874272753436
MeanAbsoluteError value on hold-out data: 0.026294387876987457
Epoch: 83
Loss on hold-out set: 0.001801674208285189
MeanAbsoluteError value on hold-out data: 0.03203245997428894
Epoch: 84
```

```
Loss on hold-out set: 0.0014398978107094177
MeanAbsoluteError value on hold-out data: 0.02836860902607441
Epoch: 85
Loss on hold-out set: 0.0031876979812391496
MeanAbsoluteError value on hold-out data: 0.05007040873169899
Epoch: 86
Loss on hold-out set: 0.001058465333220451
MeanAbsoluteError value on hold-out data: 0.02440597675740719
Epoch: 87
Loss on hold-out set: 0.0015343259215832834
MeanAbsoluteError value on hold-out data: 0.028663447126746178
Epoch: 88

Loss on hold-out set: 0.0017083892257927034
MeanAbsoluteError value on hold-out data: 0.03242304548621178
Epoch: 89
Loss on hold-out set: 0.001735917309384891
MeanAbsoluteError value on hold-out data: 0.030932292342185974
Epoch: 90
Loss on hold-out set: 0.0014139894085115213
MeanAbsoluteError value on hold-out data: 0.027579443529248238
Epoch: 91
Loss on hold-out set: 0.0015294405778771953
MeanAbsoluteError value on hold-out data: 0.028436709195375443
Epoch: 92
Loss on hold-out set: 0.0015916246767645997
MeanAbsoluteError value on hold-out data: 0.031277697533369064
Epoch: 93
Loss on hold-out set: 0.0016018123416487423
MeanAbsoluteError value on hold-out data: 0.029805254191160202
Epoch: 94
Loss on hold-out set: 0.0026403104060782902
MeanAbsoluteError value on hold-out data: 0.04301321879029274
Early stopping at epoch 93
Returned to Spot: Validation loss: 0.0026403104060782902
----------------------------------------------

spotPython tuning: 0.00226078798847371 [###-------] 33.79%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.1949976903885119, 'lr_mult': 6
Epoch: 1
```

```
Loss on hold-out set: 0.025616842377195626
MeanAbsoluteError value on hold-out data: 0.129347026348114
Epoch: 2
Loss on hold-out set: 0.01729234001035557
MeanAbsoluteError value on hold-out data: 0.10294090956449509
Epoch: 3
Loss on hold-out set: 0.013674520286976508
MeanAbsoluteError value on hold-out data: 0.09423430263996124
Epoch: 4
Loss on hold-out set: 0.009790251926077824
MeanAbsoluteError value on hold-out data: 0.07897890359163284
Epoch: 5
Loss on hold-out set: 0.012482332421074572
MeanAbsoluteError value on hold-out data: 0.09229733049869537
Epoch: 6
Loss on hold-out set: 0.009492245876524402
MeanAbsoluteError value on hold-out data: 0.07941746711730957
Epoch: 7
Loss on hold-out set: 0.008953631705432934
MeanAbsoluteError value on hold-out data: 0.07518705725669861
Epoch: 8
Loss on hold-out set: 0.006386709273915346
MeanAbsoluteError value on hold-out data: 0.06389153748750687
Epoch: 9
Loss on hold-out set: 0.004381117335900566
MeanAbsoluteError value on hold-out data: 0.05180206522345543
Epoch: 10
Loss on hold-out set: 0.006285645000293459
MeanAbsoluteError value on hold-out data: 0.06397520005702972
Epoch: 11

Loss on hold-out set: 0.004864678810056495
MeanAbsoluteError value on hold-out data: 0.05548335239291191
Epoch: 12
Loss on hold-out set: 0.004432127207493116
MeanAbsoluteError value on hold-out data: 0.05297182872891426
Epoch: 13
Loss on hold-out set: 0.005804993631930924
MeanAbsoluteError value on hold-out data: 0.06051040068268776
Epoch: 14
Loss on hold-out set: 0.004171475129336805
MeanAbsoluteError value on hold-out data: 0.04980352148413658
```

```
Epoch: 15
Loss on hold-out set: 0.0038131959047045952
MeanAbsoluteError value on hold-out data: 0.048400089144706726
Epoch: 16
Loss on hold-out set: 0.0066003425684022276
MeanAbsoluteError value on hold-out data: 0.06654533743858337
Epoch: 17
Loss on hold-out set: 0.003136724667121215
MeanAbsoluteError value on hold-out data: 0.041962265968322754
Epoch: 18
Loss on hold-out set: 0.0033393996112097645
MeanAbsoluteError value on hold-out data: 0.04425066336989403
Epoch: 19
Loss on hold-out set: 0.0028157383218824273
MeanAbsoluteError value on hold-out data: 0.04177478328347206
Epoch: 20
Loss on hold-out set: 0.002253611984135779
MeanAbsoluteError value on hold-out data: 0.035811036825180054
Epoch: 21
Loss on hold-out set: 0.002388795853843667
MeanAbsoluteError value on hold-out data: 0.037873733788728714
Epoch: 22

Loss on hold-out set: 0.0029881761170384522
MeanAbsoluteError value on hold-out data: 0.0439818911254406
Epoch: 23
Loss on hold-out set: 0.006060902547017772
MeanAbsoluteError value on hold-out data: 0.06378904730081558
Epoch: 24
Loss on hold-out set: 0.0020745587680721655
MeanAbsoluteError value on hold-out data: 0.03487981855869293
Epoch: 25
Loss on hold-out set: 0.0032962394823124143
MeanAbsoluteError value on hold-out data: 0.04599684476852417
Epoch: 26
Loss on hold-out set: 0.0033179741554991587
MeanAbsoluteError value on hold-out data: 0.0470958948135376
Epoch: 27
Loss on hold-out set: 0.0030531715494458026
MeanAbsoluteError value on hold-out data: 0.04136452451348305
Epoch: 28
Loss on hold-out set: 0.0020784884354246684
```

```
MeanAbsoluteError value on hold-out data: 0.035207804292440414
Epoch: 29
Loss on hold-out set: 0.0029173550735178745
MeanAbsoluteError value on hold-out data: 0.040250737220048904
Epoch: 30
Loss on hold-out set: 0.0020831728056930985
MeanAbsoluteError value on hold-out data: 0.03338949382305145
Epoch: 31
Loss on hold-out set: 0.0018728714517477017
MeanAbsoluteError value on hold-out data: 0.031832851469516754
Epoch: 32
Loss on hold-out set: 0.0020701096111320353
MeanAbsoluteError value on hold-out data: 0.03486597165465355
Epoch: 33


Loss on hold-out set: 0.0027525845982477462
MeanAbsoluteError value on hold-out data: 0.042928338050842285
Epoch: 34
Loss on hold-out set: 0.003136719676580182
MeanAbsoluteError value on hold-out data: 0.046175967901945114
Epoch: 35
Loss on hold-out set: 0.0020296506845625117
MeanAbsoluteError value on hold-out data: 0.03482288122177124
Epoch: 36
Loss on hold-out set: 0.001802120239804744
MeanAbsoluteError value on hold-out data: 0.033103086054325104
Epoch: 37
Loss on hold-out set: 0.0027609845044360938
MeanAbsoluteError value on hold-out data: 0.03831968456506729
Epoch: 38
Loss on hold-out set: 0.0025602556814096475
MeanAbsoluteError value on hold-out data: 0.03475739434361458
Epoch: 39
Loss on hold-out set: 0.005084125159651433
MeanAbsoluteError value on hold-out data: 0.06043395400047302
Epoch: 40
Loss on hold-out set: 0.0018260670767631382
MeanAbsoluteError value on hold-out data: 0.030567165464162827
Epoch: 41
Loss on hold-out set: 0.0021474242385011166
MeanAbsoluteError value on hold-out data: 0.033487360924482346
Epoch: 42
```

```
Loss on hold-out set: 0.003082482729376735
MeanAbsoluteError value on hold-out data: 0.04541749879717827
Epoch: 43
Loss on hold-out set: 0.002546247382844357
MeanAbsoluteError value on hold-out data: 0.04145682603120804
Epoch: 44

Loss on hold-out set: 0.0019639107187303076
MeanAbsoluteError value on hold-out data: 0.03401642665266991
Early stopping at epoch 43
Returned to Spot: Validation loss: 0.0019639107187303076
----------------------------------------------

spotPython tuning: 0.0019639107187303076 [####------] 36.68%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.18860003720606033, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.023670263110512967
MeanAbsoluteError value on hold-out data: 0.12367881834506989
Epoch: 2
Loss on hold-out set: 0.017169042374007404
MeanAbsoluteError value on hold-out data: 0.10440228879451752
Epoch: 3
Loss on hold-out set: 0.013619374312264355
MeanAbsoluteError value on hold-out data: 0.09324053674936295
Epoch: 4
Loss on hold-out set: 0.01114836827802815
MeanAbsoluteError value on hold-out data: 0.08374112099409103
Epoch: 5
Loss on hold-out set: 0.008657765476719329
MeanAbsoluteError value on hold-out data: 0.07275152951478958
Epoch: 6
Loss on hold-out set: 0.014391390337167602
MeanAbsoluteError value on hold-out data: 0.09987380355596542
Epoch: 7
Loss on hold-out set: 0.006957039825226131
MeanAbsoluteError value on hold-out data: 0.06634144484996796
Epoch: 8
Loss on hold-out set: 0.005528616397273972
MeanAbsoluteError value on hold-out data: 0.05800963565707207
Epoch: 9
```

```
Loss on hold-out set: 0.00852071879260046
MeanAbsoluteError value on hold-out data: 0.06947619467973709
Epoch: 10
Loss on hold-out set: 0.00945050496068832
MeanAbsoluteError value on hold-out data: 0.08135487139225006
Epoch: 11

Loss on hold-out set: 0.005829035310613874
MeanAbsoluteError value on hold-out data: 0.05929499864578247
Epoch: 12
Loss on hold-out set: 0.005572924460897124
MeanAbsoluteError value on hold-out data: 0.05547815188765526
Epoch: 13
Loss on hold-out set: 0.004350492995734767
MeanAbsoluteError value on hold-out data: 0.051539625972509384
Epoch: 14
Loss on hold-out set: 0.0038647441221033468
MeanAbsoluteError value on hold-out data: 0.048657990992069244
Epoch: 15
Loss on hold-out set: 0.003752596662563615
MeanAbsoluteError value on hold-out data: 0.048473529517650604
Epoch: 16
Loss on hold-out set: 0.004752119286230912
MeanAbsoluteError value on hold-out data: 0.05724411830306053
Epoch: 17
Loss on hold-out set: 0.006167532759718597
MeanAbsoluteError value on hold-out data: 0.06513053178787231
Epoch: 18
Loss on hold-out set: 0.0037338647985291715
MeanAbsoluteError value on hold-out data: 0.04741145297884941
Epoch: 19
Loss on hold-out set: 0.004254566876242231
MeanAbsoluteError value on hold-out data: 0.051135942339897156
Epoch: 20
Loss on hold-out set: 0.004472222545269975
MeanAbsoluteError value on hold-out data: 0.05500088259577751
Epoch: 21
Loss on hold-out set: 0.005318402085992459
MeanAbsoluteError value on hold-out data: 0.06072039157152176
Epoch: 22

Loss on hold-out set: 0.0027346727622084713
```

```
MeanAbsoluteError value on hold-out data: 0.04257833957672119
Epoch: 23
Loss on hold-out set: 0.005804682334296797
MeanAbsoluteError value on hold-out data: 0.06461187452077866
Epoch: 24
Loss on hold-out set: 0.0038228490555315816
MeanAbsoluteError value on hold-out data: 0.05083151161670685
Epoch: 25
Loss on hold-out set: 0.002872188555652668
MeanAbsoluteError value on hold-out data: 0.0408993698656559
Epoch: 26
Loss on hold-out set: 0.0035106972071317663
MeanAbsoluteError value on hold-out data: 0.048759765923023224
Epoch: 27
Loss on hold-out set: 0.0024961637245723978
MeanAbsoluteError value on hold-out data: 0.03915828838944435
Epoch: 28
Loss on hold-out set: 0.0038015590750881912
MeanAbsoluteError value on hold-out data: 0.04742176830768585
Epoch: 29
Loss on hold-out set: 0.004302679652985381
MeanAbsoluteError value on hold-out data: 0.05236615613102913
Epoch: 30
Loss on hold-out set: 0.002867269073919344
MeanAbsoluteError value on hold-out data: 0.039949268102645874
Epoch: 31
Loss on hold-out set: 0.002719653601065817
MeanAbsoluteError value on hold-out data: 0.039752449840307236
Epoch: 32
Loss on hold-out set: 0.0033037862342194116
MeanAbsoluteError value on hold-out data: 0.04524275287985802
Epoch: 33

Loss on hold-out set: 0.0023331006760647717
MeanAbsoluteError value on hold-out data: 0.0361143983900547
Epoch: 34
Loss on hold-out set: 0.0024323277634960647
MeanAbsoluteError value on hold-out data: 0.035955462604761124
Epoch: 35
Loss on hold-out set: 0.0023995093422280135
MeanAbsoluteError value on hold-out data: 0.03869687393307686
Epoch: 36
```

```
Loss on hold-out set: 0.0023590412548449087
MeanAbsoluteError value on hold-out data: 0.03835948556661606
Epoch: 37
Loss on hold-out set: 0.0020612209980179997
MeanAbsoluteError value on hold-out data: 0.033595889806747437
Epoch: 38
Loss on hold-out set: 0.002247469552553651
MeanAbsoluteError value on hold-out data: 0.033911220729351044
Epoch: 39
Loss on hold-out set: 0.0020395076288351496
MeanAbsoluteError value on hold-out data: 0.032934851944446564
Epoch: 40
Loss on hold-out set: 0.0045588438791271885
MeanAbsoluteError value on hold-out data: 0.05928204953670502
Epoch: 41
Loss on hold-out set: 0.0021845408696926348
MeanAbsoluteError value on hold-out data: 0.0351719930768013
Epoch: 42
Loss on hold-out set: 0.0023572630674798824
MeanAbsoluteError value on hold-out data: 0.03658797964453697
Epoch: 43
Loss on hold-out set: 0.003954435453603142
MeanAbsoluteError value on hold-out data: 0.050184182822704315
Epoch: 44

Loss on hold-out set: 0.001800359974272157
MeanAbsoluteError value on hold-out data: 0.032208751887083054
Epoch: 45
Loss on hold-out set: 0.0017669395785656218
MeanAbsoluteError value on hold-out data: 0.031248439103364944
Epoch: 46
Loss on hold-out set: 0.0024029128406637987
MeanAbsoluteError value on hold-out data: 0.0362776443362236
Epoch: 47
Loss on hold-out set: 0.0033105556136242263
MeanAbsoluteError value on hold-out data: 0.04644918441772461
Epoch: 48
Loss on hold-out set: 0.0035778884990385882
MeanAbsoluteError value on hold-out data: 0.050071343779563904
Epoch: 49
Loss on hold-out set: 0.0056895918617221085
MeanAbsoluteError value on hold-out data: 0.06479451060295105
```

```
Epoch: 50
Loss on hold-out set: 0.002513415198528061
MeanAbsoluteError value on hold-out data: 0.03746700659394264
Epoch: 51
Loss on hold-out set: 0.004635386257800029
MeanAbsoluteError value on hold-out data: 0.05857189744710922
Epoch: 52
Loss on hold-out set: 0.002155042177611521
MeanAbsoluteError value on hold-out data: 0.03558720648288727
Epoch: 53
Loss on hold-out set: 0.0019069711787252392
MeanAbsoluteError value on hold-out data: 0.03180483728647232
Early stopping at epoch 52
Returned to Spot: Validation loss: 0.0019069711787252392
----------------------------------------------

spotPython tuning: 0.0019069711787252392 [####------] 39.88%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.18705836739684822, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.02124309974820598
MeanAbsoluteError value on hold-out data: 0.11285647004842758
Epoch: 2
Loss on hold-out set: 0.01584451460573626
MeanAbsoluteError value on hold-out data: 0.09954173862934113
Epoch: 3
Loss on hold-out set: 0.011440595611929893
MeanAbsoluteError value on hold-out data: 0.08512739837169647
Epoch: 4
Loss on hold-out set: 0.009258489020315832
MeanAbsoluteError value on hold-out data: 0.07957471907138824
Epoch: 5
Loss on hold-out set: 0.006668837324373032
MeanAbsoluteError value on hold-out data: 0.06367668509483337
Epoch: 6
Loss on hold-out set: 0.011445016569555983
MeanAbsoluteError value on hold-out data: 0.09061775356531143
Epoch: 7
Loss on hold-out set: 0.00687966224014465
MeanAbsoluteError value on hold-out data: 0.0657244473695755
Epoch: 8
```

```
Loss on hold-out set: 0.004675279872332651
MeanAbsoluteError value on hold-out data: 0.05201004818081856
Epoch: 9
Loss on hold-out set: 0.005621246828109418
MeanAbsoluteError value on hold-out data: 0.05783095583319664
Epoch: 10
Loss on hold-out set: 0.005255200627480487
MeanAbsoluteError value on hold-out data: 0.05624132975935936
Epoch: 11

Loss on hold-out set: 0.005208622281268043
MeanAbsoluteError value on hold-out data: 0.05658618360757828
Epoch: 12
Loss on hold-out set: 0.00431900019726814
MeanAbsoluteError value on hold-out data: 0.04949729144573212
Epoch: 13
Loss on hold-out set: 0.003686660201454192
MeanAbsoluteError value on hold-out data: 0.045816969126462936
Epoch: 14
Loss on hold-out set: 0.003400678217937974
MeanAbsoluteError value on hold-out data: 0.04452641308307648
Epoch: 15
Loss on hold-out set: 0.0034023514722081784
MeanAbsoluteError value on hold-out data: 0.042909715324640274
Epoch: 16
Loss on hold-out set: 0.0033051417267415673
MeanAbsoluteError value on hold-out data: 0.04176286235451698
Epoch: 17
Loss on hold-out set: 0.0034408069577215143
MeanAbsoluteError value on hold-out data: 0.042677149176597595
Epoch: 18
Loss on hold-out set: 0.0026119904941879213
MeanAbsoluteError value on hold-out data: 0.04087044298648834
Epoch: 19
Loss on hold-out set: 0.010575198182395022
MeanAbsoluteError value on hold-out data: 0.08593431115150452
Epoch: 20
Loss on hold-out set: 0.0029191164603138246
MeanAbsoluteError value on hold-out data: 0.041696663945913315
Epoch: 21
Loss on hold-out set: 0.0033698151084153275
MeanAbsoluteError value on hold-out data: 0.04429285228252411
Epoch: 22
```

```
Loss on hold-out set: 0.002471278191813709
MeanAbsoluteError value on hold-out data: 0.037623919546604156
Epoch: 23
Loss on hold-out set: 0.003034847978453495
MeanAbsoluteError value on hold-out data: 0.04056677967309952
Epoch: 24
Loss on hold-out set: 0.0025512665329427506
MeanAbsoluteError value on hold-out data: 0.03908759355545044
Epoch: 25
Loss on hold-out set: 0.0027279998757876456
MeanAbsoluteError value on hold-out data: 0.03745671361684799
Epoch: 26
Loss on hold-out set: 0.0025171712622977793
MeanAbsoluteError value on hold-out data: 0.03830999135971069
Epoch: 27
Loss on hold-out set: 0.003153818708501364
MeanAbsoluteError value on hold-out data: 0.042114030569791794
Epoch: 28
Loss on hold-out set: 0.0030214000289561227
MeanAbsoluteError value on hold-out data: 0.040281184017658234
Epoch: 29
Loss on hold-out set: 0.0042463848918774414
MeanAbsoluteError value on hold-out data: 0.05103858932852745
Epoch: 30
Loss on hold-out set: 0.003070047871197427
MeanAbsoluteError value on hold-out data: 0.04354711249470711
Epoch: 31
Loss on hold-out set: 0.002801600301417669
MeanAbsoluteError value on hold-out data: 0.03742764890193939
Epoch: 32
Loss on hold-out set: 0.0031029180842635563
MeanAbsoluteError value on hold-out data: 0.041109561920166016
Epoch: 33

Loss on hold-out set: 0.002169223719791166
MeanAbsoluteError value on hold-out data: 0.03668810427188873
Epoch: 34
Loss on hold-out set: 0.0021808437564973964
MeanAbsoluteError value on hold-out data: 0.03461315482854843
Epoch: 35
Loss on hold-out set: 0.004576313088795072
MeanAbsoluteError value on hold-out data: 0.05215894803404808
```

```
Epoch: 36
Loss on hold-out set: 0.005607784198793142
MeanAbsoluteError value on hold-out data: 0.05964859575033188
Epoch: 37
Loss on hold-out set: 0.001970080532421554
MeanAbsoluteError value on hold-out data: 0.03147084638476372
Epoch: 38
Loss on hold-out set: 0.002675794560529635
MeanAbsoluteError value on hold-out data: 0.036482520401477814
Epoch: 39
Loss on hold-out set: 0.0022712292725612458
MeanAbsoluteError value on hold-out data: 0.03540647402405739
Epoch: 40
Loss on hold-out set: 0.003284742142760048
MeanAbsoluteError value on hold-out data: 0.047727879136800766
Epoch: 41
Loss on hold-out set: 0.0031673758747178668
MeanAbsoluteError value on hold-out data: 0.04035717993974686
Epoch: 42
Loss on hold-out set: 0.001699146698994905
MeanAbsoluteError value on hold-out data: 0.029976394027471542
Epoch: 43
Loss on hold-out set: 0.004103564997326191
MeanAbsoluteError value on hold-out data: 0.04805033653974533
Epoch: 44

Loss on hold-out set: 0.0038277058169784908
MeanAbsoluteError value on hold-out data: 0.05126376822590828
Epoch: 45
Loss on hold-out set: 0.0027579932464409226
MeanAbsoluteError value on hold-out data: 0.035432104021310806
Epoch: 46
Loss on hold-out set: 0.002997732680676946
MeanAbsoluteError value on hold-out data: 0.0375671423971653
Epoch: 47
Loss on hold-out set: 0.003010229086564658
MeanAbsoluteError value on hold-out data: 0.03926035389304161
Epoch: 48
Loss on hold-out set: 0.002659130734268968
MeanAbsoluteError value on hold-out data: 0.036794062703847885
Epoch: 49
Loss on hold-out set: 0.004836480307858437
```

```
MeanAbsoluteError value on hold-out data: 0.05926978960633278
Epoch: 50
Loss on hold-out set: 0.0028182694666994443
MeanAbsoluteError value on hold-out data: 0.03879283741116524
Epoch: 51
Loss on hold-out set: 0.0016386746359976793
MeanAbsoluteError value on hold-out data: 0.0309795793145895
Epoch: 52
Loss on hold-out set: 0.002764139371911848
MeanAbsoluteError value on hold-out data: 0.03972824662923813
Epoch: 53
Loss on hold-out set: 0.003110502424533479
MeanAbsoluteError value on hold-out data: 0.036194317042827606
Epoch: 54
Loss on hold-out set: 0.0032775262814921965
MeanAbsoluteError value on hold-out data: 0.03691413998603821
Epoch: 55

Loss on hold-out set: 0.001997413187621676
MeanAbsoluteError value on hold-out data: 0.03448726236820221
Epoch: 56
Loss on hold-out set: 0.0027725846946276235
MeanAbsoluteError value on hold-out data: 0.03283824026584625
Epoch: 57
Loss on hold-out set: 0.001998521307158578
MeanAbsoluteError value on hold-out data: 0.03237036243081093
Epoch: 58
Loss on hold-out set: 0.003487738720171987
MeanAbsoluteError value on hold-out data: 0.047115884721279144
Epoch: 59
Loss on hold-out set: 0.0031833668579469973
MeanAbsoluteError value on hold-out data: 0.04421182721853256
Epoch: 60
Loss on hold-out set: 0.0040158773557969225
MeanAbsoluteError value on hold-out data: 0.05146242305636406
Epoch: 61
Loss on hold-out set: 0.0039286246082108275
MeanAbsoluteError value on hold-out data: 0.05135183781385422
Epoch: 62
Loss on hold-out set: 0.0018070716806074703
MeanAbsoluteError value on hold-out data: 0.03264792263507843
Epoch: 63
```

```
Loss on hold-out set: 0.0019420306841646763
MeanAbsoluteError value on hold-out data: 0.03328441455960274
Epoch: 64
Loss on hold-out set: 0.001704327251278109
MeanAbsoluteError value on hold-out data: 0.02888173796236515
Epoch: 65
Loss on hold-out set: 0.003734189082598804
MeanAbsoluteError value on hold-out data: 0.04776931181550026
Epoch: 66

Loss on hold-out set: 0.002282495939748754
MeanAbsoluteError value on hold-out data: 0.03828689828515053
Epoch: 67
Loss on hold-out set: 0.001982606570604012
MeanAbsoluteError value on hold-out data: 0.03071507439017296
Early stopping at epoch 66
Returned to Spot: Validation loss: 0.001982606570604012
----------------------------------------------

spotPython tuning: 0.0019069711787252392 [#####-----] 45.46%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.18239907429346, 'lr_mult': 6.9
Epoch: 1
Loss on hold-out set: 0.02572106131303467
MeanAbsoluteError value on hold-out data: 0.13209892809391022
Epoch: 2
Loss on hold-out set: 0.023392626537794347
MeanAbsoluteError value on hold-out data: 0.12883979082107544
Epoch: 3
Loss on hold-out set: 0.016697022230609468
MeanAbsoluteError value on hold-out data: 0.10281313210725784
Epoch: 4
Loss on hold-out set: 0.010705406507967334
MeanAbsoluteError value on hold-out data: 0.08535847067832947
Epoch: 5
Loss on hold-out set: 0.009411892547321162
MeanAbsoluteError value on hold-out data: 0.07714895159006119
Epoch: 6
Loss on hold-out set: 0.014369603748874445
MeanAbsoluteError value on hold-out data: 0.10339239984750748
Epoch: 7
```

```
Loss on hold-out set: 0.016638553125391666
MeanAbsoluteError value on hold-out data: 0.11186791956424713
Epoch: 8
Loss on hold-out set: 0.007390202626610469
MeanAbsoluteError value on hold-out data: 0.0703481137752533
Epoch: 9
Loss on hold-out set: 0.007061409678212122
MeanAbsoluteError value on hold-out data: 0.06966255605220795
Epoch: 10
Loss on hold-out set: 0.005089478095454213
MeanAbsoluteError value on hold-out data: 0.05522223189473152
Epoch: 11


Loss on hold-out set: 0.0041770232155134805
MeanAbsoluteError value on hold-out data: 0.048470638692379
Epoch: 12
Loss on hold-out set: 0.00809319181318738
MeanAbsoluteError value on hold-out data: 0.07369160652160645
Epoch: 13
Loss on hold-out set: 0.004280321255608119
MeanAbsoluteError value on hold-out data: 0.049509450793266296
Epoch: 14
Loss on hold-out set: 0.004689525396219994
MeanAbsoluteError value on hold-out data: 0.055278606712818146
Epoch: 15
Loss on hold-out set: 0.0039028961729950665
MeanAbsoluteError value on hold-out data: 0.04962451756000519
Epoch: 16
Loss on hold-out set: 0.003714543853053137
MeanAbsoluteError value on hold-out data: 0.0473238006234169
Epoch: 17
Loss on hold-out set: 0.0034019833470474146
MeanAbsoluteError value on hold-out data: 0.04538370296359062
Epoch: 18
Loss on hold-out set: 0.0037101024890465566
MeanAbsoluteError value on hold-out data: 0.047993797808885574
Epoch: 19
Loss on hold-out set: 0.003308778227380428
MeanAbsoluteError value on hold-out data: 0.0440838523209095
Epoch: 20
Loss on hold-out set: 0.0037768047508219943
MeanAbsoluteError value on hold-out data: 0.0486023910343647
```

```
Epoch: 21
Loss on hold-out set: 0.0026741803893329283
MeanAbsoluteError value on hold-out data: 0.04021042212843895
Epoch: 22

Loss on hold-out set: 0.0025669907719068426
MeanAbsoluteError value on hold-out data: 0.03773278743028641
Epoch: 23
Loss on hold-out set: 0.0038175416166747085
MeanAbsoluteError value on hold-out data: 0.04924196004867554
Epoch: 24
Loss on hold-out set: 0.00825576646572077
MeanAbsoluteError value on hold-out data: 0.08152870833873749
Epoch: 25
Loss on hold-out set: 0.002844203189995728
MeanAbsoluteError value on hold-out data: 0.03996044397354126
Epoch: 26
Loss on hold-out set: 0.003162305278237909
MeanAbsoluteError value on hold-out data: 0.042111072689294815
Epoch: 27
Loss on hold-out set: 0.004493026840990703
MeanAbsoluteError value on hold-out data: 0.0573631227016449
Epoch: 28
Loss on hold-out set: 0.002315798325549909
MeanAbsoluteError value on hold-out data: 0.038526274263858795
Epoch: 29
Loss on hold-out set: 0.0028312913062492093
MeanAbsoluteError value on hold-out data: 0.0436047725379467
Epoch: 30
Loss on hold-out set: 0.0038056148700171
MeanAbsoluteError value on hold-out data: 0.05161307007074356
Epoch: 31
Loss on hold-out set: 0.0025658876769930907
MeanAbsoluteError value on hold-out data: 0.038578908890485764
Epoch: 32
Loss on hold-out set: 0.003061154414593291
MeanAbsoluteError value on hold-out data: 0.04265683516860008
Epoch: 33

Loss on hold-out set: 0.003382681705069875
MeanAbsoluteError value on hold-out data: 0.04354573413729668
Epoch: 34
```

```
Loss on hold-out set: 0.0020182473787204607
MeanAbsoluteError value on hold-out data: 0.03394272178411484
Epoch: 35
Loss on hold-out set: 0.003066571830698338
MeanAbsoluteError value on hold-out data: 0.0440642423927784
Epoch: 36
Loss on hold-out set: 0.0025705352462337799
MeanAbsoluteError value on hold-out data: 0.036017321050167084
Epoch: 37
Loss on hold-out set: 0.0024755765472563277
MeanAbsoluteError value on hold-out data: 0.040098030120134354
Epoch: 38
Loss on hold-out set: 0.004884478881170875
MeanAbsoluteError value on hold-out data: 0.06128626689314842
Epoch: 39
Loss on hold-out set: 0.003460610515168427
MeanAbsoluteError value on hold-out data: 0.04887239634990692
Epoch: 40
Loss on hold-out set: 0.0021470780729463228
MeanAbsoluteError value on hold-out data: 0.03715241700410843
Epoch: 41
Loss on hold-out set: 0.001783885567228457
MeanAbsoluteError value on hold-out data: 0.03321908414363861
Epoch: 42
Loss on hold-out set: 0.0020608489415424535
MeanAbsoluteError value on hold-out data: 0.0348060242831707
Epoch: 43
Loss on hold-out set: 0.001425022105410646
MeanAbsoluteError value on hold-out data: 0.02835792861878872
Epoch: 44

Loss on hold-out set: 0.001901992548434799
MeanAbsoluteError value on hold-out data: 0.031250279396772385
Epoch: 45
Loss on hold-out set: 0.0019433056417926167
MeanAbsoluteError value on hold-out data: 0.03401374816894531
Epoch: 46
Loss on hold-out set: 0.002288895239440822
MeanAbsoluteError value on hold-out data: 0.03592516854405403
Epoch: 47
Loss on hold-out set: 0.0014872270051120339
MeanAbsoluteError value on hold-out data: 0.02929358184337616
```

```
Epoch: 48
Loss on hold-out set: 0.0034288656170247123
MeanAbsoluteError value on hold-out data: 0.043237920850515366
Epoch: 49
Loss on hold-out set: 0.0027913026523923405
MeanAbsoluteError value on hold-out data: 0.04052935540676117
Epoch: 50
Loss on hold-out set: 0.0017998958937823772
MeanAbsoluteError value on hold-out data: 0.03296741098165512
Epoch: 51
Loss on hold-out set: 0.0014126687708898987
MeanAbsoluteError value on hold-out data: 0.028425581753253937
Epoch: 52
Loss on hold-out set: 0.0022879742609802634
MeanAbsoluteError value on hold-out data: 0.03456808254122734
Epoch: 53
Loss on hold-out set: 0.0017284894045013445
MeanAbsoluteError value on hold-out data: 0.03273522108793259
Epoch: 54
Loss on hold-out set: 0.0017893926170041883
MeanAbsoluteError value on hold-out data: 0.0314142182469368
Epoch: 55

Loss on hold-out set: 0.0025103035839397067
MeanAbsoluteError value on hold-out data: 0.04013209044933319
Epoch: 56
Loss on hold-out set: 0.002292418408232104
MeanAbsoluteError value on hold-out data: 0.03366837650537491
Epoch: 57
Loss on hold-out set: 0.0017121995165086303
MeanAbsoluteError value on hold-out data: 0.031525447964668274
Epoch: 58
Loss on hold-out set: 0.0019441916956566274
MeanAbsoluteError value on hold-out data: 0.03215397149324417
Epoch: 59
Loss on hold-out set: 0.0016853903829254896
MeanAbsoluteError value on hold-out data: 0.03179444745182991
Early stopping at epoch 58
Returned to Spot: Validation loss: 0.0016853903829254896
----------------------------------------------

spotPython tuning: 0.0016853903829254896 [#####-----] 51.98%
```

```
config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.18069584302446295, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.01775432995667583
MeanAbsoluteError value on hold-out data: 0.10838774591684341
Epoch: 2
Loss on hold-out set: 0.014572540065273643
MeanAbsoluteError value on hold-out data: 0.09292913973331451
Epoch: 3
Loss on hold-out set: 0.012616653681585663
MeanAbsoluteError value on hold-out data: 0.0895879715681076
Epoch: 4
Loss on hold-out set: 0.01085895906496597
MeanAbsoluteError value on hold-out data: 0.08545519411563873
Epoch: 5
Loss on hold-out set: 0.009487747763111992
MeanAbsoluteError value on hold-out data: 0.0799902155995369
Epoch: 6
Loss on hold-out set: 0.008057336632382908
MeanAbsoluteError value on hold-out data: 0.07328612357378006
Epoch: 7
Loss on hold-out set: 0.0069875910044892835
MeanAbsoluteError value on hold-out data: 0.06363318115472794
Epoch: 8
Loss on hold-out set: 0.006201070451520775
MeanAbsoluteError value on hold-out data: 0.06523299217224121
Epoch: 9
Loss on hold-out set: 0.005762638380187319
MeanAbsoluteError value on hold-out data: 0.05892471969127655
Epoch: 10
Loss on hold-out set: 0.005210433654658692
MeanAbsoluteError value on hold-out data: 0.058351967483758926
Epoch: 11

Loss on hold-out set: 0.00398643221706152
MeanAbsoluteError value on hold-out data: 0.04982094466686249
Epoch: 12
Loss on hold-out set: 0.006316328703082706
MeanAbsoluteError value on hold-out data: 0.06728409230709076
Epoch: 13
Loss on hold-out set: 0.004369910184514562
MeanAbsoluteError value on hold-out data: 0.05048198625445366
```

```
Epoch: 14
Loss on hold-out set: 0.003763550449787688
MeanAbsoluteError value on hold-out data: 0.04637574031949043
Epoch: 15
Loss on hold-out set: 0.003228414475942325
MeanAbsoluteError value on hold-out data: 0.04416016861796379
Epoch: 16
Loss on hold-out set: 0.003300942554089584
MeanAbsoluteError value on hold-out data: 0.04609416425228119
Epoch: 17
Loss on hold-out set: 0.0029915663839538433
MeanAbsoluteError value on hold-out data: 0.04382379353046417
Epoch: 18
Loss on hold-out set: 0.004364793360429375
MeanAbsoluteError value on hold-out data: 0.05547855421900749
Epoch: 19
Loss on hold-out set: 0.0030197322691827523
MeanAbsoluteError value on hold-out data: 0.04291084408760071
Epoch: 20
Loss on hold-out set: 0.006242188520876593
MeanAbsoluteError value on hold-out data: 0.06614182889461517
Epoch: 21
Loss on hold-out set: 0.0031249271158135103
MeanAbsoluteError value on hold-out data: 0.045890238136053085
Epoch: 22

Loss on hold-out set: 0.002383819650276564
MeanAbsoluteError value on hold-out data: 0.036718398332595825
Epoch: 23
Loss on hold-out set: 0.007368490001872966
MeanAbsoluteError value on hold-out data: 0.07293467223644257
Epoch: 24
Loss on hold-out set: 0.002474429534662417
MeanAbsoluteError value on hold-out data: 0.0384453609585762
Epoch: 25
Loss on hold-out set: 0.00233922496064272
MeanAbsoluteError value on hold-out data: 0.03587688133120537
Epoch: 26
Loss on hold-out set: 0.002649626682365411
MeanAbsoluteError value on hold-out data: 0.04055721312761307
Epoch: 27
Loss on hold-out set: 0.0029444779333732043
```

```
MeanAbsoluteError value on hold-out data: 0.040571022778749466
Epoch: 28
Loss on hold-out set: 0.0027151126651963416
MeanAbsoluteError value on hold-out data: 0.040027983486652374
Epoch: 29
Loss on hold-out set: 0.003296268811314612
MeanAbsoluteError value on hold-out data: 0.043146707117557526
Epoch: 30
Loss on hold-out set: 0.0026450165575002565
MeanAbsoluteError value on hold-out data: 0.0377977192401886
Epoch: 31
Loss on hold-out set: 0.002915519615941632
MeanAbsoluteError value on hold-out data: 0.04254990071058273
Epoch: 32
Loss on hold-out set: 0.003552909791132582
MeanAbsoluteError value on hold-out data: 0.04344087094068527
Epoch: 33

Loss on hold-out set: 0.0027251867822518476
MeanAbsoluteError value on hold-out data: 0.041792478412389755
Early stopping at epoch 32
Returned to Spot: Validation loss: 0.0027251867822518476
----------------------------------------------

spotPython tuning: 0.0016853903829254896 [######----] 57.91%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.1808660095200893, 'lr_mult': 
Epoch: 1
Loss on hold-out set: 0.024029705183286416
MeanAbsoluteError value on hold-out data: 0.12339624762535095
Epoch: 2
Loss on hold-out set: 0.023868740903899857
MeanAbsoluteError value on hold-out data: 0.12267587333917618
Epoch: 3
Loss on hold-out set: 0.02791577847184319
MeanAbsoluteError value on hold-out data: 0.13806667923927307
Epoch: 4
Loss on hold-out set: 0.017102910291501565
MeanAbsoluteError value on hold-out data: 0.10441035777330399
Epoch: 5
Loss on hold-out set: 0.012389561357466798
```

```
MeanAbsoluteError value on hold-out data: 0.0863225907087326
Epoch: 6
Loss on hold-out set: 0.013455118726644861
MeanAbsoluteError value on hold-out data: 0.0947476252913475
Epoch: 7
Loss on hold-out set: 0.010515300296614632
MeanAbsoluteError value on hold-out data: 0.08141827583312988
Epoch: 8
Loss on hold-out set: 0.007820241729189692
MeanAbsoluteError value on hold-out data: 0.06997673958539963
Epoch: 9
Loss on hold-out set: 0.009287744944326971
MeanAbsoluteError value on hold-out data: 0.07952384650707245
Epoch: 10
Loss on hold-out set: 0.00648084906309745
MeanAbsoluteError value on hold-out data: 0.06285163760185242
Epoch: 11

Loss on hold-out set: 0.010445539986616686
MeanAbsoluteError value on hold-out data: 0.08570211380720139
Epoch: 12
Loss on hold-out set: 0.0054025797381703
MeanAbsoluteError value on hold-out data: 0.0551949068903923
Epoch: 13
Loss on hold-out set: 0.0051662535804912054
MeanAbsoluteError value on hold-out data: 0.05406637117266655
Epoch: 14
Loss on hold-out set: 0.0036452128521264776
MeanAbsoluteError value on hold-out data: 0.04588617756962776
Epoch: 15
Loss on hold-out set: 0.005179547088980479
MeanAbsoluteError value on hold-out data: 0.05762725695967674
Epoch: 16
Loss on hold-out set: 0.004011188918651131
MeanAbsoluteError value on hold-out data: 0.04854381084442139
Epoch: 17
Loss on hold-out set: 0.0032540880186532283
MeanAbsoluteError value on hold-out data: 0.04499105364084244
Epoch: 18
Loss on hold-out set: 0.004762174598382492
MeanAbsoluteError value on hold-out data: 0.05726063996553421
Epoch: 19
```

```
Loss on hold-out set: 0.005299229355602476
MeanAbsoluteError value on hold-out data: 0.05989643558859825
Epoch: 20
Loss on hold-out set: 0.003775022148865422
MeanAbsoluteError value on hold-out data: 0.04854064807295799
Epoch: 21
Loss on hold-out set: 0.0035190143297720504
MeanAbsoluteError value on hold-out data: 0.045903418213129044
Epoch: 22

Loss on hold-out set: 0.0024012694300740564
MeanAbsoluteError value on hold-out data: 0.037574753165245056
Epoch: 23
Loss on hold-out set: 0.002950187441647837
MeanAbsoluteError value on hold-out data: 0.0403786301612854
Epoch: 24
Loss on hold-out set: 0.0029074221261237796
MeanAbsoluteError value on hold-out data: 0.04400496557354927
Epoch: 25
Loss on hold-out set: 0.002993414248952544
MeanAbsoluteError value on hold-out data: 0.03849294036626816
Epoch: 26
Loss on hold-out set: 0.002210728280356546
MeanAbsoluteError value on hold-out data: 0.03751414269208908
Epoch: 27
Loss on hold-out set: 0.002770479748601486
MeanAbsoluteError value on hold-out data: 0.03741719201207161
Epoch: 28
Loss on hold-out set: 0.0018679687468408559
MeanAbsoluteError value on hold-out data: 0.03469102084636688
Epoch: 29
Loss on hold-out set: 0.004972074389163601
MeanAbsoluteError value on hold-out data: 0.057661864906549454
Epoch: 30
Loss on hold-out set: 0.002454368689397693
MeanAbsoluteError value on hold-out data: 0.0372399166226387
Epoch: 31
Loss on hold-out set: 0.002608576530627416
MeanAbsoluteError value on hold-out data: 0.036004867404699326
Epoch: 32
Loss on hold-out set: 0.0023455797039021397
MeanAbsoluteError value on hold-out data: 0.03455197066068649
Epoch: 33
```

```
Loss on hold-out set: 0.0020319421960984505
MeanAbsoluteError value on hold-out data: 0.0343291275203228
Epoch: 34
Loss on hold-out set: 0.0046100648898190185
MeanAbsoluteError value on hold-out data: 0.05385603755712509
Epoch: 35
Loss on hold-out set: 0.008123941370286047
MeanAbsoluteError value on hold-out data: 0.07694654166698456
Epoch: 36
Loss on hold-out set: 0.0025356166175027426
MeanAbsoluteError value on hold-out data: 0.03576841577887535
Early stopping at epoch 35
Returned to Spot: Validation loss: 0.0025356166175027426
----------------------------------------------

spotPython tuning: 0.0016853903829254896 [######----] 63.48%

config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.19510190489199442, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.025672420075065212
MeanAbsoluteError value on hold-out data: 0.12767241895198822
Epoch: 2
Loss on hold-out set: 0.015595980797355113
MeanAbsoluteError value on hold-out data: 0.10165685415267944
Epoch: 3
Loss on hold-out set: 0.01314922740819288
MeanAbsoluteError value on hold-out data: 0.0918063372373581
Epoch: 4
Loss on hold-out set: 0.009816588971788357
MeanAbsoluteError value on hold-out data: 0.0758252814412117
Epoch: 5
Loss on hold-out set: 0.007515937322750688
MeanAbsoluteError value on hold-out data: 0.07034127414226532
Epoch: 6
Loss on hold-out set: 0.007500122374805965
MeanAbsoluteError value on hold-out data: 0.06836117058992386
Epoch: 7
Loss on hold-out set: 0.005193162844271252
MeanAbsoluteError value on hold-out data: 0.05462311953306198
Epoch: 8
Loss on hold-out set: 0.006482424248181479
```

```
MeanAbsoluteError value on hold-out data: 0.0628889724612236
Epoch: 9
Loss on hold-out set: 0.007105434037695982
MeanAbsoluteError value on hold-out data: 0.06629753857851028
Epoch: 10
Loss on hold-out set: 0.006564360167095928
MeanAbsoluteError value on hold-out data: 0.063365139067173
Epoch: 11

Loss on hold-out set: 0.004283075913247701
MeanAbsoluteError value on hold-out data: 0.050057221204042435
Epoch: 12
Loss on hold-out set: 0.0037959974586939146
MeanAbsoluteError value on hold-out data: 0.045774370431900024
Epoch: 13
Loss on hold-out set: 0.004409527416818922
MeanAbsoluteError value on hold-out data: 0.04935300722718239
Epoch: 14
Loss on hold-out set: 0.004129035723101544
MeanAbsoluteError value on hold-out data: 0.05129135400056839
Epoch: 15
Loss on hold-out set: 0.0036971569949712014
MeanAbsoluteError value on hold-out data: 0.045255064964294434
Epoch: 16
Loss on hold-out set: 0.004742416367853845
MeanAbsoluteError value on hold-out data: 0.052645616233348846
Epoch: 17
Loss on hold-out set: 0.003987989780542098
MeanAbsoluteError value on hold-out data: 0.050454627722501755
Epoch: 18
Loss on hold-out set: 0.002791798552559493
MeanAbsoluteError value on hold-out data: 0.04016653820872307
Epoch: 19
Loss on hold-out set: 0.004306413429348092
MeanAbsoluteError value on hold-out data: 0.05383618175983429
Epoch: 20
Loss on hold-out set: 0.0034013472552607326
MeanAbsoluteError value on hold-out data: 0.045559827238321304
Epoch: 21
Loss on hold-out set: 0.0028825620929159128
MeanAbsoluteError value on hold-out data: 0.04004621133208275
Epoch: 22
```

```
Loss on hold-out set: 0.0030831817306247295
MeanAbsoluteError value on hold-out data: 0.039129458367824554
Epoch: 23
Loss on hold-out set: 0.0020147551319831493
MeanAbsoluteError value on hold-out data: 0.03403378278017044
Epoch: 24
Loss on hold-out set: 0.002369677823337138
MeanAbsoluteError value on hold-out data: 0.035723503679037094
Epoch: 25
Loss on hold-out set: 0.0024473769054135404
MeanAbsoluteError value on hold-out data: 0.03598228096961975
Epoch: 26
Loss on hold-out set: 0.002110403377293168
MeanAbsoluteError value on hold-out data: 0.03403189033269882
Epoch: 27
Loss on hold-out set: 0.0024769443729095847
MeanAbsoluteError value on hold-out data: 0.03871876001358032
Epoch: 28
Loss on hold-out set: 0.005556668522522638
MeanAbsoluteError value on hold-out data: 0.0603661872446537
Epoch: 29
Loss on hold-out set: 0.003019485565968544
MeanAbsoluteError value on hold-out data: 0.043687593191862106
Epoch: 30
Loss on hold-out set: 0.0034821123270759066
MeanAbsoluteError value on hold-out data: 0.04787645488977432
Epoch: 31
Loss on hold-out set: 0.0027850789789992726
MeanAbsoluteError value on hold-out data: 0.04028184339404106
Early stopping at epoch 30
Returned to Spot: Validation loss: 0.0027850789789992726
----------------------------------------------

spotPython tuning: 0.0016853903829254896 [#######---] 69.37%


config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.18304497689243543, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.025163849938268725
MeanAbsoluteError value on hold-out data: 0.12306047976016998
Epoch: 2
Loss on hold-out set: 0.023268417871900295
```

```
MeanAbsoluteError value on hold-out data: 0.12108466774225235
Epoch: 3
Loss on hold-out set: 0.017727515917565478
MeanAbsoluteError value on hold-out data: 0.10337762534618378
Epoch: 4
Loss on hold-out set: 0.015393080606468414
MeanAbsoluteError value on hold-out data: 0.09930551052093506
Epoch: 5
Loss on hold-out set: 0.010230135209368248
MeanAbsoluteError value on hold-out data: 0.07984274625778198
Epoch: 6
Loss on hold-out set: 0.015538562113713277
MeanAbsoluteError value on hold-out data: 0.10085870325565338
Epoch: 7
Loss on hold-out set: 0.00917867107292343
MeanAbsoluteError value on hold-out data: 0.07894930243492126
Epoch: 8
Loss on hold-out set: 0.0073638452204728595
MeanAbsoluteError value on hold-out data: 0.06828553974628448
Epoch: 9
Loss on hold-out set: 0.006293435663744611
MeanAbsoluteError value on hold-out data: 0.06209877133369446
Epoch: 10
Loss on hold-out set: 0.006288502487893167
MeanAbsoluteError value on hold-out data: 0.06207117810845375
Epoch: 11

Loss on hold-out set: 0.0071970388127834
MeanAbsoluteError value on hold-out data: 0.06488391011953354
Epoch: 12
Loss on hold-out set: 0.005867634918295631
MeanAbsoluteError value on hold-out data: 0.058099303394556046
Epoch: 13
Loss on hold-out set: 0.005209516660359345
MeanAbsoluteError value on hold-out data: 0.05532100796699524
Epoch: 14
Loss on hold-out set: 0.005632176407073673
MeanAbsoluteError value on hold-out data: 0.057809777557849884
Epoch: 15
Loss on hold-out set: 0.004774846982112841
MeanAbsoluteError value on hold-out data: 0.05394985154271126
Epoch: 16
```

```
Loss on hold-out set: 0.004119223976311715
MeanAbsoluteError value on hold-out data: 0.04940371215343475
Epoch: 17
Loss on hold-out set: 0.003928972437279299
MeanAbsoluteError value on hold-out data: 0.04748337343335152
Epoch: 18
Loss on hold-out set: 0.0035952976843538252
MeanAbsoluteError value on hold-out data: 0.04511364549398422
Epoch: 19
Loss on hold-out set: 0.003417411852799552
MeanAbsoluteError value on hold-out data: 0.04608588293194771
Epoch: 20
Loss on hold-out set: 0.002827914779405355
MeanAbsoluteError value on hold-out data: 0.041131842881441116
Epoch: 21
Loss on hold-out set: 0.002921246388914848
MeanAbsoluteError value on hold-out data: 0.04366178810596466
Epoch: 22

Loss on hold-out set: 0.0025749390234092347
MeanAbsoluteError value on hold-out data: 0.03743786737322807
Epoch: 23
Loss on hold-out set: 0.005759138917231834
MeanAbsoluteError value on hold-out data: 0.059224389493465424
Epoch: 24
Loss on hold-out set: 0.005103194482600023
MeanAbsoluteError value on hold-out data: 0.05619857832789421
Epoch: 25
Loss on hold-out set: 0.002337595965639737
MeanAbsoluteError value on hold-out data: 0.037119679152965546
Epoch: 26
Loss on hold-out set: 0.002218423086512638
MeanAbsoluteError value on hold-out data: 0.03547119349241257
Epoch: 27
Loss on hold-out set: 0.003163228202059767
MeanAbsoluteError value on hold-out data: 0.04400192201137543
Epoch: 28
Loss on hold-out set: 0.0030290230780864427
MeanAbsoluteError value on hold-out data: 0.0430152527987957
Epoch: 29
Loss on hold-out set: 0.002760215879932634
MeanAbsoluteError value on hold-out data: 0.04306931421160698
```

```
Epoch: 30
Loss on hold-out set: 0.004010872576863652
MeanAbsoluteError value on hold-out data: 0.04680655151605606
Epoch: 31
Loss on hold-out set: 0.0024276262870683383
MeanAbsoluteError value on hold-out data: 0.03708052635192871
Epoch: 32
Loss on hold-out set: 0.002471522122505121
MeanAbsoluteError value on hold-out data: 0.03917140141129494
Epoch: 33

Loss on hold-out set: 0.0024978713619547258
MeanAbsoluteError value on hold-out data: 0.03885315731167793
Epoch: 34
Loss on hold-out set: 0.003975405146392356
MeanAbsoluteError value on hold-out data: 0.052524302154779434
Early stopping at epoch 33
Returned to Spot: Validation loss: 0.003975405146392356
----------------------------------------------
```

```
spotPython tuning: 0.0016853903829254896 [########--] 75.55%
```

```
config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.2019472721744788, 'lr_mult': 6
Epoch: 1
Loss on hold-out set: 0.024277626659329
MeanAbsoluteError value on hold-out data: 0.12380000948905945
Epoch: 2
Loss on hold-out set: 0.016807884676381946
MeanAbsoluteError value on hold-out data: 0.1076345294713974
Epoch: 3
Loss on hold-out set: 0.013188265067966361
MeanAbsoluteError value on hold-out data: 0.0886632576584816
Epoch: 4
Loss on hold-out set: 0.011837352238791553
MeanAbsoluteError value on hold-out data: 0.08521883934736252
Epoch: 5
Loss on hold-out set: 0.012957137653996286
MeanAbsoluteError value on hold-out data: 0.09112519025802612
Epoch: 6
Loss on hold-out set: 0.010019199460083129
MeanAbsoluteError value on hold-out data: 0.07892432063817978
```

```
Epoch: 7
Loss on hold-out set: 0.007882517658321089
MeanAbsoluteError value on hold-out data: 0.06771665066480637
Epoch: 8
Loss on hold-out set: 0.006450355158640856
MeanAbsoluteError value on hold-out data: 0.061124809086322784
Epoch: 9
Loss on hold-out set: 0.0068541383523935155
MeanAbsoluteError value on hold-out data: 0.06369102746248245
Epoch: 10
Loss on hold-out set: 0.008798824126930222
MeanAbsoluteError value on hold-out data: 0.07585211843252182
Epoch: 11

Loss on hold-out set: 0.004937839970807545
MeanAbsoluteError value on hold-out data: 0.05275155231356621
Epoch: 12
Loss on hold-out set: 0.006583755293640455
MeanAbsoluteError value on hold-out data: 0.06233559176325798
Epoch: 13
Loss on hold-out set: 0.00473845535491005
MeanAbsoluteError value on hold-out data: 0.05139080435037613
Epoch: 14
Loss on hold-out set: 0.0052607826410645715
MeanAbsoluteError value on hold-out data: 0.05812942981719971
Epoch: 15
Loss on hold-out set: 0.0042245935611917
MeanAbsoluteError value on hold-out data: 0.05346834659576416
Epoch: 16
Loss on hold-out set: 0.0041801915687852
MeanAbsoluteError value on hold-out data: 0.05124242976307869
Epoch: 17
Loss on hold-out set: 0.002578277424235191
MeanAbsoluteError value on hold-out data: 0.04064444825053215
Epoch: 18
Loss on hold-out set: 0.005869881127421793
MeanAbsoluteError value on hold-out data: 0.059611473232507706
Epoch: 19
Loss on hold-out set: 0.0035804884422472433
MeanAbsoluteError value on hold-out data: 0.04397158324718475
Epoch: 20
Loss on hold-out set: 0.003613499828038345
```

```
MeanAbsoluteError value on hold-out data: 0.04716076701879501
Epoch: 21
Loss on hold-out set: 0.003509663751557175
MeanAbsoluteError value on hold-out data: 0.044246770441532135
Epoch: 22

Loss on hold-out set: 0.00329769823369325
MeanAbsoluteError value on hold-out data: 0.04330923408269882
Epoch: 23
Loss on hold-out set: 0.004223825112843004
MeanAbsoluteError value on hold-out data: 0.05010741949081421
Epoch: 24
Loss on hold-out set: 0.002565429014411118
MeanAbsoluteError value on hold-out data: 0.03809977322816849
Epoch: 25
Loss on hold-out set: 0.002425454412954614
MeanAbsoluteError value on hold-out data: 0.03730204328894615
Epoch: 26
Loss on hold-out set: 0.0028623526986369767
MeanAbsoluteError value on hold-out data: 0.040968477725982666
Epoch: 27
Loss on hold-out set: 0.0029819970567539138
MeanAbsoluteError value on hold-out data: 0.04402847960591316
Epoch: 28
Loss on hold-out set: 0.0024773078161830966
MeanAbsoluteError value on hold-out data: 0.04001104086637497
Epoch: 29
Loss on hold-out set: 0.0026239777951942464
MeanAbsoluteError value on hold-out data: 0.038519974797964096
Epoch: 30
Loss on hold-out set: 0.003696557492826526
MeanAbsoluteError value on hold-out data: 0.04631515592336655
Epoch: 31
Loss on hold-out set: 0.005622864921430224
MeanAbsoluteError value on hold-out data: 0.06252557784318924
Epoch: 32
Loss on hold-out set: 0.002492114270449077
MeanAbsoluteError value on hold-out data: 0.03966102749109268
Epoch: 33

Loss on hold-out set: 0.00207794350525977
MeanAbsoluteError value on hold-out data: 0.03356443718075752
```

```
Epoch: 34
Loss on hold-out set: 0.00201273532155411
MeanAbsoluteError value on hold-out data: 0.03411753475666046
Epoch: 35
Loss on hold-out set: 0.00216794693628081
MeanAbsoluteError value on hold-out data: 0.03502804785966873
Epoch: 36
Loss on hold-out set: 0.0023542080414604
MeanAbsoluteError value on hold-out data: 0.03871183097362518
Epoch: 37
Loss on hold-out set: 0.002022577119580666
MeanAbsoluteError value on hold-out data: 0.03291765972971916
Epoch: 38
Loss on hold-out set: 0.002325389103804666
MeanAbsoluteError value on hold-out data: 0.03979581966996193
Epoch: 39
Loss on hold-out set: 0.001821498780229472
MeanAbsoluteError value on hold-out data: 0.033105429261922836
Epoch: 40
Loss on hold-out set: 0.006522469320579579
MeanAbsoluteError value on hold-out data: 0.06908981502056122
Epoch: 41
Loss on hold-out set: 0.002241385029935229
MeanAbsoluteError value on hold-out data: 0.0380752794444561
Epoch: 42
Loss on hold-out set: 0.002898531840305383
MeanAbsoluteError value on hold-out data: 0.040456824004650116
Epoch: 43
Loss on hold-out set: 0.00322434029658325
MeanAbsoluteError value on hold-out data: 0.04302561283111572
Epoch: 44

Loss on hold-out set: 0.002580966587533782
MeanAbsoluteError value on hold-out data: 0.04045713692903519
Epoch: 45
Loss on hold-out set: 0.002295702070880093
MeanAbsoluteError value on hold-out data: 0.03938649222254753
Epoch: 46
Loss on hold-out set: 0.002270681965072935
MeanAbsoluteError value on hold-out data: 0.036960210651159286
Epoch: 47
Loss on hold-out set: 0.004836709094601438
```

```
MeanAbsoluteError value on hold-out data: 0.05409213528037071
Epoch: 48
Loss on hold-out set: 0.003056200731263839
MeanAbsoluteError value on hold-out data: 0.042787887156009674
Epoch: 49
Loss on hold-out set: 0.002996770306612904
MeanAbsoluteError value on hold-out data: 0.04038219898939133
Epoch: 50
Loss on hold-out set: 0.002172582551889048
MeanAbsoluteError value on hold-out data: 0.03575451299548149
Epoch: 51
Loss on hold-out set: 0.0019823642827472405
MeanAbsoluteError value on hold-out data: 0.030780212953686714
Epoch: 52
Loss on hold-out set: 0.00366410992788396
MeanAbsoluteError value on hold-out data: 0.044123031198978424
Epoch: 53
Loss on hold-out set: 0.0015515198572661336
MeanAbsoluteError value on hold-out data: 0.02924351952970028
Epoch: 54
Loss on hold-out set: 0.0015856229078245203
MeanAbsoluteError value on hold-out data: 0.029927918687462807
Epoch: 55

Loss on hold-out set: 0.0032115707198452008
MeanAbsoluteError value on hold-out data: 0.047924529761075974
Epoch: 56
Loss on hold-out set: 0.0019136957968217566
MeanAbsoluteError value on hold-out data: 0.03450019657611847
Epoch: 57
Loss on hold-out set: 0.0032072983663774244
MeanAbsoluteError value on hold-out data: 0.04748791456222534
Epoch: 58
Loss on hold-out set: 0.0019502487304730732
MeanAbsoluteError value on hold-out data: 0.0328410267829895
Epoch: 59
Loss on hold-out set: 0.0021548171797277113
MeanAbsoluteError value on hold-out data: 0.03732668608427048
Epoch: 60
Loss on hold-out set: 0.005214087334216425
MeanAbsoluteError value on hold-out data: 0.06113283708691597
Epoch: 61
```

```
Loss on hold-out set: 0.0040771294152364135
MeanAbsoluteError value on hold-out data: 0.05394865199923515
Epoch: 62
Loss on hold-out set: 0.0034358811374802733
MeanAbsoluteError value on hold-out data: 0.04719262942671776
Epoch: 63
Loss on hold-out set: 0.0030987052688081014
MeanAbsoluteError value on hold-out data: 0.04640195146203041
Epoch: 64
Loss on hold-out set: 0.0018410417450420362
MeanAbsoluteError value on hold-out data: 0.03207452595233917
Epoch: 65
Loss on hold-out set: 0.0034704639355799087
MeanAbsoluteError value on hold-out data: 0.04910876974463463
Epoch: 66
```

```
Loss on hold-out set: 0.001944625515821635
MeanAbsoluteError value on hold-out data: 0.032184846699237823
Epoch: 67
Loss on hold-out set: 0.0027471146236884556
MeanAbsoluteError value on hold-out data: 0.03752489760518074
Epoch: 68
Loss on hold-out set: 0.0016702978295813267
MeanAbsoluteError value on hold-out data: 0.029994118958711624
Epoch: 69
Loss on hold-out set: 0.004414556805338515
MeanAbsoluteError value on hold-out data: 0.056894443929195404
Epoch: 70
Loss on hold-out set: 0.003238050628600544
MeanAbsoluteError value on hold-out data: 0.04637539014220238
Epoch: 71
Loss on hold-out set: 0.0020371134451124817
MeanAbsoluteError value on hold-out data: 0.03516005352139473
Epoch: 72
Loss on hold-out set: 0.0035387616524913987
MeanAbsoluteError value on hold-out data: 0.0496743768453598
Epoch: 73
Loss on hold-out set: 0.002002212368288862
MeanAbsoluteError value on hold-out data: 0.03358997777104378
Epoch: 74
Loss on hold-out set: 0.002552378330667699
MeanAbsoluteError value on hold-out data: 0.03449597209692001
```

```
Epoch: 75
Loss on hold-out set: 0.0014156469214389002
MeanAbsoluteError value on hold-out data: 0.028027022257447243
Epoch: 76
Loss on hold-out set: 0.0024554619142834687
MeanAbsoluteError value on hold-out data: 0.03699516877532005
Epoch: 77

Loss on hold-out set: 0.002138910780654681
MeanAbsoluteError value on hold-out data: 0.03596213459968567
Epoch: 78
Loss on hold-out set: 0.0019876474183739014
MeanAbsoluteError value on hold-out data: 0.035099875181913376
Epoch: 79
Loss on hold-out set: 0.0020500169224473403
MeanAbsoluteError value on hold-out data: 0.03602387383580208
Epoch: 80
Loss on hold-out set: 0.0018674818121852648
MeanAbsoluteError value on hold-out data: 0.03255654498934746
Epoch: 81
Loss on hold-out set: 0.002563875907646051
MeanAbsoluteError value on hold-out data: 0.03668183088302612
Epoch: 82
Loss on hold-out set: 0.002213715664478705
MeanAbsoluteError value on hold-out data: 0.04028526693582535
Epoch: 83
Loss on hold-out set: 0.00434157328900734
MeanAbsoluteError value on hold-out data: 0.049693599343299866
Epoch: 84
Loss on hold-out set: 0.0017708628802211024
MeanAbsoluteError value on hold-out data: 0.029979269951581955
Epoch: 85
Loss on hold-out set: 0.00262040534902266
MeanAbsoluteError value on hold-out data: 0.037661146372556686
Epoch: 86
Loss on hold-out set: 0.0024989301225440087
MeanAbsoluteError value on hold-out data: 0.03929448872804642
Epoch: 87
Loss on hold-out set: 0.0019740003657429234
MeanAbsoluteError value on hold-out data: 0.03554845228791237
Epoch: 88

Loss on hold-out set: 0.0015791246328980808
```

```
MeanAbsoluteError value on hold-out data: 0.030872926115989685
Epoch: 89
Loss on hold-out set: 0.0015114518043303274
MeanAbsoluteError value on hold-out data: 0.02885598875582218
Epoch: 90
Loss on hold-out set: 0.0018456124277068547
MeanAbsoluteError value on hold-out data: 0.03158138692378998
Epoch: 91
Loss on hold-out set: 0.0045631289739455835
MeanAbsoluteError value on hold-out data: 0.05475418642163277
Epoch: 92
Loss on hold-out set: 0.0018271828437144378
MeanAbsoluteError value on hold-out data: 0.0319363959133625
Epoch: 93
Loss on hold-out set: 0.0013898200145616244
MeanAbsoluteError value on hold-out data: 0.028686311095952988
Epoch: 94
Loss on hold-out set: 0.0025216054499124815
MeanAbsoluteError value on hold-out data: 0.04020077735185623
Epoch: 95
Loss on hold-out set: 0.003578577319307155
MeanAbsoluteError value on hold-out data: 0.051647283136844635
Epoch: 96
Loss on hold-out set: 0.0028425457559550474
MeanAbsoluteError value on hold-out data: 0.03715616464614868
Epoch: 97
Loss on hold-out set: 0.0013902291964194248
MeanAbsoluteError value on hold-out data: 0.02852041646838188
Epoch: 98
Loss on hold-out set: 0.001462785600635566
MeanAbsoluteError value on hold-out data: 0.029078500345349312
Epoch: 99

Loss on hold-out set: 0.0016645965393093463
MeanAbsoluteError value on hold-out data: 0.031783007085323334
Epoch: 100
Loss on hold-out set: 0.003371279904202215
MeanAbsoluteError value on hold-out data: 0.045630354434251785
Epoch: 101
Loss on hold-out set: 0.002622942931147439
MeanAbsoluteError value on hold-out data: 0.039085157215595245
Epoch: 102
```

```
Loss on hold-out set: 0.002691954938008597
MeanAbsoluteError value on hold-out data: 0.04084929823875427
Epoch: 103
Loss on hold-out set: 0.0015206104021911557
MeanAbsoluteError value on hold-out data: 0.028450138866901398
Epoch: 104
Loss on hold-out set: 0.0038416756096443065
MeanAbsoluteError value on hold-out data: 0.05113814398646355
Epoch: 105
Loss on hold-out set: 0.0030176458255338824
MeanAbsoluteError value on hold-out data: 0.04147406294941902
Epoch: 106
Loss on hold-out set: 0.0029059456551055376
MeanAbsoluteError value on hold-out data: 0.04288352653384209
Epoch: 107
Loss on hold-out set: 0.0022032667766325176
MeanAbsoluteError value on hold-out data: 0.03506488353013992
Epoch: 108
Loss on hold-out set: 0.001815096469822732
MeanAbsoluteError value on hold-out data: 0.03256797417998314
Epoch: 109
Loss on hold-out set: 0.0017822498103717073
MeanAbsoluteError value on hold-out data: 0.03227999061346054
Epoch: 110

Loss on hold-out set: 0.0024664167170780466
MeanAbsoluteError value on hold-out data: 0.04006955772638321
Epoch: 111
Loss on hold-out set: 0.0024026673161547238
MeanAbsoluteError value on hold-out data: 0.03586035966873169
Epoch: 112
Loss on hold-out set: 0.0018868976606570772
MeanAbsoluteError value on hold-out data: 0.033988285809755325
Epoch: 113
Loss on hold-out set: 0.0020821305017881585
MeanAbsoluteError value on hold-out data: 0.03551759570837021
Epoch: 114
Loss on hold-out set: 0.0021564422112485197
MeanAbsoluteError value on hold-out data: 0.034579768776893616
Epoch: 115
Loss on hold-out set: 0.00139225087523779
MeanAbsoluteError value on hold-out data: 0.027105335146188736
```

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Epoch: 116
Loss on hold-out set: 0.001500592331706828
MeanAbsoluteError value on hold-out data: 0.0295132827013731
Epoch: 117
Loss on hold-out set: 0.0014234227005784448
MeanAbsoluteError value on hold-out data: 0.028940947726368904
Epoch: 118
Loss on hold-out set: 0.0017676680102962756
MeanAbsoluteError value on hold-out data: 0.0313718356192112
Epoch: 119
Loss on hold-out set: 0.0015562283377604264
MeanAbsoluteError value on hold-out data: 0.03078128583729267
Epoch: 120
Loss on hold-out set: 0.0018756553058904644
MeanAbsoluteError value on hold-out data: 0.03107025846838951
Epoch: 121


Loss on hold-out set: 0.0019879226517667504
MeanAbsoluteError value on hold-out data: 0.0329940989613533
Epoch: 122
Loss on hold-out set: 0.002862361036118512
MeanAbsoluteError value on hold-out data: 0.044347211718559265
Epoch: 123
Loss on hold-out set: 0.0038373503484763205
MeanAbsoluteError value on hold-out data: 0.05225648730993271
Epoch: 124
Loss on hold-out set: 0.0015878918884003437
MeanAbsoluteError value on hold-out data: 0.031499214470386505
Epoch: 125
Loss on hold-out set: 0.0019896273312808356
MeanAbsoluteError value on hold-out data: 0.03514355793595314
Epoch: 126
Loss on hold-out set: 0.0025388566182779244
MeanAbsoluteError value on hold-out data: 0.03835536167025566
Epoch: 127
Loss on hold-out set: 0.0012474536595522966
MeanAbsoluteError value on hold-out data: 0.027602287009358406
Epoch: 128
Loss on hold-out set: 0.001474243321832833
MeanAbsoluteError value on hold-out data: 0.030731715261936188
Epoch: 129
Loss on hold-out set: 0.0020172661338859286
```

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MeanAbsoluteError value on hold-out data: 0.03687634319067001
Epoch: 130
Loss on hold-out set: 0.002236250743551768
MeanAbsoluteError value on hold-out data: 0.03534913435578346
Epoch: 131
Loss on hold-out set: 0.001674692100526667
MeanAbsoluteError value on hold-out data: 0.030573952943086624
Epoch: 132

Loss on hold-out set: 0.003565133484938231
MeanAbsoluteError value on hold-out data: 0.047639187425374985
Epoch: 133
Loss on hold-out set: 0.0026363444079546944
MeanAbsoluteError value on hold-out data: 0.04065388813614845
Epoch: 134
Loss on hold-out set: 0.0019499435017534875
MeanAbsoluteError value on hold-out data: 0.03358440101146698
Epoch: 135
Loss on hold-out set: 0.002154304056985941
MeanAbsoluteError value on hold-out data: 0.033829037100076675
Epoch: 136
Loss on hold-out set: 0.0019820529912402364
MeanAbsoluteError value on hold-out data: 0.0342726930975914
Epoch: 137
Loss on hold-out set: 0.0021117130925535762
MeanAbsoluteError value on hold-out data: 0.03684117645025253
Epoch: 138
Loss on hold-out set: 0.002567432557330712
MeanAbsoluteError value on hold-out data: 0.03956106677651405
Epoch: 139
Loss on hold-out set: 0.0018035317388191622
MeanAbsoluteError value on hold-out data: 0.029720719903707504
Epoch: 140
Loss on hold-out set: 0.001767824878793602
MeanAbsoluteError value on hold-out data: 0.032225627452135086
Epoch: 141
Loss on hold-out set: 0.0026467712396927375
MeanAbsoluteError value on hold-out data: 0.04010050743818283
Epoch: 142
Loss on hold-out set: 0.0019143954590330587
MeanAbsoluteError value on hold-out data: 0.03253183886408806
Epoch: 143
```

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Loss on hold-out set: 0.00166063927999379
MeanAbsoluteError value on hold-out data: 0.032727114856243134
Epoch: 144
Loss on hold-out set: 0.003085940618276302
MeanAbsoluteError value on hold-out data: 0.0447859950363636
Epoch: 145
Loss on hold-out set: 0.0018956905765471195
MeanAbsoluteError value on hold-out data: 0.03245062008500099
Epoch: 146
Loss on hold-out set: 0.0028713082137983292
MeanAbsoluteError value on hold-out data: 0.044515904039144516
Epoch: 147
Loss on hold-out set: 0.002061616620171423
MeanAbsoluteError value on hold-out data: 0.03620949387550354
Epoch: 148
Loss on hold-out set: 0.0014017293257271185
MeanAbsoluteError value on hold-out data: 0.028536997735500336
Epoch: 149
Loss on hold-out set: 0.0022181120002642274
MeanAbsoluteError value on hold-out data: 0.03557959198951721
Epoch: 150
Loss on hold-out set: 0.0022799394405171227
MeanAbsoluteError value on hold-out data: 0.034402795135974884
Epoch: 151
Loss on hold-out set: 0.0013134380630952748
MeanAbsoluteError value on hold-out data: 0.02712591551244259
Epoch: 152
Loss on hold-out set: 0.002090136349771025
MeanAbsoluteError value on hold-out data: 0.03395823389291763
Epoch: 153
Loss on hold-out set: 0.0017007422942888777
MeanAbsoluteError value on hold-out data: 0.03286779299378395
Epoch: 154

Loss on hold-out set: 0.0020042449889986435
MeanAbsoluteError value on hold-out data: 0.03396442160010338
Epoch: 155
Loss on hold-out set: 0.002178808049249806
MeanAbsoluteError value on hold-out data: 0.036168649792671204
Epoch: 156
Loss on hold-out set: 0.0011972689972026274
MeanAbsoluteError value on hold-out data: 0.027087170630693436
```

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Epoch: 157
Loss on hold-out set: 0.0020594914431536666
MeanAbsoluteError value on hold-out data: 0.03431353718042374
Epoch: 158
Loss on hold-out set: 0.0018176654542146839
MeanAbsoluteError value on hold-out data: 0.029812803491950035
Epoch: 159
Loss on hold-out set: 0.001714509799249323
MeanAbsoluteError value on hold-out data: 0.031394459307193756
Epoch: 160
Loss on hold-out set: 0.0028446447548431983
MeanAbsoluteError value on hold-out data: 0.04074225574731827
Epoch: 161
Loss on hold-out set: 0.0013229028458896976
MeanAbsoluteError value on hold-out data: 0.027656253427267075
Epoch: 162
Loss on hold-out set: 0.004217464697400206
MeanAbsoluteError value on hold-out data: 0.05120394751429558
Epoch: 163
Loss on hold-out set: 0.002769827980572652
MeanAbsoluteError value on hold-out data: 0.04107687622308731
Epoch: 164
Loss on hold-out set: 0.001701751600577202
MeanAbsoluteError value on hold-out data: 0.02792808786034584
Epoch: 165

Loss on hold-out set: 0.0047823248345306825
MeanAbsoluteError value on hold-out data: 0.05374099686741829
Epoch: 166
Loss on hold-out set: 0.0020393503188020795
MeanAbsoluteError value on hold-out data: 0.03599965199828148
Epoch: 167
Loss on hold-out set: 0.003135909563800516
MeanAbsoluteError value on hold-out data: 0.04136190563440323
Epoch: 168
Loss on hold-out set: 0.0016327883583328099
MeanAbsoluteError value on hold-out data: 0.02853989228606224
Epoch: 169
Loss on hold-out set: 0.002275512539965444
MeanAbsoluteError value on hold-out data: 0.03604152053594589
Epoch: 170
Loss on hold-out set: 0.0019040160987060517
```

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MeanAbsoluteError value on hold-out data: 0.032629210501909256
Epoch: 171
Loss on hold-out set: 0.003843065029573872
MeanAbsoluteError value on hold-out data: 0.05038885399699211
Epoch: 172
Loss on hold-out set: 0.001594237941102811
MeanAbsoluteError value on hold-out data: 0.02800147607922554
Epoch: 173
Loss on hold-out set: 0.00214619065120228
MeanAbsoluteError value on hold-out data: 0.03625348582863808
Epoch: 174
Loss on hold-out set: 0.0018458657662114618
MeanAbsoluteError value on hold-out data: 0.03287940472364426
Epoch: 175
Loss on hold-out set: 0.0027780403585271223
MeanAbsoluteError value on hold-out data: 0.044088318943977356
Epoch: 176

Loss on hold-out set: 0.001203933169323902
MeanAbsoluteError value on hold-out data: 0.026435941457748413
Epoch: 177
Loss on hold-out set: 0.0017446337488332862
MeanAbsoluteError value on hold-out data: 0.03184560686349869
Epoch: 178
Loss on hold-out set: 0.001771895113051869
MeanAbsoluteError value on hold-out data: 0.030682189390063286
Epoch: 179
Loss on hold-out set: 0.0018472171589229746
MeanAbsoluteError value on hold-out data: 0.0314636155962944
Epoch: 180
Loss on hold-out set: 0.0016963442905858085
MeanAbsoluteError value on hold-out data: 0.030402135103940964
Epoch: 181
Loss on hold-out set: 0.003811295796798444
MeanAbsoluteError value on hold-out data: 0.04844410717487335
Epoch: 182
Loss on hold-out set: 0.0025052877179788133
MeanAbsoluteError value on hold-out data: 0.042104996740818024
Epoch: 183
Loss on hold-out set: 0.0021985657658660784
MeanAbsoluteError value on hold-out data: 0.0328679159283638
Epoch: 184
```

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Loss on hold-out set: 0.0032301377152754484
MeanAbsoluteError value on hold-out data: 0.04420734941959381
Epoch: 185
Loss on hold-out set: 0.0019398127172424115
MeanAbsoluteError value on hold-out data: 0.03265263885259628
Epoch: 186
Loss on hold-out set: 0.0024159571598590304
MeanAbsoluteError value on hold-out data: 0.03819586709141731
Epoch: 187

Loss on hold-out set: 0.0023322703169756814
MeanAbsoluteError value on hold-out data: 0.03724755346775055
Epoch: 188
Loss on hold-out set: 0.0017205710158266715
MeanAbsoluteError value on hold-out data: 0.030538301914930344
Epoch: 189
Loss on hold-out set: 0.002737394409977194
MeanAbsoluteError value on hold-out data: 0.04005210101604462
Epoch: 190
Loss on hold-out set: 0.002221671120327971
MeanAbsoluteError value on hold-out data: 0.03454175963997841
Epoch: 191
Loss on hold-out set: 0.0018067805503960699
MeanAbsoluteError value on hold-out data: 0.03175486624240875
Epoch: 192
Loss on hold-out set: 0.0017482088970657635
MeanAbsoluteError value on hold-out data: 0.032128460705280304
Epoch: 193
Loss on hold-out set: 0.001997113616150608
MeanAbsoluteError value on hold-out data: 0.03217174857854843
Epoch: 194
Loss on hold-out set: 0.00239303123549019
MeanAbsoluteError value on hold-out data: 0.04028845578432083
Epoch: 195
Loss on hold-out set: 0.0019351748663834051
MeanAbsoluteError value on hold-out data: 0.03193080425262451
Epoch: 196
Loss on hold-out set: 0.0017396698048718175
MeanAbsoluteError value on hold-out data: 0.028652191162109375
Epoch: 197
Loss on hold-out set: 0.0016215526212411198
MeanAbsoluteError value on hold-out data: 0.029611870646476746
Epoch: 198
```

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Loss on hold-out set: 0.0016715639595579553
MeanAbsoluteError value on hold-out data: 0.030017025768756866
Epoch: 199
Loss on hold-out set: 0.00248452897128453
MeanAbsoluteError value on hold-out data: 0.038982849568128586
Epoch: 200
Loss on hold-out set: 0.0016303018599405493
MeanAbsoluteError value on hold-out data: 0.031975824385881424
Epoch: 201
Loss on hold-out set: 0.001658595616678021
MeanAbsoluteError value on hold-out data: 0.02787145972251892
Epoch: 202
Loss on hold-out set: 0.0019110725805053096
MeanAbsoluteError value on hold-out data: 0.031193742528557777
Epoch: 203
Loss on hold-out set: 0.002082812053758014
MeanAbsoluteError value on hold-out data: 0.03670073300600052
Epoch: 204
Loss on hold-out set: 0.0016938425772088138
MeanAbsoluteError value on hold-out data: 0.030803576111793518
Epoch: 205
Loss on hold-out set: 0.0019461828384297213
MeanAbsoluteError value on hold-out data: 0.03366300091147423
Epoch: 206
Loss on hold-out set: 0.0030738180993418944
MeanAbsoluteError value on hold-out data: 0.04311329498887062
Epoch: 207
Loss on hold-out set: 0.00406249264855624
MeanAbsoluteError value on hold-out data: 0.05453380569815636
Epoch: 208
Loss on hold-out set: 0.0015513357560082927
MeanAbsoluteError value on hold-out data: 0.02868403121829033
Epoch: 209

Loss on hold-out set: 0.00258901107238336
MeanAbsoluteError value on hold-out data: 0.03555098548531532
Epoch: 210
Loss on hold-out set: 0.0017520711660740506
MeanAbsoluteError value on hold-out data: 0.03129054605960846
Epoch: 211
Loss on hold-out set: 0.0022830291418358684
MeanAbsoluteError value on hold-out data: 0.03853651508688927
```

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Epoch: 212
Loss on hold-out set: 0.0026156416003543293
MeanAbsoluteError value on hold-out data: 0.04067012295126915
Epoch: 213
Loss on hold-out set: 0.0023422827990112922
MeanAbsoluteError value on hold-out data: 0.034452736377716064
Epoch: 214
Loss on hold-out set: 0.0013207684027484472
MeanAbsoluteError value on hold-out data: 0.028404079377651215
Epoch: 215
Loss on hold-out set: 0.0014227901150374428
MeanAbsoluteError value on hold-out data: 0.027796844020485878
Epoch: 216
Loss on hold-out set: 0.001620835803853544
MeanAbsoluteError value on hold-out data: 0.03060702607035637
Epoch: 217
Loss on hold-out set: 0.0012513102741841546
MeanAbsoluteError value on hold-out data: 0.025616340339183807
Epoch: 218
Loss on hold-out set: 0.001901144379716195
MeanAbsoluteError value on hold-out data: 0.030147165060043335
Epoch: 219
Loss on hold-out set: 0.002317564716672917
MeanAbsoluteError value on hold-out data: 0.03672987222671509
Epoch: 220
```

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Loss on hold-out set: 0.0016897442393727896
MeanAbsoluteError value on hold-out data: 0.031202148646116257
Epoch: 221
Loss on hold-out set: 0.0019413776482044916
MeanAbsoluteError value on hold-out data: 0.03066747635602951
Epoch: 222
Loss on hold-out set: 0.002009867650677303
MeanAbsoluteError value on hold-out data: 0.03262306749820709
Epoch: 223
Loss on hold-out set: 0.0015304287494233761
MeanAbsoluteError value on hold-out data: 0.029685286805033684
Epoch: 224
Loss on hold-out set: 0.003378515960464842
MeanAbsoluteError value on hold-out data: 0.04581848904490471
Epoch: 225
Loss on hold-out set: 0.0016230391729071638
```

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MeanAbsoluteError value on hold-out data: 0.029848216101527214
Epoch: 226
Loss on hold-out set: 0.002340788165671065
MeanAbsoluteError value on hold-out data: 0.0419590137898922
Epoch: 227
Loss on hold-out set: 0.001966158306458965
MeanAbsoluteError value on hold-out data: 0.03317340835928917
Epoch: 228
Loss on hold-out set: 0.001634494579201074
MeanAbsoluteError value on hold-out data: 0.030261261388659477
Epoch: 229
Loss on hold-out set: 0.002070277361015446
MeanAbsoluteError value on hold-out data: 0.03370463475584984
Epoch: 230
Loss on hold-out set: 0.001960957243634192
MeanAbsoluteError value on hold-out data: 0.033124569803476334
Epoch: 231

Loss on hold-out set: 0.001392169170063234
MeanAbsoluteError value on hold-out data: 0.02719675935804844
Epoch: 232
Loss on hold-out set: 0.002453634662455634
MeanAbsoluteError value on hold-out data: 0.041532035917043686
Epoch: 233
Loss on hold-out set: 0.0024077190479913136
MeanAbsoluteError value on hold-out data: 0.0382506400346756
Epoch: 234
Loss on hold-out set: 0.002251279376459455
MeanAbsoluteError value on hold-out data: 0.038914620876312256
Epoch: 235
Loss on hold-out set: 0.0020263727691551474
MeanAbsoluteError value on hold-out data: 0.03175145760178566
Epoch: 236
Loss on hold-out set: 0.0018023820494387397
MeanAbsoluteError value on hold-out data: 0.03137403354048729
Epoch: 237
Loss on hold-out set: 0.001897840113853913
MeanAbsoluteError value on hold-out data: 0.030139027163386345
Epoch: 238
Loss on hold-out set: 0.001930619548626342
MeanAbsoluteError value on hold-out data: 0.03337887302041054
Epoch: 239
```

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Loss on hold-out set: 0.0025117848356450466
MeanAbsoluteError value on hold-out data: 0.035512544214725494
Epoch: 240
Loss on hold-out set: 0.001963107508536747
MeanAbsoluteError value on hold-out data: 0.03228344768285751
Epoch: 241
Loss on hold-out set: 0.002489973581089687
MeanAbsoluteError value on hold-out data: 0.041293784976005554
Epoch: 242

Loss on hold-out set: 0.0019262485193872923
MeanAbsoluteError value on hold-out data: 0.03520742431282997
Epoch: 243
Loss on hold-out set: 0.002209276881522352
MeanAbsoluteError value on hold-out data: 0.036413248628377914
Epoch: 244
Loss on hold-out set: 0.0027627687201234757
MeanAbsoluteError value on hold-out data: 0.039195939898490906
Epoch: 245
Loss on hold-out set: 0.0015857861335940757
MeanAbsoluteError value on hold-out data: 0.029417145997285843
Epoch: 246
Loss on hold-out set: 0.002330741748569141
MeanAbsoluteError value on hold-out data: 0.038591351360082626
Epoch: 247
Loss on hold-out set: 0.002639906286372264
MeanAbsoluteError value on hold-out data: 0.03743816912174225
Epoch: 248
Loss on hold-out set: 0.0022329953943354716
MeanAbsoluteError value on hold-out data: 0.03717530146241188
Epoch: 249
Loss on hold-out set: 0.0014614050876269559
MeanAbsoluteError value on hold-out data: 0.03006836213171482
Epoch: 250
Loss on hold-out set: 0.0015745517348956415
MeanAbsoluteError value on hold-out data: 0.02998645417392254
Epoch: 251
Loss on hold-out set: 0.002627486597415746
MeanAbsoluteError value on hold-out data: 0.03831386938691139
Epoch: 252
Loss on hold-out set: 0.0022350174710338345
MeanAbsoluteError value on hold-out data: 0.03485799580812454
Epoch: 253
```

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Loss on hold-out set: 0.002064487118715126
MeanAbsoluteError value on hold-out data: 0.03278149664402008
Epoch: 254
Loss on hold-out set: 0.001761655194537812
MeanAbsoluteError value on hold-out data: 0.03290019929409027
Epoch: 255
Loss on hold-out set: 0.00265225527599748
MeanAbsoluteError value on hold-out data: 0.04197436571121216
Epoch: 256
Loss on hold-out set: 0.001886082434410989
MeanAbsoluteError value on hold-out data: 0.029449326917529106
Epoch: 257
Loss on hold-out set: 0.0016290224168762123
MeanAbsoluteError value on hold-out data: 0.030555903911590576
Epoch: 258
Loss on hold-out set: 0.0018608881165212217
MeanAbsoluteError value on hold-out data: 0.03299170359969139
Epoch: 259
Loss on hold-out set: 0.0036463659887790286
MeanAbsoluteError value on hold-out data: 0.04738279804587364
Epoch: 260
Loss on hold-out set: 0.0015239875677874998
MeanAbsoluteError value on hold-out data: 0.027831420302391052
Epoch: 261
Loss on hold-out set: 0.0021925607752085567
MeanAbsoluteError value on hold-out data: 0.034182094037532806
Epoch: 262
Loss on hold-out set: 0.0016751566313599284
MeanAbsoluteError value on hold-out data: 0.02999589964747429
Epoch: 263
Loss on hold-out set: 0.0018463008240551541
MeanAbsoluteError value on hold-out data: 0.032842669636011124
Epoch: 264

Loss on hold-out set: 0.0026418324942872125
MeanAbsoluteError value on hold-out data: 0.03660242259502411
Epoch: 265
Loss on hold-out set: 0.0023241153287113106
MeanAbsoluteError value on hold-out data: 0.03702576458454132
Epoch: 266
Loss on hold-out set: 0.002523888357437069
MeanAbsoluteError value on hold-out data: 0.03978477790951729
```

```
Epoch: 267
Loss on hold-out set: 0.0020290137985476144
MeanAbsoluteError value on hold-out data: 0.03460453450679779
Epoch: 268
Loss on hold-out set: 0.0035466556743669665
MeanAbsoluteError value on hold-out data: 0.04146132245659828
Epoch: 269
Loss on hold-out set: 0.0016732481208715686
MeanAbsoluteError value on hold-out data: 0.02921329252421856
Epoch: 270
Loss on hold-out set: 0.0028817283692708436
MeanAbsoluteError value on hold-out data: 0.044874634593725204
Epoch: 271
Loss on hold-out set: 0.0019357483006866747
MeanAbsoluteError value on hold-out data: 0.03148495778441429
Epoch: 272
Loss on hold-out set: 0.002097489468724234
MeanAbsoluteError value on hold-out data: 0.031649935990571976
Epoch: 273
Loss on hold-out set: 0.002331408362615069
MeanAbsoluteError value on hold-out data: 0.036538802087306976
Epoch: 274
Loss on hold-out set: 0.001580968413403944
MeanAbsoluteError value on hold-out data: 0.029040753841400146
Epoch: 275

Loss on hold-out set: 0.0019725597215399736
MeanAbsoluteError value on hold-out data: 0.03263242170214653
Epoch: 276
Loss on hold-out set: 0.0019717452922027165
MeanAbsoluteError value on hold-out data: 0.030340157449245453
Epoch: 277
Loss on hold-out set: 0.0013335803596419282
MeanAbsoluteError value on hold-out data: 0.027087900787591934
Epoch: 278
Loss on hold-out set: 0.0025067326235952542
MeanAbsoluteError value on hold-out data: 0.03898606821894646
Epoch: 279
Loss on hold-out set: 0.002675097944263957
MeanAbsoluteError value on hold-out data: 0.040226228535175323
Epoch: 280
Loss on hold-out set: 0.002806117353764804
```

```
MeanAbsoluteError value on hold-out data: 0.0427849106490612
Epoch: 281
Loss on hold-out set: 0.0022349741400256263
MeanAbsoluteError value on hold-out data: 0.03300477936863899
Epoch: 282
Loss on hold-out set: 0.0019806737247180487
MeanAbsoluteError value on hold-out data: 0.03331640735268593
Epoch: 283
Loss on hold-out set: 0.0018155556815480324
MeanAbsoluteError value on hold-out data: 0.035295940935611725
Epoch: 284
Loss on hold-out set: 0.0016644078201160913
MeanAbsoluteError value on hold-out data: 0.02870512381196022
Early stopping at epoch 283
Returned to Spot: Validation loss: 0.0016644078201160913
----------------------------------------------

spotPython tuning: 0.0016644078201160913 [#########-] 89.21%

config: {'_L_in': 10, '_L_out': 1, 'l1': 64, 'dropout_prob': 0.20599653012779642, 'lr_mult':
Epoch: 1
Loss on hold-out set: 0.022875861142222818
MeanAbsoluteError value on hold-out data: 0.12026795744895935
Epoch: 2
Loss on hold-out set: 0.015931674757188086
MeanAbsoluteError value on hold-out data: 0.09962271898984909
Epoch: 3
Loss on hold-out set: 0.010601561093751929
MeanAbsoluteError value on hold-out data: 0.08362201601266861
Epoch: 4
Loss on hold-out set: 0.011027785802358076
MeanAbsoluteError value on hold-out data: 0.08418939262628555
Epoch: 5
Loss on hold-out set: 0.008073882567451188
MeanAbsoluteError value on hold-out data: 0.07221224159002304
Epoch: 6
Loss on hold-out set: 0.007176461663268702
MeanAbsoluteError value on hold-out data: 0.06557171046733856
Epoch: 7
Loss on hold-out set: 0.0067081493478709535
MeanAbsoluteError value on hold-out data: 0.0649309977889061
```

```
Epoch: 8
Loss on hold-out set: 0.007309598995274619
MeanAbsoluteError value on hold-out data: 0.06584645062685013
Epoch: 9
Loss on hold-out set: 0.006402457718075694
MeanAbsoluteError value on hold-out data: 0.06307818740606308
Epoch: 10
Loss on hold-out set: 0.004949845762702783
MeanAbsoluteError value on hold-out data: 0.05437877029180527
Epoch: 11

Loss on hold-out set: 0.005356290491028248
MeanAbsoluteError value on hold-out data: 0.05646059662103653
Epoch: 12
Loss on hold-out set: 0.007159262362524475
MeanAbsoluteError value on hold-out data: 0.07008680701255798
Epoch: 13
Loss on hold-out set: 0.004023881333475737
MeanAbsoluteError value on hold-out data: 0.051995277404785156
Epoch: 14
Loss on hold-out set: 0.003438421253935973
MeanAbsoluteError value on hold-out data: 0.0435178279876709
Epoch: 15
Loss on hold-out set: 0.003452615962535339
MeanAbsoluteError value on hold-out data: 0.04440607875585556
Epoch: 16
Loss on hold-out set: 0.004324081798059572
MeanAbsoluteError value on hold-out data: 0.05258186534047127
Epoch: 17
Loss on hold-out set: 0.003103010932375726
MeanAbsoluteError value on hold-out data: 0.04355994239449501
Epoch: 18
Loss on hold-out set: 0.003585630882298574
MeanAbsoluteError value on hold-out data: 0.04396090656518936
Epoch: 19
Loss on hold-out set: 0.0025930248681872493
MeanAbsoluteError value on hold-out data: 0.040707338601350784
Epoch: 20
Loss on hold-out set: 0.003458798155311103
MeanAbsoluteError value on hold-out data: 0.04288075864315033
Epoch: 21
Loss on hold-out set: 0.0025585111105005795
```

```
MeanAbsoluteError value on hold-out data: 0.03823966160416603
Epoch: 22

Loss on hold-out set: 0.0032026730339949658
MeanAbsoluteError value on hold-out data: 0.040408454835414886
Epoch: 23
Loss on hold-out set: 0.003055315060344966
MeanAbsoluteError value on hold-out data: 0.040579911321401596
Epoch: 24
Loss on hold-out set: 0.0033350369761281306
MeanAbsoluteError value on hold-out data: 0.04238089174032211
Epoch: 25
Loss on hold-out set: 0.004372618387079504
MeanAbsoluteError value on hold-out data: 0.05297845974564552
Epoch: 26
Loss on hold-out set: 0.003839350896764939
MeanAbsoluteError value on hold-out data: 0.04784736782312393
Epoch: 27
Loss on hold-out set: 0.003060287837318978
MeanAbsoluteError value on hold-out data: 0.040081799030303955
Epoch: 28
Loss on hold-out set: 0.002628645897953232
MeanAbsoluteError value on hold-out data: 0.036289338022470474
Epoch: 29
Loss on hold-out set: 0.002476899755971604
MeanAbsoluteError value on hold-out data: 0.037107694894075394
Epoch: 30
Loss on hold-out set: 0.0040737156186399885
MeanAbsoluteError value on hold-out data: 0.04379173368215561
Epoch: 31
Loss on hold-out set: 0.003146758352063204
MeanAbsoluteError value on hold-out data: 0.03991877660155296
Epoch: 32
Loss on hold-out set: 0.0037676804441664565
MeanAbsoluteError value on hold-out data: 0.04817609861493111
Epoch: 33

Loss on hold-out set: 0.003651148964356827
MeanAbsoluteError value on hold-out data: 0.04732636734843254
Epoch: 34
Loss on hold-out set: 0.0019107973245186976
MeanAbsoluteError value on hold-out data: 0.03229952231049538
```

```
Epoch: 35
Loss on hold-out set: 0.003423855675225097
MeanAbsoluteError value on hold-out data: 0.04470670968294144
Epoch: 36
Loss on hold-out set: 0.0030347213201151278
MeanAbsoluteError value on hold-out data: 0.04028845578432083
Epoch: 37
Loss on hold-out set: 0.002739792354987003
MeanAbsoluteError value on hold-out data: 0.03389580920338631
Epoch: 38
Loss on hold-out set: 0.002682799959745209
MeanAbsoluteError value on hold-out data: 0.03339866176247597
Epoch: 39
Loss on hold-out set: 0.00288449458802413
MeanAbsoluteError value on hold-out data: 0.03855394572019577
Epoch: 40
Loss on hold-out set: 0.002500484700584294
MeanAbsoluteError value on hold-out data: 0.03887133672833443
Epoch: 41
Loss on hold-out set: 0.0024588327781346286
MeanAbsoluteError value on hold-out data: 0.03539736568927765
Epoch: 42
Loss on hold-out set: 0.0032392640270317266
MeanAbsoluteError value on hold-out data: 0.04332442954182625
Epoch: 43
Loss on hold-out set: 0.0028078023537282683
MeanAbsoluteError value on hold-out data: 0.03891655057668686
Epoch: 44

Loss on hold-out set: 0.0021842732867777444
MeanAbsoluteError value on hold-out data: 0.03275226056575775
Epoch: 45
Loss on hold-out set: 0.002733351037788548
MeanAbsoluteError value on hold-out data: 0.03784036636352539
Epoch: 46
Loss on hold-out set: 0.002511035902180562
MeanAbsoluteError value on hold-out data: 0.039499059319496155
Epoch: 47
Loss on hold-out set: 0.003049039547668623
MeanAbsoluteError value on hold-out data: 0.038877300918102264
Epoch: 48
Loss on hold-out set: 0.00776934070439127
```

```
MeanAbsoluteError value on hold-out data: 0.0781412124633789
Epoch: 49
Loss on hold-out set: 0.0032640975520112797
MeanAbsoluteError value on hold-out data: 0.04479754716157913
Epoch: 50
Loss on hold-out set: 0.003681256564481086
MeanAbsoluteError value on hold-out data: 0.045172788202762604
Epoch: 51
Loss on hold-out set: 0.0027763403639638503
MeanAbsoluteError value on hold-out data: 0.03645342215895653
Epoch: 52
Loss on hold-out set: 0.002566489432386956
MeanAbsoluteError value on hold-out data: 0.040341127663850784
Epoch: 53
Loss on hold-out set: 0.0026924123154266886
MeanAbsoluteError value on hold-out data: 0.0341067798435688
Epoch: 54
Loss on hold-out set: 0.00264314256951605
MeanAbsoluteError value on hold-out data: 0.034566882997751236
Epoch: 55

Loss on hold-out set: 0.004743771750087801
MeanAbsoluteError value on hold-out data: 0.05765311047434807
Epoch: 56
Loss on hold-out set: 0.0018640056349747617
MeanAbsoluteError value on hold-out data: 0.0312078595161438
Epoch: 57
Loss on hold-out set: 0.002970812227239979
MeanAbsoluteError value on hold-out data: 0.037232544273138046
Epoch: 58
Loss on hold-out set: 0.0023738203239382096
MeanAbsoluteError value on hold-out data: 0.03394055366516113
Epoch: 59
Loss on hold-out set: 0.0038319541735721656
MeanAbsoluteError value on hold-out data: 0.040900565683841705
Epoch: 60
Loss on hold-out set: 0.002764501108781827
MeanAbsoluteError value on hold-out data: 0.03559558466076851
Epoch: 61
Loss on hold-out set: 0.0034593982226828017
MeanAbsoluteError value on hold-out data: 0.04860380291938782
Epoch: 62
```

```
Loss on hold-out set: 0.002161146562828339
MeanAbsoluteError value on hold-out data: 0.03315545618534088
Epoch: 63
Loss on hold-out set: 0.0036860969787659613
MeanAbsoluteError value on hold-out data: 0.04534957557916641
Epoch: 64
Loss on hold-out set: 0.00293136831207544
MeanAbsoluteError value on hold-out data: 0.04124203696846962
Epoch: 65
Loss on hold-out set: 0.004127911656580277
MeanAbsoluteError value on hold-out data: 0.04965432733297348
Epoch: 66


Loss on hold-out set: 0.002761324249532711
MeanAbsoluteError value on hold-out data: 0.036464862525463104
Epoch: 67
Loss on hold-out set: 0.001972645358029312
MeanAbsoluteError value on hold-out data: 0.032229233533144
Epoch: 68
Loss on hold-out set: 0.0019921451886674682
MeanAbsoluteError value on hold-out data: 0.030919574201107025
Epoch: 69
Loss on hold-out set: 0.0021449988615993214
MeanAbsoluteError value on hold-out data: 0.03395087271928787
Epoch: 70
Loss on hold-out set: 0.003944010968552902
MeanAbsoluteError value on hold-out data: 0.0441615916788578
Epoch: 71
Loss on hold-out set: 0.0033540817783336693
MeanAbsoluteError value on hold-out data: 0.047060005366802216
Epoch: 72
Loss on hold-out set: 0.00330316158176988
MeanAbsoluteError value on hold-out data: 0.03876928240060806
Epoch: 73
Loss on hold-out set: 0.002342937179491855
MeanAbsoluteError value on hold-out data: 0.03406147286295891
Epoch: 74
Loss on hold-out set: 0.002833023967564498
MeanAbsoluteError value on hold-out data: 0.038854457437992096
Epoch: 75
Loss on hold-out set: 0.0024613460447749516
MeanAbsoluteError value on hold-out data: 0.0385718010365963
```

```
Epoch: 76
Loss on hold-out set: 0.0024192452585434935
MeanAbsoluteError value on hold-out data: 0.034146569669246674
Epoch: 77

Loss on hold-out set: 0.002612890244467723
MeanAbsoluteError value on hold-out data: 0.03688843175768852
Epoch: 78
Loss on hold-out set: 0.002123792981269377
MeanAbsoluteError value on hold-out data: 0.03263067081570625
Epoch: 79
Loss on hold-out set: 0.0036468281576066816
MeanAbsoluteError value on hold-out data: 0.039136048406362534
Epoch: 80
Loss on hold-out set: 0.002372458635363728
MeanAbsoluteError value on hold-out data: 0.03258410468697548
Epoch: 81
Loss on hold-out set: 0.0025358378418451665
MeanAbsoluteError value on hold-out data: 0.03440149873495102
Epoch: 82
Loss on hold-out set: 0.003378287352174275
MeanAbsoluteError value on hold-out data: 0.04209970310330391
Epoch: 83
Loss on hold-out set: 0.002569908539666549
MeanAbsoluteError value on hold-out data: 0.039549317210912704
Epoch: 84
Loss on hold-out set: 0.003203539859417728
MeanAbsoluteError value on hold-out data: 0.04065578803420067
Epoch: 85
Loss on hold-out set: 0.0033622534277750866
MeanAbsoluteError value on hold-out data: 0.03927765041589737
Epoch: 86
Loss on hold-out set: 0.002349161524570694
MeanAbsoluteError value on hold-out data: 0.03495534136891365
Epoch: 87
Loss on hold-out set: 0.0024470765707328133
MeanAbsoluteError value on hold-out data: 0.03741905093193054
Epoch: 88

Loss on hold-out set: 0.002181206445368987
MeanAbsoluteError value on hold-out data: 0.03439520299434662
Epoch: 89
```

```
Loss on hold-out set: 0.001972659337824505
MeanAbsoluteError value on hold-out data: 0.03352440893650055
Epoch: 90
Loss on hold-out set: 0.0038926072547359296
MeanAbsoluteError value on hold-out data: 0.04918016865849495
Epoch: 91
Loss on hold-out set: 0.0021096622987993455
MeanAbsoluteError value on hold-out data: 0.03260670229792595
Epoch: 92
Loss on hold-out set: 0.003042572688029491
MeanAbsoluteError value on hold-out data: 0.03947601467370987
Epoch: 93
Loss on hold-out set: 0.002441268333074588
MeanAbsoluteError value on hold-out data: 0.03295217081904411
Epoch: 94
Loss on hold-out set: 0.0021217836260084845
MeanAbsoluteError value on hold-out data: 0.03359620273113251
Epoch: 95
Loss on hold-out set: 0.00253837604663874
MeanAbsoluteError value on hold-out data: 0.03702152147889137
Epoch: 96
Loss on hold-out set: 0.002821555836003666
MeanAbsoluteError value on hold-out data: 0.03429523855447769
Epoch: 97
Loss on hold-out set: 0.004555540407493122
MeanAbsoluteError value on hold-out data: 0.052892737090587616
Epoch: 98
Loss on hold-out set: 0.005145307195274846
MeanAbsoluteError value on hold-out data: 0.06171783432364464
Epoch: 99

Loss on hold-out set: 0.002486504581419898
MeanAbsoluteError value on hold-out data: 0.03305859863758087
Epoch: 100
Loss on hold-out set: 0.0017686203921728424
MeanAbsoluteError value on hold-out data: 0.028667787089943886
Epoch: 101
Loss on hold-out set: 0.0027486571374251262
MeanAbsoluteError value on hold-out data: 0.03728495165705681
Epoch: 102
Loss on hold-out set: 0.0023113999953861103
MeanAbsoluteError value on hold-out data: 0.031756412237882614
```

```
Epoch: 103
Loss on hold-out set: 0.0029841771006192033
MeanAbsoluteError value on hold-out data: 0.04365191608667374
Epoch: 104
Loss on hold-out set: 0.001931537106620932
MeanAbsoluteError value on hold-out data: 0.032224055379629135
Epoch: 105
Loss on hold-out set: 0.002382354313005252
MeanAbsoluteError value on hold-out data: 0.03565000742673874
Epoch: 106
Loss on hold-out set: 0.002302247529242825
MeanAbsoluteError value on hold-out data: 0.03298522159457207
Epoch: 107
Loss on hold-out set: 0.0027789098140170894
MeanAbsoluteError value on hold-out data: 0.0432465523481369
Epoch: 108
Loss on hold-out set: 0.0018844331904179661
MeanAbsoluteError value on hold-out data: 0.03222429379820824
Epoch: 109
Loss on hold-out set: 0.002604138191887423
MeanAbsoluteError value on hold-out data: 0.03996342420578003
Epoch: 110
```

```
Loss on hold-out set: 0.0025402360073425562
MeanAbsoluteError value on hold-out data: 0.03566816449165344
Epoch: 111
Loss on hold-out set: 0.002846790301478713
MeanAbsoluteError value on hold-out data: 0.0384967215359211
Epoch: 112
Loss on hold-out set: 0.004402739654515723
MeanAbsoluteError value on hold-out data: 0.05591047182679176
Epoch: 113
Loss on hold-out set: 0.003427313126035427
MeanAbsoluteError value on hold-out data: 0.045667197555303574
Epoch: 114
Loss on hold-out set: 0.0034080200482429447
MeanAbsoluteError value on hold-out data: 0.04392491653561592
Epoch: 115
Loss on hold-out set: 0.0028259144290993725
MeanAbsoluteError value on hold-out data: 0.035469867289066315
Epoch: 116
Loss on hold-out set: 0.0022803052186071383
```

```
MeanAbsoluteError value on hold-out data: 0.03510907664895058
Epoch: 117
Loss on hold-out set: 0.0026955783848136073
MeanAbsoluteError value on hold-out data: 0.03861795365810394
Epoch: 118
Loss on hold-out set: 0.0022003572682335383
MeanAbsoluteError value on hold-out data: 0.0371074303984642
Epoch: 119
Loss on hold-out set: 0.0021601834067903262
MeanAbsoluteError value on hold-out data: 0.03322702273726463
Epoch: 120
Loss on hold-out set: 0.0034209465267945475
MeanAbsoluteError value on hold-out data: 0.04835857078433037
Epoch: 121

Loss on hold-out set: 0.0019558797242720367
MeanAbsoluteError value on hold-out data: 0.03216666355729103
Epoch: 122
Loss on hold-out set: 0.0024212909767428706
MeanAbsoluteError value on hold-out data: 0.035329774022102356
Epoch: 123
Loss on hold-out set: 0.002249277144744012
MeanAbsoluteError value on hold-out data: 0.03495846688747406
Epoch: 124
Loss on hold-out set: 0.0015761623845288628
MeanAbsoluteError value on hold-out data: 0.03057911805808544
Epoch: 125
Loss on hold-out set: 0.0018994250069801254
MeanAbsoluteError value on hold-out data: 0.03168163821101189
Epoch: 126
Loss on hold-out set: 0.002666126694652791
MeanAbsoluteError value on hold-out data: 0.0343637652695179
Epoch: 127
Loss on hold-out set: 0.002455819634058954
MeanAbsoluteError value on hold-out data: 0.03575771301984787
Epoch: 128
Loss on hold-out set: 0.0026378444178446537
MeanAbsoluteError value on hold-out data: 0.03811444342136383
Epoch: 129
Loss on hold-out set: 0.003770590471839042
MeanAbsoluteError value on hold-out data: 0.04427560046315193
Epoch: 130
```

```
Loss on hold-out set: 0.002979176009447608
MeanAbsoluteError value on hold-out data: 0.039295632392168045
Epoch: 131
Loss on hold-out set: 0.0016122316240063427
MeanAbsoluteError value on hold-out data: 0.027837680652737617
Epoch: 132

Loss on hold-out set: 0.0024572876511803387
MeanAbsoluteError value on hold-out data: 0.038427408784627914
Epoch: 133
Loss on hold-out set: 0.002378435151369654
MeanAbsoluteError value on hold-out data: 0.03333340957760811
Epoch: 134
Loss on hold-out set: 0.0023784124794857284
MeanAbsoluteError value on hold-out data: 0.034437429159879684
Epoch: 135
Loss on hold-out set: 0.0026466755792314777
MeanAbsoluteError value on hold-out data: 0.03583675995469093
Epoch: 136
Loss on hold-out set: 0.0022417968443493776
MeanAbsoluteError value on hold-out data: 0.03217010200023651
Epoch: 137
Loss on hold-out set: 0.0023991171922381526
MeanAbsoluteError value on hold-out data: 0.03279991075396538
Epoch: 138
Loss on hold-out set: 0.0030003799405868017
MeanAbsoluteError value on hold-out data: 0.03775091841816902
Epoch: 139
Loss on hold-out set: 0.002240699055714925
MeanAbsoluteError value on hold-out data: 0.034148987382650375
Epoch: 140
Loss on hold-out set: 0.002614889577288475
MeanAbsoluteError value on hold-out data: 0.03544485569000244
Epoch: 141
Loss on hold-out set: 0.0029304010462702103
MeanAbsoluteError value on hold-out data: 0.035535410046577454
Epoch: 142
Loss on hold-out set: 0.003016757284058258
MeanAbsoluteError value on hold-out data: 0.03659410402178764
Epoch: 143

Loss on hold-out set: 0.0017696270461831439
```

```
MeanAbsoluteError value on hold-out data: 0.03093140944838524
Epoch: 144
Loss on hold-out set: 0.002931765815255379
MeanAbsoluteError value on hold-out data: 0.039901137351989746
Epoch: 145
Loss on hold-out set: 0.0022721944482519143
MeanAbsoluteError value on hold-out data: 0.03065798431634903
Epoch: 146
Loss on hold-out set: 0.001566052241526593
MeanAbsoluteError value on hold-out data: 0.029749982059001923
Epoch: 147
Loss on hold-out set: 0.0027400288504156236
MeanAbsoluteError value on hold-out data: 0.03115958534181118
Epoch: 148
Loss on hold-out set: 0.0024368269889811544
MeanAbsoluteError value on hold-out data: 0.034503091126680374
Epoch: 149
Loss on hold-out set: 0.002391325191925525
MeanAbsoluteError value on hold-out data: 0.036057405173778534
Epoch: 150
Loss on hold-out set: 0.0019121510099227492
MeanAbsoluteError value on hold-out data: 0.03196458891034126
Epoch: 151
Loss on hold-out set: 0.004295528952130361
MeanAbsoluteError value on hold-out data: 0.05699664354324341
Epoch: 152
Loss on hold-out set: 0.0020977961424872966
MeanAbsoluteError value on hold-out data: 0.032719552516937256
Epoch: 153
Loss on hold-out set: 0.0023326236497316706
MeanAbsoluteError value on hold-out data: 0.03228709474205971
Epoch: 154

Loss on hold-out set: 0.0018152611523155908
MeanAbsoluteError value on hold-out data: 0.028778135776519775
Epoch: 155
Loss on hold-out set: 0.0030164630159944003
MeanAbsoluteError value on hold-out data: 0.03774859011173248
Epoch: 156
Loss on hold-out set: 0.0031760024423037017
MeanAbsoluteError value on hold-out data: 0.040614333003759384
Epoch: 157
```

```
Loss on hold-out set: 0.0035741343293155202
MeanAbsoluteError value on hold-out data: 0.042551811784505844
Epoch: 158
Loss on hold-out set: 0.0021668393563136065
MeanAbsoluteError value on hold-out data: 0.03063621185719967
Epoch: 159
Loss on hold-out set: 0.0023012816474013227
MeanAbsoluteError value on hold-out data: 0.03631298616528511
Epoch: 160
Loss on hold-out set: 0.0029783744279197172
MeanAbsoluteError value on hold-out data: 0.038937825709581375
Epoch: 161
Loss on hold-out set: 0.0026140488625969738
MeanAbsoluteError value on hold-out data: 0.03925790637731552
Epoch: 162
Loss on hold-out set: 0.00319379393859938
MeanAbsoluteError value on hold-out data: 0.04051869735121727
Epoch: 163
Loss on hold-out set: 0.0020249196754057743
MeanAbsoluteError value on hold-out data: 0.03147267550230026
Epoch: 164
Loss on hold-out set: 0.0023312349325064325
MeanAbsoluteError value on hold-out data: 0.03042195551097393
Epoch: 165

Loss on hold-out set: 0.002362277377917627
MeanAbsoluteError value on hold-out data: 0.03331238403916359
Epoch: 166
Loss on hold-out set: 0.002073011272985145
MeanAbsoluteError value on hold-out data: 0.032054007053375244
Epoch: 167
Loss on hold-out set: 0.0018626087127670058
MeanAbsoluteError value on hold-out data: 0.03143427520990372
Epoch: 168
Loss on hold-out set: 0.0019003722171826091
MeanAbsoluteError value on hold-out data: 0.03153488412499428
Epoch: 169
Loss on hold-out set: 0.0026212923962463577
MeanAbsoluteError value on hold-out data: 0.037104345858097076
Epoch: 170
Loss on hold-out set: 0.0016767250000205088
MeanAbsoluteError value on hold-out data: 0.031014099717140198
```

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Epoch: 171
Loss on hold-out set: 0.0026343290611341792
MeanAbsoluteError value on hold-out data: 0.03564948961138725
Epoch: 172
Loss on hold-out set: 0.002457659170000912
MeanAbsoluteError value on hold-out data: 0.031798265874385834
Epoch: 173
Loss on hold-out set: 0.003178315229505595
MeanAbsoluteError value on hold-out data: 0.04260941967368126
Epoch: 174
Loss on hold-out set: 0.002413605784424458
MeanAbsoluteError value on hold-out data: 0.03095199353992939
Epoch: 175
Loss on hold-out set: 0.0019875479242488694
MeanAbsoluteError value on hold-out data: 0.02883012779057026
Epoch: 176


Loss on hold-out set: 0.0030513422787312025
MeanAbsoluteError value on hold-out data: 0.03947530686855316
Epoch: 177
Loss on hold-out set: 0.0020994372017938937
MeanAbsoluteError value on hold-out data: 0.02984047308564186
Epoch: 178
Loss on hold-out set: 0.001654973306837124
MeanAbsoluteError value on hold-out data: 0.028767315670847893
Epoch: 179
Loss on hold-out set: 0.0022656530613618855
MeanAbsoluteError value on hold-out data: 0.037841953337192535
Epoch: 180
Loss on hold-out set: 0.001866144460540167
MeanAbsoluteError value on hold-out data: 0.030694663524627686
Epoch: 181
Loss on hold-out set: 0.002507992830942385
MeanAbsoluteError value on hold-out data: 0.03679583966732025
Epoch: 182
Loss on hold-out set: 0.002189929553424008
MeanAbsoluteError value on hold-out data: 0.030717238783836365
Epoch: 183
Loss on hold-out set: 0.002905410554376431
MeanAbsoluteError value on hold-out data: 0.03500906005501747
Epoch: 184
Loss on hold-out set: 0.0016408179244057177
```

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MeanAbsoluteError value on hold-out data: 0.027791809290647507
Epoch: 185
Loss on hold-out set: 0.0024151531343752715
MeanAbsoluteError value on hold-out data: 0.034437842667102814
Epoch: 186
Loss on hold-out set: 0.0019134481737733279
MeanAbsoluteError value on hold-out data: 0.028032805770635605
Epoch: 187

Loss on hold-out set: 0.002085396157589888
MeanAbsoluteError value on hold-out data: 0.03302090987563133
Epoch: 188
Loss on hold-out set: 0.0025213504849441386
MeanAbsoluteError value on hold-out data: 0.03268061578273773
Epoch: 189
Loss on hold-out set: 0.0017470173770561814
MeanAbsoluteError value on hold-out data: 0.029745902866125107
Epoch: 190
Loss on hold-out set: 0.0017799167973479551
MeanAbsoluteError value on hold-out data: 0.03136463835835457
Epoch: 191
Loss on hold-out set: 0.002150166021525174
MeanAbsoluteError value on hold-out data: 0.032618798315525055
Epoch: 192
Loss on hold-out set: 0.0020784701360083233
MeanAbsoluteError value on hold-out data: 0.028462419286370277
Epoch: 193
Loss on hold-out set: 0.002177992303347166
MeanAbsoluteError value on hold-out data: 0.03143138438463211
Epoch: 194
Loss on hold-out set: 0.0018038868055507344
MeanAbsoluteError value on hold-out data: 0.029248526319861412
Epoch: 195
Loss on hold-out set: 0.002384909832280276
MeanAbsoluteError value on hold-out data: 0.03334830328822136
Epoch: 196
Loss on hold-out set: 0.0037642641814033453
MeanAbsoluteError value on hold-out data: 0.043640851974487305
Epoch: 197
Loss on hold-out set: 0.001984129045587523
MeanAbsoluteError value on hold-out data: 0.030321089550852776
Epoch: 198
```

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Loss on hold-out set: 0.0022888802494363566
MeanAbsoluteError value on hold-out data: 0.03635816648602486
Epoch: 199
Loss on hold-out set: 0.0027718615862173273
MeanAbsoluteError value on hold-out data: 0.036615025252103806
Epoch: 200
Loss on hold-out set: 0.0017761792443802972
MeanAbsoluteError value on hold-out data: 0.030474131926894188
Epoch: 201
Loss on hold-out set: 0.0028120429870844084
MeanAbsoluteError value on hold-out data: 0.03752423822879791
Epoch: 202
Loss on hold-out set: 0.003714593617539657
MeanAbsoluteError value on hold-out data: 0.04966673627495766
Epoch: 203
Loss on hold-out set: 0.00357882590661144
MeanAbsoluteError value on hold-out data: 0.04567113518714905
Epoch: 204
Loss on hold-out set: 0.002184530060683181
MeanAbsoluteError value on hold-out data: 0.031120847910642624
Epoch: 205
Loss on hold-out set: 0.0024174003598378285
MeanAbsoluteError value on hold-out data: 0.0341501459479332
Epoch: 206
Loss on hold-out set: 0.002691170351968858
MeanAbsoluteError value on hold-out data: 0.03300147131085396
Epoch: 207
Loss on hold-out set: 0.0030381715125833196
MeanAbsoluteError value on hold-out data: 0.03890587016940117
Epoch: 208
Loss on hold-out set: 0.00234741212165988
MeanAbsoluteError value on hold-out data: 0.03671800345182419
Epoch: 209

Loss on hold-out set: 0.002421117025828847
MeanAbsoluteError value on hold-out data: 0.036075036972761154
Epoch: 210
Loss on hold-out set: 0.0016433032073301117
MeanAbsoluteError value on hold-out data: 0.030543381348252296
Epoch: 211
Loss on hold-out set: 0.00302121293038669
MeanAbsoluteError value on hold-out data: 0.03424552083015442
```

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Epoch: 212
Loss on hold-out set: 0.0031016672031623066
MeanAbsoluteError value on hold-out data: 0.03738584369421005
Epoch: 213
Loss on hold-out set: 0.0027384057860839867
MeanAbsoluteError value on hold-out data: 0.03310021758079529
Epoch: 214
Loss on hold-out set: 0.0017399867287359054
MeanAbsoluteError value on hold-out data: 0.03108738549053669
Epoch: 215
Loss on hold-out set: 0.0017614774000034423
MeanAbsoluteError value on hold-out data: 0.02773156203329563
Epoch: 216
Loss on hold-out set: 0.0018679325508664509
MeanAbsoluteError value on hold-out data: 0.032365210354328156
Epoch: 217
Loss on hold-out set: 0.0021084930141162324
MeanAbsoluteError value on hold-out data: 0.033809494227170944
Epoch: 218
Loss on hold-out set: 0.004983928063761835
MeanAbsoluteError value on hold-out data: 0.05636698380112648
Epoch: 219
Loss on hold-out set: 0.0027594320555707733
MeanAbsoluteError value on hold-out data: 0.03987802565097809
Epoch: 220
```

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Loss on hold-out set: 0.0031907967564429305
MeanAbsoluteError value on hold-out data: 0.041923511773347855
Epoch: 221
Loss on hold-out set: 0.0017120725793862029
MeanAbsoluteError value on hold-out data: 0.02919762022793293
Epoch: 222
Loss on hold-out set: 0.002379056689709327
MeanAbsoluteError value on hold-out data: 0.032954126596450806
Epoch: 223
Loss on hold-out set: 0.0026139314447247764
MeanAbsoluteError value on hold-out data: 0.03163177892565727
Epoch: 224
Loss on hold-out set: 0.0018073355175530243
MeanAbsoluteError value on hold-out data: 0.02987755835056305
Epoch: 225
Loss on hold-out set: 0.0030734901788252358
```

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MeanAbsoluteError value on hold-out data: 0.04609585553407669
Epoch: 226
Loss on hold-out set: 0.0021989210221554935
MeanAbsoluteError value on hold-out data: 0.03220850229263306
Epoch: 227
Loss on hold-out set: 0.002670171041819757
MeanAbsoluteError value on hold-out data: 0.03389155864715576
Epoch: 228
Loss on hold-out set: 0.0020700113883848595
MeanAbsoluteError value on hold-out data: 0.031738266348838806
Epoch: 229
Loss on hold-out set: 0.0019871804795816147
MeanAbsoluteError value on hold-out data: 0.03169303014874458
Epoch: 230
Loss on hold-out set: 0.002114472815408494
MeanAbsoluteError value on hold-out data: 0.028365900740027428
Epoch: 231

Loss on hold-out set: 0.0016525772528104042
MeanAbsoluteError value on hold-out data: 0.031023813411593437
Epoch: 232
Loss on hold-out set: 0.0017518845168907366
MeanAbsoluteError value on hold-out data: 0.031772859394550323
Epoch: 233
Loss on hold-out set: 0.0019124508820057503
MeanAbsoluteError value on hold-out data: 0.029819484800100327
Epoch: 234
Loss on hold-out set: 0.003014814706004568
MeanAbsoluteError value on hold-out data: 0.04114160314202309
Epoch: 235
Loss on hold-out set: 0.001648239279012686
MeanAbsoluteError value on hold-out data: 0.02911369688808918
Epoch: 236
Loss on hold-out set: 0.0026827918681144518
MeanAbsoluteError value on hold-out data: 0.03874973952770233
Epoch: 237
Loss on hold-out set: 0.002414519999307997
MeanAbsoluteError value on hold-out data: 0.033428728580474854
Epoch: 238
Loss on hold-out set: 0.0029506805371248015
MeanAbsoluteError value on hold-out data: 0.045218050479888916
Epoch: 239
```

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Loss on hold-out set: 0.002833302344171036
MeanAbsoluteError value on hold-out data: 0.04016151279211044
Epoch: 240
Loss on hold-out set: 0.0017392921811398608
MeanAbsoluteError value on hold-out data: 0.030874431133270264
Epoch: 241
Loss on hold-out set: 0.0026212508758027596
MeanAbsoluteError value on hold-out data: 0.0360136479139328
Epoch: 242

Loss on hold-out set: 0.002085855730049508
MeanAbsoluteError value on hold-out data: 0.03383040055632591
Epoch: 243
Loss on hold-out set: 0.001583415321013155
MeanAbsoluteError value on hold-out data: 0.030003074556589127
Epoch: 244
Loss on hold-out set: 0.0020568114169260583
MeanAbsoluteError value on hold-out data: 0.02905094437301159
Epoch: 245
Loss on hold-out set: 0.0016980434746456969
MeanAbsoluteError value on hold-out data: 0.03045458160340786
Epoch: 246
Loss on hold-out set: 0.001973395636780065
MeanAbsoluteError value on hold-out data: 0.030913403257727623
Epoch: 247
Loss on hold-out set: 0.001781583545380272
MeanAbsoluteError value on hold-out data: 0.030948566272854805
Epoch: 248
Loss on hold-out set: 0.002762600133121994
MeanAbsoluteError value on hold-out data: 0.03741496056318283
Epoch: 249
Loss on hold-out set: 0.002386511103587078
MeanAbsoluteError value on hold-out data: 0.03276780620217323
Epoch: 250
Loss on hold-out set: 0.003786561940183961
MeanAbsoluteError value on hold-out data: 0.049954142421483994
Epoch: 251
Loss on hold-out set: 0.0023006823068594954
MeanAbsoluteError value on hold-out data: 0.033994197845458984
Epoch: 252
Loss on hold-out set: 0.0036121884875587726
MeanAbsoluteError value on hold-out data: 0.04606439173221588
Epoch: 253
```

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Loss on hold-out set: 0.0018325653333082109
MeanAbsoluteError value on hold-out data: 0.029901081696152687
Epoch: 254
Loss on hold-out set: 0.0033072621912364603
MeanAbsoluteError value on hold-out data: 0.03880850970745087
Epoch: 255
Loss on hold-out set: 0.003625408346507404
MeanAbsoluteError value on hold-out data: 0.04078720137476921
Epoch: 256
Loss on hold-out set: 0.0023765383293242563
MeanAbsoluteError value on hold-out data: 0.03079056181013584
Epoch: 257
Loss on hold-out set: 0.0019768789099639675
MeanAbsoluteError value on hold-out data: 0.029304256662726402
Epoch: 258
Loss on hold-out set: 0.00130695343192967
MeanAbsoluteError value on hold-out data: 0.025781290605664253
Epoch: 259
Loss on hold-out set: 0.0021490887991508075
MeanAbsoluteError value on hold-out data: 0.03202857822179794
Epoch: 260
Loss on hold-out set: 0.002271866264269001
MeanAbsoluteError value on hold-out data: 0.03183743357658386
Epoch: 261
Loss on hold-out set: 0.00517345380687498
MeanAbsoluteError value on hold-out data: 0.0564689114689827
Epoch: 262
Loss on hold-out set: 0.0037830709728663542
MeanAbsoluteError value on hold-out data: 0.037568800151348114
Epoch: 263
Loss on hold-out set: 0.002300003395679309
MeanAbsoluteError value on hold-out data: 0.0351828970015049
Epoch: 264

Loss on hold-out set: 0.002455320433670606
MeanAbsoluteError value on hold-out data: 0.036257654428482056
Epoch: 265
Loss on hold-out set: 0.0038718154859165416
MeanAbsoluteError value on hold-out data: 0.04162411019206047
Epoch: 266
Loss on hold-out set: 0.00166224736542637
MeanAbsoluteError value on hold-out data: 0.028668930754065514
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Epoch: 267
Loss on hold-out set: 0.0024550301405772764
MeanAbsoluteError value on hold-out data: 0.03880865126848221
Epoch: 268
Loss on hold-out set: 0.0021657236042971675
MeanAbsoluteError value on hold-out data: 0.03481503948569298
Epoch: 269
Loss on hold-out set: 0.0028583305071438908
MeanAbsoluteError value on hold-out data: 0.04009353742003441
Epoch: 270
Loss on hold-out set: 0.0024323269554818246
MeanAbsoluteError value on hold-out data: 0.03380284458398819
Epoch: 271
Loss on hold-out set: 0.002609907257321634
MeanAbsoluteError value on hold-out data: 0.037691161036491394
Epoch: 272
Loss on hold-out set: 0.0019339727533454272
MeanAbsoluteError value on hold-out data: 0.031374912708997726
Epoch: 273
Loss on hold-out set: 0.004539765187808753
MeanAbsoluteError value on hold-out data: 0.04693218693137169
Epoch: 274
Loss on hold-out set: 0.0026827957588370496
MeanAbsoluteError value on hold-out data: 0.03420155495405197
Epoch: 275
```

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Loss on hold-out set: 0.001960003495026429
MeanAbsoluteError value on hold-out data: 0.032166238874197006
Epoch: 276
Loss on hold-out set: 0.0017765487182738358
MeanAbsoluteError value on hold-out data: 0.030529581010341644
Epoch: 277
Loss on hold-out set: 0.0025667787550973068
MeanAbsoluteError value on hold-out data: 0.0402245856821537
Epoch: 278
Loss on hold-out set: 0.003184357576078343
MeanAbsoluteError value on hold-out data: 0.041004616767168045
Epoch: 279
Loss on hold-out set: 0.003179534066523621
MeanAbsoluteError value on hold-out data: 0.03458397090435028
Epoch: 280
Loss on hold-out set: 0.0018089753238631314
```

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MeanAbsoluteError value on hold-out data: 0.03219309449195862
Epoch: 281
Loss on hold-out set: 0.0026336336036604877
MeanAbsoluteError value on hold-out data: 0.0395038016140461
Epoch: 282
Loss on hold-out set: 0.0013688952619160869
MeanAbsoluteError value on hold-out data: 0.02799670584499836
Epoch: 283
Loss on hold-out set: 0.002435122932901753
MeanAbsoluteError value on hold-out data: 0.033141471445560455
Epoch: 284
Loss on hold-out set: 0.0018449016321315675
MeanAbsoluteError value on hold-out data: 0.02855033241212368
Epoch: 285
Loss on hold-out set: 0.00222198650283788
MeanAbsoluteError value on hold-out data: 0.03401275351643562
Epoch: 286

Loss on hold-out set: 0.002692933365898697
MeanAbsoluteError value on hold-out data: 0.042592521756887436
Epoch: 287
Loss on hold-out set: 0.0019650292310152986
MeanAbsoluteError value on hold-out data: 0.03208501264452934
Epoch: 288
Loss on hold-out set: 0.002426377898556989
MeanAbsoluteError value on hold-out data: 0.030899249017238617
Epoch: 289
Loss on hold-out set: 0.0019339265984997741
MeanAbsoluteError value on hold-out data: 0.031409379094839096
Epoch: 290
Loss on hold-out set: 0.002313133670740124
MeanAbsoluteError value on hold-out data: 0.03340442478656769
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Loss on hold-out set: 0.0029888440392249705
MeanAbsoluteError value on hold-out data: 0.041904039680957794
Epoch: 292
Loss on hold-out set: 0.00254738953050324
MeanAbsoluteError value on hold-out data: 0.03844607621431351
Epoch: 293
Loss on hold-out set: 0.0020794874657631703
MeanAbsoluteError value on hold-out data: 0.03020036779344082
Epoch: 294
```

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Loss on hold-out set: 0.004258207731733197
MeanAbsoluteError value on hold-out data: 0.046752817928791046
Epoch: 295
Loss on hold-out set: 0.0026304571350154126
MeanAbsoluteError value on hold-out data: 0.03533356636762619
Epoch: 296
Loss on hold-out set: 0.0021072559489096563
MeanAbsoluteError value on hold-out data: 0.03313141688704491
Epoch: 297

Loss on hold-out set: 0.002558244522477157
MeanAbsoluteError value on hold-out data: 0.038648221641778946
Epoch: 298
Loss on hold-out set: 0.0021074574098364743
MeanAbsoluteError value on hold-out data: 0.031194139271974564
Epoch: 299
Loss on hold-out set: 0.002349333969361492
MeanAbsoluteError value on hold-out data: 0.033739760518074036
Epoch: 300
Loss on hold-out set: 0.002459740145193217
MeanAbsoluteError value on hold-out data: 0.034543633460998535
Epoch: 301
Loss on hold-out set: 0.002627569566309256
MeanAbsoluteError value on hold-out data: 0.03579587861895561
Epoch: 302
Loss on hold-out set: 0.0036310272668120696
MeanAbsoluteError value on hold-out data: 0.04336069896817207
Epoch: 303
Loss on hold-out set: 0.0017374157189471206
MeanAbsoluteError value on hold-out data: 0.032346077263355255
Epoch: 304
Loss on hold-out set: 0.0024483100500411205
MeanAbsoluteError value on hold-out data: 0.032167624682188034
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Loss on hold-out set: 0.0015078263725291962
MeanAbsoluteError value on hold-out data: 0.025879519060254097
Epoch: 306
Loss on hold-out set: 0.0016502776086685788
MeanAbsoluteError value on hold-out data: 0.027296332642436028
Epoch: 307
Loss on hold-out set: 0.00188533366982531
MeanAbsoluteError value on hold-out data: 0.030492467805743217
Epoch: 308
```

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Loss on hold-out set: 0.0025970490119346466
MeanAbsoluteError value on hold-out data: 0.038097258657217026
Epoch: 309
Loss on hold-out set: 0.002416734062104584
MeanAbsoluteError value on hold-out data: 0.037856198847293854
Epoch: 310
Loss on hold-out set: 0.0023772752002083793
MeanAbsoluteError value on hold-out data: 0.03251589834690094
Epoch: 311
Loss on hold-out set: 0.006189420684485843
MeanAbsoluteError value on hold-out data: 0.06639838963747025
Epoch: 312
Loss on hold-out set: 0.0027919419731724225
MeanAbsoluteError value on hold-out data: 0.03919166699051857
Epoch: 313
Loss on hold-out set: 0.003008842883757193
MeanAbsoluteError value on hold-out data: 0.03867606446146965
Epoch: 314
Loss on hold-out set: 0.003244855491701808
MeanAbsoluteError value on hold-out data: 0.03905971720814705
Epoch: 315
Loss on hold-out set: 0.003291056410250205
MeanAbsoluteError value on hold-out data: 0.038530122488737106
Epoch: 316
Loss on hold-out set: 0.0061087996184237695
MeanAbsoluteError value on hold-out data: 0.06168968230485916
Epoch: 317
Loss on hold-out set: 0.0026023507747786902
MeanAbsoluteError value on hold-out data: 0.03628166392445564
Epoch: 318
Loss on hold-out set: 0.004920496507302711
MeanAbsoluteError value on hold-out data: 0.05208517611026764
Epoch: 319

Loss on hold-out set: 0.002867616539955825
MeanAbsoluteError value on hold-out data: 0.03753378987312317
Epoch: 320
Loss on hold-out set: 0.003873308921404379
MeanAbsoluteError value on hold-out data: 0.04092393442988396
Epoch: 321
Loss on hold-out set: 0.002403600502140379
MeanAbsoluteError value on hold-out data: 0.03279245272278786
```

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Epoch: 322
Loss on hold-out set: 0.0029300188608957748
MeanAbsoluteError value on hold-out data: 0.03775104507803917
Epoch: 323
Loss on hold-out set: 0.002522504075099469
MeanAbsoluteError value on hold-out data: 0.035348277539014816
Epoch: 324
Loss on hold-out set: 0.003143189514766594
MeanAbsoluteError value on hold-out data: 0.04037874937057495
Epoch: 325
Loss on hold-out set: 0.003033981915857447
MeanAbsoluteError value on hold-out data: 0.03970958665013313
Epoch: 326
Loss on hold-out set: 0.0037072467813758473
MeanAbsoluteError value on hold-out data: 0.044151853770017624
Epoch: 327
Loss on hold-out set: 0.005283777257749247
MeanAbsoluteError value on hold-out data: 0.05295243114233017
Epoch: 328
Loss on hold-out set: 0.003236126384428261
MeanAbsoluteError value on hold-out data: 0.03703936189413071
Epoch: 329
Loss on hold-out set: 0.002717214350061687
MeanAbsoluteError value on hold-out data: 0.04046263173222542
Epoch: 330

Loss on hold-out set: 0.003090862288924032
MeanAbsoluteError value on hold-out data: 0.0418231301009655
Epoch: 331
Loss on hold-out set: 0.0030972079694038257
MeanAbsoluteError value on hold-out data: 0.036877937614917755
Epoch: 332
Loss on hold-out set: 0.0036568862177725685
MeanAbsoluteError value on hold-out data: 0.04837904870510101
Epoch: 333
Loss on hold-out set: 0.002785962091844627
MeanAbsoluteError value on hold-out data: 0.04044204205274582
Epoch: 334
Loss on hold-out set: 0.0034446350565351743
MeanAbsoluteError value on hold-out data: 0.044241465628147125
Epoch: 335
Loss on hold-out set: 0.002293079575266395
```

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MeanAbsoluteError value on hold-out data: 0.03421420603990555
Epoch: 336
Loss on hold-out set: 0.0030345845106670537
MeanAbsoluteError value on hold-out data: 0.03792174160480499
Epoch: 337
Loss on hold-out set: 0.00235901097613877
MeanAbsoluteError value on hold-out data: 0.03269774839282036
Epoch: 338
Loss on hold-out set: 0.0028297491907754817
MeanAbsoluteError value on hold-out data: 0.03850298374891281
Epoch: 339
Loss on hold-out set: 0.003115708330848352
MeanAbsoluteError value on hold-out data: 0.03892552852630615
Epoch: 340
Loss on hold-out set: 0.0033760719754929213
MeanAbsoluteError value on hold-out data: 0.04612160846590996
Epoch: 341

Loss on hold-out set: 0.003724316347966363
MeanAbsoluteError value on hold-out data: 0.044360026717185974
Epoch: 342
Loss on hold-out set: 0.0032565463916398585
MeanAbsoluteError value on hold-out data: 0.03876758739352226
Epoch: 343
Loss on hold-out set: 0.0028179270815790482
MeanAbsoluteError value on hold-out data: 0.035536814481019974
Epoch: 344
Loss on hold-out set: 0.0027637852188873743
MeanAbsoluteError value on hold-out data: 0.03456476330757141
Epoch: 345
Loss on hold-out set: 0.004352167378927238
MeanAbsoluteError value on hold-out data: 0.044394806027412415
Epoch: 346
Loss on hold-out set: 0.0030076701636732508
MeanAbsoluteError value on hold-out data: 0.03802214190363884
Epoch: 347
Loss on hold-out set: 0.0029609025452947734
MeanAbsoluteError value on hold-out data: 0.037723932415246964
Epoch: 348
Loss on hold-out set: 0.002509622728930002
MeanAbsoluteError value on hold-out data: 0.03633434325456619
Epoch: 349
```

```
Loss on hold-out set: 0.005314304609782994
MeanAbsoluteError value on hold-out data: 0.05607014521956444
Epoch: 350
Loss on hold-out set: 0.0037071647085739593
MeanAbsoluteError value on hold-out data: 0.045274823904037476
Epoch: 351
Loss on hold-out set: 0.001992078727007059
MeanAbsoluteError value on hold-out data: 0.03183494508266449
Epoch: 352

Loss on hold-out set: 0.00307125729006274
MeanAbsoluteError value on hold-out data: 0.04060698673129082
Epoch: 353
Loss on hold-out set: 0.0024443870551246953
MeanAbsoluteError value on hold-out data: 0.035919129848480225
Epoch: 354
Loss on hold-out set: 0.0036649964259643304
MeanAbsoluteError value on hold-out data: 0.04194051772356033
Epoch: 355
Loss on hold-out set: 0.0023446210114726504
MeanAbsoluteError value on hold-out data: 0.033374473452568054
Epoch: 356
Loss on hold-out set: 0.0037283458981332124
MeanAbsoluteError value on hold-out data: 0.038124147802591324
Epoch: 357
Loss on hold-out set: 0.0034819177112934228
MeanAbsoluteError value on hold-out data: 0.0353366956114769
Epoch: 358
Loss on hold-out set: 0.0026604995502183507
MeanAbsoluteError value on hold-out data: 0.03495309129357338
Epoch: 359
Loss on hold-out set: 0.003916144223981782
MeanAbsoluteError value on hold-out data: 0.04955483600497246
Epoch: 360
Loss on hold-out set: 0.00387141761357749
MeanAbsoluteError value on hold-out data: 0.04270963370800018
Epoch: 361
Loss on hold-out set: 0.0025993685152283625
MeanAbsoluteError value on hold-out data: 0.038126446306705475
Epoch: 362
Loss on hold-out set: 0.0028583903499805417
MeanAbsoluteError value on hold-out data: 0.038171980530023575
Epoch: 363
```

```
Loss on hold-out set: 0.002761989649642553
MeanAbsoluteError value on hold-out data: 0.03835413232445717
Epoch: 364
Loss on hold-out set: 0.0034595554185982203
MeanAbsoluteError value on hold-out data: 0.04173463210463524
Epoch: 365
Loss on hold-out set: 0.0032649945596380063
MeanAbsoluteError value on hold-out data: 0.03928554058074951
Epoch: 366
Loss on hold-out set: 0.004207404180258317
MeanAbsoluteError value on hold-out data: 0.050411324948072433
Epoch: 367
Loss on hold-out set: 0.002458550481701662
MeanAbsoluteError value on hold-out data: 0.03170590102672577
Epoch: 368
Loss on hold-out set: 0.0024882687721401453
MeanAbsoluteError value on hold-out data: 0.03263826668262482
Epoch: 369
Loss on hold-out set: 0.0026251703460921385
MeanAbsoluteError value on hold-out data: 0.0336034782230854
Epoch: 370
Loss on hold-out set: 0.002399305085418746
MeanAbsoluteError value on hold-out data: 0.0348396860063076
Epoch: 371
Loss on hold-out set: 0.0032819492779181977
MeanAbsoluteError value on hold-out data: 0.04121256247162819
Epoch: 372
Loss on hold-out set: 0.0036999056740712965
MeanAbsoluteError value on hold-out data: 0.04162425175309181
Epoch: 373
Loss on hold-out set: 0.003954622108722106
MeanAbsoluteError value on hold-out data: 0.047071389853954315
Epoch: 374

Loss on hold-out set: 0.003487676178338006
MeanAbsoluteError value on hold-out data: 0.044979725033044815
Epoch: 375
Loss on hold-out set: 0.00274269654198035
MeanAbsoluteError value on hold-out data: 0.039515651762485504
Epoch: 376
Loss on hold-out set: 0.0024094908773182205
MeanAbsoluteError value on hold-out data: 0.0320390984416008
```

```
Epoch: 377
Loss on hold-out set: 0.00276016709233916
MeanAbsoluteError value on hold-out data: 0.03608415275812149
Epoch: 378
Loss on hold-out set: 0.0026350731694899303
MeanAbsoluteError value on hold-out data: 0.03674352169036865
Epoch: 379
Loss on hold-out set: 0.0021184942996019104
MeanAbsoluteError value on hold-out data: 0.02958446554839611
Epoch: 380
Loss on hold-out set: 0.0023981999731500095
MeanAbsoluteError value on hold-out data: 0.034287966787815094
Epoch: 381
Loss on hold-out set: 0.0030784914668306315
MeanAbsoluteError value on hold-out data: 0.04139833152294159
Epoch: 382
Loss on hold-out set: 0.0019430358760904422
MeanAbsoluteError value on hold-out data: 0.034876950085163116
Epoch: 383
Loss on hold-out set: 0.0029531823246016805
MeanAbsoluteError value on hold-out data: 0.03357355669140816
Epoch: 384
Loss on hold-out set: 0.0022454052416019535
MeanAbsoluteError value on hold-out data: 0.034369464963674545
Epoch: 385

Loss on hold-out set: 0.0023701938242945623
MeanAbsoluteError value on hold-out data: 0.03479927033185959
Epoch: 386
Loss on hold-out set: 0.002637757493893763
MeanAbsoluteError value on hold-out data: 0.03379338979721069
Early stopping at epoch 385
Returned to Spot: Validation loss: 0.002637757493893763
----------------------------------------------

spotPython tuning: 0.0016644078201160913 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x156fd3c40>
```

25.13 Tensorboard

The textual output shown in the console (or code cell) can be visualized with Tensorboard as described in Section 20.13.

25.14 Results

After the hyperparameter tuning run is finished, the results can be analyzed as described in Section 20.14.

```python
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

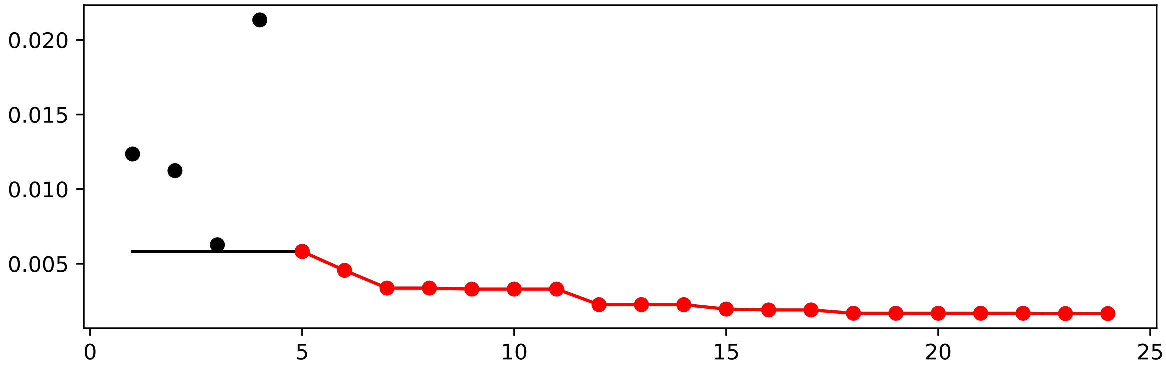

Figure 25.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

```python
print(gen_design_table(fun_control=fun_control, spot=spot_tuner))
```

```
| name         | type   | default   |   lower |   upper |                tuned | transform
|--------------|--------|-----------|---------|---------|----------------------|--------------
| _L_in        | int    | 10        |    10.0 |    10.0 |                 10.0 | None
| _L_out       | int    | 1         |     1.0 |     1.0 |                  1.0 | None
| l1           | int    | 3         |     3.0 |     8.0 |                  6.0 | transform_powe
| dropout_prob | float  | 0.01      |     0.0 |     0.9 | 0.2019472721744788 | None
| lr_mult      | float  | 1.0       |     0.1 |    10.0 |   6.915540780149216 | None
| batch_size   | int    | 4         |     1.0 |     4.0 |                  3.0 | transform_powe
| epochs       | int    | 4         |     2.0 |    16.0 |                 14.0 | transform_powe
```

```
| k_folds       | int    | 1         |       1.0 |       1.0 |                   1.0 | None
| patience      | int    | 2         |       3.0 |       7.0 |                   7.0 | transform_powe
| optimizer     | factor | SGD       |       0.0 |       6.0 |                   2.0 | None
| sgd_momentum  | float  | 0.0       |       0.0 |       1.0 |                   1.0 | None
```

```
spot_tuner.plot_importance(threshold=0.025,
    filename="./figures/" + experiment_name+"_importance.png")
```

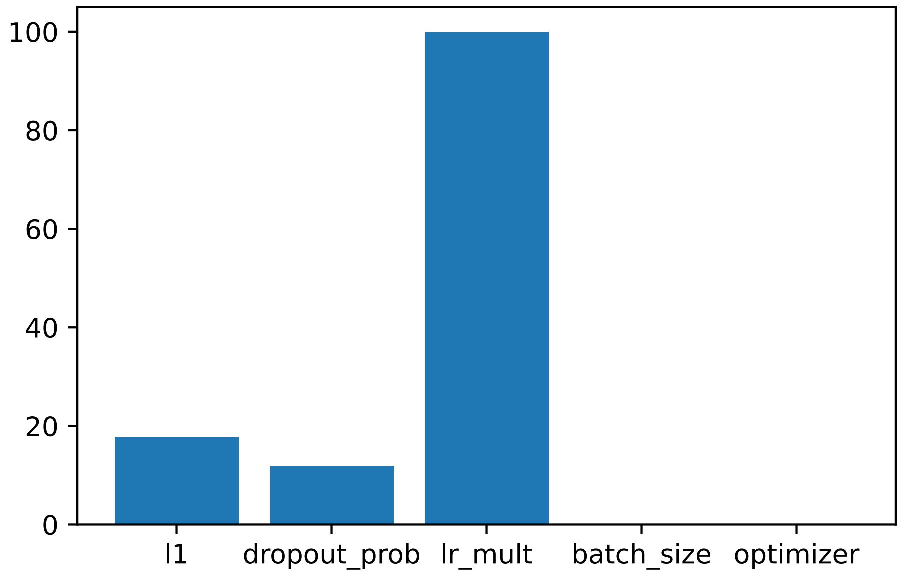

Figure 25.2: Variable importance plot, threshold 0.025.

25.15 Get the Tuned Architecture (SPOT Results)

```
from spotPython.hyperparameters.values import get_one_core_model_from_X
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
model_spot = get_one_core_model_from_X(X, fun_control)
model_spot
```

```
Net_lin_reg(
  (fc1): Linear(in_features=10, out_features=64, bias=True)
  (fc2): Linear(in_features=64, out_features=32, bias=True)
  (fc3): Linear(in_features=32, out_features=1, bias=True)
```

```
  (relu): ReLU()
  (softmax): Softmax(dim=1)
  (dropout1): Dropout(p=0.2019472721744788, inplace=False)
  (dropout2): Dropout(p=0.1009736360872394, inplace=False)
)
```

25.16 Evaluation of the Tuned Architecture

```python
from spotPython.torch.traintest import (
    train_tuned,
    test_tuned,
    )
```

```python
train_tuned(net=model_spot, train_dataset=train,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        shuffle=True,
        device = fun_control["device"],
        path=None,
        task=fun_control["task"],)
```

```
Epoch: 1
Loss on hold-out set: 0.02148273076224876
MeanAbsoluteError value on hold-out data: 0.11288867890834808
Epoch: 2
Loss on hold-out set: 0.014192740788291159
MeanAbsoluteError value on hold-out data: 0.09803571552038193
Epoch: 3

Loss on hold-out set: 0.011599589445579921
MeanAbsoluteError value on hold-out data: 0.08973921090364456
Epoch: 4
Loss on hold-out set: 0.011159729028708841
MeanAbsoluteError value on hold-out data: 0.08153815567493439
Epoch: 5
Loss on hold-out set: 0.006978445493395587
MeanAbsoluteError value on hold-out data: 0.06612411886453629
Epoch: 6
Loss on hold-out set: 0.006616502994132277
```

```
MeanAbsoluteError value on hold-out data: 0.0625387653708458
Epoch: 7
Loss on hold-out set: 0.006443817186855564
MeanAbsoluteError value on hold-out data: 0.06641817837953568
Epoch: 8
Loss on hold-out set: 0.005005715684475083
MeanAbsoluteError value on hold-out data: 0.05610944703221321
Epoch: 9
Loss on hold-out set: 0.004885936120684308
MeanAbsoluteError value on hold-out data: 0.054448045790195465
Epoch: 10
Loss on hold-out set: 0.005749812202626153
MeanAbsoluteError value on hold-out data: 0.06263218075037003
Epoch: 11

Loss on hold-out set: 0.004025345907154444
MeanAbsoluteError value on hold-out data: 0.05121192708611488
Epoch: 12
Loss on hold-out set: 0.004099053247237431
MeanAbsoluteError value on hold-out data: 0.051957517862319946
Epoch: 13
Loss on hold-out set: 0.009761980722511285
MeanAbsoluteError value on hold-out data: 0.08438359946012497
Epoch: 14

Loss on hold-out set: 0.0035141959823177834
MeanAbsoluteError value on hold-out data: 0.047456901520490646
Epoch: 15
Loss on hold-out set: 0.0036856744348034752
MeanAbsoluteError value on hold-out data: 0.04857263341546059
Epoch: 16
Loss on hold-out set: 0.004474474823310677
MeanAbsoluteError value on hold-out data: 0.05341189727187157
Epoch: 17
Loss on hold-out set: 0.006945909356306258
MeanAbsoluteError value on hold-out data: 0.0670829489827156
Epoch: 18
Loss on hold-out set: 0.002431392788390727
MeanAbsoluteError value on hold-out data: 0.039748407900333405
Epoch: 19
Loss on hold-out set: 0.004361507259186749
MeanAbsoluteError value on hold-out data: 0.05328439548611641
```

```
Epoch: 20
Loss on hold-out set: 0.0027687009619273197
MeanAbsoluteError value on hold-out data: 0.038979943841695786
Epoch: 21
Loss on hold-out set: 0.007477621498860811
MeanAbsoluteError value on hold-out data: 0.07261612266302109
Epoch: 22

Loss on hold-out set: 0.0031075679687905663
MeanAbsoluteError value on hold-out data: 0.04444887489080429
Epoch: 23
Loss on hold-out set: 0.0025016627179483245
MeanAbsoluteError value on hold-out data: 0.0377718061208725
Epoch: 24
Loss on hold-out set: 0.002230006859846119
MeanAbsoluteError value on hold-out data: 0.03500320017337799
Epoch: 25

Loss on hold-out set: 0.003027055869001503
MeanAbsoluteError value on hold-out data: 0.04272351413965225
Epoch: 26
Loss on hold-out set: 0.00316445523946497
MeanAbsoluteError value on hold-out data: 0.04525255784392357
Epoch: 27
Loss on hold-out set: 0.0020186185429338366
MeanAbsoluteError value on hold-out data: 0.03308369219303131
Epoch: 28
Loss on hold-out set: 0.0040734452363961424
MeanAbsoluteError value on hold-out data: 0.049330975860357285
Epoch: 29
Loss on hold-out set: 0.0019305068616583747
MeanAbsoluteError value on hold-out data: 0.03304780647158623
Epoch: 30
Loss on hold-out set: 0.0037356351615591464
MeanAbsoluteError value on hold-out data: 0.04637724533677101
Epoch: 31
Loss on hold-out set: 0.003580454229928651
MeanAbsoluteError value on hold-out data: 0.043901801109313965
Epoch: 32
Loss on hold-out set: 0.002209009743589712
MeanAbsoluteError value on hold-out data: 0.03729726001620293
Epoch: 33
```

```
Loss on hold-out set: 0.0032293773072428608
MeanAbsoluteError value on hold-out data: 0.04339681565761566
Epoch: 34
Loss on hold-out set: 0.004503221557426609
MeanAbsoluteError value on hold-out data: 0.05685720592737198
Epoch: 35
Loss on hold-out set: 0.003318121286084581
MeanAbsoluteError value on hold-out data: 0.0466034971177578
Epoch: 36

Loss on hold-out set: 0.004182444575953444
MeanAbsoluteError value on hold-out data: 0.053955331444740295
Epoch: 37
Loss on hold-out set: 0.0023592732445410405
MeanAbsoluteError value on hold-out data: 0.036316610872745514
Epoch: 38
Loss on hold-out set: 0.00656553518370186
MeanAbsoluteError value on hold-out data: 0.06465302407741547
Epoch: 39
Loss on hold-out set: 0.005746477427524759
MeanAbsoluteError value on hold-out data: 0.06626217067241669
Epoch: 40
Loss on hold-out set: 0.003086069841581201
MeanAbsoluteError value on hold-out data: 0.04612654820084572
Epoch: 41
Loss on hold-out set: 0.0030458694887592606
MeanAbsoluteError value on hold-out data: 0.04319379851222038
Epoch: 42
Loss on hold-out set: 0.003024849084843146
MeanAbsoluteError value on hold-out data: 0.04368703067302704
Epoch: 43
Loss on hold-out set: 0.0019126190868279849
MeanAbsoluteError value on hold-out data: 0.03444240242242813
Epoch: 44

Loss on hold-out set: 0.0019726531777690213
MeanAbsoluteError value on hold-out data: 0.031521204859018326
Epoch: 45
Loss on hold-out set: 0.0026000462806366974
MeanAbsoluteError value on hold-out data: 0.0364747978746891
Epoch: 46
Loss on hold-out set: 0.0020975738351760235
```

```
MeanAbsoluteError value on hold-out data: 0.033801041543483734
Epoch: 47

Loss on hold-out set: 0.002255197772204778
MeanAbsoluteError value on hold-out data: 0.03642784431576729
Epoch: 48
Loss on hold-out set: 0.005119302959524487
MeanAbsoluteError value on hold-out data: 0.062000490725040436
Epoch: 49
Loss on hold-out set: 0.0025736138547807442
MeanAbsoluteError value on hold-out data: 0.03640887513756752
Epoch: 50
Loss on hold-out set: 0.0027066791387225842
MeanAbsoluteError value on hold-out data: 0.04150724038481712
Epoch: 51
Loss on hold-out set: 0.0023268891856883115
MeanAbsoluteError value on hold-out data: 0.03607504069805145
Epoch: 52
Loss on hold-out set: 0.0017808287991915438
MeanAbsoluteError value on hold-out data: 0.031352028250694275
Epoch: 53
Loss on hold-out set: 0.0023292396937521468
MeanAbsoluteError value on hold-out data: 0.035909466445446014
Epoch: 54
Loss on hold-out set: 0.003675824340653459
MeanAbsoluteError value on hold-out data: 0.050031743943691254
Epoch: 55

Loss on hold-out set: 0.004545649357360641
MeanAbsoluteError value on hold-out data: 0.051742084324359894
Epoch: 56
Loss on hold-out set: 0.002941837777861541
MeanAbsoluteError value on hold-out data: 0.041258305311203
Epoch: 57
Loss on hold-out set: 0.003320990700127655
MeanAbsoluteError value on hold-out data: 0.0453067310154438
Epoch: 58

Loss on hold-out set: 0.002164080522274353
MeanAbsoluteError value on hold-out data: 0.03337148204445839
Epoch: 59
Loss on hold-out set: 0.0020239848197793195
```

```
MeanAbsoluteError value on hold-out data: 0.030980167910456657
Epoch: 60
Loss on hold-out set: 0.0031736222138677383
MeanAbsoluteError value on hold-out data: 0.042035963386297226
Epoch: 61
Loss on hold-out set: 0.0022727782703249864
MeanAbsoluteError value on hold-out data: 0.03847014158964157
Epoch: 62
Loss on hold-out set: 0.0037171950036855904
MeanAbsoluteError value on hold-out data: 0.05018535628914833
Epoch: 63
Loss on hold-out set: 0.002181513918147079
MeanAbsoluteError value on hold-out data: 0.03634432330727577
Epoch: 64
Loss on hold-out set: 0.002147132820314973
MeanAbsoluteError value on hold-out data: 0.03404764458537102
Epoch: 65
Loss on hold-out set: 0.0022068857383840765
MeanAbsoluteError value on hold-out data: 0.03541664034128189
Epoch: 66

Loss on hold-out set: 0.0019967319186482775
MeanAbsoluteError value on hold-out data: 0.032831232994794846
Epoch: 67
Loss on hold-out set: 0.003999630821789124
MeanAbsoluteError value on hold-out data: 0.04808390140533447
Epoch: 68
Loss on hold-out set: 0.002064963487148481
MeanAbsoluteError value on hold-out data: 0.030562512576580048
Epoch: 69

Loss on hold-out set: 0.0021830953957856095
MeanAbsoluteError value on hold-out data: 0.0363762341439724
Epoch: 70
Loss on hold-out set: 0.002528555893437251
MeanAbsoluteError value on hold-out data: 0.03895312547683716
Epoch: 71
Loss on hold-out set: 0.002130653725256898
MeanAbsoluteError value on hold-out data: 0.03445696830749512
Epoch: 72
Loss on hold-out set: 0.0021225481928252663
MeanAbsoluteError value on hold-out data: 0.034008339047431946
```

```
Epoch: 73
Loss on hold-out set: 0.0012548935549267825
MeanAbsoluteError value on hold-out data: 0.02693070098757744
Epoch: 74
Loss on hold-out set: 0.001426200470297389
MeanAbsoluteError value on hold-out data: 0.027059847488999367
Epoch: 75
Loss on hold-out set: 0.0025621129913672215
MeanAbsoluteError value on hold-out data: 0.04035687446594238
Epoch: 76
Loss on hold-out set: 0.0019143128853389307
MeanAbsoluteError value on hold-out data: 0.032555095851421356
Epoch: 77

Loss on hold-out set: 0.0016657249124316302
MeanAbsoluteError value on hold-out data: 0.03164300695061684
Epoch: 78
Loss on hold-out set: 0.0020318454557319023
MeanAbsoluteError value on hold-out data: 0.03178376331925392
Epoch: 79
Loss on hold-out set: 0.0023086846738710606
MeanAbsoluteError value on hold-out data: 0.03475270792841911
Epoch: 80

Loss on hold-out set: 0.0032232695276003427
MeanAbsoluteError value on hold-out data: 0.039936188608407974
Epoch: 81
Loss on hold-out set: 0.0016555280208673427
MeanAbsoluteError value on hold-out data: 0.028214000165462494
Epoch: 82
Loss on hold-out set: 0.0025067845996856798
MeanAbsoluteError value on hold-out data: 0.04086164012551308
Epoch: 83
Loss on hold-out set: 0.0015405558113247696
MeanAbsoluteError value on hold-out data: 0.02791478857398033
Epoch: 84
Loss on hold-out set: 0.0016932206092046965
MeanAbsoluteError value on hold-out data: 0.03221742436289787
Epoch: 85
Loss on hold-out set: 0.002579425856789672
MeanAbsoluteError value on hold-out data: 0.03878452628850937
Epoch: 86
```

```
Loss on hold-out set: 0.0022599395206749535
MeanAbsoluteError value on hold-out data: 0.038529105484485626
Epoch: 87
Loss on hold-out set: 0.004212612178985421
MeanAbsoluteError value on hold-out data: 0.05628424882888794
Epoch: 88

Loss on hold-out set: 0.0020731575901950954
MeanAbsoluteError value on hold-out data: 0.031181545928120613
Epoch: 89
Loss on hold-out set: 0.0029677497988909876
MeanAbsoluteError value on hold-out data: 0.04390142112970352
Epoch: 90
Loss on hold-out set: 0.0012414916874197508
MeanAbsoluteError value on hold-out data: 0.026426242664456367
Epoch: 91

Loss on hold-out set: 0.0014187560767535807
MeanAbsoluteError value on hold-out data: 0.02860700525343418
Epoch: 92
Loss on hold-out set: 0.002361255031581478
MeanAbsoluteError value on hold-out data: 0.037321630865335464
Epoch: 93
Loss on hold-out set: 0.0015662351652281359
MeanAbsoluteError value on hold-out data: 0.029440689831972122
Epoch: 94
Loss on hold-out set: 0.0016182507085767085
MeanAbsoluteError value on hold-out data: 0.02911841683089733
Epoch: 95
Loss on hold-out set: 0.00359963338001092
MeanAbsoluteError value on hold-out data: 0.04539016634225845
Epoch: 96
Loss on hold-out set: 0.0020710657577422496
MeanAbsoluteError value on hold-out data: 0.033814188092947006
Epoch: 97
Loss on hold-out set: 0.002128131187514794
MeanAbsoluteError value on hold-out data: 0.03598508983850479
Epoch: 98
Loss on hold-out set: 0.0020474035983696873
MeanAbsoluteError value on hold-out data: 0.03498505800962448
Epoch: 99
```

```
Loss on hold-out set: 0.0016892789954956818
MeanAbsoluteError value on hold-out data: 0.030040044337511063
Epoch: 100
Loss on hold-out set: 0.001714752977836485
MeanAbsoluteError value on hold-out data: 0.03067290037870407
Epoch: 101
Loss on hold-out set: 0.0022452017721278886
MeanAbsoluteError value on hold-out data: 0.035255737602710724
Epoch: 102

Loss on hold-out set: 0.0016661461329357209
MeanAbsoluteError value on hold-out data: 0.02864900603890419
Epoch: 103
Loss on hold-out set: 0.0015046614514032722
MeanAbsoluteError value on hold-out data: 0.02705465257167816
Epoch: 104
Loss on hold-out set: 0.004988460697380728
MeanAbsoluteError value on hold-out data: 0.05143794044852257
Epoch: 105
Loss on hold-out set: 0.0016226456967782916
MeanAbsoluteError value on hold-out data: 0.031856879591941833
Epoch: 106
Loss on hold-out set: 0.003576841240589458
MeanAbsoluteError value on hold-out data: 0.04392413794994354
Epoch: 107
Loss on hold-out set: 0.0015111554319829385
MeanAbsoluteError value on hold-out data: 0.0300933588296175
Epoch: 108
Loss on hold-out set: 0.0024493499873451106
MeanAbsoluteError value on hold-out data: 0.039732642471790314
Epoch: 109
Loss on hold-out set: 0.002095117565324089
MeanAbsoluteError value on hold-out data: 0.03421077877283096
Epoch: 110

Loss on hold-out set: 0.004357227813575025
MeanAbsoluteError value on hold-out data: 0.055893655866384506
Epoch: 111
Loss on hold-out set: 0.003186040073878278 7
MeanAbsoluteError value on hold-out data: 0.04749941825866699
Epoch: 112
Loss on hold-out set: 0.0018859924940012494
```

```
MeanAbsoluteError value on hold-out data: 0.03035137802362442
Epoch: 113

Loss on hold-out set: 0.001671557699170846
MeanAbsoluteError value on hold-out data: 0.029938777908682823
Epoch: 114
Loss on hold-out set: 0.0014696410025384179
MeanAbsoluteError value on hold-out data: 0.02835005149245262
Epoch: 115
Loss on hold-out set: 0.004401726130469653
MeanAbsoluteError value on hold-out data: 0.054903991520404816
Epoch: 116
Loss on hold-out set: 0.002378085573007794
MeanAbsoluteError value on hold-out data: 0.03603585436940193
Epoch: 117
Loss on hold-out set: 0.0017034287172320642
MeanAbsoluteError value on hold-out data: 0.0319950208067894
Epoch: 118
Loss on hold-out set: 0.0020974692926852426
MeanAbsoluteError value on hold-out data: 0.036202624440193176
Epoch: 119
Loss on hold-out set: 0.002071059399321185
MeanAbsoluteError value on hold-out data: 0.034492090344429016
Epoch: 120
Loss on hold-out set: 0.0017289682306765922
MeanAbsoluteError value on hold-out data: 0.03147511929273605
Epoch: 121

Loss on hold-out set: 0.0032926108504302406
MeanAbsoluteError value on hold-out data: 0.04507995769381523
Epoch: 122
Loss on hold-out set: 0.0015518695344278392
MeanAbsoluteError value on hold-out data: 0.02889932692050934
Epoch: 123
Loss on hold-out set: 0.0020322519121691585
MeanAbsoluteError value on hold-out data: 0.03168675675988197
Epoch: 124

Loss on hold-out set: 0.0024183472904903617
MeanAbsoluteError value on hold-out data: 0.03909275308251381
Epoch: 125
Loss on hold-out set: 0.0015417137068365456
```

```
MeanAbsoluteError value on hold-out data: 0.02890700101852417
Epoch: 126
Loss on hold-out set: 0.0036796137911120526
MeanAbsoluteError value on hold-out data: 0.04437551647424698
Epoch: 127
Loss on hold-out set: 0.0020907129157996295
MeanAbsoluteError value on hold-out data: 0.03239869326353073
Epoch: 128
Loss on hold-out set: 0.0018684142062403751
MeanAbsoluteError value on hold-out data: 0.03198704868555069
Epoch: 129
Loss on hold-out set: 0.00247490614971244
MeanAbsoluteError value on hold-out data: 0.038414206355810165
Epoch: 130
Loss on hold-out set: 0.0018391586904487525
MeanAbsoluteError value on hold-out data: 0.031245820224285126
Epoch: 131
Loss on hold-out set: 0.0014947276450632337
MeanAbsoluteError value on hold-out data: 0.026196224614977837
Epoch: 132

Loss on hold-out set: 0.0052646017743666704
MeanAbsoluteError value on hold-out data: 0.05886678025126457
Epoch: 133
Loss on hold-out set: 0.0027816341684420444
MeanAbsoluteError value on hold-out data: 0.03951583802700043
Epoch: 134
Loss on hold-out set: 0.002454484537960716
MeanAbsoluteError value on hold-out data: 0.037296827882528305
Epoch: 135

Loss on hold-out set: 0.0028612452197672895
MeanAbsoluteError value on hold-out data: 0.04461636021733284
Epoch: 136
Loss on hold-out set: 0.002404762055161164
MeanAbsoluteError value on hold-out data: 0.03372395411133766
Epoch: 137
Loss on hold-out set: 0.0025343835862402463
MeanAbsoluteError value on hold-out data: 0.03899935260415077
Epoch: 138
Loss on hold-out set: 0.0025348891948325267
MeanAbsoluteError value on hold-out data: 0.04029233753681183
```

```
Epoch: 139
Loss on hold-out set: 0.0028552383117034638
MeanAbsoluteError value on hold-out data: 0.04193924739956856
Epoch: 140
Loss on hold-out set: 0.0022665338581550473
MeanAbsoluteError value on hold-out data: 0.03492407873272896
Epoch: 141
Loss on hold-out set: 0.0026497312064748257
MeanAbsoluteError value on hold-out data: 0.03772759437561035
Epoch: 142
Loss on hold-out set: 0.0020205455067824865
MeanAbsoluteError value on hold-out data: 0.03489456698298454
Epoch: 143

Loss on hold-out set: 0.00211580641840364
MeanAbsoluteError value on hold-out data: 0.03338496759533882
Epoch: 144
Loss on hold-out set: 0.0039033107428909524
MeanAbsoluteError value on hold-out data: 0.05077269673347473
Epoch: 145
Loss on hold-out set: 0.004161218300731362
MeanAbsoluteError value on hold-out data: 0.05150553584098816
Epoch: 146

Loss on hold-out set: 0.003009011452760253
MeanAbsoluteError value on hold-out data: 0.039147548377513885
Epoch: 147
Loss on hold-out set: 0.001936856908478627
MeanAbsoluteError value on hold-out data: 0.03412004932761192
Epoch: 148
Loss on hold-out set: 0.0018075638700362393
MeanAbsoluteError value on hold-out data: 0.031510692089796066
Epoch: 149
Loss on hold-out set: 0.002376396473233686
MeanAbsoluteError value on hold-out data: 0.035777729004621506
Epoch: 150
Loss on hold-out set: 0.002130198969098273 7
MeanAbsoluteError value on hold-out data: 0.03184964507818222
Epoch: 151
Loss on hold-out set: 0.0034401916322837536
MeanAbsoluteError value on hold-out data: 0.05016123503446579
Epoch: 152
```

```
Loss on hold-out set: 0.0030510656192506615
MeanAbsoluteError value on hold-out data: 0.043851375579833984
Epoch: 153
Loss on hold-out set: 0.004485315658568747
MeanAbsoluteError value on hold-out data: 0.05819731578230858
Epoch: 154

Loss on hold-out set: 0.0028456576232871924
MeanAbsoluteError value on hold-out data: 0.039229799062013626
Epoch: 155
Loss on hold-out set: 0.001554414114492063
MeanAbsoluteError value on hold-out data: 0.029446935281157494
Epoch: 156
Loss on hold-out set: 0.00233819256582616
MeanAbsoluteError value on hold-out data: 0.03573615476489067
Epoch: 157

Loss on hold-out set: 0.002559344097359204
MeanAbsoluteError value on hold-out data: 0.03787747398018837
Epoch: 158
Loss on hold-out set: 0.0027624042765972646
MeanAbsoluteError value on hold-out data: 0.03758472949266434
Epoch: 159
Loss on hold-out set: 0.0016154874886667944
MeanAbsoluteError value on hold-out data: 0.030074071139097214
Epoch: 160
Loss on hold-out set: 0.002792459342009878
MeanAbsoluteError value on hold-out data: 0.03754636272788048
Epoch: 161
Loss on hold-out set: 0.0029663638606986127
MeanAbsoluteError value on hold-out data: 0.04270641505718231
Epoch: 162
Loss on hold-out set: 0.001918649174943934
MeanAbsoluteError value on hold-out data: 0.031155450269579887
Epoch: 163
Loss on hold-out set: 0.0015766076509240328
MeanAbsoluteError value on hold-out data: 0.02840600349009037
Epoch: 164
Loss on hold-out set: 0.0019134421634493936
MeanAbsoluteError value on hold-out data: 0.030319219455122948
Epoch: 165
```

```
Loss on hold-out set: 0.0024524607012465006
MeanAbsoluteError value on hold-out data: 0.038905106484889984
Epoch: 166
Loss on hold-out set: 0.002610020032366983
MeanAbsoluteError value on hold-out data: 0.03707672655582428
Epoch: 167
Loss on hold-out set: 0.002509727326564883
MeanAbsoluteError value on hold-out data: 0.036387257277965546
Epoch: 168

Loss on hold-out set: 0.0050719002702910645
MeanAbsoluteError value on hold-out data: 0.059734173119068146
Epoch: 169
Loss on hold-out set: 0.0028756729795867087
MeanAbsoluteError value on hold-out data: 0.042334046214818954
Epoch: 170
Loss on hold-out set: 0.002728449605025449
MeanAbsoluteError value on hold-out data: 0.040161632001399994
Epoch: 171
Loss on hold-out set: 0.001634240603858703
MeanAbsoluteError value on hold-out data: 0.030303310602903366
Epoch: 172
Loss on hold-out set: 0.003570204377051835
MeanAbsoluteError value on hold-out data: 0.04686911031603813
Epoch: 173
Loss on hold-out set: 0.0025587345972828764
MeanAbsoluteError value on hold-out data: 0.04097384586930275
Epoch: 174
Loss on hold-out set: 0.002253288696489395
MeanAbsoluteError value on hold-out data: 0.03328602388501167
Epoch: 175
Loss on hold-out set: 0.0014972248548139376
MeanAbsoluteError value on hold-out data: 0.028719311580061913
Epoch: 176

Loss on hold-out set: 0.0031492126014965927
MeanAbsoluteError value on hold-out data: 0.046134915202856064
Epoch: 177
Loss on hold-out set: 0.0018758859545127244
MeanAbsoluteError value on hold-out data: 0.02924513816833496
Epoch: 178
Loss on hold-out set: 0.0018990845289265149
```

```
MeanAbsoluteError value on hold-out data: 0.030979359522461 89
Epoch: 179

Loss on hold-out set: 0.0019085554442043711
MeanAbsoluteError value on hold-out data: 0.034311797469854355
Epoch: 180
Loss on hold-out set: 0.0028912302284305426
MeanAbsoluteError value on hold-out data: 0.04208078607916832
Epoch: 181
Loss on hold-out set: 0.0018031004261789157
MeanAbsoluteError value on hold-out data: 0.03006642311811447
Epoch: 182
Loss on hold-out set: 0.0020746177431551346
MeanAbsoluteError value on hold-out data: 0.037292178720235825
Epoch: 183
Loss on hold-out set: 0.001539522955059319
MeanAbsoluteError value on hold-out data: 0.02920704148709774
Epoch: 184
Loss on hold-out set: 0.0025121422368101776
MeanAbsoluteError value on hold-out data: 0.0386510007083416
Epoch: 185
Loss on hold-out set: 0.0028819103003785897
MeanAbsoluteError value on hold-out data: 0.03906799852848053
Epoch: 186
Loss on hold-out set: 0.0028168234015251265
MeanAbsoluteError value on hold-out data: 0.037420496344566345
Epoch: 187

Loss on hold-out set: 0.002621938946264747
MeanAbsoluteError value on hold-out data: 0.03932049497961998
Epoch: 188
Loss on hold-out set: 0.00235691195197624
MeanAbsoluteError value on hold-out data: 0.03619628772139549
Epoch: 189
Loss on hold-out set: 0.0030454998379450685
MeanAbsoluteError value on hold-out data: 0.04137231782078743
Epoch: 190

Loss on hold-out set: 0.002891913139089746
MeanAbsoluteError value on hold-out data: 0.04416942596435547
Epoch: 191
Loss on hold-out set: 0.0029549931534443444
```

```
MeanAbsoluteError value on hold-out data: 0.04303395748138428
Epoch: 192
Loss on hold-out set: 0.002251304026063544
MeanAbsoluteError value on hold-out data: 0.0356551855802536
Epoch: 193
Loss on hold-out set: 0.0035173241049051285
MeanAbsoluteError value on hold-out data: 0.050287194550037384
Epoch: 194
Loss on hold-out set: 0.002420314990510968
MeanAbsoluteError value on hold-out data: 0.03827955946326256
Epoch: 195
Loss on hold-out set: 0.0039193894251519324
MeanAbsoluteError value on hold-out data: 0.048903852701187134
Epoch: 196
Loss on hold-out set: 0.0021985006789787135
MeanAbsoluteError value on hold-out data: 0.03538988158106804
Epoch: 197
Loss on hold-out set: 0.0032040634266051805
MeanAbsoluteError value on hold-out data: 0.04645964503288269
Epoch: 198

Loss on hold-out set: 0.0044945544152716664
MeanAbsoluteError value on hold-out data: 0.05608830600976944
Epoch: 199
Loss on hold-out set: 0.001959292429857765
MeanAbsoluteError value on hold-out data: 0.03538183122873306
Epoch: 200
Loss on hold-out set: 0.002073322788323582
MeanAbsoluteError value on hold-out data: 0.03379075229167938
Epoch: 201

Loss on hold-out set: 0.002839767629905653
MeanAbsoluteError value on hold-out data: 0.0377080999314785
Epoch: 202
Loss on hold-out set: 0.003088046295727652
MeanAbsoluteError value on hold-out data: 0.04011835530400276
Epoch: 203
Loss on hold-out set: 0.002059946759561028
MeanAbsoluteError value on hold-out data: 0.03330856189131737
Epoch: 204
Loss on hold-out set: 0.002591035015939269
MeanAbsoluteError value on hold-out data: 0.03890825808048248
```

```
Epoch: 205
Loss on hold-out set: 0.0029246627006949367
MeanAbsoluteError value on hold-out data: 0.0388939194381237
Epoch: 206
Loss on hold-out set: 0.002129299942967727
MeanAbsoluteError value on hold-out data: 0.035785891115665436
Epoch: 207
Loss on hold-out set: 0.0031556153308453135
MeanAbsoluteError value on hold-out data: 0.04112402722239494
Epoch: 208
Loss on hold-out set: 0.0023483862582667683
MeanAbsoluteError value on hold-out data: 0.03650321811437607
Epoch: 209

Loss on hold-out set: 0.0035877961536722354
MeanAbsoluteError value on hold-out data: 0.043043289333581924
Epoch: 210
Loss on hold-out set: 0.002542719558971983
MeanAbsoluteError value on hold-out data: 0.03701302036643028
Epoch: 211
Loss on hold-out set: 0.0034898781726185823
MeanAbsoluteError value on hold-out data: 0.04733426123857498
Epoch: 212

Loss on hold-out set: 0.002176502203311477
MeanAbsoluteError value on hold-out data: 0.03344300389289856
Epoch: 213
Loss on hold-out set: 0.004320356602731504
MeanAbsoluteError value on hold-out data: 0.05150369182229042
Epoch: 214
Loss on hold-out set: 0.0024476781208680846
MeanAbsoluteError value on hold-out data: 0.03771761432290077
Epoch: 215
Loss on hold-out set: 0.0051068689453562625
MeanAbsoluteError value on hold-out data: 0.053677037358284
Epoch: 216
Loss on hold-out set: 0.0026049809913322526
MeanAbsoluteError value on hold-out data: 0.040638040751218796
Epoch: 217
Loss on hold-out set: 0.0024938295108241667
MeanAbsoluteError value on hold-out data: 0.034606948494911194
Epoch: 218
```

```
Loss on hold-out set: 0.0031722544337849526
MeanAbsoluteError value on hold-out data: 0.04084264487028122
Early stopping at epoch 217
Returned to Spot: Validation loss: 0.0031722544337849526
----------------------------------------------
```

If `path` is set to a filename, e.g., `path = "model_spot_trained.pt"`, the weights of the trained model will be loaded from this file.

```
test_tuned(net=model_spot, test_dataset=test,
            shuffle=False,
            loss_function=fun_control["loss_function"],
            metric=fun_control["metric_torch"],
            device = fun_control["device"],
            task=fun_control["task"],)
```

```
Loss on hold-out set: 0.0037043515367258806
MeanAbsoluteError value on hold-out data: 0.043754544109106064
Final evaluation: Validation loss: 0.0037043515367258806
Final evaluation: Validation metric: 0.043754544109106064
----------------------------------------------
```

```
(0.0037043515367258806, nan, tensor(0.0438))
```

25.17 Cross-validated Evaluations

- This is the evaluation that will be used in the comparison (evaluatecv has to be updated before, to get metric vlaues!):

```
from spotPython.torch.traintest import evaluate_cv
# modify k-kolds:
setattr(model_spot, "k_folds",  10)
df_eval, df_preds, df_metrics = evaluate_cv(net=model_spot,
            dataset=fun_control["data"],
            loss_function=fun_control["loss_function"],
            metric=fun_control["metric_torch"],
            task=fun_control["task"],
            writer=fun_control["writer"],
            writerId="model_spot_cv",
            device = fun_control["device"])
```

```
Fold: 1
Epoch: 1

Loss on hold-out set: 0.012692000824384965
MeanAbsoluteError value on hold-out data: 0.09483733773231506
Epoch: 2
Loss on hold-out set: 0.00935836791848907
MeanAbsoluteError value on hold-out data: 0.07357105612754822
Epoch: 3

Loss on hold-out set: 0.008003047318197787
MeanAbsoluteError value on hold-out data: 0.06899234652519226
Epoch: 4
Loss on hold-out set: 0.006169301726353856
MeanAbsoluteError value on hold-out data: 0.061294469982385635
Epoch: 5
Loss on hold-out set: 0.005503852618858218
MeanAbsoluteError value on hold-out data: 0.0627584159374237
Epoch: 6

Loss on hold-out set: 0.004824529863141764
MeanAbsoluteError value on hold-out data: 0.05552791431546211
Epoch: 7

Loss on hold-out set: 0.003611825666247079
MeanAbsoluteError value on hold-out data: 0.04487162083387375
Epoch: 8
Loss on hold-out set: 0.005027942896748965
MeanAbsoluteError value on hold-out data: 0.05706587806344032
Epoch: 9
Loss on hold-out set: 0.0035297314528948986
MeanAbsoluteError value on hold-out data: 0.04508917033672333
Epoch: 10

Loss on hold-out set: 0.0031002505633156174
MeanAbsoluteError value on hold-out data: 0.04167172312736511
Epoch: 11
Loss on hold-out set: 0.0025076259267874635
MeanAbsoluteError value on hold-out data: 0.03591878339648247
Epoch: 12
Loss on hold-out set: 0.0030365193244786216
```

```
MeanAbsoluteError value on hold-out data: 0.041848234832286835
Epoch: 13

Loss on hold-out set: 0.004518382537823457
MeanAbsoluteError value on hold-out data: 0.054931264370679855
Epoch: 14

Loss on hold-out set: 0.0028304848461770094
MeanAbsoluteError value on hold-out data: 0.04193520173430443
Epoch: 15
Loss on hold-out set: 0.002170827255423109
MeanAbsoluteError value on hold-out data: 0.035014476627111435
Epoch: 16
Loss on hold-out set: 0.001740857672232848
MeanAbsoluteError value on hold-out data: 0.03309883177280426
Epoch: 17

Loss on hold-out set: 0.0022027169918426527
MeanAbsoluteError value on hold-out data: 0.03727395087480545
Epoch: 18
Loss on hold-out set: 0.001810539142192843
MeanAbsoluteError value on hold-out data: 0.03341641277074814
Epoch: 19
Loss on hold-out set: 0.0027986602732338584
MeanAbsoluteError value on hold-out data: 0.04285057634115219
Epoch: 20

Loss on hold-out set: 0.0019922142875237535
MeanAbsoluteError value on hold-out data: 0.03456127271056175

Epoch: 21
Loss on hold-out set: 0.002991457371256099
MeanAbsoluteError value on hold-out data: 0.04384728893637657
Epoch: 22
Loss on hold-out set: 0.001809763941519822
MeanAbsoluteError value on hold-out data: 0.03315419703722
Epoch: 23
Loss on hold-out set: 0.002119044364707616
MeanAbsoluteError value on hold-out data: 0.0346943661570549
Epoch: 24
```

```
Loss on hold-out set: 0.00429764726700691
MeanAbsoluteError value on hold-out data: 0.054618217051029205
Epoch: 25
Loss on hold-out set: 0.0011651655659079552
MeanAbsoluteError value on hold-out data: 0.025045504793524742
Epoch: 26
Loss on hold-out set: 0.0013767692188803966
MeanAbsoluteError value on hold-out data: 0.027047159150242805
Epoch: 27

Loss on hold-out set: 0.0028084124451897177
MeanAbsoluteError value on hold-out data: 0.04233024641871452
Epoch: 28
Loss on hold-out set: 0.0021866770067180577
MeanAbsoluteError value on hold-out data: 0.03461892530322075
Epoch: 29
Loss on hold-out set: 0.002431559806259779
MeanAbsoluteError value on hold-out data: 0.04287019744515419
Epoch: 30
Loss on hold-out set: 0.002502990601127609
MeanAbsoluteError value on hold-out data: 0.038528647273778915
Epoch: 31

Loss on hold-out set: 0.002459007765327652
MeanAbsoluteError value on hold-out data: 0.03619324415922165
Epoch: 32
Loss on hold-out set: 0.0024487252096430613
MeanAbsoluteError value on hold-out data: 0.035609886050224304
Epoch: 33
Loss on hold-out set: 0.001867068913550331
MeanAbsoluteError value on hold-out data: 0.03348234295845032
Epoch: 34

Loss on hold-out set: 0.003334441311800709
MeanAbsoluteError value on hold-out data: 0.045948635786771774
Epoch: 35
Loss on hold-out set: 0.0028395890437353114
MeanAbsoluteError value on hold-out data: 0.04529498890042305
Epoch: 36
Loss on hold-out set: 0.0011895553526790957
MeanAbsoluteError value on hold-out data: 0.02619221620261669
Epoch: 37
```

```
Loss on hold-out set: 0.0018302860508601253
MeanAbsoluteError value on hold-out data: 0.031196918338537216
Epoch: 38

Loss on hold-out set: 0.003275105765519234
MeanAbsoluteError value on hold-out data: 0.044522665441036224
Epoch: 39
Loss on hold-out set: 0.002460128063550935
MeanAbsoluteError value on hold-out data: 0.04039967060089111
Epoch: 40
Loss on hold-out set: 0.00240062796868957
MeanAbsoluteError value on hold-out data: 0.03974667191505432
Epoch: 41

Loss on hold-out set: 0.0024407848518771622
MeanAbsoluteError value on hold-out data: 0.035830941051244736
Epoch: 42
Loss on hold-out set: 0.0016583845202918523
MeanAbsoluteError value on hold-out data: 0.02913484163582325
Epoch: 43
Loss on hold-out set: 0.0019092618357927466
MeanAbsoluteError value on hold-out data: 0.0333247184753418
Epoch: 44
Loss on hold-out set: 0.0033458528073074725
MeanAbsoluteError value on hold-out data: 0.042681798338890076

Epoch: 45
Loss on hold-out set: 0.0018578600004100455
MeanAbsoluteError value on hold-out data: 0.03414912894368172
Epoch: 46
Loss on hold-out set: 0.0023316363624941846
MeanAbsoluteError value on hold-out data: 0.032990362495183945
Epoch: 47
Loss on hold-out set: 0.0012516288015131766
MeanAbsoluteError value on hold-out data: 0.0261231679469347
Epoch: 48

Loss on hold-out set: 0.00443823030218482
MeanAbsoluteError value on hold-out data: 0.0481548011302948
Epoch: 49
Loss on hold-out set: 0.0024780061033267816
```

```
MeanAbsoluteError value on hold-out data: 0.036313533782958984
Epoch: 50
Loss on hold-out set: 0.0039625362081166645
MeanAbsoluteError value on hold-out data: 0.05109158158302307
Epoch: 51

Loss on hold-out set: 0.003702106104286101
MeanAbsoluteError value on hold-out data: 0.04606960341334343
Epoch: 52
Loss on hold-out set: 0.002507650754593599
MeanAbsoluteError value on hold-out data: 0.03637361899018288
Epoch: 53
Loss on hold-out set: 0.00218400553925536
MeanAbsoluteError value on hold-out data: 0.03048994578421116
Epoch: 54
Loss on hold-out set: 0.0012198783515486866
MeanAbsoluteError value on hold-out data: 0.025874173268675804
Epoch: 55

Loss on hold-out set: 0.0018823473365046084
MeanAbsoluteError value on hold-out data: 0.032350894063711166
Epoch: 56
Loss on hold-out set: 0.0018750673603230657
MeanAbsoluteError value on hold-out data: 0.03595579043030739
Epoch: 57
Loss on hold-out set: 0.0021914777372820447
MeanAbsoluteError value on hold-out data: 0.03701159358024597
Epoch: 58

Loss on hold-out set: 0.003690121086457601
MeanAbsoluteError value on hold-out data: 0.04759474843740463
Epoch: 59
Loss on hold-out set: 0.002055054414086044
MeanAbsoluteError value on hold-out data: 0.03460043668746948
Epoch: 60
Loss on hold-out set: 0.0028582539167613364
MeanAbsoluteError value on hold-out data: 0.04040157422423363
Epoch: 61
Loss on hold-out set: 0.002157281900648601
MeanAbsoluteError value on hold-out data: 0.034909602254629135
Epoch: 62
```

```
Loss on hold-out set: 0.0018018958922206925
MeanAbsoluteError value on hold-out data: 0.030033616349101067
Epoch: 63
Loss on hold-out set: 0.0019410060754475684
MeanAbsoluteError value on hold-out data: 0.0327773243188858
Epoch: 64
Loss on hold-out set: 0.002118062344379723
MeanAbsoluteError value on hold-out data: 0.038310278207063675
Epoch: 65

Loss on hold-out set: 0.0021191307325632526
MeanAbsoluteError value on hold-out data: 0.035016149282455444
Epoch: 66
Loss on hold-out set: 0.002402861454846481
MeanAbsoluteError value on hold-out data: 0.0357726588845253
Epoch: 67
Loss on hold-out set: 0.003588220932914947
MeanAbsoluteError value on hold-out data: 0.044845446944236755
Epoch: 68
Loss on hold-out set: 0.002371289489719157
MeanAbsoluteError value on hold-out data: 0.035646952688694
Epoch: 69

Loss on hold-out set: 0.0014117343593030595
MeanAbsoluteError value on hold-out data: 0.026671085506677628
Epoch: 70
Loss on hold-out set: 0.0018570117401675535
MeanAbsoluteError value on hold-out data: 0.03113367408514023
Epoch: 71
Loss on hold-out set: 0.0011264371636431091
MeanAbsoluteError value on hold-out data: 0.025761665776371956
Epoch: 72

Loss on hold-out set: 0.002515483840117947
MeanAbsoluteError value on hold-out data: 0.035365354269742966
Epoch: 73
Loss on hold-out set: 0.0013818869035905944
MeanAbsoluteError value on hold-out data: 0.027321157976984978
Epoch: 74
Loss on hold-out set: 0.0032407143354738275
MeanAbsoluteError value on hold-out data: 0.038148947060108185
Epoch: 75
```

```
Loss on hold-out set: 0.0020296320390815917
MeanAbsoluteError value on hold-out data: 0.030132973566651344
Epoch: 76

Loss on hold-out set: 0.0027767483216638747
MeanAbsoluteError value on hold-out data: 0.03930860385298729
Epoch: 77
Loss on hold-out set: 0.0014836580264202964
MeanAbsoluteError value on hold-out data: 0.02972964011132717
Epoch: 78
Loss on hold-out set: 0.002079844259871886
MeanAbsoluteError value on hold-out data: 0.03490498661994934
Epoch: 79

Loss on hold-out set: 0.002869920258840116
MeanAbsoluteError value on hold-out data: 0.042520660907030106
Epoch: 80
Loss on hold-out set: 0.0023171064811042296
MeanAbsoluteError value on hold-out data: 0.037128839641809464
Epoch: 81
Loss on hold-out set: 0.005160389897915034
MeanAbsoluteError value on hold-out data: 0.06285972893238068
Epoch: 82
Loss on hold-out set: 0.002823619536894302
MeanAbsoluteError value on hold-out data: 0.0347418412566185
Epoch: 83

Loss on hold-out set: 0.0018792292058396225
MeanAbsoluteError value on hold-out data: 0.03372543677687645
Epoch: 84
Loss on hold-out set: 0.0024473480119083365
MeanAbsoluteError value on hold-out data: 0.03696246072649956
Epoch: 85
Loss on hold-out set: 0.0020266327505501416
MeanAbsoluteError value on hold-out data: 0.034463733434677124
Epoch: 86

Loss on hold-out set: 0.0011176941496579764
MeanAbsoluteError value on hold-out data: 0.022956790402531624
Epoch: 87
Loss on hold-out set: 0.0014336980272603866
```

```
MeanAbsoluteError value on hold-out data: 0.026262231171131134
Epoch: 88
Loss on hold-out set: 0.0012032334592591864
MeanAbsoluteError value on hold-out data: 0.02495492994785309
Epoch: 89
Loss on hold-out set: 0.0021466187743219333
MeanAbsoluteError value on hold-out data: 0.03380216658115387
Epoch: 90

Loss on hold-out set: 0.0030301838414743543
MeanAbsoluteError value on hold-out data: 0.04336969926953316
Epoch: 91
Loss on hold-out set: 0.001274706983867173
MeanAbsoluteError value on hold-out data: 0.0268547460436821
Epoch: 92
Loss on hold-out set: 0.002326690468740148
MeanAbsoluteError value on hold-out data: 0.03961145505309105
Epoch: 93

Loss on hold-out set: 0.005779629179204886
MeanAbsoluteError value on hold-out data: 0.05933563783764839
Epoch: 94
Loss on hold-out set: 0.002666833513873056
MeanAbsoluteError value on hold-out data: 0.03855746611952782
Epoch: 95
Loss on hold-out set: 0.0021608272867384725
MeanAbsoluteError value on hold-out data: 0.031056448817253113
Epoch: 96
Loss on hold-out set: 0.0026554280551723563
MeanAbsoluteError value on hold-out data: 0.04351060092449188
Epoch: 97

Loss on hold-out set: 0.0028347281174949156
MeanAbsoluteError value on hold-out data: 0.038422130048274994
Epoch: 98
Loss on hold-out set: 0.0019800211661137068
MeanAbsoluteError value on hold-out data: 0.03142014518380165
Epoch: 99
Loss on hold-out set: 0.0009819949695016616
MeanAbsoluteError value on hold-out data: 0.024126123636960983
Epoch: 100
```

```
Loss on hold-out set: 0.0022041801802025964
MeanAbsoluteError value on hold-out data: 0.03392554819583893
Epoch: 101
Loss on hold-out set: 0.0022394197742239786
MeanAbsoluteError value on hold-out data: 0.035922370851039886
Epoch: 102
Loss on hold-out set: 0.001825979634304531
MeanAbsoluteError value on hold-out data: 0.027195598930120468
Epoch: 103
Loss on hold-out set: 0.0012072059952725584
MeanAbsoluteError value on hold-out data: 0.027372345328330994
Epoch: 104

Loss on hold-out set: 0.002206242576134033
MeanAbsoluteError value on hold-out data: 0.032377082854509354
Epoch: 105
Loss on hold-out set: 0.0016448403207155375
MeanAbsoluteError value on hold-out data: 0.025163421407341957
Epoch: 106
Loss on hold-out set: 0.0028038935091059944
MeanAbsoluteError value on hold-out data: 0.03450147807598114
Epoch: 107

Loss on hold-out set: 0.0017909644207415672
MeanAbsoluteError value on hold-out data: 0.03134547546505928
Epoch: 108
Loss on hold-out set: 0.0025581218427620255
MeanAbsoluteError value on hold-out data: 0.03398967906832695
Epoch: 109
Loss on hold-out set: 0.0015822373075374903
MeanAbsoluteError value on hold-out data: 0.027792472392320633
Epoch: 110
Loss on hold-out set: 0.0026480761208893876
MeanAbsoluteError value on hold-out data: 0.03368965536355972
Epoch: 111

Loss on hold-out set: 0.001589669229220957
MeanAbsoluteError value on hold-out data: 0.02944549173116684
Epoch: 112
Loss on hold-out set: 0.0017567225418483408
MeanAbsoluteError value on hold-out data: 0.029748788103461266
Epoch: 113
```

```
Loss on hold-out set: 0.0014723486347065773
MeanAbsoluteError value on hold-out data: 0.027600204572081566
Epoch: 114

Loss on hold-out set: 0.0030531417321001822
MeanAbsoluteError value on hold-out data: 0.03859969973564148
Epoch: 115
Loss on hold-out set: 0.0024470357860151967
MeanAbsoluteError value on hold-out data: 0.0373491495847702
Epoch: 116
Loss on hold-out set: 0.0022550523191547166
MeanAbsoluteError value on hold-out data: 0.03367675468325615
Epoch: 117
Loss on hold-out set: 0.0014557321376812
MeanAbsoluteError value on hold-out data: 0.02671564742922783
Epoch: 118

Loss on hold-out set: 0.0013578760856314777
MeanAbsoluteError value on hold-out data: 0.02630455419421196
Epoch: 119
Loss on hold-out set: 0.0023616130257813404
MeanAbsoluteError value on hold-out data: 0.03625824302434921
Epoch: 120
Loss on hold-out set: 0.00221675460656675
MeanAbsoluteError value on hold-out data: 0.033759407699108124
Epoch: 121

Loss on hold-out set: 0.002318334135522421
MeanAbsoluteError value on hold-out data: 0.03236056864261627
Epoch: 122
Loss on hold-out set: 0.002256208932242141
MeanAbsoluteError value on hold-out data: 0.03525461629033089
Epoch: 123
Loss on hold-out set: 0.001475774022625186
MeanAbsoluteError value on hold-out data: 0.029752220958471298
Epoch: 124
Loss on hold-out set: 0.0010172339926402157
MeanAbsoluteError value on hold-out data: 0.02468804083764553
Epoch: 125

Loss on hold-out set: 0.0021453799115708815
```

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MeanAbsoluteError value on hold-out data: 0.033475544303655624
Epoch: 126
Loss on hold-out set: 0.0019785569770297464
MeanAbsoluteError value on hold-out data: 0.029600203037261963
Epoch: 127
Loss on hold-out set: 0.0021160710602998734
MeanAbsoluteError value on hold-out data: 0.03227395564317703
Epoch: 128

Loss on hold-out set: 0.002332089025563059
MeanAbsoluteError value on hold-out data: 0.03253158926963806
Epoch: 129
Loss on hold-out set: 0.0011100203454798947
MeanAbsoluteError value on hold-out data: 0.023788966238498688
Epoch: 130
Loss on hold-out set: 0.0036450142685610512
MeanAbsoluteError value on hold-out data: 0.05029933899641037
Epoch: 131
Loss on hold-out set: 0.0025734588897858676
MeanAbsoluteError value on hold-out data: 0.038040537387132645
Epoch: 132

Loss on hold-out set: 0.005581652602324119
MeanAbsoluteError value on hold-out data: 0.06207507103681564
Epoch: 133
Loss on hold-out set: 0.0012572272412049083
MeanAbsoluteError value on hold-out data: 0.02590467780828476
Epoch: 134
Loss on hold-out set: 0.0019687007275374178
MeanAbsoluteError value on hold-out data: 0.03225867822766304
Epoch: 135

Loss on hold-out set: 0.0022704766340141827
MeanAbsoluteError value on hold-out data: 0.03270675241947174
Epoch: 136
Loss on hold-out set: 0.001196648576296866
MeanAbsoluteError value on hold-out data: 0.025648724287748337
Epoch: 137
Loss on hold-out set: 0.0016391411862479379
MeanAbsoluteError value on hold-out data: 0.026540707796812057
Epoch: 138
Loss on hold-out set: 0.002082185607063226
```

```
MeanAbsoluteError value on hold-out data: 0.027319561690092087
Epoch: 139

Loss on hold-out set: 0.001348349659775312
MeanAbsoluteError value on hold-out data: 0.029430758208036423
Epoch: 140
Loss on hold-out set: 0.0025902411703450177
MeanAbsoluteError value on hold-out data: 0.040616150945425034
Epoch: 141
Loss on hold-out set: 0.002592201311087522
MeanAbsoluteError value on hold-out data: 0.03696434199810028
Epoch: 142

Loss on hold-out set: 0.0016237488352299596
MeanAbsoluteError value on hold-out data: 0.02759941667318344
Epoch: 143
Loss on hold-out set: 0.002254514372907579
MeanAbsoluteError value on hold-out data: 0.03681349381804466
Epoch: 144
Loss on hold-out set: 0.0012601582454338383
MeanAbsoluteError value on hold-out data: 0.024545134976506233
Epoch: 145
Loss on hold-out set: 0.0025868252985394346
MeanAbsoluteError value on hold-out data: 0.0304816085845232
Epoch: 146

Loss on hold-out set: 0.0017873031185724987
MeanAbsoluteError value on hold-out data: 0.03272942081093788
Epoch: 147
Loss on hold-out set: 0.0020810456883807024
MeanAbsoluteError value on hold-out data: 0.03095983900129795
Epoch: 148
Loss on hold-out set: 0.0019537351998643805
MeanAbsoluteError value on hold-out data: 0.03495103120803833
Epoch: 149

Loss on hold-out set: 0.0013821140970461643
MeanAbsoluteError value on hold-out data: 0.027903491631150246
Epoch: 150
Loss on hold-out set: 0.001199072111586037
MeanAbsoluteError value on hold-out data: 0.023992246016860008
```

```
Epoch: 151
Loss on hold-out set: 0.0026946775559246396
MeanAbsoluteError value on hold-out data: 0.03078795224428177
Epoch: 152
Loss on hold-out set: 0.0028883804200002207
MeanAbsoluteError value on hold-out data: 0.03341337665915489
Epoch: 153

Loss on hold-out set: 0.0016272550565190613
MeanAbsoluteError value on hold-out data: 0.03380812332034111
Epoch: 154
Loss on hold-out set: 0.002049461553374735
MeanAbsoluteError value on hold-out data: 0.036799103021621704
Epoch: 155
Loss on hold-out set: 0.002142328437632666
MeanAbsoluteError value on hold-out data: 0.03430146723985672
Epoch: 156

Loss on hold-out set: 0.004095933274724162
MeanAbsoluteError value on hold-out data: 0.047992266714572906
Epoch: 157
Loss on hold-out set: 0.0024433213089091275
MeanAbsoluteError value on hold-out data: 0.03305083140730858
Epoch: 158
Loss on hold-out set: 0.001357942797207775
MeanAbsoluteError value on hold-out data: 0.03032105229794979
Epoch: 159
Loss on hold-out set: 0.002015490192346848
MeanAbsoluteError value on hold-out data: 0.035993266850709915
Epoch: 160

Loss on hold-out set: 0.0011353338307414449
MeanAbsoluteError value on hold-out data: 0.02762254700064659
Epoch: 161
Loss on hold-out set: 0.0044236386333628055
MeanAbsoluteError value on hold-out data: 0.04109445959329605
Epoch: 162
Loss on hold-out set: 0.0025542972054189215
MeanAbsoluteError value on hold-out data: 0.03478952497243881
Epoch: 163
```

```
Loss on hold-out set: 0.0016826758913409251
MeanAbsoluteError value on hold-out data: 0.028260808438062668
Epoch: 164
Loss on hold-out set: 0.0018057548127566965
MeanAbsoluteError value on hold-out data: 0.025748882442712784
Epoch: 165
Loss on hold-out set: 0.001986085537982245
MeanAbsoluteError value on hold-out data: 0.03310572728514671
Epoch: 166
Loss on hold-out set: 0.002104638025719816
MeanAbsoluteError value on hold-out data: 0.030666247010231018
Epoch: 167

Loss on hold-out set: 0.002027457105354048
MeanAbsoluteError value on hold-out data: 0.030679909512400627
Epoch: 168
Loss on hold-out set: 0.0022847996554516544
MeanAbsoluteError value on hold-out data: 0.029315102845430374
Epoch: 169
Loss on hold-out set: 0.0018382674002518447
MeanAbsoluteError value on hold-out data: 0.026523485779762268
Epoch: 170

Loss on hold-out set: 0.0015015293387337946
MeanAbsoluteError value on hold-out data: 0.02958541177213192
Epoch: 171
Loss on hold-out set: 0.0040544698623797065
MeanAbsoluteError value on hold-out data: 0.051856108009815216
Epoch: 172
Loss on hold-out set: 0.0015980451067802138
MeanAbsoluteError value on hold-out data: 0.031207550317049026
Epoch: 173
Loss on hold-out set: 0.0015432401403534012
MeanAbsoluteError value on hold-out data: 0.024957071989774704
Epoch: 174

Loss on hold-out set: 0.0022984432625190285
MeanAbsoluteError value on hold-out data: 0.028704704716801643
Epoch: 175
Loss on hold-out set: 0.001963245854802573
MeanAbsoluteError value on hold-out data: 0.029113801196217537
Epoch: 176
```

```
Loss on hold-out set: 0.0011806747240300935
MeanAbsoluteError value on hold-out data: 0.024092523381114006
Epoch: 177

Loss on hold-out set: 0.0016194031833527754
MeanAbsoluteError value on hold-out data: 0.02985914796590805
Epoch: 178
Loss on hold-out set: 0.0017214947236845126
MeanAbsoluteError value on hold-out data: 0.029959144070744514
Epoch: 179
Loss on hold-out set: 0.002928830018320766
MeanAbsoluteError value on hold-out data: 0.03815379738807678
Epoch: 180
Loss on hold-out set: 0.0023521876025300184
MeanAbsoluteError value on hold-out data: 0.03065718151628971
Epoch: 181

Loss on hold-out set: 0.0023563038065241505
MeanAbsoluteError value on hold-out data: 0.03260219097137451
Epoch: 182
Loss on hold-out set: 0.002900367938519384
MeanAbsoluteError value on hold-out data: 0.03529481962323189
Epoch: 183
Loss on hold-out set: 0.0017097132367780432
MeanAbsoluteError value on hold-out data: 0.02642808109521866
Epoch: 184

Loss on hold-out set: 0.0024157190995398336
MeanAbsoluteError value on hold-out data: 0.03178710117936134
Epoch: 185
Loss on hold-out set: 0.0029331194415975074
MeanAbsoluteError value on hold-out data: 0.039762359112501144
Epoch: 186
Loss on hold-out set: 0.002218747587623791
MeanAbsoluteError value on hold-out data: 0.03173856809735298
Epoch: 187
Loss on hold-out set: 0.0022014423571258355
MeanAbsoluteError value on hold-out data: 0.031210798770189285
Epoch: 188

Loss on hold-out set: 0.003499238536908076
```

```
MeanAbsoluteError value on hold-out data: 0.04835052415728569
Epoch: 189
Loss on hold-out set: 0.0024096103499267395
MeanAbsoluteError value on hold-out data: 0.03043282777070999
Epoch: 190
Loss on hold-out set: 0.0024203180957836313
MeanAbsoluteError value on hold-out data: 0.033680509775877
Epoch: 191

Loss on hold-out set: 0.0011545429028606473
MeanAbsoluteError value on hold-out data: 0.02766340784728527
Epoch: 192
Loss on hold-out set: 0.00373065697763545
MeanAbsoluteError value on hold-out data: 0.03670356795191765
Epoch: 193
Loss on hold-out set: 0.002027174054931563
MeanAbsoluteError value on hold-out data: 0.0327136255800724
Epoch: 194
Loss on hold-out set: 0.001175732029458651
MeanAbsoluteError value on hold-out data: 0.02663002721965313
Epoch: 195

Loss on hold-out set: 0.0016031645892116313
MeanAbsoluteError value on hold-out data: 0.02743556909263134
Epoch: 196
Loss on hold-out set: 0.0029172048895046688
MeanAbsoluteError value on hold-out data: 0.04269961267709732
Epoch: 197
Loss on hold-out set: 0.002773164726722126
MeanAbsoluteError value on hold-out data: 0.03088812530040741
Epoch: 198

Loss on hold-out set: 0.002183773698141942
MeanAbsoluteError value on hold-out data: 0.03910665214061737
Epoch: 199
Loss on hold-out set: 0.0018666375522465946
MeanAbsoluteError value on hold-out data: 0.032463040202856064
Epoch: 200
Loss on hold-out set: 0.0019447231360782797
MeanAbsoluteError value on hold-out data: 0.034113071858882904
Epoch: 201
Loss on hold-out set: 0.002466089111224462
```

```
MeanAbsoluteError value on hold-out data: 0.032511886209249496
Epoch: 202

Loss on hold-out set: 0.001348937566105563
MeanAbsoluteError value on hold-out data: 0.02146388776600361
Epoch: 203
Loss on hold-out set: 0.001827614032663405
MeanAbsoluteError value on hold-out data: 0.027642564848065376
Epoch: 204
Loss on hold-out set: 0.002108689097580142
MeanAbsoluteError value on hold-out data: 0.03454044461250305
Epoch: 205

Loss on hold-out set: 0.0018138267959539706
MeanAbsoluteError value on hold-out data: 0.033001963049173355
Epoch: 206
Loss on hold-out set: 0.0020933026093049333
MeanAbsoluteError value on hold-out data: 0.02625308185815811
Epoch: 207
Loss on hold-out set: 0.001986749516128419
MeanAbsoluteError value on hold-out data: 0.028649089857935905
Epoch: 208
Loss on hold-out set: 0.002178052834306772
MeanAbsoluteError value on hold-out data: 0.033235687762498856
Epoch: 209

Loss on hold-out set: 0.0021596164129172955
MeanAbsoluteError value on hold-out data: 0.034970931708812714
Epoch: 210
Loss on hold-out set: 0.0016548038592400888
MeanAbsoluteError value on hold-out data: 0.026691386476159096
Epoch: 211
Loss on hold-out set: 0.0012799460315503753
MeanAbsoluteError value on hold-out data: 0.027545254677534103
Epoch: 212

Loss on hold-out set: 0.003015662073336828
MeanAbsoluteError value on hold-out data: 0.03919001668691635
Epoch: 213
Loss on hold-out set: 0.0012610462995675893
MeanAbsoluteError value on hold-out data: 0.023040711879730225
```

```
Epoch: 214
Loss on hold-out set: 0.002665842023606484
MeanAbsoluteError value on hold-out data: 0.04453187435865402
Epoch: 215
Loss on hold-out set: 0.003919527937586491
MeanAbsoluteError value on hold-out data: 0.038825564086437225
Epoch: 216

Loss on hold-out set: 0.0015005607162423145
MeanAbsoluteError value on hold-out data: 0.026295609772205353
Epoch: 217
Loss on hold-out set: 0.0016650363283518415
MeanAbsoluteError value on hold-out data: 0.028029851615428925
Epoch: 218
Loss on hold-out set: 0.002657493818193101
MeanAbsoluteError value on hold-out data: 0.03860161453485489
Epoch: 219

Loss on hold-out set: 0.0019074344924704817
MeanAbsoluteError value on hold-out data: 0.03089531697332859
Epoch: 220
Loss on hold-out set: 0.004026997449377982
MeanAbsoluteError value on hold-out data: 0.05368511751294136
Epoch: 221
Loss on hold-out set: 0.0017452914258823372
MeanAbsoluteError value on hold-out data: 0.02697635628283024
Epoch: 222
Loss on hold-out set: 0.0014638072215557958
MeanAbsoluteError value on hold-out data: 0.026236945763230324
Epoch: 223

Loss on hold-out set: 0.0015580560989642085
MeanAbsoluteError value on hold-out data: 0.028760947287082672
Epoch: 224
Loss on hold-out set: 0.0021977072599558877
MeanAbsoluteError value on hold-out data: 0.036338575184345245
Epoch: 225
Loss on hold-out set: 0.0019741853018506216
MeanAbsoluteError value on hold-out data: 0.03310325741767883
Epoch: 226
```

```
Loss on hold-out set: 0.0016267445932428997
MeanAbsoluteError value on hold-out data: 0.02991892397403717
Epoch: 227
Loss on hold-out set: 0.0034279043186241044
MeanAbsoluteError value on hold-out data: 0.042052969336509705
Early stopping at epoch 226
Fold: 2
Epoch: 1
Loss on hold-out set: 0.018474471021013763
MeanAbsoluteError value on hold-out data: 0.1081111803650856
Epoch: 2
Loss on hold-out set: 0.015261377601955946
MeanAbsoluteError value on hold-out data: 0.09958308935165405
Epoch: 3

Loss on hold-out set: 0.005513353237452416
MeanAbsoluteError value on hold-out data: 0.05994585528969765
Epoch: 4
Loss on hold-out set: 0.005356248593530976
MeanAbsoluteError value on hold-out data: 0.05807340517640114
Epoch: 5
Loss on hold-out set: 0.005322943360974582
MeanAbsoluteError value on hold-out data: 0.05195754021406174
Epoch: 6

Loss on hold-out set: 0.0027231627251379765
MeanAbsoluteError value on hold-out data: 0.043877676129341125
Epoch: 7
Loss on hold-out set: 0.005204875049038002
MeanAbsoluteError value on hold-out data: 0.05483535677194595
Epoch: 8
Loss on hold-out set: 0.004983638225194926
MeanAbsoluteError value on hold-out data: 0.05683496594429016
Epoch: 9
Loss on hold-out set: 0.002374292163249965
MeanAbsoluteError value on hold-out data: 0.03938332945108414
Epoch: 10

Loss on hold-out set: 0.0023520726065796157
MeanAbsoluteError value on hold-out data: 0.035058118402957916
Epoch: 11
Loss on hold-out set: 0.001904919425634524
```

```
MeanAbsoluteError value on hold-out data: 0.03574402257800102
Epoch: 12
Loss on hold-out set: 0.002399352114970008
MeanAbsoluteError value on hold-out data: 0.03367317095398903
Epoch: 13

Loss on hold-out set: 0.0021485524305787226
MeanAbsoluteError value on hold-out data: 0.03278198838233948
Epoch: 14
Loss on hold-out set: 0.004492816139155855
MeanAbsoluteError value on hold-out data: 0.051740627735853195
Epoch: 15
Loss on hold-out set: 0.005577333862535083
MeanAbsoluteError value on hold-out data: 0.0636887401342392
Epoch: 16
Loss on hold-out set: 0.0028084486928911735
MeanAbsoluteError value on hold-out data: 0.031418576836586
Epoch: 17

Loss on hold-out set: 0.0019698281181403077
MeanAbsoluteError value on hold-out data: 0.03375299647450447
Epoch: 18
Loss on hold-out set: 0.002040914555366796
MeanAbsoluteError value on hold-out data: 0.031010601669549942
Epoch: 19
Loss on hold-out set: 0.007136973856876676
MeanAbsoluteError value on hold-out data: 0.06638725847005844
Epoch: 20

Loss on hold-out set: 0.0016311383828556596
MeanAbsoluteError value on hold-out data: 0.02900843136012554
Epoch: 21
Loss on hold-out set: 0.0036097719298245814
MeanAbsoluteError value on hold-out data: 0.04622376337647438
Epoch: 22
Loss on hold-out set: 0.0027210792983309007
MeanAbsoluteError value on hold-out data: 0.037160538136959076
Epoch: 23
Loss on hold-out set: 0.001901749167210745
MeanAbsoluteError value on hold-out data: 0.027856511995196342
Epoch: 24
```

```
Loss on hold-out set: 0.00201568604433515
MeanAbsoluteError value on hold-out data: 0.03204277530312538
Epoch: 25
Loss on hold-out set: 0.0016994837631220715
MeanAbsoluteError value on hold-out data: 0.028213422745466232
Epoch: 26
Loss on hold-out set: 0.0028718081302940845
MeanAbsoluteError value on hold-out data: 0.03912537172436714
Epoch: 27

Loss on hold-out set: 0.003401461299150609
MeanAbsoluteError value on hold-out data: 0.050514232367277145
Epoch: 28
Loss on hold-out set: 0.0016075815186083603
MeanAbsoluteError value on hold-out data: 0.024371758103370667
Epoch: 29
Loss on hold-out set: 0.0025303961167362733
MeanAbsoluteError value on hold-out data: 0.03180961310863495
Epoch: 30
Loss on hold-out set: 0.002100865387966713
MeanAbsoluteError value on hold-out data: 0.030486412346363068
Epoch: 31

Loss on hold-out set: 0.0013369297711715961
MeanAbsoluteError value on hold-out data: 0.02663866989314556
Epoch: 32
Loss on hold-out set: 0.0027062340478341165
MeanAbsoluteError value on hold-out data: 0.04198415204882622
Epoch: 33
Loss on hold-out set: 0.002765934137502112
MeanAbsoluteError value on hold-out data: 0.0333927646279335
Epoch: 34

Loss on hold-out set: 0.003263948883753843
MeanAbsoluteError value on hold-out data: 0.041591811925172806
Epoch: 35
Loss on hold-out set: 0.004703437999034157
MeanAbsoluteError value on hold-out data: 0.054557107388973236
Epoch: 36
Loss on hold-out set: 0.001663008310760443
MeanAbsoluteError value on hold-out data: 0.0281009990721941
Epoch: 37
```

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Loss on hold-out set: 0.002148184304062922
MeanAbsoluteError value on hold-out data: 0.029666375368833542
Epoch: 38

Loss on hold-out set: 0.0017727889935486019
MeanAbsoluteError value on hold-out data: 0.024377698078751564
Epoch: 39
Loss on hold-out set: 0.0027337802054647068
MeanAbsoluteError value on hold-out data: 0.04194764047861099
Epoch: 40
Loss on hold-out set: 0.0035873708906225287
MeanAbsoluteError value on hold-out data: 0.044031448662281036
Epoch: 41

Loss on hold-out set: 0.001284004005496032
MeanAbsoluteError value on hold-out data: 0.0255235955119133
Epoch: 42
Loss on hold-out set: 0.002029353411321958
MeanAbsoluteError value on hold-out data: 0.027698645368218422
Epoch: 43
Loss on hold-out set: 0.001964671920107391
MeanAbsoluteError value on hold-out data: 0.03490111976861954
Epoch: 44
Loss on hold-out set: 0.002289213580437578
MeanAbsoluteError value on hold-out data: 0.033185675740242004
Epoch: 45

Loss on hold-out set: 0.0018687272856298548
MeanAbsoluteError value on hold-out data: 0.03032883256673813
Epoch: 46
Loss on hold-out set: 0.00517215587807676
MeanAbsoluteError value on hold-out data: 0.05869148671627045
Epoch: 47
Loss on hold-out set: 0.0027443837428178927
MeanAbsoluteError value on hold-out data: 0.041604701429605484
Epoch: 48

Loss on hold-out set: 0.0011346749424074704
MeanAbsoluteError value on hold-out data: 0.022864097729325294
Epoch: 49
Loss on hold-out set: 0.0019555843587463293
```

```
MeanAbsoluteError value on hold-out data: 0.02898394875228405
Epoch: 50
Loss on hold-out set: 0.001963835454751881
MeanAbsoluteError value on hold-out data: 0.03327198326587677
Epoch: 51
Loss on hold-out set: 0.001820017442626592
MeanAbsoluteError value on hold-out data: 0.03009738028049469
Epoch: 52

Loss on hold-out set: 0.002459455071052966
MeanAbsoluteError value on hold-out data: 0.03879943862557411
Epoch: 53
Loss on hold-out set: 0.001972089631285948
MeanAbsoluteError value on hold-out data: 0.02685977704823017
Epoch: 54
Loss on hold-out set: 0.0015536902624612243
MeanAbsoluteError value on hold-out data: 0.026321103796362877
Epoch: 55

Loss on hold-out set: 0.002165572592415489
MeanAbsoluteError value on hold-out data: 0.03132656216621399
Epoch: 56
Loss on hold-out set: 0.0018866975912645173
MeanAbsoluteError value on hold-out data: 0.029229164123535156
Epoch: 57
Loss on hold-out set: 0.0018831242710942975
MeanAbsoluteError value on hold-out data: 0.03066534548997879
Epoch: 58
Loss on hold-out set: 0.0011716814993773229
MeanAbsoluteError value on hold-out data: 0.022142969071865082
Epoch: 59

Loss on hold-out set: 0.0025484357208300093
MeanAbsoluteError value on hold-out data: 0.02852761186659336
Epoch: 60
Loss on hold-out set: 0.0023117655834469656
MeanAbsoluteError value on hold-out data: 0.041042957454919815
Epoch: 61
Loss on hold-out set: 0.0017232391356418913
MeanAbsoluteError value on hold-out data: 0.029813522472977638
Epoch: 62
```

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Loss on hold-out set: 0.002322066772299317
MeanAbsoluteError value on hold-out data: 0.03157445788383484
Epoch: 63
Loss on hold-out set: 0.0014732317957588327
MeanAbsoluteError value on hold-out data: 0.028222383931279182
Epoch: 64
Loss on hold-out set: 0.0012920199559840302
MeanAbsoluteError value on hold-out data: 0.024668013677001
Epoch: 65
Loss on hold-out set: 0.0013488460860501688
MeanAbsoluteError value on hold-out data: 0.028724931180477142
Epoch: 66

Loss on hold-out set: 0.002048817984849358
MeanAbsoluteError value on hold-out data: 0.030898403376340866
Epoch: 67
Loss on hold-out set: 0.0025962525262282444
MeanAbsoluteError value on hold-out data: 0.042417291551828384
Epoch: 68
Loss on hold-out set: 0.0011526991707237007
MeanAbsoluteError value on hold-out data: 0.02191237360239029
Epoch: 69

Loss on hold-out set: 0.0012435158121381672
MeanAbsoluteError value on hold-out data: 0.02474266104400158
Epoch: 70
Loss on hold-out set: 0.001683653515871041
MeanAbsoluteError value on hold-out data: 0.030529841780662537
Epoch: 71
Loss on hold-out set: 0.0019367358517439032
MeanAbsoluteError value on hold-out data: 0.03033050335943699
Epoch: 72
Loss on hold-out set: 0.0009213025063777772
MeanAbsoluteError value on hold-out data: 0.021781735122203827
Epoch: 73

Loss on hold-out set: 0.0014979424170003487
MeanAbsoluteError value on hold-out data: 0.03052075393497944
Epoch: 74
Loss on hold-out set: 0.0009117974550463259
MeanAbsoluteError value on hold-out data: 0.021477501839399338
Epoch: 75
```

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Loss on hold-out set: 0.0023378347776507814
MeanAbsoluteError value on hold-out data: 0.03583862632513046
Epoch: 76

Loss on hold-out set: 0.001744645220102169
MeanAbsoluteError value on hold-out data: 0.027367711067199707
Epoch: 77
Loss on hold-out set: 0.003628102937140144
MeanAbsoluteError value on hold-out data: 0.04670194536447525
Epoch: 78
Loss on hold-out set: 0.002093925723994079
MeanAbsoluteError value on hold-out data: 0.03119819238781929
Epoch: 79
Loss on hold-out set: 0.0017788577847218572
MeanAbsoluteError value on hold-out data: 0.03272167220711708
Epoch: 80

Loss on hold-out set: 0.0010058113067106416
MeanAbsoluteError value on hold-out data: 0.02561613731086254
Epoch: 81
Loss on hold-out set: 0.0037560189151778244
MeanAbsoluteError value on hold-out data: 0.038017481565475464
Epoch: 82
Loss on hold-out set: 0.0013889325334905432
MeanAbsoluteError value on hold-out data: 0.027382126078009605
Epoch: 83

Loss on hold-out set: 0.0024996110453055454
MeanAbsoluteError value on hold-out data: 0.036648936569690704
Epoch: 84
Loss on hold-out set: 0.0021939458943401966
MeanAbsoluteError value on hold-out data: 0.033484019339084625
Epoch: 85
Loss on hold-out set: 0.0009299492767940348
MeanAbsoluteError value on hold-out data: 0.02283070981502533
Epoch: 86
Loss on hold-out set: 0.001291658017390336
MeanAbsoluteError value on hold-out data: 0.02823007106781006
Epoch: 87

Loss on hold-out set: 0.0026028090281985127
```

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MeanAbsoluteError value on hold-out data: 0.040241461247205734
Epoch: 88
Loss on hold-out set: 0.0014031627607227375
MeanAbsoluteError value on hold-out data: 0.025487136095762253
Epoch: 89
Loss on hold-out set: 0.001452999234271164
MeanAbsoluteError value on hold-out data: 0.029796767979860306
Epoch: 90

Loss on hold-out set: 0.0017831456722118533
MeanAbsoluteError value on hold-out data: 0.03457837924361229
Epoch: 91
Loss on hold-out set: 0.0016006370245192486
MeanAbsoluteError value on hold-out data: 0.03232000023126602
Epoch: 92
Loss on hold-out set: 0.00113252888527663
MeanAbsoluteError value on hold-out data: 0.022127646952867508
Epoch: 93
Loss on hold-out set: 0.0022514432673163423
MeanAbsoluteError value on hold-out data: 0.02994369901716709
Epoch: 94

Loss on hold-out set: 0.001414121056978519
MeanAbsoluteError value on hold-out data: 0.03012361377477646
Epoch: 95
Loss on hold-out set: 0.002007254869498026
MeanAbsoluteError value on hold-out data: 0.029850730672478676
Epoch: 96
Loss on hold-out set: 0.002437033054705423
MeanAbsoluteError value on hold-out data: 0.039692096412181854
Epoch: 97

Loss on hold-out set: 0.002375502882596965
MeanAbsoluteError value on hold-out data: 0.03542713820934296
Epoch: 98
Loss on hold-out set: 0.0014001244540290476
MeanAbsoluteError value on hold-out data: 0.024805059656500816
Epoch: 99
Loss on hold-out set: 0.00114423477386411
MeanAbsoluteError value on hold-out data: 0.024992400780320168
Epoch: 100
Loss on hold-out set: 0.0016862261601580451
```

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MeanAbsoluteError value on hold-out data: 0.027315247803926468
Epoch: 101

Loss on hold-out set: 0.0015778402605344756
MeanAbsoluteError value on hold-out data: 0.027361376211047173
Epoch: 102
Loss on hold-out set: 0.0011435727490327107
MeanAbsoluteError value on hold-out data: 0.026723479852080345
Epoch: 103
Loss on hold-out set: 0.001233313143110046
MeanAbsoluteError value on hold-out data: 0.027184803038835526
Epoch: 104

Loss on hold-out set: 0.003649891560109189
MeanAbsoluteError value on hold-out data: 0.04950759932398796
Epoch: 105
Loss on hold-out set: 0.0015453955521269774
MeanAbsoluteError value on hold-out data: 0.026325512677431107
Epoch: 106
Loss on hold-out set: 0.0036794388523468603
MeanAbsoluteError value on hold-out data: 0.050488200038671494
Epoch: 107
Loss on hold-out set: 0.003064077589302682
MeanAbsoluteError value on hold-out data: 0.04279769957065582
Epoch: 108

Loss on hold-out set: 0.0021040714345872402
MeanAbsoluteError value on hold-out data: 0.0286080501973629
Epoch: 109
Loss on hold-out set: 0.0034694676735223485
MeanAbsoluteError value on hold-out data: 0.04638654366135597
Epoch: 110
Loss on hold-out set: 0.0012196625578396309
MeanAbsoluteError value on hold-out data: 0.02824482135474682
Epoch: 111

Loss on hold-out set: 0.001266298620276547
MeanAbsoluteError value on hold-out data: 0.023250939324498177
Epoch: 112
Loss on hold-out set: 0.0019343067900850796
MeanAbsoluteError value on hold-out data: 0.02712283656001091
```

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Epoch: 113
Loss on hold-out set: 0.001441717676173609
MeanAbsoluteError value on hold-out data: 0.02768397517502308
Epoch: 114
Loss on hold-out set: 0.0013626454030879987
MeanAbsoluteError value on hold-out data: 0.030896062031388283
Epoch: 115

Loss on hold-out set: 0.0010707942184616025
MeanAbsoluteError value on hold-out data: 0.02091188356280327
Epoch: 116
Loss on hold-out set: 0.0021949481742922217
MeanAbsoluteError value on hold-out data: 0.03091399371623993
Epoch: 117
Loss on hold-out set: 0.002130716277931172
MeanAbsoluteError value on hold-out data: 0.036502573639154434
Epoch: 118

Loss on hold-out set: 0.000758506471846396
MeanAbsoluteError value on hold-out data: 0.020007073879241943
Epoch: 119
Loss on hold-out set: 0.0016010340253929966
MeanAbsoluteError value on hold-out data: 0.02584938332438469
Epoch: 120
Loss on hold-out set: 0.003312152465626311
MeanAbsoluteError value on hold-out data: 0.04207377880811691
Epoch: 121
Loss on hold-out set: 0.002664964834156518
MeanAbsoluteError value on hold-out data: 0.037968993186950684
Epoch: 122

Loss on hold-out set: 0.0007790610420320613
MeanAbsoluteError value on hold-out data: 0.0200806874781847
Epoch: 123
Loss on hold-out set: 0.002768904154296391
MeanAbsoluteError value on hold-out data: 0.04686478525400162
Epoch: 124
Loss on hold-out set: 0.0010070063760325026
MeanAbsoluteError value on hold-out data: 0.024399762973189354
Epoch: 125
```

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Loss on hold-out set: 0.000979936433185895
MeanAbsoluteError value on hold-out data: 0.022146912291646004
Epoch: 126
Loss on hold-out set: 0.001543475068711604
MeanAbsoluteError value on hold-out data: 0.029212191700935364
Epoch: 127
Loss on hold-out set: 0.0013563712239444542
MeanAbsoluteError value on hold-out data: 0.02470353990793228
Epoch: 128
Loss on hold-out set: 0.002861440208597252
MeanAbsoluteError value on hold-out data: 0.041323885321617126
Epoch: 129

Loss on hold-out set: 0.0016819277258876425
MeanAbsoluteError value on hold-out data: 0.03318396583199501
Epoch: 130
Loss on hold-out set: 0.001170715047919657
MeanAbsoluteError value on hold-out data: 0.02279762737452984
Epoch: 131
Loss on hold-out set: 0.0030329797255734983
MeanAbsoluteError value on hold-out data: 0.0456179715692997
Epoch: 132

Loss on hold-out set: 0.002185481074355686
MeanAbsoluteError value on hold-out data: 0.029979651793837547
Epoch: 133
Loss on hold-out set: 0.000833628591723167
MeanAbsoluteError value on hold-out data: 0.020914409309625626
Epoch: 134
Loss on hold-out set: 0.002115598696176536
MeanAbsoluteError value on hold-out data: 0.029992075636982918
Epoch: 135
Loss on hold-out set: 0.0021571654092090633
MeanAbsoluteError value on hold-out data: 0.03635440021753311
Epoch: 136

Loss on hold-out set: 0.001584735349752009
MeanAbsoluteError value on hold-out data: 0.03489195182919502
Epoch: 137
Loss on hold-out set: 0.0012879110022018163
MeanAbsoluteError value on hold-out data: 0.026125192642211914
Epoch: 138
```

```
Loss on hold-out set: 0.0024089670131126274
MeanAbsoluteError value on hold-out data: 0.03955953195691109
Epoch: 139

Loss on hold-out set: 0.0017233606418952919
MeanAbsoluteError value on hold-out data: 0.03317093849182129
Epoch: 140
Loss on hold-out set: 0.0017414106170270736
MeanAbsoluteError value on hold-out data: 0.028160464018583298
Epoch: 141
Loss on hold-out set: 0.00215288021046525
MeanAbsoluteError value on hold-out data: 0.032007619738578796
Epoch: 142
Loss on hold-out set: 0.001176230103458063
MeanAbsoluteError value on hold-out data: 0.026679016649723053
Epoch: 143

Loss on hold-out set: 0.0018649863912007557
MeanAbsoluteError value on hold-out data: 0.03297646343708038
Epoch: 144
Loss on hold-out set: 0.0021071581420703577
MeanAbsoluteError value on hold-out data: 0.02841823548078537
Epoch: 145
Loss on hold-out set: 0.0013392280536488844
MeanAbsoluteError value on hold-out data: 0.027970844879746437
Epoch: 146

Loss on hold-out set: 0.0007851420456203274
MeanAbsoluteError value on hold-out data: 0.021359222009778023
Epoch: 147
Loss on hold-out set: 0.001154850483334695
MeanAbsoluteError value on hold-out data: 0.026202769950032234
Epoch: 148
Loss on hold-out set: 0.001442534116414698
MeanAbsoluteError value on hold-out data: 0.024882659316062927
Epoch: 149
Loss on hold-out set: 0.0014898825242058733
MeanAbsoluteError value on hold-out data: 0.03099956549704075
Epoch: 150

Loss on hold-out set: 0.0027389950611485313
```

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MeanAbsoluteError value on hold-out data: 0.028711508959531784
Epoch: 151
Loss on hold-out set: 0.0018970740605324793
MeanAbsoluteError value on hold-out data: 0.029990948736667633
Epoch: 152
Loss on hold-out set: 0.0019607559325567517
MeanAbsoluteError value on hold-out data: 0.029016608372330666
Epoch: 153

Loss on hold-out set: 0.001406250595419596
MeanAbsoluteError value on hold-out data: 0.026731781661510468
Epoch: 154
Loss on hold-out set: 0.0014075034503968288
MeanAbsoluteError value on hold-out data: 0.02888677828013897
Epoch: 155
Loss on hold-out set: 0.0012500056182034314
MeanAbsoluteError value on hold-out data: 0.022602397948503494
Epoch: 156
Loss on hold-out set: 0.004019954660459637
MeanAbsoluteError value on hold-out data: 0.04525833949446678
Epoch: 157

Loss on hold-out set: 0.001023587957696201
MeanAbsoluteError value on hold-out data: 0.021555932238698006
Epoch: 158
Loss on hold-out set: 0.0019408615704518384
MeanAbsoluteError value on hold-out data: 0.03198586776852608
Epoch: 159
Loss on hold-out set: 0.00107626336438653
MeanAbsoluteError value on hold-out data: 0.02427070401608944
Epoch: 160

Loss on hold-out set: 0.0027852574332008283
MeanAbsoluteError value on hold-out data: 0.03493167459964752
Epoch: 161
Loss on hold-out set: 0.0027754907317173024
MeanAbsoluteError value on hold-out data: 0.033430732786655426
Epoch: 162
Loss on hold-out set: 0.0013877364662431108
MeanAbsoluteError value on hold-out data: 0.023714233189821243
Epoch: 163
Loss on hold-out set: 0.002357510522975085
```

```
MeanAbsoluteError value on hold-out data: 0.03748610243201256
Epoch: 164

Loss on hold-out set: 0.0016546954038158918
MeanAbsoluteError value on hold-out data: 0.029909009113907814
Epoch: 165
Loss on hold-out set: 0.0019325624049927753
MeanAbsoluteError value on hold-out data: 0.034479741007089615
Epoch: 166
Loss on hold-out set: 0.0008761131880769077
MeanAbsoluteError value on hold-out data: 0.02169509418308735
Epoch: 167

Loss on hold-out set: 0.0010839301304748426
MeanAbsoluteError value on hold-out data: 0.022845938801765442
Epoch: 168
Loss on hold-out set: 0.0013844301574863493
MeanAbsoluteError value on hold-out data: 0.02477940171957016
Epoch: 169
Loss on hold-out set: 0.0010092062338326986
MeanAbsoluteError value on hold-out data: 0.02328171208500862
Epoch: 170
Loss on hold-out set: 0.0006501983298221603
MeanAbsoluteError value on hold-out data: 0.01917535997927189
Epoch: 171

Loss on hold-out set: 0.0028420018766505215
MeanAbsoluteError value on hold-out data: 0.04573174566030502
Epoch: 172
Loss on hold-out set: 0.0017395166304105748
MeanAbsoluteError value on hold-out data: 0.03425586596131325
Epoch: 173
Loss on hold-out set: 0.003104468879218285
MeanAbsoluteError value on hold-out data: 0.04310707747936249
Epoch: 174

Loss on hold-out set: 0.002205569270210197
MeanAbsoluteError value on hold-out data: 0.03747788071632385
Epoch: 175
Loss on hold-out set: 0.0012726738081815152
MeanAbsoluteError value on hold-out data: 0.02911187708377838
```

```
Epoch: 176
Loss on hold-out set: 0.0007722626424555739
MeanAbsoluteError value on hold-out data: 0.019992826506495476
Epoch: 177
Loss on hold-out set: 0.001741706053368174
MeanAbsoluteError value on hold-out data: 0.03652571141719818
Epoch: 178
Loss on hold-out set: 0.004226226511841 21
MeanAbsoluteError value on hold-out data: 0.05109434947371483
Epoch: 179
Loss on hold-out set: 0.0012650181799052427
MeanAbsoluteError value on hold-out data: 0.025795087218284607
Epoch: 180
Loss on hold-out set: 0.0009782660770444917
MeanAbsoluteError value on hold-out data: 0.023275544866919518
Epoch: 181
Loss on hold-out set: 0.001978275330307392
MeanAbsoluteError value on hold-out data: 0.03624625504016876
Epoch: 182
Loss on hold-out set: 0.0018977474425740254
MeanAbsoluteError value on hold-out data: 0.028953194618225098
Epoch: 183
Loss on hold-out set: 0.0008031033548132444
MeanAbsoluteError value on hold-out data: 0.021111443638801575
Epoch: 184
Loss on hold-out set: 0.0016946320739897112
MeanAbsoluteError value on hold-out data: 0.02815583534538746
Epoch: 185
Loss on hold-out set: 0.003250902755938184
MeanAbsoluteError value on hold-out data: 0.039580997079610825
Epoch: 186
Loss on hold-out set: 0.0021849383528415975
MeanAbsoluteError value on hold-out data: 0.03431697562336922
Epoch: 187
Loss on hold-out set: 0.0014436250158513968
MeanAbsoluteError value on hold-out data: 0.029040692374110222
Epoch: 188
```

```
Loss on hold-out set: 0.0012426451811244567
MeanAbsoluteError value on hold-out data: 0.02485438622534275
Epoch: 189
Loss on hold-out set: 0.0016088080055151994
MeanAbsoluteError value on hold-out data: 0.03223004192113876
Epoch: 190
Loss on hold-out set: 0.001668528355926705
MeanAbsoluteError value on hold-out data: 0.02832990139722824
Epoch: 191
Loss on hold-out set: 0.004501773966834522
MeanAbsoluteError value on hold-out data: 0.05407463014125824
Epoch: 192

Loss on hold-out set: 0.0012119693151012494
MeanAbsoluteError value on hold-out data: 0.02544798143208027
Epoch: 193
Loss on hold-out set: 0.001775662531144917
MeanAbsoluteError value on hold-out data: 0.034387312829494476
Epoch: 194
Loss on hold-out set: 0.0011794676359456319
MeanAbsoluteError value on hold-out data: 0.02640114352107048
Epoch: 195

Loss on hold-out set: 0.0008373342078322401
MeanAbsoluteError value on hold-out data: 0.02370946854352951
Epoch: 196
Loss on hold-out set: 0.0009920098236761987
MeanAbsoluteError value on hold-out data: 0.02137904427945614
Epoch: 197
Loss on hold-out set: 0.002290086522967053
MeanAbsoluteError value on hold-out data: 0.036427728831768036
Epoch: 198
Loss on hold-out set: 0.001481051532139715
MeanAbsoluteError value on hold-out data: 0.022746849805116653
Epoch: 199

Loss on hold-out set: 0.002277298506949312
MeanAbsoluteError value on hold-out data: 0.03066956251859665
Epoch: 200
Loss on hold-out set: 0.0014288230987194066
MeanAbsoluteError value on hold-out data: 0.027451569214463234
Epoch: 201
```

```
Loss on hold-out set: 0.0012244713815072407
MeanAbsoluteError value on hold-out data: 0.026798641309142113
Epoch: 202

Loss on hold-out set: 0.0017916406863010847
MeanAbsoluteError value on hold-out data: 0.030454330146312714
Epoch: 203
Loss on hold-out set: 0.0017858938349840732
MeanAbsoluteError value on hold-out data: 0.028134550899267197
Epoch: 204
Loss on hold-out set: 0.0015999526636173518
MeanAbsoluteError value on hold-out data: 0.031105242669582367
Epoch: 205
Loss on hold-out set: 0.0012877986300736666
MeanAbsoluteError value on hold-out data: 0.026954052969813347
Epoch: 206

Loss on hold-out set: 0.0012155471306938964
MeanAbsoluteError value on hold-out data: 0.02747245877981186
Epoch: 207
Loss on hold-out set: 0.0034143091985382712
MeanAbsoluteError value on hold-out data: 0.03650987520813942
Epoch: 208
Loss on hold-out set: 0.0010599658103623928
MeanAbsoluteError value on hold-out data: 0.024927783757448196
Epoch: 209

Loss on hold-out set: 0.001192972036033797
MeanAbsoluteError value on hold-out data: 0.022167716175317764
Epoch: 210
Loss on hold-out set: 0.0017897411095103822
MeanAbsoluteError value on hold-out data: 0.026773259043693542
Epoch: 211
Loss on hold-out set: 0.00192865250685897
MeanAbsoluteError value on hold-out data: 0.03406238928437233
Epoch: 212
Loss on hold-out set: 0.0019904859184932252
MeanAbsoluteError value on hold-out data: 0.03264491260051727
Epoch: 213

Loss on hold-out set: 0.001403206410871532
```

```
MeanAbsoluteError value on hold-out data: 0.02749236673116684
Epoch: 214
Loss on hold-out set: 0.0012580409815060333
MeanAbsoluteError value on hold-out data: 0.02396896295249462
Epoch: 215
Loss on hold-out set: 0.0011084616691312897
MeanAbsoluteError value on hold-out data: 0.02354075014591217
Epoch: 216

Loss on hold-out set: 0.002085749906165382
MeanAbsoluteError value on hold-out data: 0.03619769588112831
Epoch: 217
Loss on hold-out set: 0.001285314495012594
MeanAbsoluteError value on hold-out data: 0.024942820891737938
Epoch: 218
Loss on hold-out set: 0.001215974097319234
MeanAbsoluteError value on hold-out data: 0.03009917214512825
Epoch: 219
Loss on hold-out set: 0.001700488192280038
MeanAbsoluteError value on hold-out data: 0.028820984065532684
Epoch: 220

Loss on hold-out set: 0.0024518196856101546
MeanAbsoluteError value on hold-out data: 0.03771986812353134
Epoch: 221
Loss on hold-out set: 0.0008272664809527879
MeanAbsoluteError value on hold-out data: 0.018256312236189842
Epoch: 222
Loss on hold-out set: 0.0010157151454432795
MeanAbsoluteError value on hold-out data: 0.02380342036485672
Epoch: 223

Loss on hold-out set: 0.0010895276612315613
MeanAbsoluteError value on hold-out data: 0.025681262835860252
Epoch: 224
Loss on hold-out set: 0.0008103470429957199
MeanAbsoluteError value on hold-out data: 0.021639253944158554
Epoch: 225
Loss on hold-out set: 0.0014580776993310652
MeanAbsoluteError value on hold-out data: 0.024314409121870995
Epoch: 226
Loss on hold-out set: 0.001969058462866367
```

```
MeanAbsoluteError value on hold-out data: 0.02993384189903736
Epoch: 227

Loss on hold-out set: 0.0015497914282605052
MeanAbsoluteError value on hold-out data: 0.02467975579202175
Epoch: 228
Loss on hold-out set: 0.001921320899362819
MeanAbsoluteError value on hold-out data: 0.02784544974565506
Epoch: 229
Loss on hold-out set: 0.002307973112552785
MeanAbsoluteError value on hold-out data: 0.04045911133289337
Epoch: 230

Loss on hold-out set: 0.0008209514568219534
MeanAbsoluteError value on hold-out data: 0.0230476763099432
Epoch: 231
Loss on hold-out set: 0.0009436091025306198
MeanAbsoluteError value on hold-out data: 0.020501986145973206
Epoch: 232
Loss on hold-out set: 0.001403136454218139
MeanAbsoluteError value on hold-out data: 0.0241922028362751
Epoch: 233
Loss on hold-out set: 0.0015514217688737868
MeanAbsoluteError value on hold-out data: 0.027369922026991844
Epoch: 234

Loss on hold-out set: 0.0011569207216290613
MeanAbsoluteError value on hold-out data: 0.02594311535358429
Epoch: 235
Loss on hold-out set: 0.0006796957347362947
MeanAbsoluteError value on hold-out data: 0.019201915711164474
Epoch: 236
Loss on hold-out set: 0.002051132269955885
MeanAbsoluteError value on hold-out data: 0.03828885406255722
Epoch: 237

Loss on hold-out set: 0.0012414347595320297
MeanAbsoluteError value on hold-out data: 0.024459274485707283
Epoch: 238
Loss on hold-out set: 0.0023070887769930637
MeanAbsoluteError value on hold-out data: 0.03678957372903824
```

```
Epoch: 239
Loss on hold-out set: 0.001398046026364542
MeanAbsoluteError value on hold-out data: 0.026507310569286346
Epoch: 240
Loss on hold-out set: 0.0014160432687136703
MeanAbsoluteError value on hold-out data: 0.02634785696864128
Epoch: 241

Loss on hold-out set: 0.001461499124371375
MeanAbsoluteError value on hold-out data: 0.025754990056157112
Epoch: 242
Loss on hold-out set: 0.0017282984962758536
MeanAbsoluteError value on hold-out data: 0.02613815851509571
Epoch: 243
Loss on hold-out set: 0.000811776555985069
MeanAbsoluteError value on hold-out data: 0.0215147752314806
Epoch: 244

Loss on hold-out set: 0.0013504600255356098
MeanAbsoluteError value on hold-out data: 0.025670843198895454
Epoch: 245
Loss on hold-out set: 0.0013093319228993584
MeanAbsoluteError value on hold-out data: 0.026885638013482094
Epoch: 246
Loss on hold-out set: 0.004655577437146208
MeanAbsoluteError value on hold-out data: 0.029979346320033073
Epoch: 247
Loss on hold-out set: 0.003137258808307636
MeanAbsoluteError value on hold-out data: 0.04100913181900978
Epoch: 248

Loss on hold-out set: 0.0010082782111847056
MeanAbsoluteError value on hold-out data: 0.022132761776447296
Epoch: 249
Loss on hold-out set: 0.0014178870075668853
MeanAbsoluteError value on hold-out data: 0.025904789566993713
Epoch: 250
Loss on hold-out set: 0.000953914409574981
MeanAbsoluteError value on hold-out data: 0.023339569568634033
Epoch: 251
```

```
Loss on hold-out set: 0.0018791052906845624
MeanAbsoluteError value on hold-out data: 0.03681684657931328
Epoch: 252
Loss on hold-out set: 0.0011519794475484209
MeanAbsoluteError value on hold-out data: 0.026027703657746315
Epoch: 253
Loss on hold-out set: 0.0015223477496944654
MeanAbsoluteError value on hold-out data: 0.028302274644374847
Epoch: 254
Loss on hold-out set: 0.0011358991278729474
MeanAbsoluteError value on hold-out data: 0.023593826219439507
Epoch: 255

Loss on hold-out set: 0.0020348206252002944
MeanAbsoluteError value on hold-out data: 0.03773607313632965
Epoch: 256
Loss on hold-out set: 0.001411394180300144
MeanAbsoluteError value on hold-out data: 0.025339340791106224
Epoch: 257
Loss on hold-out set: 0.0010083267681273776
MeanAbsoluteError value on hold-out data: 0.022808635607361794
Epoch: 258

Loss on hold-out set: 0.0012255016330387802
MeanAbsoluteError value on hold-out data: 0.02121078222990036
Epoch: 259
Loss on hold-out set: 0.002504914560211966
MeanAbsoluteError value on hold-out data: 0.04264511168003082
Epoch: 260
Loss on hold-out set: 0.0010173351340479432
MeanAbsoluteError value on hold-out data: 0.020051898434758186
Epoch: 261
Loss on hold-out set: 0.001117804271276467
MeanAbsoluteError value on hold-out data: 0.02644074521958828
Epoch: 262

Loss on hold-out set: 0.002910292960363082
MeanAbsoluteError value on hold-out data: 0.0387352779507637
Epoch: 263
Loss on hold-out set: 0.001315589371817903
MeanAbsoluteError value on hold-out data: 0.02843840792775154
Epoch: 264
```

```
Loss on hold-out set: 0.001625394171032195
MeanAbsoluteError value on hold-out data: 0.027420787140727043
Epoch: 265

Loss on hold-out set: 0.001221504093756756
MeanAbsoluteError value on hold-out data: 0.028056414797902107
Epoch: 266
Loss on hold-out set: 0.0010842371714086486
MeanAbsoluteError value on hold-out data: 0.024801934137940407
Epoch: 267
Loss on hold-out set: 0.0018101555984825469
MeanAbsoluteError value on hold-out data: 0.03242097795009613
Epoch: 268
Loss on hold-out set: 0.0012973954816026469
MeanAbsoluteError value on hold-out data: 0.025831427425146103
Epoch: 269

Loss on hold-out set: 0.0012707179210757692
MeanAbsoluteError value on hold-out data: 0.02415805496275425
Epoch: 270
Loss on hold-out set: 0.0013671318637744451
MeanAbsoluteError value on hold-out data: 0.021210579201579094
Epoch: 271
Loss on hold-out set: 0.0019587499420874966
MeanAbsoluteError value on hold-out data: 0.03050488792359829
Epoch: 272

Loss on hold-out set: 0.0016361580279548294
MeanAbsoluteError value on hold-out data: 0.02990756183862686
Epoch: 273
Loss on hold-out set: 0.001415417246439924
MeanAbsoluteError value on hold-out data: 0.02070026658475399
Epoch: 274
Loss on hold-out set: 0.0016382663810733133
MeanAbsoluteError value on hold-out data: 0.03085567057132721
Epoch: 275
Loss on hold-out set: 0.0010349992718637134
MeanAbsoluteError value on hold-out data: 0.02140125446021557
Epoch: 276

Loss on hold-out set: 0.0011545816221489357
```

```
MeanAbsoluteError value on hold-out data: 0.024127723649144173
Epoch: 277
Loss on hold-out set: 0.002007452672562347
MeanAbsoluteError value on hold-out data: 0.03560962900519371
Epoch: 278
Loss on hold-out set: 0.0019189808338593978
MeanAbsoluteError value on hold-out data: 0.0323808379471302
Epoch: 279

Loss on hold-out set: 0.0013196662554177097
MeanAbsoluteError value on hold-out data: 0.024673709645867348
Epoch: 280
Loss on hold-out set: 0.0013279051390082503
MeanAbsoluteError value on hold-out data: 0.02756199799478054
Epoch: 281
Loss on hold-out set: 0.001996701923557199
MeanAbsoluteError value on hold-out data: 0.03817353397607803
Epoch: 282
Loss on hold-out set: 0.0012715929322159635
MeanAbsoluteError value on hold-out data: 0.027918636798858643
Epoch: 283

Loss on hold-out set: 0.002177735830907925
MeanAbsoluteError value on hold-out data: 0.03193741291761398
Epoch: 284
Loss on hold-out set: 0.0011943164415872442
MeanAbsoluteError value on hold-out data: 0.02556723915040493
Epoch: 285
Loss on hold-out set: 0.0016256529410244324
MeanAbsoluteError value on hold-out data: 0.02628270909190178
Epoch: 286

Loss on hold-out set: 0.002590667357883201
MeanAbsoluteError value on hold-out data: 0.036053501069545746
Epoch: 287
Loss on hold-out set: 0.0012749018966972542
MeanAbsoluteError value on hold-out data: 0.02741897851228714
Epoch: 288
Loss on hold-out set: 0.0018724389419031257
MeanAbsoluteError value on hold-out data: 0.027943838387727737
Epoch: 289
Loss on hold-out set: 0.0014175163193543155
```

```
MeanAbsoluteError value on hold-out data: 0.023931384086608887
Epoch: 290

Loss on hold-out set: 0.0018335868595526195
MeanAbsoluteError value on hold-out data: 0.02674487605690956
Epoch: 291
Loss on hold-out set: 0.0021325456865060213
MeanAbsoluteError value on hold-out data: 0.03158414363861084
Epoch: 292
Loss on hold-out set: 0.0012324159302247257
MeanAbsoluteError value on hold-out data: 0.025024624541401863
Epoch: 293

Loss on hold-out set: 0.0032825183499461184
MeanAbsoluteError value on hold-out data: 0.04663296788930893
Epoch: 294
Loss on hold-out set: 0.0012883966802082097
MeanAbsoluteError value on hold-out data: 0.02372014708817005
Epoch: 295
Loss on hold-out set: 0.0016607445476648326
MeanAbsoluteError value on hold-out data: 0.025145146995782852
Epoch: 296
Loss on hold-out set: 0.0031909027602523565
MeanAbsoluteError value on hold-out data: 0.04282171279191971
Epoch: 297

Loss on hold-out set: 0.0018234233631609152
MeanAbsoluteError value on hold-out data: 0.028809349983930588
Epoch: 298
Loss on hold-out set: 0.003007982293358789
MeanAbsoluteError value on hold-out data: 0.0442153736948967
Early stopping at epoch 297
Fold: 3
Epoch: 1
Loss on hold-out set: 0.015018731606407808
MeanAbsoluteError value on hold-out data: 0.10423804074525833
Epoch: 2

Loss on hold-out set: 0.007764469993372376
MeanAbsoluteError value on hold-out data: 0.06910012662410736
Epoch: 3
```

```
Loss on hold-out set: 0.004644747107074811
MeanAbsoluteError value on hold-out data: 0.05416398495435715
Epoch: 4
Loss on hold-out set: 0.00452790751408499
MeanAbsoluteError value on hold-out data: 0.05164607986807823
Epoch: 5
Loss on hold-out set: 0.0023451621219954598
MeanAbsoluteError value on hold-out data: 0.03929806500673294
Epoch: 6

Loss on hold-out set: 0.00523004864449971
MeanAbsoluteError value on hold-out data: 0.06158795207738876
Epoch: 7
Loss on hold-out set: 0.0033731654537125276
MeanAbsoluteError value on hold-out data: 0.04091208428144455
Epoch: 8
Loss on hold-out set: 0.002747031546627673
MeanAbsoluteError value on hold-out data: 0.04286056384444237
Epoch: 9

Loss on hold-out set: 0.003210664650676056
MeanAbsoluteError value on hold-out data: 0.045385800302028656
Epoch: 10
Loss on hold-out set: 0.0025951916781755593
MeanAbsoluteError value on hold-out data: 0.03784231096506119
Epoch: 11
Loss on hold-out set: 0.005529405316337943
MeanAbsoluteError value on hold-out data: 0.06395640224218369
Epoch: 12
Loss on hold-out set: 0.0032794520240993453
MeanAbsoluteError value on hold-out data: 0.04344446584582329
Epoch: 13

Loss on hold-out set: 0.0021684846858708905
MeanAbsoluteError value on hold-out data: 0.0350477397441864
Epoch: 14
Loss on hold-out set: 0.0031709773913742257
MeanAbsoluteError value on hold-out data: 0.04538758099079132
Epoch: 15
Loss on hold-out set: 0.0021480923840919365
MeanAbsoluteError value on hold-out data: 0.03598193824291229
Epoch: 16
```

```
Loss on hold-out set: 0.0012767344507245491
MeanAbsoluteError value on hold-out data: 0.02878226526081562
Epoch: 17
Loss on hold-out set: 0.0027167841415995588
MeanAbsoluteError value on hold-out data: 0.040293894708156586
Epoch: 18
Loss on hold-out set: 0.00344015656110759
MeanAbsoluteError value on hold-out data: 0.05116266757249832
Epoch: 19
Loss on hold-out set: 0.0018077191645995928
MeanAbsoluteError value on hold-out data: 0.030601734295487404
Epoch: 20

Loss on hold-out set: 0.002950820760676064
MeanAbsoluteError value on hold-out data: 0.040122900158166885
Epoch: 21
Loss on hold-out set: 0.0011361748060713021
MeanAbsoluteError value on hold-out data: 0.027274928987026215
Epoch: 22
Loss on hold-out set: 0.0021505083557433234
MeanAbsoluteError value on hold-out data: 0.03596802055835724
Epoch: 23

Loss on hold-out set: 0.0022560050531935235
MeanAbsoluteError value on hold-out data: 0.03831426054239273
Epoch: 24
Loss on hold-out set: 0.0016164957465102465
MeanAbsoluteError value on hold-out data: 0.031232958659529686
Epoch: 25
Loss on hold-out set: 0.0028806195657055536
MeanAbsoluteError value on hold-out data: 0.0434466153383255
Epoch: 26
Loss on hold-out set: 0.004385295377757687
MeanAbsoluteError value on hold-out data: 0.055654093623161316
Epoch: 27

Loss on hold-out set: 0.003278199281619611
MeanAbsoluteError value on hold-out data: 0.04793776571750641
Epoch: 28
Loss on hold-out set: 0.001343396317679435
MeanAbsoluteError value on hold-out data: 0.02608325518667698
Epoch: 29
```

```
Loss on hold-out set: 0.0014160798387960172
MeanAbsoluteError value on hold-out data: 0.029122021049261093
Epoch: 30

Loss on hold-out set: 0.002385890426991794
MeanAbsoluteError value on hold-out data: 0.0376606211066246
Epoch: 31
Loss on hold-out set: 0.001582713261506377
MeanAbsoluteError value on hold-out data: 0.030016889795660973
Epoch: 32
Loss on hold-out set: 0.0019233260379853444
MeanAbsoluteError value on hold-out data: 0.031524334102869034
Epoch: 33
Loss on hold-out set: 0.002982428633213903
MeanAbsoluteError value on hold-out data: 0.03977569565176964
Epoch: 34

Loss on hold-out set: 0.0021276547609326932
MeanAbsoluteError value on hold-out data: 0.03761603683233261
Epoch: 35
Loss on hold-out set: 0.0012537611082035045
MeanAbsoluteError value on hold-out data: 0.027654636651277542
Epoch: 36
Loss on hold-out set: 0.0021197721496439325
MeanAbsoluteError value on hold-out data: 0.03047151491045952
Epoch: 37

Loss on hold-out set: 0.001406539072587083
MeanAbsoluteError value on hold-out data: 0.025885386392474174
Epoch: 38
Loss on hold-out set: 0.0020310792606323957
MeanAbsoluteError value on hold-out data: 0.037409719079732895
Epoch: 39
Loss on hold-out set: 0.002076936037225935
MeanAbsoluteError value on hold-out data: 0.03876780718564987
Epoch: 40
Loss on hold-out set: 0.0034904833435295867
MeanAbsoluteError value on hold-out data: 0.04362844303250313
Epoch: 41

Loss on hold-out set: 0.0025293064357426306
```

```
MeanAbsoluteError value on hold-out data: 0.04339277371764183
Epoch: 42
Loss on hold-out set: 0.0025659898170628226
MeanAbsoluteError value on hold-out data: 0.04337416961789131
Epoch: 43
Loss on hold-out set: 0.0023555502680560145
MeanAbsoluteError value on hold-out data: 0.03679287061095238
Epoch: 44

Loss on hold-out set: 0.0024805380918013933
MeanAbsoluteError value on hold-out data: 0.040629129856824875
Epoch: 45
Loss on hold-out set: 0.0019279797024165208
MeanAbsoluteError value on hold-out data: 0.0355428010225296
Epoch: 46
Loss on hold-out set: 0.0021789708765796744
MeanAbsoluteError value on hold-out data: 0.03604523837566376
Epoch: 47
Loss on hold-out set: 0.0015028527951262032
MeanAbsoluteError value on hold-out data: 0.025560840964317322
Epoch: 48

Loss on hold-out set: 0.0017356293526693033
MeanAbsoluteError value on hold-out data: 0.03284526243805885
Epoch: 49
Loss on hold-out set: 0.002061616235341017
MeanAbsoluteError value on hold-out data: 0.0339864082634449
Epoch: 50
Loss on hold-out set: 0.0014272253163373815
MeanAbsoluteError value on hold-out data: 0.029117729514837265
Epoch: 51

Loss on hold-out set: 0.0011778680614392774
MeanAbsoluteError value on hold-out data: 0.025392301380634308
Epoch: 52
Loss on hold-out set: 0.0012584266458781292
MeanAbsoluteError value on hold-out data: 0.02680973708629608
Epoch: 53
Loss on hold-out set: 0.002065213464307957
MeanAbsoluteError value on hold-out data: 0.033817168325185776
Epoch: 54
Loss on hold-out set: 0.0014465416584593745
```

```
MeanAbsoluteError value on hold-out data: 0.02875218540430069
Epoch: 55

Loss on hold-out set: 0.0014849135388011257
MeanAbsoluteError value on hold-out data: 0.03193473443388939
Epoch: 56
Loss on hold-out set: 0.0013742260858774758
MeanAbsoluteError value on hold-out data: 0.028783511370420456
Epoch: 57
Loss on hold-out set: 0.001036329329228745
MeanAbsoluteError value on hold-out data: 0.02555629424750805
Epoch: 58

Loss on hold-out set: 0.0015571173795391447
MeanAbsoluteError value on hold-out data: 0.03060208633542061
Epoch: 59
Loss on hold-out set: 0.0011025324929505587
MeanAbsoluteError value on hold-out data: 0.023127617314457893
Epoch: 60
Loss on hold-out set: 0.0026446253759786487
MeanAbsoluteError value on hold-out data: 0.040281228721141815
Epoch: 61
Loss on hold-out set: 0.0015526903063381235
MeanAbsoluteError value on hold-out data: 0.031093129888176918
Epoch: 62

Loss on hold-out set: 0.001209593463080147
MeanAbsoluteError value on hold-out data: 0.02467416226863861
Epoch: 63
Loss on hold-out set: 0.0009391244423638384
MeanAbsoluteError value on hold-out data: 0.0245619248598814
Epoch: 64
Loss on hold-out set: 0.0020066313803769075
MeanAbsoluteError value on hold-out data: 0.03269360959529877
Epoch: 65

Loss on hold-out set: 0.001257247719107769
MeanAbsoluteError value on hold-out data: 0.021429825574159622
Epoch: 66
Loss on hold-out set: 0.0020540573078995715
MeanAbsoluteError value on hold-out data: 0.03644854947924614
```

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Epoch: 67
Loss on hold-out set: 0.0013335128359568233
MeanAbsoluteError value on hold-out data: 0.029221680015325546
Epoch: 68
Loss on hold-out set: 0.0025790044545339276
MeanAbsoluteError value on hold-out data: 0.039848197251558304
Epoch: 69

Loss on hold-out set: 0.001040880266093434
MeanAbsoluteError value on hold-out data: 0.024510296061635017
Epoch: 70
Loss on hold-out set: 0.003970029857905151
MeanAbsoluteError value on hold-out data: 0.04132290929555893
Epoch: 71
Loss on hold-out set: 0.0022796928219927046
MeanAbsoluteError value on hold-out data: 0.034586351364851
Epoch: 72

Loss on hold-out set: 0.002868625510018319
MeanAbsoluteError value on hold-out data: 0.04167332500219345
Epoch: 73
Loss on hold-out set: 0.0009400327578007889
MeanAbsoluteError value on hold-out data: 0.02054901048541069
Epoch: 74
Loss on hold-out set: 0.003763097535388974
MeanAbsoluteError value on hold-out data: 0.050907548516988754
Epoch: 75
Loss on hold-out set: 0.0012468303365704531
MeanAbsoluteError value on hold-out data: 0.02456342615187168
Epoch: 76

Loss on hold-out set: 0.0014925405535345466
MeanAbsoluteError value on hold-out data: 0.02747683972120285
Epoch: 77
Loss on hold-out set: 0.001987460320099042
MeanAbsoluteError value on hold-out data: 0.03311612084507942
Epoch: 78
Loss on hold-out set: 0.0024134882483989573
MeanAbsoluteError value on hold-out data: 0.035405054688453674
Epoch: 79
```

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Loss on hold-out set: 0.002447255519935145
MeanAbsoluteError value on hold-out data: 0.04253867641091347
Epoch: 80
Loss on hold-out set: 0.003167736863430876
MeanAbsoluteError value on hold-out data: 0.043452367186546326
Epoch: 81
Loss on hold-out set: 0.0017739550138895328
MeanAbsoluteError value on hold-out data: 0.031866781413555145
Epoch: 82
Loss on hold-out set: 0.0016706724530265022
MeanAbsoluteError value on hold-out data: 0.031911760568618774
Epoch: 83

Loss on hold-out set: 0.0015887110516464768
MeanAbsoluteError value on hold-out data: 0.029886681586503983
Epoch: 84
Loss on hold-out set: 0.0020834695314988494
MeanAbsoluteError value on hold-out data: 0.03748185932636261
Epoch: 85

Loss on hold-out set: 0.0019159478968224274
MeanAbsoluteError value on hold-out data: 0.03221301734447479
Epoch: 86
Loss on hold-out set: 0.001627816888055979
MeanAbsoluteError value on hold-out data: 0.029705950990319252
Epoch: 87
Loss on hold-out set: 0.0020315035273177694
MeanAbsoluteError value on hold-out data: 0.03403783217072487
Epoch: 88
Loss on hold-out set: 0.001417846441304741
MeanAbsoluteError value on hold-out data: 0.029083598405122757
Epoch: 89
Loss on hold-out set: 0.0014445356931761266
MeanAbsoluteError value on hold-out data: 0.024898767471313477
Epoch: 90

Loss on hold-out set: 0.0021282580878155734
MeanAbsoluteError value on hold-out data: 0.030109291896224022
Epoch: 91
Loss on hold-out set: 0.0029831861342804935
MeanAbsoluteError value on hold-out data: 0.04312486946582794
Epoch: 92
```

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Loss on hold-out set: 0.0015228538809774013
MeanAbsoluteError value on hold-out data: 0.027853811159729958
Epoch: 93
Loss on hold-out set: 0.0012649810120749932
MeanAbsoluteError value on hold-out data: 0.02631600946187973
Epoch: 94
Loss on hold-out set: 0.0019028039778976773
MeanAbsoluteError value on hold-out data: 0.02999717742204666
Epoch: 95
Loss on hold-out set: 0.0013983886277016539
MeanAbsoluteError value on hold-out data: 0.028640560805797577
Epoch: 96
Loss on hold-out set: 0.00287263231495252
MeanAbsoluteError value on hold-out data: 0.03930826857686043
Epoch: 97

Loss on hold-out set: 0.0020172313446752154
MeanAbsoluteError value on hold-out data: 0.039353109896183014
Epoch: 98
Loss on hold-out set: 0.0014178663035496497
MeanAbsoluteError value on hold-out data: 0.029761290177702904
Epoch: 99

Loss on hold-out set: 0.0017833637964661019
MeanAbsoluteError value on hold-out data: 0.031195981428027153
Epoch: 100
Loss on hold-out set: 0.0032793859763142583
MeanAbsoluteError value on hold-out data: 0.045923005789518356
Epoch: 101
Loss on hold-out set: 0.004727980193610375
MeanAbsoluteError value on hold-out data: 0.061245668679475784
Epoch: 102
Loss on hold-out set: 0.0014638076525163623
MeanAbsoluteError value on hold-out data: 0.026785431429743767
Epoch: 103
Loss on hold-out set: 0.0015449031399419676
MeanAbsoluteError value on hold-out data: 0.028628816828131676
Epoch: 104

Loss on hold-out set: 0.0016146729064460557
MeanAbsoluteError value on hold-out data: 0.030230149626731873
Epoch: 105
```

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Loss on hold-out set: 0.0011550574585831223
MeanAbsoluteError value on hold-out data: 0.024949710816144943
Epoch: 106

Loss on hold-out set: 0.0009622706767494002
MeanAbsoluteError value on hold-out data: 0.021984124556183815
Epoch: 107
Loss on hold-out set: 0.0018383910422786497
MeanAbsoluteError value on hold-out data: 0.032234348356723785
Epoch: 108
Loss on hold-out set: 0.0014300823990757076
MeanAbsoluteError value on hold-out data: 0.030394315719604492
Epoch: 109
Loss on hold-out set: 0.0019773970707319677
MeanAbsoluteError value on hold-out data: 0.028841532766819
Epoch: 110
Loss on hold-out set: 0.001525800008004388
MeanAbsoluteError value on hold-out data: 0.029950223863124847
Epoch: 111

Loss on hold-out set: 0.0016343816040227045
MeanAbsoluteError value on hold-out data: 0.029715528711676598
Epoch: 112
Loss on hold-out set: 0.0014363608811086474
MeanAbsoluteError value on hold-out data: 0.0303786713629961
Epoch: 113

Loss on hold-out set: 0.001232674352090376
MeanAbsoluteError value on hold-out data: 0.021865377202630043
Epoch: 114
Loss on hold-out set: 0.0022900891087304512
MeanAbsoluteError value on hold-out data: 0.03844663128256798
Epoch: 115
Loss on hold-out set: 0.0008402796318897834
MeanAbsoluteError value on hold-out data: 0.021613748744130135
Epoch: 116
Loss on hold-out set: 0.001870406997533372
MeanAbsoluteError value on hold-out data: 0.029372869059443474
Epoch: 117
Loss on hold-out set: 0.0008496417117734941
MeanAbsoluteError value on hold-out data: 0.02562486194074154
Epoch: 118
```

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Loss on hold-out set: 0.001070042798976199
MeanAbsoluteError value on hold-out data: 0.024747930467128754
Epoch: 119
Loss on hold-out set: 0.0015585280086200398
MeanAbsoluteError value on hold-out data: 0.030176613479852676
Epoch: 120

Loss on hold-out set: 0.0015911494130985094
MeanAbsoluteError value on hold-out data: 0.03235809877514839
Epoch: 121
Loss on hold-out set: 0.001240873389178887
MeanAbsoluteError value on hold-out data: 0.024938933551311493
Epoch: 122
Loss on hold-out set: 0.003302157247582307
MeanAbsoluteError value on hold-out data: 0.04722798243165016
Epoch: 123
Loss on hold-out set: 0.0019746464542829646
MeanAbsoluteError value on hold-out data: 0.0355200469493866
Epoch: 124
Loss on hold-out set: 0.0030348676507576154
MeanAbsoluteError value on hold-out data: 0.03951137140393257
Epoch: 125

Loss on hold-out set: 0.0010372617913302607
MeanAbsoluteError value on hold-out data: 0.022777916863560677
Epoch: 126
Loss on hold-out set: 0.0008259068999905139
MeanAbsoluteError value on hold-out data: 0.02234131284058094
Epoch: 127

Loss on hold-out set: 0.001419122800983202
MeanAbsoluteError value on hold-out data: 0.02777562104165554
Epoch: 128
Loss on hold-out set: 0.0014463207559086955
MeanAbsoluteError value on hold-out data: 0.02693222276866436
Epoch: 129
Loss on hold-out set: 0.002330026739330676
MeanAbsoluteError value on hold-out data: 0.03178611397743225
Epoch: 130
Loss on hold-out set: 0.001219179989465584
MeanAbsoluteError value on hold-out data: 0.024477262049913406
Epoch: 131
```

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Loss on hold-out set: 0.0011524483091377008
MeanAbsoluteError value on hold-out data: 0.02437962032854557
Epoch: 132

Loss on hold-out set: 0.0012956077362804746
MeanAbsoluteError value on hold-out data: 0.030811287462711334
Epoch: 133
Loss on hold-out set: 0.0016001705460859318
MeanAbsoluteError value on hold-out data: 0.02705826796591282
Epoch: 134

Loss on hold-out set: 0.0016730235723886066
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Epoch: 135
Loss on hold-out set: 0.0016382111397643501
MeanAbsoluteError value on hold-out data: 0.028665808960795403
Epoch: 136
Loss on hold-out set: 0.0014602172416813958
MeanAbsoluteError value on hold-out data: 0.03044881299138069
Epoch: 137
Loss on hold-out set: 0.0011908567438905055
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Epoch: 138
Loss on hold-out set: 0.0008841366954864218
MeanAbsoluteError value on hold-out data: 0.021709371358156204
Epoch: 139

Loss on hold-out set: 0.0021538189970529997
MeanAbsoluteError value on hold-out data: 0.03236129507422447
Epoch: 140
Loss on hold-out set: 0.002456200488198262
MeanAbsoluteError value on hold-out data: 0.037086836993694305
Epoch: 141

Loss on hold-out set: 0.002019754051266668
MeanAbsoluteError value on hold-out data: 0.032589592039585114
Epoch: 142
Loss on hold-out set: 0.0007956366853949686
MeanAbsoluteError value on hold-out data: 0.02231287769973278
Epoch: 143
Loss on hold-out set: 0.0021650053901024736
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MeanAbsoluteError value on hold-out data: 0.03790576383471489
Epoch: 144
Loss on hold-out set: 0.002341999949959035
MeanAbsoluteError value on hold-out data: 0.04001663997769356
Epoch: 145
Loss on hold-out set: 0.0012303296098252758
MeanAbsoluteError value on hold-out data: 0.024747762829065323
Epoch: 146

Loss on hold-out set: 0.0017905768333837594
MeanAbsoluteError value on hold-out data: 0.0324939526617527
Epoch: 147
Loss on hold-out set: 0.0017818093384938459
MeanAbsoluteError value on hold-out data: 0.032073501497507095
Epoch: 148

Loss on hold-out set: 0.0017162827783837342
MeanAbsoluteError value on hold-out data: 0.03191446140408516
Epoch: 149
Loss on hold-out set: 0.0023172176263939878
MeanAbsoluteError value on hold-out data: 0.03634504973888397
Epoch: 150
Loss on hold-out set: 0.001996937619808775
MeanAbsoluteError value on hold-out data: 0.03004513308405876
Epoch: 151
Loss on hold-out set: 0.0013744850875809789
MeanAbsoluteError value on hold-out data: 0.03033183142542839
Epoch: 152
Loss on hold-out set: 0.0016356576771403735
MeanAbsoluteError value on hold-out data: 0.032946571707725525
Epoch: 153

Loss on hold-out set: 0.0011882072598942055
MeanAbsoluteError value on hold-out data: 0.02647266536951065
Epoch: 154
Loss on hold-out set: 0.0011974015013458063
MeanAbsoluteError value on hold-out data: 0.026619603857398033
Epoch: 155

Loss on hold-out set: 0.0015864336746744812
MeanAbsoluteError value on hold-out data: 0.033691879361867905
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Epoch: 156
Loss on hold-out set: 0.0013577377887066598
MeanAbsoluteError value on hold-out data: 0.025346269831061363
Epoch: 157
Loss on hold-out set: 0.0009478368491937334
MeanAbsoluteError value on hold-out data: 0.02236572466790676
Epoch: 158
Loss on hold-out set: 0.001980936459194009
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Epoch: 159
Loss on hold-out set: 0.003612354782839807
MeanAbsoluteError value on hold-out data: 0.045781511813402176
Epoch: 160

Loss on hold-out set: 0.0018877739203162491
MeanAbsoluteError value on hold-out data: 0.03246622160077095
Epoch: 161
Loss on hold-out set: 0.0011138666909223853
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Epoch: 162

Loss on hold-out set: 0.0013519217788528365
MeanAbsoluteError value on hold-out data: 0.028363816440105438
Epoch: 163
Loss on hold-out set: 0.0015574607957835095
MeanAbsoluteError value on hold-out data: 0.02645811066031456
Epoch: 164
Loss on hold-out set: 0.004003228252538695
MeanAbsoluteError value on hold-out data: 0.05229939520359039
Epoch: 165
Loss on hold-out set: 0.0014360160477316151
MeanAbsoluteError value on hold-out data: 0.030005579814314842
Epoch: 166
Loss on hold-out set: 0.0028282041133094868
MeanAbsoluteError value on hold-out data: 0.03984426334500313
Epoch: 167

Loss on hold-out set: 0.0014403632510668384
MeanAbsoluteError value on hold-out data: 0.029009701684117317
Epoch: 168
Loss on hold-out set: 0.0011527385571613335
MeanAbsoluteError value on hold-out data: 0.02509966678917408
```

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Epoch: 169

Loss on hold-out set: 0.0014015466821057578
MeanAbsoluteError value on hold-out data: 0.027450961992144585
Epoch: 170
Loss on hold-out set: 0.002029645417888577
MeanAbsoluteError value on hold-out data: 0.03517480194568634
Epoch: 171
Loss on hold-out set: 0.0022211302600156227
MeanAbsoluteError value on hold-out data: 0.03421218320727348
Epoch: 172
Loss on hold-out set: 0.0022604293234717962
MeanAbsoluteError value on hold-out data: 0.03368368744850159
Epoch: 173
Loss on hold-out set: 0.0018104121912843906
MeanAbsoluteError value on hold-out data: 0.03153935819864273
Epoch: 174

Loss on hold-out set: 0.0008139617611260081
MeanAbsoluteError value on hold-out data: 0.021915266290307045
Epoch: 175
Loss on hold-out set: 0.0009452930557577369
MeanAbsoluteError value on hold-out data: 0.021204691380262375
Epoch: 176

Loss on hold-out set: 0.002104046208282503
MeanAbsoluteError value on hold-out data: 0.0342482291162014
Epoch: 177
Loss on hold-out set: 0.0015874912541431303
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Epoch: 178
Loss on hold-out set: 0.002173205174935552
MeanAbsoluteError value on hold-out data: 0.0356295220553875
Epoch: 179
Loss on hold-out set: 0.0011101203999714926
MeanAbsoluteError value on hold-out data: 0.022990919649600983
Epoch: 180
Loss on hold-out set: 0.002315695943812338
MeanAbsoluteError value on hold-out data: 0.036850422620773315
Epoch: 181
```

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Loss on hold-out set: 0.0011790776110361689
MeanAbsoluteError value on hold-out data: 0.02523481287062168
Epoch: 182
Loss on hold-out set: 0.0017941853125543834
MeanAbsoluteError value on hold-out data: 0.02994338981807232
Epoch: 183

Loss on hold-out set: 0.00159439371782355
MeanAbsoluteError value on hold-out data: 0.02894476242363453
Epoch: 184
Loss on hold-out set: 0.0016742110086712413
MeanAbsoluteError value on hold-out data: 0.02840549685060978
Epoch: 185
Loss on hold-out set: 0.001290373732514966
MeanAbsoluteError value on hold-out data: 0.02965596690773964
Epoch: 186
Loss on hold-out set: 0.0019507820700080348
MeanAbsoluteError value on hold-out data: 0.03248600661754608
Epoch: 187
Loss on hold-out set: 0.0014427488741393273
MeanAbsoluteError value on hold-out data: 0.029237203299999237
Epoch: 188

Loss on hold-out set: 0.0023977803379798737
MeanAbsoluteError value on hold-out data: 0.03566823899745941
Epoch: 189
Loss on hold-out set: 0.0011783900554291904
MeanAbsoluteError value on hold-out data: 0.027480699121952057
Epoch: 190

Loss on hold-out set: 0.0012002048225930105
MeanAbsoluteError value on hold-out data: 0.02511371299624443
Epoch: 191
Loss on hold-out set: 0.0010738965591791873
MeanAbsoluteError value on hold-out data: 0.02269524149596691
Epoch: 192
Loss on hold-out set: 0.000989173147200535
MeanAbsoluteError value on hold-out data: 0.0210588239133358
Epoch: 193
Loss on hold-out set: 0.003867325811790159
MeanAbsoluteError value on hold-out data: 0.04571764916181564
Epoch: 194
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Loss on hold-out set: 0.001995400700252503
MeanAbsoluteError value on hold-out data: 0.03654472902417183
Epoch: 195

Loss on hold-out set: 0.0018425136435185918
MeanAbsoluteError value on hold-out data: 0.03083667904138565
Epoch: 196
Loss on hold-out set: 0.001017553048978488
MeanAbsoluteError value on hold-out data: 0.02239362709224224
Epoch: 197

Loss on hold-out set: 0.0013079506349570763
MeanAbsoluteError value on hold-out data: 0.02609342336654663
Epoch: 198
Loss on hold-out set: 0.0015351544789155014
MeanAbsoluteError value on hold-out data: 0.027336282655596733
Epoch: 199
Loss on hold-out set: 0.0017404261295898603
MeanAbsoluteError value on hold-out data: 0.03316624090075493
Epoch: 200
Loss on hold-out set: 0.0013730653445236385
MeanAbsoluteError value on hold-out data: 0.03068559430539608
Epoch: 201
Loss on hold-out set: 0.0012799790330553572
MeanAbsoluteError value on hold-out data: 0.025734001770615578
Epoch: 202

Loss on hold-out set: 0.0014415201328050059
MeanAbsoluteError value on hold-out data: 0.024920761585235596
Epoch: 203
Loss on hold-out set: 0.0013308157929434227
MeanAbsoluteError value on hold-out data: 0.029430637136101723
Epoch: 204

Loss on hold-out set: 0.0010750988641610513
MeanAbsoluteError value on hold-out data: 0.024968145415186882
Epoch: 205
Loss on hold-out set: 0.0016101671946951402
MeanAbsoluteError value on hold-out data: 0.02547960914671421
Epoch: 206
Loss on hold-out set: 0.0021251684251742866
```

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MeanAbsoluteError value on hold-out data: 0.034498974680900574
Epoch: 207
Loss on hold-out set: 0.0028874772967985617
MeanAbsoluteError value on hold-out data: 0.037535130977630615
Epoch: 208
Loss on hold-out set: 0.0013941209225987012
MeanAbsoluteError value on hold-out data: 0.024335628375411034
Epoch: 209

Loss on hold-out set: 0.0017276069489665902
MeanAbsoluteError value on hold-out data: 0.031245369464159012
Epoch: 210

Loss on hold-out set: 0.0008948897112322112
MeanAbsoluteError value on hold-out data: 0.018851976841688156
Epoch: 211
Loss on hold-out set: 0.0014052616808420191
MeanAbsoluteError value on hold-out data: 0.02906874194741249
Epoch: 212
Loss on hold-out set: 0.0014476143428160308
MeanAbsoluteError value on hold-out data: 0.02782323770225048
Epoch: 213
Loss on hold-out set: 0.0012846618975835065
MeanAbsoluteError value on hold-out data: 0.025300826877355576
Epoch: 214

Loss on hold-out set: 0.002615832544576663
MeanAbsoluteError value on hold-out data: 0.04108120873570442
Epoch: 215
Loss on hold-out set: 0.0012461921634474914
MeanAbsoluteError value on hold-out data: 0.025783928111195564
Epoch: 216
Loss on hold-out set: 0.0020664022774256477
MeanAbsoluteError value on hold-out data: 0.030193211510777473
Epoch: 217

Loss on hold-out set: 0.0013807791132981388
MeanAbsoluteError value on hold-out data: 0.02729540504515171
Epoch: 218
Loss on hold-out set: 0.004431614956746881
MeanAbsoluteError value on hold-out data: 0.05613112449645996
```

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Epoch: 219
Loss on hold-out set: 0.0012316249597531098
MeanAbsoluteError value on hold-out data: 0.027456562966108322
Epoch: 220
Loss on hold-out set: 0.0024295345277865776
MeanAbsoluteError value on hold-out data: 0.028275981545448303
Epoch: 221

Loss on hold-out set: 0.0019094467257113697
MeanAbsoluteError value on hold-out data: 0.03580979257822037
Epoch: 222
Loss on hold-out set: 0.00283088912972464
MeanAbsoluteError value on hold-out data: 0.03848111629486084
Epoch: 223
Loss on hold-out set: 0.001260190168977715
MeanAbsoluteError value on hold-out data: 0.02924928441643715
Epoch: 224

Loss on hold-out set: 0.0012471577748118972
MeanAbsoluteError value on hold-out data: 0.027154183015227318
Epoch: 225
Loss on hold-out set: 0.0008012907682523991
MeanAbsoluteError value on hold-out data: 0.019974060356616974
Epoch: 226
Loss on hold-out set: 0.0016352266594857122
MeanAbsoluteError value on hold-out data: 0.025826068595051765
Epoch: 227
Loss on hold-out set: 0.001610770890972792
MeanAbsoluteError value on hold-out data: 0.028672795742750168
Epoch: 228

Loss on hold-out set: 0.002075517254595
MeanAbsoluteError value on hold-out data: 0.03045884519815445
Epoch: 229
Loss on hold-out set: 0.0013622510999154586
MeanAbsoluteError value on hold-out data: 0.026188528165221214
Epoch: 230
Loss on hold-out set: 0.0020928628465089086
MeanAbsoluteError value on hold-out data: 0.03009471856057644
Epoch: 231
```

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Loss on hold-out set: 0.0019812715517428634
MeanAbsoluteError value on hold-out data: 0.03250245749950409
Epoch: 232
Loss on hold-out set: 0.0011571419085017764
MeanAbsoluteError value on hold-out data: 0.024106793105602264
Epoch: 233
Loss on hold-out set: 0.0015365477078236067
MeanAbsoluteError value on hold-out data: 0.03035525232553482
Epoch: 234
Loss on hold-out set: 0.0012771329538036997
MeanAbsoluteError value on hold-out data: 0.02848368138074875
Epoch: 235

Loss on hold-out set: 0.000995346197249511
MeanAbsoluteError value on hold-out data: 0.020464351400732994
Epoch: 236
Loss on hold-out set: 0.0019985264650760936
MeanAbsoluteError value on hold-out data: 0.03415830060839653
Epoch: 237
Loss on hold-out set: 0.0019102732258033939
MeanAbsoluteError value on hold-out data: 0.025207044556736946
Epoch: 238

Loss on hold-out set: 0.0011997785846828125
MeanAbsoluteError value on hold-out data: 0.022327953949570656
Epoch: 239
Loss on hold-out set: 0.0013844472044953504
MeanAbsoluteError value on hold-out data: 0.026296954602003098
Epoch: 240
Loss on hold-out set: 0.0016464615316810803
MeanAbsoluteError value on hold-out data: 0.031231030821800232
Epoch: 241
Loss on hold-out set: 0.0023690623750623604
MeanAbsoluteError value on hold-out data: 0.03646881505846977
Epoch: 242

Loss on hold-out set: 0.00144217716744886
MeanAbsoluteError value on hold-out data: 0.030509887263178825
Epoch: 243
Loss on hold-out set: 0.0028107247378032366
MeanAbsoluteError value on hold-out data: 0.040847841650247574
Epoch: 244
```

```
Loss on hold-out set: 0.0024217680665270355
MeanAbsoluteError value on hold-out data: 0.03524089232087135
Epoch: 245

Loss on hold-out set: 0.0015072572031595672
MeanAbsoluteError value on hold-out data: 0.02785004861652851
Epoch: 246
Loss on hold-out set: 0.0013429928434421667
MeanAbsoluteError value on hold-out data: 0.022785572335124016
Epoch: 247
Loss on hold-out set: 0.0050698770926548885
MeanAbsoluteError value on hold-out data: 0.06023523211479187
Epoch: 248
Loss on hold-out set: 0.002496436909915736
MeanAbsoluteError value on hold-out data: 0.037161171436309814
Epoch: 249

Loss on hold-out set: 0.00247711022474015
MeanAbsoluteError value on hold-out data: 0.03550414741039276
Epoch: 250
Loss on hold-out set: 0.0016443092961428473
MeanAbsoluteError value on hold-out data: 0.029026834294199944
Epoch: 251
Loss on hold-out set: 0.0011016776059897472
MeanAbsoluteError value on hold-out data: 0.021894546225667
Epoch: 252

Loss on hold-out set: 0.0012494113135079925
MeanAbsoluteError value on hold-out data: 0.02591296285390854
Epoch: 253
Loss on hold-out set: 0.001061644257368663
MeanAbsoluteError value on hold-out data: 0.02210722491145134
Epoch: 254
Loss on hold-out set: 0.0016392699259225852
MeanAbsoluteError value on hold-out data: 0.03068232350051403
Epoch: 255
Loss on hold-out set: 0.0010935670199195067
MeanAbsoluteError value on hold-out data: 0.021723438054323196
Epoch: 256

Loss on hold-out set: 0.0018424812498359154
```

```
MeanAbsoluteError value on hold-out data: 0.03299738094210625
Epoch: 257
Loss on hold-out set: 0.0013262168414747487
MeanAbsoluteError value on hold-out data: 0.02650323323905468
Epoch: 258
Loss on hold-out set: 0.00102036864308712
MeanAbsoluteError value on hold-out data: 0.02343614026904106
Epoch: 259

Loss on hold-out set: 0.0016730302662696117
MeanAbsoluteError value on hold-out data: 0.02702038735151291
Epoch: 260
Loss on hold-out set: 0.0008849523829457422
MeanAbsoluteError value on hold-out data: 0.01961984671652317
Epoch: 261
Loss on hold-out set: 0.0016408314919457412
MeanAbsoluteError value on hold-out data: 0.02715829201042652
Epoch: 262
Loss on hold-out set: 0.0017477357670521508
MeanAbsoluteError value on hold-out data: 0.031912945210933685
Epoch: 263

Loss on hold-out set: 0.0013091404689475894
MeanAbsoluteError value on hold-out data: 0.0292851310223341
Epoch: 264
Loss on hold-out set: 0.0012814392774509122
MeanAbsoluteError value on hold-out data: 0.02761179953813553
Epoch: 265
Loss on hold-out set: 0.004020356832860181
MeanAbsoluteError value on hold-out data: 0.04696883261203766
Epoch: 266

Loss on hold-out set: 0.003208607372541267
MeanAbsoluteError value on hold-out data: 0.0411103256046772
Epoch: 267
Loss on hold-out set: 0.0010617613376010782
MeanAbsoluteError value on hold-out data: 0.023150784894824028
Epoch: 268
Loss on hold-out set: 0.0015466886912830747
MeanAbsoluteError value on hold-out data: 0.02363703027367592
Epoch: 269
Loss on hold-out set: 0.00219415308898673
```

```
MeanAbsoluteError value on hold-out data: 0.03664962574839592
Epoch: 270

Loss on hold-out set: 0.0016397709192600674
MeanAbsoluteError value on hold-out data: 0.02838064730167389
Early stopping at epoch 269
Fold: 4
Epoch: 1
Loss on hold-out set: 0.01595925074070692
MeanAbsoluteError value on hold-out data: 0.09620936214923859
Epoch: 2
Loss on hold-out set: 0.014963918293897923
MeanAbsoluteError value on hold-out data: 0.10040276497602463
Epoch: 3

Loss on hold-out set: 0.008663134156869581
MeanAbsoluteError value on hold-out data: 0.07097411155700684
Epoch: 4
Loss on hold-out set: 0.0054688467017303295
MeanAbsoluteError value on hold-out data: 0.05639252811670303
Epoch: 5
Loss on hold-out set: 0.007608864281792194
MeanAbsoluteError value on hold-out data: 0.06053885444998741
Epoch: 6
Loss on hold-out set: 0.005245308293244586
MeanAbsoluteError value on hold-out data: 0.049978528171777725
Epoch: 7

Loss on hold-out set: 0.004826518406984038
MeanAbsoluteError value on hold-out data: 0.045704688876867294
Epoch: 8
Loss on hold-out set: 0.004129101710322385
MeanAbsoluteError value on hold-out data: 0.047726940363645554
Epoch: 9
Loss on hold-out set: 0.004489679749195392
MeanAbsoluteError value on hold-out data: 0.052564073354005814
Epoch: 10

Loss on hold-out set: 0.0033374882768839598
MeanAbsoluteError value on hold-out data: 0.04531087726354599
Epoch: 11
```

```
Loss on hold-out set: 0.0031581655180511568
MeanAbsoluteError value on hold-out data: 0.038171157240867615
Epoch: 12
Loss on hold-out set: 0.0028731154116730276
MeanAbsoluteError value on hold-out data: 0.038368627429008484
Epoch: 13
Loss on hold-out set: 0.004201066626522403
MeanAbsoluteError value on hold-out data: 0.048621173948049545
Epoch: 14

Loss on hold-out set: 0.0027788527703915653
MeanAbsoluteError value on hold-out data: 0.038837455213069916
Epoch: 15
Loss on hold-out set: 0.004214673285157635
MeanAbsoluteError value on hold-out data: 0.054461169987916946
Epoch: 16
Loss on hold-out set: 0.006395253639381666
MeanAbsoluteError value on hold-out data: 0.05403497815132141
Epoch: 17

Loss on hold-out set: 0.005463978374161973
MeanAbsoluteError value on hold-out data: 0.055158328264951706
Epoch: 18
Loss on hold-out set: 0.0026723137707449496
MeanAbsoluteError value on hold-out data: 0.038296353071928024
Epoch: 19
Loss on hold-out set: 0.002681141678924457
MeanAbsoluteError value on hold-out data: 0.03916432708501816
Epoch: 20
Loss on hold-out set: 0.003199604561534495
MeanAbsoluteError value on hold-out data: 0.041988763958215714
Epoch: 21

Loss on hold-out set: 0.0027466705427146875
MeanAbsoluteError value on hold-out data: 0.03802977502346039
Epoch: 22
Loss on hold-out set: 0.004077074798540427
MeanAbsoluteError value on hold-out data: 0.04941655322909355
Epoch: 23
Loss on hold-out set: 0.003553720674692438
MeanAbsoluteError value on hold-out data: 0.044174641370773315
Epoch: 24
```

```
Loss on hold-out set: 0.003027713105369073
MeanAbsoluteError value on hold-out data: 0.03653157129883766
Epoch: 25
Loss on hold-out set: 0.00581109534519223
MeanAbsoluteError value on hold-out data: 0.062197696417570114
Epoch: 26
Loss on hold-out set: 0.0024883243604563177
MeanAbsoluteError value on hold-out data: 0.03345165401697159
Epoch: 27
Loss on hold-out set: 0.0034205968773816354
MeanAbsoluteError value on hold-out data: 0.045043397694826126
Epoch: 28

Loss on hold-out set: 0.0016383112088078633
MeanAbsoluteError value on hold-out data: 0.02952338010072708
Epoch: 29
Loss on hold-out set: 0.003833413267364869
MeanAbsoluteError value on hold-out data: 0.048432059586048126
Epoch: 30
Loss on hold-out set: 0.002206735841285151
MeanAbsoluteError value on hold-out data: 0.03673173114657402
Epoch: 31

Loss on hold-out set: 0.0035077269242789885
MeanAbsoluteError value on hold-out data: 0.039802782237529755
Epoch: 32
Loss on hold-out set: 0.0022237976977171805
MeanAbsoluteError value on hold-out data: 0.03390143811702728
Epoch: 33
Loss on hold-out set: 0.004476104719707599
MeanAbsoluteError value on hold-out data: 0.04471971467137337
Epoch: 34
Loss on hold-out set: 0.003148250313153347
MeanAbsoluteError value on hold-out data: 0.04109411686658859
Epoch: 35

Loss on hold-out set: 0.0022613689160117735
MeanAbsoluteError value on hold-out data: 0.03117445856332779
Epoch: 36
Loss on hold-out set: 0.0022594140542563624
MeanAbsoluteError value on hold-out data: 0.03414703533053398
Epoch: 37
```

```
Loss on hold-out set: 0.0025704599863204817
MeanAbsoluteError value on hold-out data: 0.029690971598029137
Epoch: 38

Loss on hold-out set: 0.004215522678210759
MeanAbsoluteError value on hold-out data: 0.05459417402744293
Epoch: 39
Loss on hold-out set: 0.002292337769176811
MeanAbsoluteError value on hold-out data: 0.03560518100857735
Epoch: 40
Loss on hold-out set: 0.0031513713497238662
MeanAbsoluteError value on hold-out data: 0.043700046837329865
Epoch: 41
Loss on hold-out set: 0.0028591394209517883
MeanAbsoluteError value on hold-out data: 0.0379103422164917
Epoch: 42

Loss on hold-out set: 0.0022833747587775667
MeanAbsoluteError value on hold-out data: 0.02949877828359604
Epoch: 43
Loss on hold-out set: 0.0016195325006265193
MeanAbsoluteError value on hold-out data: 0.029249105602502823
Epoch: 44
Loss on hold-out set: 0.002989720154661112
MeanAbsoluteError value on hold-out data: 0.03491325303912163
Epoch: 45

Loss on hold-out set: 0.002415769088726777
MeanAbsoluteError value on hold-out data: 0.03338314965367317
Epoch: 46
Loss on hold-out set: 0.0014759608557841813
MeanAbsoluteError value on hold-out data: 0.02731030434370041
Epoch: 47
Loss on hold-out set: 0.0024649126079076757
MeanAbsoluteError value on hold-out data: 0.03932802379131317
Epoch: 48
Loss on hold-out set: 0.002215772974663056
MeanAbsoluteError value on hold-out data: 0.033871278166770935
Epoch: 49

Loss on hold-out set: 0.001420732332357707
```

```
MeanAbsoluteError value on hold-out data: 0.02919880673289299
Epoch: 50
Loss on hold-out set: 0.0025854162074840413
MeanAbsoluteError value on hold-out data: 0.03580863028764725
Epoch: 51
Loss on hold-out set: 0.001180049656585862
MeanAbsoluteError value on hold-out data: 0.028678828850388527
Epoch: 52

Loss on hold-out set: 0.0018925453522779907
MeanAbsoluteError value on hold-out data: 0.02951187826693058
Epoch: 53
Loss on hold-out set: 0.0026106905469742534
MeanAbsoluteError value on hold-out data: 0.03996168449521065
Epoch: 54
Loss on hold-out set: 0.004009141559855869
MeanAbsoluteError value on hold-out data: 0.04036710411310196
Epoch: 55
Loss on hold-out set: 0.0021534982594088293
MeanAbsoluteError value on hold-out data: 0.033168163150548935
Epoch: 56

Loss on hold-out set: 0.003480216046647491
MeanAbsoluteError value on hold-out data: 0.04041936993598938
Epoch: 57
Loss on hold-out set: 0.0016094296655725115
MeanAbsoluteError value on hold-out data: 0.030657708644866943
Epoch: 58
Loss on hold-out set: 0.0027163616390540623
MeanAbsoluteError value on hold-out data: 0.037058886140584946
Epoch: 59

Loss on hold-out set: 0.0017719445279978502
MeanAbsoluteError value on hold-out data: 0.03163282573223114
Epoch: 60
Loss on hold-out set: 0.0013559061346593527
MeanAbsoluteError value on hold-out data: 0.02496475540101528
Epoch: 61
Loss on hold-out set: 0.0019643706350157466
MeanAbsoluteError value on hold-out data: 0.030322767794132233
Epoch: 62
Loss on hold-out set: 0.0022055811289017303
```

```
MeanAbsoluteError value on hold-out data: 0.033769987523555756
Epoch: 63

Loss on hold-out set: 0.0029259196016937494
MeanAbsoluteError value on hold-out data: 0.04581712186336517
Epoch: 64
Loss on hold-out set: 0.0030610081555026295
MeanAbsoluteError value on hold-out data: 0.04077481850981712
Epoch: 65
Loss on hold-out set: 0.0015443760673336398
MeanAbsoluteError value on hold-out data: 0.02746490016579628
Epoch: 66

Loss on hold-out set: 0.003837141499388963
MeanAbsoluteError value on hold-out data: 0.04502061754465103
Epoch: 67
Loss on hold-out set: 0.0016698154101434809
MeanAbsoluteError value on hold-out data: 0.029855437576770782
Epoch: 68
Loss on hold-out set: 0.0018696187113304264
MeanAbsoluteError value on hold-out data: 0.030800485983490944
Epoch: 69
Loss on hold-out set: 0.002457392202743974
MeanAbsoluteError value on hold-out data: 0.03466375917196274
Epoch: 70

Loss on hold-out set: 0.0021622508485541823
MeanAbsoluteError value on hold-out data: 0.026035813614726067
Epoch: 71
Loss on hold-out set: 0.0014023495291789563
MeanAbsoluteError value on hold-out data: 0.02708347514271736
Epoch: 72
Loss on hold-out set: 0.0019014052589997076
MeanAbsoluteError value on hold-out data: 0.03358098864555359
Epoch: 73

Loss on hold-out set: 0.001869373162312863
MeanAbsoluteError value on hold-out data: 0.03382393717765808
Epoch: 74
Loss on hold-out set: 0.003792665845069748
MeanAbsoluteError value on hold-out data: 0.04022575914859772
```

```
Epoch: 75
Loss on hold-out set: 0.003337200131052389
MeanAbsoluteError value on hold-out data: 0.04938003420829773
Epoch: 76
Loss on hold-out set: 0.0014834335620085208
MeanAbsoluteError value on hold-out data: 0.027804536744952202
Epoch: 77

Loss on hold-out set: 0.004529426886270253
MeanAbsoluteError value on hold-out data: 0.050226449966430664
Epoch: 78
Loss on hold-out set: 0.0019711315354260686
MeanAbsoluteError value on hold-out data: 0.030240783467888832
Epoch: 79
Loss on hold-out set: 0.0021944407355756713
MeanAbsoluteError value on hold-out data: 0.03516653552651405
Epoch: 80

Loss on hold-out set: 0.0031179734953464223
MeanAbsoluteError value on hold-out data: 0.03748086094856262
Epoch: 81
Loss on hold-out set: 0.0018511061341716694
MeanAbsoluteError value on hold-out data: 0.03370507061481476
Epoch: 82
Loss on hold-out set: 0.0029116671883877223
MeanAbsoluteError value on hold-out data: 0.04105813428759575
Epoch: 83
Loss on hold-out set: 0.0015869172997414493
MeanAbsoluteError value on hold-out data: 0.025673160329461098
Epoch: 84

Loss on hold-out set: 0.002693488755120108
MeanAbsoluteError value on hold-out data: 0.035663899034261703
Epoch: 85
Loss on hold-out set: 0.00340208332412518
MeanAbsoluteError value on hold-out data: 0.04329518973827362
Epoch: 86
Loss on hold-out set: 0.004078261607971329
MeanAbsoluteError value on hold-out data: 0.040157902985811234
Epoch: 87
```

```
Loss on hold-out set: 0.0015556356005478078
MeanAbsoluteError value on hold-out data: 0.02551206201314926
Epoch: 88
Loss on hold-out set: 0.00274490067609944
MeanAbsoluteError value on hold-out data: 0.03450394049286842
Epoch: 89
Loss on hold-out set: 0.0020382135654262337
MeanAbsoluteError value on hold-out data: 0.030238306149840355
Epoch: 90
Loss on hold-out set: 0.0013977009310530354
MeanAbsoluteError value on hold-out data: 0.027657782658934593
Epoch: 91

Loss on hold-out set: 0.0025606061793111553
MeanAbsoluteError value on hold-out data: 0.03571421653032303
Epoch: 92
Loss on hold-out set: 0.002519264971712031
MeanAbsoluteError value on hold-out data: 0.031044011935591698
Epoch: 93
Loss on hold-out set: 0.003510551421920984
MeanAbsoluteError value on hold-out data: 0.03686382621526718
Epoch: 94

Loss on hold-out set: 0.0019117846565607649
MeanAbsoluteError value on hold-out data: 0.03251579403877258
Epoch: 95
Loss on hold-out set: 0.001528975620973282
MeanAbsoluteError value on hold-out data: 0.024898197501897812
Epoch: 96
Loss on hold-out set: 0.003528693637165886
MeanAbsoluteError value on hold-out data: 0.03891536593437195
Epoch: 97
Loss on hold-out set: 0.002588229737459467
MeanAbsoluteError value on hold-out data: 0.03661341220140457
Epoch: 98

Loss on hold-out set: 0.0013632209044702065
MeanAbsoluteError value on hold-out data: 0.026377245783805847
Epoch: 99
Loss on hold-out set: 0.001707063065483593
MeanAbsoluteError value on hold-out data: 0.026933738961815834
Epoch: 100
```

```
Loss on hold-out set: 0.002592452112227105
MeanAbsoluteError value on hold-out data: 0.038693029433488846
Epoch: 101

Loss on hold-out set: 0.0036689926816437105
MeanAbsoluteError value on hold-out data: 0.04717215895652771
Epoch: 102
Loss on hold-out set: 0.0022323356354788234
MeanAbsoluteError value on hold-out data: 0.03076012432575226
Epoch: 103
Loss on hold-out set: 0.002370973409807238
MeanAbsoluteError value on hold-out data: 0.03289700672030449
Epoch: 104
Loss on hold-out set: 0.0020186758215109315
MeanAbsoluteError value on hold-out data: 0.03434351086616516
Epoch: 105

Loss on hold-out set: 0.0020037483101567398
MeanAbsoluteError value on hold-out data: 0.03079507313668728
Epoch: 106
Loss on hold-out set: 0.002898476059691837
MeanAbsoluteError value on hold-out data: 0.04750380665063858
Epoch: 107
Loss on hold-out set: 0.0016960313301891661
MeanAbsoluteError value on hold-out data: 0.02731172740459442
Epoch: 108

Loss on hold-out set: 0.001834086849927329
MeanAbsoluteError value on hold-out data: 0.030959803611040115
Epoch: 109
Loss on hold-out set: 0.0020488321785635958
MeanAbsoluteError value on hold-out data: 0.029746072366833687
Epoch: 110
Loss on hold-out set: 0.0035403771505046347
MeanAbsoluteError value on hold-out data: 0.03673437982797623
Epoch: 111
Loss on hold-out set: 0.00303567829541862
MeanAbsoluteError value on hold-out data: 0.041208915412425995
Epoch: 112

Loss on hold-out set: 0.002147682521563883
```

```
MeanAbsoluteError value on hold-out data: 0.033834654837846756
Epoch: 113
Loss on hold-out set: 0.0025672593977875435
MeanAbsoluteError value on hold-out data: 0.035631194710731506
Epoch: 114
Loss on hold-out set: 0.002354090021421703
MeanAbsoluteError value on hold-out data: 0.03241514414548874
Epoch: 115

Loss on hold-out set: 0.002793091506016656
MeanAbsoluteError value on hold-out data: 0.03539659082889557
Epoch: 116
Loss on hold-out set: 0.0014896223057383816
MeanAbsoluteError value on hold-out data: 0.028801703825592995
Epoch: 117
Loss on hold-out set: 0.0022429066638533887
MeanAbsoluteError value on hold-out data: 0.0363181009888649
Epoch: 118
Loss on hold-out set: 0.002015193982515484
MeanAbsoluteError value on hold-out data: 0.03428517282009125
Epoch: 119

Loss on hold-out set: 0.0028572257187289116
MeanAbsoluteError value on hold-out data: 0.03434114530682564
Epoch: 120
Loss on hold-out set: 0.0019484888359259528
MeanAbsoluteError value on hold-out data: 0.029085684567689896
Epoch: 121
Loss on hold-out set: 0.0019815004914282607
MeanAbsoluteError value on hold-out data: 0.03200157359242439
Epoch: 122

Loss on hold-out set: 0.002778440113895788
MeanAbsoluteError value on hold-out data: 0.04041677340865135
Epoch: 123
Loss on hold-out set: 0.0016278961937552174
MeanAbsoluteError value on hold-out data: 0.028590142726898193
Epoch: 124
Loss on hold-out set: 0.0018723648883259068
MeanAbsoluteError value on hold-out data: 0.031093383207917213
Epoch: 125
Loss on hold-out set: 0.001476070480958487
```

```
MeanAbsoluteError value on hold-out data: 0.02910606935620308
Epoch: 126

Loss on hold-out set: 0.005414526614073951
MeanAbsoluteError value on hold-out data: 0.05803060904145241
Epoch: 127
Loss on hold-out set: 0.0018489793583285064
MeanAbsoluteError value on hold-out data: 0.02855772338807583
Epoch: 128
Loss on hold-out set: 0.002170319581637159
MeanAbsoluteError value on hold-out data: 0.03377651423215866
Epoch: 129

Loss on hold-out set: 0.002394799993803295
MeanAbsoluteError value on hold-out data: 0.03871320188045502
Epoch: 130
Loss on hold-out set: 0.00195760500859111
MeanAbsoluteError value on hold-out data: 0.03473322466015816
Epoch: 131
Loss on hold-out set: 0.0020533958315634383
MeanAbsoluteError value on hold-out data: 0.033114053308963776
Epoch: 132
Loss on hold-out set: 0.001255948436804689
MeanAbsoluteError value on hold-out data: 0.024048812687397003
Epoch: 133

Loss on hold-out set: 0.004125827314475408
MeanAbsoluteError value on hold-out data: 0.055369142442941666
Epoch: 134
Loss on hold-out set: 0.002987427417582904
MeanAbsoluteError value on hold-out data: 0.03743115812540054
Epoch: 135
Loss on hold-out set: 0.002208806386289115
MeanAbsoluteError value on hold-out data: 0.03622928634285927
Epoch: 136

Loss on hold-out set: 0.002168487448496028
MeanAbsoluteError value on hold-out data: 0.025009265169501305
Epoch: 137
Loss on hold-out set: 0.002084394234071414
MeanAbsoluteError value on hold-out data: 0.03181006386876106
```

```
Epoch: 138
Loss on hold-out set: 0.0012046236370224506
MeanAbsoluteError value on hold-out data: 0.026372238993644714
Epoch: 139
Loss on hold-out set: 0.00312510006971514
MeanAbsoluteError value on hold-out data: 0.036161404103040695
Epoch: 140

Loss on hold-out set: 0.0013792532666299779
MeanAbsoluteError value on hold-out data: 0.027986472472548485
Epoch: 141
Loss on hold-out set: 0.001940858107096014
MeanAbsoluteError value on hold-out data: 0.033263638615608215
Epoch: 142
Loss on hold-out set: 0.0033228669378261725
MeanAbsoluteError value on hold-out data: 0.04108946770429611
Epoch: 143

Loss on hold-out set: 0.0020357940498238
MeanAbsoluteError value on hold-out data: 0.032541483640670776
Epoch: 144
Loss on hold-out set: 0.0020412957842031922
MeanAbsoluteError value on hold-out data: 0.03348085284233093
Epoch: 145
Loss on hold-out set: 0.0031921751170347515
MeanAbsoluteError value on hold-out data: 0.04212977737188339
Epoch: 146
Loss on hold-out set: 0.00718824638841817
MeanAbsoluteError value on hold-out data: 0.07022005319595337
Epoch: 147

Loss on hold-out set: 0.0017446033777489972
MeanAbsoluteError value on hold-out data: 0.026940403506159782
Epoch: 148
Loss on hold-out set: 0.0019578974953709315
MeanAbsoluteError value on hold-out data: 0.02909836731851101
Epoch: 149
Loss on hold-out set: 0.002521609771065414
MeanAbsoluteError value on hold-out data: 0.0376734659075737
Epoch: 150
```

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Loss on hold-out set: 0.002578179546757243
MeanAbsoluteError value on hold-out data: 0.037617091089487076
Epoch: 151
Loss on hold-out set: 0.0013588000572501467
MeanAbsoluteError value on hold-out data: 0.02758471667766571
Epoch: 152
Loss on hold-out set: 0.0026290976675227284
MeanAbsoluteError value on hold-out data: 0.03686269372701645
Epoch: 153
Loss on hold-out set: 0.0011610576363566976
MeanAbsoluteError value on hold-out data: 0.02566593885421753
Epoch: 154

Loss on hold-out set: 0.0030752869878107538
MeanAbsoluteError value on hold-out data: 0.0413069874048233
Epoch: 155
Loss on hold-out set: 0.0018398784730099859
MeanAbsoluteError value on hold-out data: 0.02928566187620163
Epoch: 156
Loss on hold-out set: 0.002273752394383057
MeanAbsoluteError value on hold-out data: 0.033003244549036026
Epoch: 157

Loss on hold-out set: 0.002908687323304968
MeanAbsoluteError value on hold-out data: 0.03138413280248642
Epoch: 158
Loss on hold-out set: 0.0021183748484383193
MeanAbsoluteError value on hold-out data: 0.031936127692461014
Epoch: 159
Loss on hold-out set: 0.0015709644425302171
MeanAbsoluteError value on hold-out data: 0.030527792870998383
Epoch: 160
Loss on hold-out set: 0.0027333506441209465
MeanAbsoluteError value on hold-out data: 0.03189660236239433
Epoch: 161

Loss on hold-out set: 0.0026883927393310633
MeanAbsoluteError value on hold-out data: 0.03247348964214325
Epoch: 162
Loss on hold-out set: 0.002333513564036156
MeanAbsoluteError value on hold-out data: 0.033232394605875015
Epoch: 163
```

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Loss on hold-out set: 0.0020244333472174522
MeanAbsoluteError value on hold-out data: 0.03407039865851402
Epoch: 164

Loss on hold-out set: 0.0014245744566254031
MeanAbsoluteError value on hold-out data: 0.028356464579701424
Epoch: 165
Loss on hold-out set: 0.0021527676889001248
MeanAbsoluteError value on hold-out data: 0.0357729010283947
Epoch: 166
Loss on hold-out set: 0.002057917586241204
MeanAbsoluteError value on hold-out data: 0.031329378485679626
Epoch: 167
Loss on hold-out set: 0.004836117633833335
MeanAbsoluteError value on hold-out data: 0.05232257768511772
Epoch: 168

Loss on hold-out set: 0.0021291443789288257
MeanAbsoluteError value on hold-out data: 0.031549230217933655
Epoch: 169
Loss on hold-out set: 0.0022431285727249747
MeanAbsoluteError value on hold-out data: 0.030379729345440865
Epoch: 170
Loss on hold-out set: 0.0026171504197498928
MeanAbsoluteError value on hold-out data: 0.03480693697929382
Epoch: 171

Loss on hold-out set: 0.0019789694029336367
MeanAbsoluteError value on hold-out data: 0.03591480851173401
Epoch: 172
Loss on hold-out set: 0.0028211568938926435
MeanAbsoluteError value on hold-out data: 0.03554222732782364
Epoch: 173
Loss on hold-out set: 0.0014229390351549508
MeanAbsoluteError value on hold-out data: 0.027197789400815964
Epoch: 174
Loss on hold-out set: 0.0032294585656088134
MeanAbsoluteError value on hold-out data: 0.045650970190763474
Epoch: 175

Loss on hold-out set: 0.0021046935222469843
```

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MeanAbsoluteError value on hold-out data: 0.0396505631506443
Epoch: 176
Loss on hold-out set: 0.0017383961060729164
MeanAbsoluteError value on hold-out data: 0.03159661591053009
Epoch: 177
Loss on hold-out set: 0.0019633699289093223
MeanAbsoluteError value on hold-out data: 0.032631561160087585
Epoch: 178

Loss on hold-out set: 0.0032567793789964458
MeanAbsoluteError value on hold-out data: 0.044114209711551666
Epoch: 179
Loss on hold-out set: 0.0017119909059077215
MeanAbsoluteError value on hold-out data: 0.0319853276014328
Epoch: 180
Loss on hold-out set: 0.0020920403498726394
MeanAbsoluteError value on hold-out data: 0.033142827451229095
Epoch: 181
Loss on hold-out set: 0.002975955157755659
MeanAbsoluteError value on hold-out data: 0.04199289157986641
Epoch: 182

Loss on hold-out set: 0.0022223114524072465
MeanAbsoluteError value on hold-out data: 0.03771209344267845
Epoch: 183
Loss on hold-out set: 0.002648695582488122
MeanAbsoluteError value on hold-out data: 0.03341159224510193
Epoch: 184
Loss on hold-out set: 0.002653541164293599
MeanAbsoluteError value on hold-out data: 0.04163862392306328
Epoch: 185

Loss on hold-out set: 0.003437886551882212
MeanAbsoluteError value on hold-out data: 0.03625619038939476
Epoch: 186
Loss on hold-out set: 0.005519051301794557
MeanAbsoluteError value on hold-out data: 0.0641939789056778
Epoch: 187
Loss on hold-out set: 0.0019219864580708628
MeanAbsoluteError value on hold-out data: 0.030519112944602966
Epoch: 188
Loss on hold-out set: 0.002029250595324601
```

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MeanAbsoluteError value on hold-out data: 0.028930984437465668
Epoch: 189

Loss on hold-out set: 0.003989907089047707
MeanAbsoluteError value on hold-out data: 0.05189921706914902
Epoch: 190
Loss on hold-out set: 0.0028604956325859977
MeanAbsoluteError value on hold-out data: 0.040502648800611496
Epoch: 191
Loss on hold-out set: 0.0024884984646073114
MeanAbsoluteError value on hold-out data: 0.03777433559298515
Epoch: 192

Loss on hold-out set: 0.0013814993099703526
MeanAbsoluteError value on hold-out data: 0.02932819537818432
Epoch: 193
Loss on hold-out set: 0.0013254103900040858
MeanAbsoluteError value on hold-out data: 0.028240377083420753
Epoch: 194
Loss on hold-out set: 0.0019271518450785573
MeanAbsoluteError value on hold-out data: 0.03200783208012581
Epoch: 195
Loss on hold-out set: 0.0016046301741600754
MeanAbsoluteError value on hold-out data: 0.02788093499839306
Epoch: 196

Loss on hold-out set: 0.0018858704648804492
MeanAbsoluteError value on hold-out data: 0.02805454283952713
Epoch: 197
Loss on hold-out set: 0.00241014774208172
MeanAbsoluteError value on hold-out data: 0.03579166904091835
Epoch: 198
Loss on hold-out set: 0.0023616106952361474
MeanAbsoluteError value on hold-out data: 0.03286528214812279
Epoch: 199

Loss on hold-out set: 0.002315412468026177
MeanAbsoluteError value on hold-out data: 0.038341883569955826
Epoch: 200
Loss on hold-out set: 0.0018384860282262357
MeanAbsoluteError value on hold-out data: 0.031167710199952126
```

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Epoch: 201
Loss on hold-out set: 0.0028424245202376577
MeanAbsoluteError value on hold-out data: 0.03855404257774353
Epoch: 202
Loss on hold-out set: 0.0017840222795852101
MeanAbsoluteError value on hold-out data: 0.030121590942144394
Epoch: 203

Loss on hold-out set: 0.0014963737921789289
MeanAbsoluteError value on hold-out data: 0.02821316011250019
Epoch: 204
Loss on hold-out set: 0.002045918195597971
MeanAbsoluteError value on hold-out data: 0.030691618099808693
Epoch: 205
Loss on hold-out set: 0.002067898212072368
MeanAbsoluteError value on hold-out data: 0.035519205033779144
Epoch: 206

Loss on hold-out set: 0.003065676432855141
MeanAbsoluteError value on hold-out data: 0.03606483340263367
Epoch: 207
Loss on hold-out set: 0.002256885748535681
MeanAbsoluteError value on hold-out data: 0.03217300772666931
Epoch: 208
Loss on hold-out set: 0.002471938953161813
MeanAbsoluteError value on hold-out data: 0.04126109555363655
Epoch: 209
Loss on hold-out set: 0.002217250939933225
MeanAbsoluteError value on hold-out data: 0.03003067895770073
Epoch: 210

Loss on hold-out set: 0.0028279059244176517
MeanAbsoluteError value on hold-out data: 0.03719937428832054
Epoch: 211
Loss on hold-out set: 0.005153591914747197
MeanAbsoluteError value on hold-out data: 0.057072464376688004
Epoch: 212
Loss on hold-out set: 0.0018587186171386677
MeanAbsoluteError value on hold-out data: 0.032903578132390976
Epoch: 213
```

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Loss on hold-out set: 0.002195837867195503
MeanAbsoluteError value on hold-out data: 0.027309119701385498
Epoch: 214
Loss on hold-out set: 0.002881947049620346
MeanAbsoluteError value on hold-out data: 0.041736043989658356
Epoch: 215
Loss on hold-out set: 0.0035415676326150647
MeanAbsoluteError value on hold-out data: 0.034678973257541656
Epoch: 216
Loss on hold-out set: 0.0013627951131918682
MeanAbsoluteError value on hold-out data: 0.02248498983681202
Epoch: 217

Loss on hold-out set: 0.0020393676509579215
MeanAbsoluteError value on hold-out data: 0.030095508322119713
Epoch: 218
Loss on hold-out set: 0.0021717963435758767
MeanAbsoluteError value on hold-out data: 0.03080272488296032
Epoch: 219
Loss on hold-out set: 0.0015176078114354124
MeanAbsoluteError value on hold-out data: 0.026571309193968773
Epoch: 220

Loss on hold-out set: 0.0022026635840750085
MeanAbsoluteError value on hold-out data: 0.03047328069806099
Epoch: 221
Loss on hold-out set: 0.0016373271847931812
MeanAbsoluteError value on hold-out data: 0.030676988884806633
Epoch: 222
Loss on hold-out set: 0.0023273490145444297
MeanAbsoluteError value on hold-out data: 0.03854567930102348
Epoch: 223
Loss on hold-out set: 0.001792563112058605
MeanAbsoluteError value on hold-out data: 0.029486069455742836
Epoch: 224

Loss on hold-out set: 0.0017966500577481033
MeanAbsoluteError value on hold-out data: 0.029825499281287193
Epoch: 225
Loss on hold-out set: 0.0022891118782214248
MeanAbsoluteError value on hold-out data: 0.03406805172562599
Epoch: 226
```

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Loss on hold-out set: 0.0019150281788405175
MeanAbsoluteError value on hold-out data: 0.032550204545259476
Epoch: 227

Loss on hold-out set: 0.0017468862598224615
MeanAbsoluteError value on hold-out data: 0.03252299129962921
Epoch: 228
Loss on hold-out set: 0.0019085968412512627
MeanAbsoluteError value on hold-out data: 0.030453180894255638
Epoch: 229
Loss on hold-out set: 0.001791641577326048
MeanAbsoluteError value on hold-out data: 0.03142555058002472
Epoch: 230
Loss on hold-out set: 0.0028881484982915795
MeanAbsoluteError value on hold-out data: 0.035710472613573074
Epoch: 231

Loss on hold-out set: 0.002206482651392714
MeanAbsoluteError value on hold-out data: 0.034226033836603165
Epoch: 232
Loss on hold-out set: 0.0025425759757546564
MeanAbsoluteError value on hold-out data: 0.03587587550282478
Epoch: 233
Loss on hold-out set: 0.0010215530581682776
MeanAbsoluteError value on hold-out data: 0.022795293480157852
Epoch: 234

Loss on hold-out set: 0.002922031851574922
MeanAbsoluteError value on hold-out data: 0.03473679721355438
Epoch: 235
Loss on hold-out set: 0.002302890658029355
MeanAbsoluteError value on hold-out data: 0.03152661770582199
Epoch: 236
Loss on hold-out set: 0.0018773774477617384
MeanAbsoluteError value on hold-out data: 0.031483493745326996
Epoch: 237
Loss on hold-out set: 0.0022274515649769455
MeanAbsoluteError value on hold-out data: 0.038083240389823914
Epoch: 238

Loss on hold-out set: 0.002209983779511486
```

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MeanAbsoluteError value on hold-out data: 0.03377865254878998
Epoch: 239
Loss on hold-out set: 0.0015361889583381037
MeanAbsoluteError value on hold-out data: 0.02850835770368576
Epoch: 240
Loss on hold-out set: 0.0017698369562052763
MeanAbsoluteError value on hold-out data: 0.03155398741364479
Epoch: 241

Loss on hold-out set: 0.0028262301169049283
MeanAbsoluteError value on hold-out data: 0.04168536141514778
Epoch: 242
Loss on hold-out set: 0.003663050028710411
MeanAbsoluteError value on hold-out data: 0.04888226464390755
Epoch: 243
Loss on hold-out set: 0.0016223781522757446
MeanAbsoluteError value on hold-out data: 0.027127427980303764
Epoch: 244
Loss on hold-out set: 0.0014012832185611702
MeanAbsoluteError value on hold-out data: 0.027021989226341248
Epoch: 245

Loss on hold-out set: 0.0031746518798172474
MeanAbsoluteError value on hold-out data: 0.03990867733955383
Epoch: 246
Loss on hold-out set: 0.001301433818298392
MeanAbsoluteError value on hold-out data: 0.025342803448438644
Epoch: 247
Loss on hold-out set: 0.0016227018876144518
MeanAbsoluteError value on hold-out data: 0.029343614354729652
Epoch: 248

Loss on hold-out set: 0.002679175679357006
MeanAbsoluteError value on hold-out data: 0.03933103382587433
Epoch: 249
Loss on hold-out set: 0.0021293765860788813
MeanAbsoluteError value on hold-out data: 0.031098593026399612
Epoch: 250
Loss on hold-out set: 0.0023820914435558594
MeanAbsoluteError value on hold-out data: 0.0314473919570446
Epoch: 251
Loss on hold-out set: 0.002669364444535369
```

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MeanAbsoluteError value on hold-out data: 0.03516450896859169
Epoch: 252

Loss on hold-out set: 0.0026459972096535447
MeanAbsoluteError value on hold-out data: 0.042668476700782776
Epoch: 253
Loss on hold-out set: 0.002209793200913387
MeanAbsoluteError value on hold-out data: 0.03473101183772087
Epoch: 254
Loss on hold-out set: 0.0021655225718859583
MeanAbsoluteError value on hold-out data: 0.03433753177523613
Epoch: 255

Loss on hold-out set: 0.001986210252373264
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Epoch: 256
Loss on hold-out set: 0.0013041951259275754
MeanAbsoluteError value on hold-out data: 0.022115256637334824
Epoch: 257
Loss on hold-out set: 0.0024644653939713654
MeanAbsoluteError value on hold-out data: 0.031249165534973145
Epoch: 258
Loss on hold-out set: 0.0021785602730233222
MeanAbsoluteError value on hold-out data: 0.030987881124019623
Epoch: 259

Loss on hold-out set: 0.0014586869208589913
MeanAbsoluteError value on hold-out data: 0.026384972035884857
Epoch: 260
Loss on hold-out set: 0.0013630315818143291
MeanAbsoluteError value on hold-out data: 0.027517447248101234
Epoch: 261
Loss on hold-out set: 0.0035999212234925767
MeanAbsoluteError value on hold-out data: 0.049924470484256744
Epoch: 262

Loss on hold-out set: 0.0011577248067344325
MeanAbsoluteError value on hold-out data: 0.023943400010466576
Epoch: 263
Loss on hold-out set: 0.002865419741003559
MeanAbsoluteError value on hold-out data: 0.042188290506601334
```

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Epoch: 264
Loss on hold-out set: 0.00366082544832562
MeanAbsoluteError value on hold-out data: 0.04321115463972092
Epoch: 265
Loss on hold-out set: 0.0018573795857194525
MeanAbsoluteError value on hold-out data: 0.028246961534023285
Epoch: 266

Loss on hold-out set: 0.0022212065702590803
MeanAbsoluteError value on hold-out data: 0.028916986659169197
Epoch: 267
Loss on hold-out set: 0.0029933971415560404
MeanAbsoluteError value on hold-out data: 0.03173268586397171
Epoch: 268
Loss on hold-out set: 0.00401520395042518
MeanAbsoluteError value on hold-out data: 0.04156413674354553
Epoch: 269

Loss on hold-out set: 0.004630145670559544
MeanAbsoluteError value on hold-out data: 0.05578088387846947
Epoch: 270
Loss on hold-out set: 0.0009585402115660075
MeanAbsoluteError value on hold-out data: 0.024545399472117424
Epoch: 271
Loss on hold-out set: 0.0012901641983682145
MeanAbsoluteError value on hold-out data: 0.025723528116941452
Epoch: 272
Loss on hold-out set: 0.001994943192515236
MeanAbsoluteError value on hold-out data: 0.03419311344623566
Epoch: 273

Loss on hold-out set: 0.002149483363609761
MeanAbsoluteError value on hold-out data: 0.03260718658566475
Epoch: 274
Loss on hold-out set: 0.0021307939985910286
MeanAbsoluteError value on hold-out data: 0.03744467720389366
Epoch: 275
Loss on hold-out set: 0.0011845801289802273
MeanAbsoluteError value on hold-out data: 0.026059234514832497
Epoch: 276
```

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Loss on hold-out set: 0.0031802523970747222
MeanAbsoluteError value on hold-out data: 0.03591148555278778
Epoch: 277
Loss on hold-out set: 0.001716683439623851
MeanAbsoluteError value on hold-out data: 0.028678542003035545
Epoch: 278
Loss on hold-out set: 0.0020658875985715827
MeanAbsoluteError value on hold-out data: 0.03472071513533592
Epoch: 279
Loss on hold-out set: 0.0025189739557950255
MeanAbsoluteError value on hold-out data: 0.034951549023389816

Epoch: 280
Loss on hold-out set: 0.003277617179824469
MeanAbsoluteError value on hold-out data: 0.037941526621580124
Epoch: 281
Loss on hold-out set: 0.0024245724758097473
MeanAbsoluteError value on hold-out data: 0.029915807768702507
Epoch: 282
Loss on hold-out set: 0.001695336457207584
MeanAbsoluteError value on hold-out data: 0.030095143243670464
Epoch: 283

Loss on hold-out set: 0.001058529819532011
MeanAbsoluteError value on hold-out data: 0.022858979180455208
Epoch: 284
Loss on hold-out set: 0.0009874436408818627
MeanAbsoluteError value on hold-out data: 0.021357083693146706
Epoch: 285
Loss on hold-out set: 0.0020109232461366514
MeanAbsoluteError value on hold-out data: 0.03381624072790146
Epoch: 286

Loss on hold-out set: 0.0008122445282284529
MeanAbsoluteError value on hold-out data: 0.020824318751692772
Epoch: 287
Loss on hold-out set: 0.0016282999870152427
MeanAbsoluteError value on hold-out data: 0.0280130784958601
Epoch: 288
Loss on hold-out set: 0.0026302159083290743
MeanAbsoluteError value on hold-out data: 0.03602423891425133
Epoch: 289
```

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Loss on hold-out set: 0.0017216407084980835
MeanAbsoluteError value on hold-out data: 0.03037918545305729
Epoch: 290

Loss on hold-out set: 0.0016476341630690373
MeanAbsoluteError value on hold-out data: 0.03124621883034706
Epoch: 291
Loss on hold-out set: 0.0023275607829698576
MeanAbsoluteError value on hold-out data: 0.03456854447722435
Epoch: 292
Loss on hold-out set: 0.0016290783891096138
MeanAbsoluteError value on hold-out data: 0.031239748001098633
Epoch: 293

Loss on hold-out set: 0.002320083619381946
MeanAbsoluteError value on hold-out data: 0.03408220410346985
Epoch: 294
Loss on hold-out set: 0.0020488249596942645
MeanAbsoluteError value on hold-out data: 0.03156610578298569
Epoch: 295
Loss on hold-out set: 0.003152357181534171
MeanAbsoluteError value on hold-out data: 0.03833774849772453
Epoch: 296
Loss on hold-out set: 0.0019581404854901708
MeanAbsoluteError value on hold-out data: 0.031769368797540665
Epoch: 297

Loss on hold-out set: 0.0018272069103729266
MeanAbsoluteError value on hold-out data: 0.032753605395555496
Epoch: 298
Loss on hold-out set: 0.0018480317432057257
MeanAbsoluteError value on hold-out data: 0.027007825672626495
Epoch: 299
Loss on hold-out set: 0.0028111334764756835
MeanAbsoluteError value on hold-out data: 0.041410189121961594
Epoch: 300

Loss on hold-out set: 0.0032044176433163765
MeanAbsoluteError value on hold-out data: 0.036844395101070404
Epoch: 301
Loss on hold-out set: 0.002131230099341617
```

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MeanAbsoluteError value on hold-out data: 0.03435900807380676
Epoch: 302
Loss on hold-out set: 0.0021165932367484155
MeanAbsoluteError value on hold-out data: 0.03610561043024063
Epoch: 303
Loss on hold-out set: 0.002042365029830342
MeanAbsoluteError value on hold-out data: 0.030431363731622696
Epoch: 304

Loss on hold-out set: 0.0016349283955955447
MeanAbsoluteError value on hold-out data: 0.026566384360194206
Epoch: 305
Loss on hold-out set: 0.0019340349938899565
MeanAbsoluteError value on hold-out data: 0.026753423735499382
Epoch: 306
Loss on hold-out set: 0.0023227322201889297
MeanAbsoluteError value on hold-out data: 0.03613007441163063
Epoch: 307

Loss on hold-out set: 0.0028137974620151976
MeanAbsoluteError value on hold-out data: 0.041422758251428604
Epoch: 308
Loss on hold-out set: 0.002044234612885003
MeanAbsoluteError value on hold-out data: 0.03343473747372627
Epoch: 309
Loss on hold-out set: 0.001968938754334186
MeanAbsoluteError value on hold-out data: 0.03317730501294136
Epoch: 310
Loss on hold-out set: 0.0025517492993878056
MeanAbsoluteError value on hold-out data: 0.040565621107816696
Epoch: 311

Loss on hold-out set: 0.0022348104908954925
MeanAbsoluteError value on hold-out data: 0.035477280616760254
Epoch: 312
Loss on hold-out set: 0.0032428593347923686
MeanAbsoluteError value on hold-out data: 0.0413566455245018
Epoch: 313
Loss on hold-out set: 0.0019110384119602924
MeanAbsoluteError value on hold-out data: 0.03305566683411598
Epoch: 314
```

```
Loss on hold-out set: 0.002490869465803441
MeanAbsoluteError value on hold-out data: 0.030080566182732582
Epoch: 315
Loss on hold-out set: 0.0016447320343174327
MeanAbsoluteError value on hold-out data: 0.028074586763978004
Epoch: 316
Loss on hold-out set: 0.0033660274661647584
MeanAbsoluteError value on hold-out data: 0.04103808104991913
Epoch: 317
Loss on hold-out set: 0.0023330731301729637
MeanAbsoluteError value on hold-out data: 0.03564261272549629
Epoch: 318

Loss on hold-out set: 0.002088058444384772
MeanAbsoluteError value on hold-out data: 0.03329048678278923
Epoch: 319
Loss on hold-out set: 0.0018959278341543933
MeanAbsoluteError value on hold-out data: 0.028830870985984802
Epoch: 320
Loss on hold-out set: 0.0023800216865940737
MeanAbsoluteError value on hold-out data: 0.036099422723054886
Epoch: 321

Loss on hold-out set: 0.0015971195087051736
MeanAbsoluteError value on hold-out data: 0.02916024439036846
Epoch: 322
Loss on hold-out set: 0.0022644507989753038
MeanAbsoluteError value on hold-out data: 0.03317294642329216
Epoch: 323
Loss on hold-out set: 0.0015958776295100017
MeanAbsoluteError value on hold-out data: 0.025203077122569084
Epoch: 324
Loss on hold-out set: 0.003947317909198598
MeanAbsoluteError value on hold-out data: 0.04711633548140526
Epoch: 325

Loss on hold-out set: 0.0019491450713338475
MeanAbsoluteError value on hold-out data: 0.026585211977362633
Epoch: 326
Loss on hold-out set: 0.0021428282332355874
MeanAbsoluteError value on hold-out data: 0.033430684357881546
Epoch: 327
```

```
Loss on hold-out set: 0.001705172496328417
MeanAbsoluteError value on hold-out data: 0.030545759946107864
Epoch: 328

Loss on hold-out set: 0.002250389980662686
MeanAbsoluteError value on hold-out data: 0.03052087500691414
Epoch: 329
Loss on hold-out set: 0.00195799760807019
MeanAbsoluteError value on hold-out data: 0.03175467625260353
Epoch: 330
Loss on hold-out set: 0.0024479484082593653
MeanAbsoluteError value on hold-out data: 0.0338723249733448
Epoch: 331
Loss on hold-out set: 0.0014366463695366222
MeanAbsoluteError value on hold-out data: 0.028164805844426155
Epoch: 332

Loss on hold-out set: 0.0034028181152489898
MeanAbsoluteError value on hold-out data: 0.04326556995511055
Epoch: 333
Loss on hold-out set: 0.003579141755695813
MeanAbsoluteError value on hold-out data: 0.046425387263298035
Epoch: 334
Loss on hold-out set: 0.0016858228213655262
MeanAbsoluteError value on hold-out data: 0.030087938532233238
Epoch: 335

Loss on hold-out set: 0.0013344504315262805
MeanAbsoluteError value on hold-out data: 0.025825459510087967
Epoch: 336
Loss on hold-out set: 0.00276836066488893
MeanAbsoluteError value on hold-out data: 0.0372573584318161
Epoch: 337
Loss on hold-out set: 0.00310974125078736
MeanAbsoluteError value on hold-out data: 0.03561512380838394
Epoch: 338
Loss on hold-out set: 0.0026547720996089852
MeanAbsoluteError value on hold-out data: 0.03715038672089577
Epoch: 339

Loss on hold-out set: 0.0015274284042579194
```

```
MeanAbsoluteError value on hold-out data: 0.025446195155382156
Epoch: 340
Loss on hold-out set: 0.0018955936561374424
MeanAbsoluteError value on hold-out data: 0.028718125075101852
Epoch: 341
Loss on hold-out set: 0.002924949409834181
MeanAbsoluteError value on hold-out data: 0.03854880481958389
Epoch: 342

Loss on hold-out set: 0.00274514938176323
MeanAbsoluteError value on hold-out data: 0.04433701932430267
Epoch: 343
Loss on hold-out set: 0.002994989206154759
MeanAbsoluteError value on hold-out data: 0.040708690881729126
Epoch: 344
Loss on hold-out set: 0.0017158097403947837
MeanAbsoluteError value on hold-out data: 0.030959032475948334
Epoch: 345
Loss on hold-out set: 0.001811880871313266
MeanAbsoluteError value on hold-out data: 0.02920561097562313
Epoch: 346

Loss on hold-out set: 0.0021440745913423598
MeanAbsoluteError value on hold-out data: 0.03438013419508934
Epoch: 347
Loss on hold-out set: 0.003353168650601919
MeanAbsoluteError value on hold-out data: 0.041196309030056
Epoch: 348
Loss on hold-out set: 0.0026141827648433927
MeanAbsoluteError value on hold-out data: 0.038005270063877106
Epoch: 349

Loss on hold-out set: 0.0018752606254285918
MeanAbsoluteError value on hold-out data: 0.03215441107749939
Epoch: 350
Loss on hold-out set: 0.0022541766028063227
MeanAbsoluteError value on hold-out data: 0.03485943377017975
Epoch: 351
Loss on hold-out set: 0.0012848758443187063
MeanAbsoluteError value on hold-out data: 0.024856947362422943
Epoch: 352
Loss on hold-out set: 0.0015122404550381291
```

```
MeanAbsoluteError value on hold-out data: 0.02962990291416645
Epoch: 353

Loss on hold-out set: 0.0018021825101011647
MeanAbsoluteError value on hold-out data: 0.03676570951938629
Epoch: 354
Loss on hold-out set: 0.002318069361186085
MeanAbsoluteError value on hold-out data: 0.03012196533381939
Epoch: 355
Loss on hold-out set: 0.0035569396568462253
MeanAbsoluteError value on hold-out data: 0.05052424594759941
Epoch: 356

Loss on hold-out set: 0.002724145769696826
MeanAbsoluteError value on hold-out data: 0.032134346663951874
Epoch: 357
Loss on hold-out set: 0.0021264728946754565
MeanAbsoluteError value on hold-out data: 0.03278977796435356
Epoch: 358
Loss on hold-out set: 0.0015864075562254025
MeanAbsoluteError value on hold-out data: 0.026798399165272713
Epoch: 359
Loss on hold-out set: 0.002401995922599991
MeanAbsoluteError value on hold-out data: 0.03197384625673294
Epoch: 360

Loss on hold-out set: 0.002094161280323393
MeanAbsoluteError value on hold-out data: 0.03244687616825104
Epoch: 361
Loss on hold-out set: 0.0018539096389968807
MeanAbsoluteError value on hold-out data: 0.02917529083788395
Epoch: 362
Loss on hold-out set: 0.0017901714980745544
MeanAbsoluteError value on hold-out data: 0.027922580018639565
Epoch: 363

Loss on hold-out set: 0.0022106518445070833
MeanAbsoluteError value on hold-out data: 0.035507682710886
Epoch: 364
Loss on hold-out set: 0.002157429166030712
MeanAbsoluteError value on hold-out data: 0.02958570048213005
```

```
Epoch: 365
Loss on hold-out set: 0.0017303371658691992
MeanAbsoluteError value on hold-out data: 0.025863278657197952
Epoch: 366
Loss on hold-out set: 0.0013101271179039031
MeanAbsoluteError value on hold-out data: 0.024445097893476486
Epoch: 367

Loss on hold-out set: 0.002374138360699782
MeanAbsoluteError value on hold-out data: 0.035648804157972336
Epoch: 368
Loss on hold-out set: 0.0016050557404434164
MeanAbsoluteError value on hold-out data: 0.031419552862644196
Epoch: 369
Loss on hold-out set: 0.0022823690132309613
MeanAbsoluteError value on hold-out data: 0.03851637244224548
Epoch: 370

Loss on hold-out set: 0.002074630046711088
MeanAbsoluteError value on hold-out data: 0.029269805178046227
Epoch: 371
Loss on hold-out set: 0.0026474912950876527
MeanAbsoluteError value on hold-out data: 0.03921569511294365
Epoch: 372
Loss on hold-out set: 0.0024525058587851864
MeanAbsoluteError value on hold-out data: 0.03159226104617119
Epoch: 373
Loss on hold-out set: 0.002644467084722307
MeanAbsoluteError value on hold-out data: 0.03609538823366165
Epoch: 374

Loss on hold-out set: 0.0026142649495830904
MeanAbsoluteError value on hold-out data: 0.03458687290549278
Epoch: 375
Loss on hold-out set: 0.002291371170520926
MeanAbsoluteError value on hold-out data: 0.029139962047338486
Epoch: 376
Loss on hold-out set: 0.0032580926434513037
MeanAbsoluteError value on hold-out data: 0.036085546016693115
Epoch: 377
```

```
Loss on hold-out set: 0.0014814026194821613
MeanAbsoluteError value on hold-out data: 0.026504594832658768
Epoch: 378
Loss on hold-out set: 0.0015958098094695462
MeanAbsoluteError value on hold-out data: 0.02956714667379856
Epoch: 379
Loss on hold-out set: 0.003909323615236924
MeanAbsoluteError value on hold-out data: 0.04655919969081879
Epoch: 380
Loss on hold-out set: 0.0020411920805390063
MeanAbsoluteError value on hold-out data: 0.029514305293560028
Epoch: 381

Loss on hold-out set: 0.003163093004751807
MeanAbsoluteError value on hold-out data: 0.03881746158003807
Epoch: 382
Loss on hold-out set: 0.003274528161944965
MeanAbsoluteError value on hold-out data: 0.04387917369604111
Epoch: 383
Loss on hold-out set: 0.0020287005956141422
MeanAbsoluteError value on hold-out data: 0.02873990498483181
Epoch: 384

Loss on hold-out set: 0.0015586454045170774
MeanAbsoluteError value on hold-out data: 0.029299667105078697
Epoch: 385
Loss on hold-out set: 0.0020822016477513197
MeanAbsoluteError value on hold-out data: 0.032639436423778534
Epoch: 386
Loss on hold-out set: 0.0024540206426396393
MeanAbsoluteError value on hold-out data: 0.035465773195028305
Epoch: 387
Loss on hold-out set: 0.0017294413678777905
MeanAbsoluteError value on hold-out data: 0.031918302178382874
Epoch: 388

Loss on hold-out set: 0.0038422788224684503
MeanAbsoluteError value on hold-out data: 0.040708355605602264
Epoch: 389
Loss on hold-out set: 0.0026400595849666456
MeanAbsoluteError value on hold-out data: 0.034087348729372025
Epoch: 390
```

```
Loss on hold-out set: 0.0025582839040837893
MeanAbsoluteError value on hold-out data: 0.03553156927227974
Epoch: 391

Loss on hold-out set: 0.002053611873774431
MeanAbsoluteError value on hold-out data: 0.035544633865356445
Epoch: 392
Loss on hold-out set: 0.0026173749356530607
MeanAbsoluteError value on hold-out data: 0.04059349000453949
Epoch: 393
Loss on hold-out set: 0.001400023335008882
MeanAbsoluteError value on hold-out data: 0.02414160780608654
Epoch: 394
Loss on hold-out set: 0.004307868980014553
MeanAbsoluteError value on hold-out data: 0.04398007690906525
Epoch: 395

Loss on hold-out set: 0.0020969669612196204
MeanAbsoluteError value on hold-out data: 0.02814231440424919
Epoch: 396
Loss on hold-out set: 0.0012029020805270053
MeanAbsoluteError value on hold-out data: 0.023222405463457108
Epoch: 397
Loss on hold-out set: 0.0014366314694948064
MeanAbsoluteError value on hold-out data: 0.027139296755194664
Epoch: 398

Loss on hold-out set: 0.0023133260905384445
MeanAbsoluteError value on hold-out data: 0.03194504603743553
Epoch: 399
Loss on hold-out set: 0.0020199789410421196
MeanAbsoluteError value on hold-out data: 0.030451511964201927
Epoch: 400
Loss on hold-out set: 0.001338256653980352
MeanAbsoluteError value on hold-out data: 0.023942850530147552
Epoch: 401
Loss on hold-out set: 0.0018755080885826969
MeanAbsoluteError value on hold-out data: 0.03166935592889786
Epoch: 402

Loss on hold-out set: 0.002218415645004895
```

```
MeanAbsoluteError value on hold-out data: 0.03078455664217472
Epoch: 403
Loss on hold-out set: 0.0014090747818744814
MeanAbsoluteError value on hold-out data: 0.02758960984647274
Epoch: 404
Loss on hold-out set: 0.002922765644213471
MeanAbsoluteError value on hold-out data: 0.03896515443921089
Epoch: 405

Loss on hold-out set: 0.0021169566943381843
MeanAbsoluteError value on hold-out data: 0.03490723296999931
Epoch: 406
Loss on hold-out set: 0.003651968642281225
MeanAbsoluteError value on hold-out data: 0.04572629928588867
Epoch: 407
Loss on hold-out set: 0.0020424393084025583
MeanAbsoluteError value on hold-out data: 0.030238358303904533
Epoch: 408
Loss on hold-out set: 0.001849685728442497
MeanAbsoluteError value on hold-out data: 0.0273387860506773
Epoch: 409

Loss on hold-out set: 0.0021831206350515667
MeanAbsoluteError value on hold-out data: 0.035764697939157486
Epoch: 410
Loss on hold-out set: 0.001777927167355441
MeanAbsoluteError value on hold-out data: 0.029883291572332382
Epoch: 411
Loss on hold-out set: 0.0017908146736982206
MeanAbsoluteError value on hold-out data: 0.026323754340410233
Epoch: 412

Loss on hold-out set: 0.0015765546435991733
MeanAbsoluteError value on hold-out data: 0.027125999331474304
Epoch: 413
Loss on hold-out set: 0.00222534314245702
MeanAbsoluteError value on hold-out data: 0.0335550419986248
Epoch: 414
Loss on hold-out set: 0.0028623301791063007
MeanAbsoluteError value on hold-out data: 0.040602680295705795
Early stopping at epoch 413
Fold: 5
```

```
Epoch: 1
Loss on hold-out set: 0.016724021245653812
MeanAbsoluteError value on hold-out data: 0.10951952636241913
Epoch: 2

Loss on hold-out set: 0.012675166237526216
MeanAbsoluteError value on hold-out data: 0.08997004479169846
Epoch: 3
Loss on hold-out set: 0.007218727233031621
MeanAbsoluteError value on hold-out data: 0.05903344973921776
Epoch: 4
Loss on hold-out set: 0.0043773356054981165
MeanAbsoluteError value on hold-out data: 0.05321456119418144
Epoch: 5

Loss on hold-out set: 0.005023954203352332
MeanAbsoluteError value on hold-out data: 0.05620598793029785
Epoch: 6
Loss on hold-out set: 0.0035934617223504642
MeanAbsoluteError value on hold-out data: 0.04301457852125168
Epoch: 7
Loss on hold-out set: 0.005024238605983555
MeanAbsoluteError value on hold-out data: 0.052962783724069595
Epoch: 8
Loss on hold-out set: 0.003276909307505076
MeanAbsoluteError value on hold-out data: 0.045519307255744934
Epoch: 9

Loss on hold-out set: 0.004808593783169412
MeanAbsoluteError value on hold-out data: 0.05600782483816147
Epoch: 10
Loss on hold-out set: 0.003375847483626925
MeanAbsoluteError value on hold-out data: 0.0420672707259655
Epoch: 11
Loss on hold-out set: 0.0033674813681640304
MeanAbsoluteError value on hold-out data: 0.04186331108212471
Epoch: 12

Loss on hold-out set: 0.003968234370964078
MeanAbsoluteError value on hold-out data: 0.04927996173501015
Epoch: 13
```

```
Loss on hold-out set: 0.0036772315103847245
MeanAbsoluteError value on hold-out data: 0.045647382736206055
Epoch: 14
Loss on hold-out set: 0.0030183538149755737
MeanAbsoluteError value on hold-out data: 0.04050273448228836
Epoch: 15
Loss on hold-out set: 0.005126602043254444
MeanAbsoluteError value on hold-out data: 0.05769922211766243
Epoch: 16

Loss on hold-out set: 0.00421733776322351
MeanAbsoluteError value on hold-out data: 0.04918353259563446
Epoch: 17
Loss on hold-out set: 0.0035702703037084295
MeanAbsoluteError value on hold-out data: 0.04413871467113495
Epoch: 18
Loss on hold-out set: 0.003869931365793141
MeanAbsoluteError value on hold-out data: 0.04607535898685455
Epoch: 19

Loss on hold-out set: 0.0025525144749106122
MeanAbsoluteError value on hold-out data: 0.03819524124264717
Epoch: 20
Loss on hold-out set: 0.002591942078792132
MeanAbsoluteError value on hold-out data: 0.03838474676012993
Epoch: 21
Loss on hold-out set: 0.002943361160130455
MeanAbsoluteError value on hold-out data: 0.04151936620473862
Epoch: 22
Loss on hold-out set: 0.005073258809996053
MeanAbsoluteError value on hold-out data: 0.05695180967450142
Epoch: 23

Loss on hold-out set: 0.005409744165193003
MeanAbsoluteError value on hold-out data: 0.05218479037284851
Epoch: 24
Loss on hold-out set: 0.004461517454519008
MeanAbsoluteError value on hold-out data: 0.04744161665439606
Epoch: 25
Loss on hold-out set: 0.004169246043042781
MeanAbsoluteError value on hold-out data: 0.04002850130200386
Epoch: 26
```

```
Loss on hold-out set: 0.004986280091823294
MeanAbsoluteError value on hold-out data: 0.05701860040426254
Epoch: 27
Loss on hold-out set: 0.0033666675623792866
MeanAbsoluteError value on hold-out data: 0.042822547256946564
Epoch: 28
Loss on hold-out set: 0.007628957149930871
MeanAbsoluteError value on hold-out data: 0.06708221137523651
Epoch: 29
Loss on hold-out set: 0.0038209287628818015
MeanAbsoluteError value on hold-out data: 0.0485888235270977
Epoch: 30

Loss on hold-out set: 0.005084815569436894
MeanAbsoluteError value on hold-out data: 0.05248192325234413
Epoch: 31
Loss on hold-out set: 0.004002057356186784
MeanAbsoluteError value on hold-out data: 0.04553864523768425
Epoch: 32
Loss on hold-out set: 0.0038831230172385964
MeanAbsoluteError value on hold-out data: 0.043354764580726624
Epoch: 33

Loss on hold-out set: 0.00424681963900534
MeanAbsoluteError value on hold-out data: 0.05064402148127556
Epoch: 34
Loss on hold-out set: 0.004199242604394944
MeanAbsoluteError value on hold-out data: 0.05091482028365135
Epoch: 35
Loss on hold-out set: 0.005194435433412974
MeanAbsoluteError value on hold-out data: 0.05653296783566475
Epoch: 36
Loss on hold-out set: 0.004622620691616948
MeanAbsoluteError value on hold-out data: 0.0540870726108551
Epoch: 37

Loss on hold-out set: 0.005519805386519203
MeanAbsoluteError value on hold-out data: 0.058876410126686096
Epoch: 38
Loss on hold-out set: 0.004662175998628999
MeanAbsoluteError value on hold-out data: 0.05347258225083351
Epoch: 39
```

```
Loss on hold-out set: 0.0030806609384643915
MeanAbsoluteError value on hold-out data: 0.04080556333065033
Epoch: 40

Loss on hold-out set: 0.004711881826201884
MeanAbsoluteError value on hold-out data: 0.05155099555850029
Epoch: 41
Loss on hold-out set: 0.0035266797774686264
MeanAbsoluteError value on hold-out data: 0.04548266902565956
Epoch: 42
Loss on hold-out set: 0.002418499287719337
MeanAbsoluteError value on hold-out data: 0.039537716656923294
Epoch: 43
Loss on hold-out set: 0.005370575674952796
MeanAbsoluteError value on hold-out data: 0.05387241765856743
Epoch: 44

Loss on hold-out set: 0.005768654706816261
MeanAbsoluteError value on hold-out data: 0.0558057464659214
Epoch: 45
Loss on hold-out set: 0.003711909485551027
MeanAbsoluteError value on hold-out data: 0.04353473335504532
Epoch: 46
Loss on hold-out set: 0.003608252899049638
MeanAbsoluteError value on hold-out data: 0.044874656945466995
Epoch: 47

Loss on hold-out set: 0.004066610529732246
MeanAbsoluteError value on hold-out data: 0.04895215108990669
Epoch: 48
Loss on hold-out set: 0.004205109963480096
MeanAbsoluteError value on hold-out data: 0.04981071874499321
Epoch: 49
Loss on hold-out set: 0.0035579859350736323
MeanAbsoluteError value on hold-out data: 0.046598661690950394
Epoch: 50
Loss on hold-out set: 0.004389373504986556
MeanAbsoluteError value on hold-out data: 0.0462053120136261
Epoch: 51

Loss on hold-out set: 0.003241549308698338
```

```
MeanAbsoluteError value on hold-out data: 0.04204472526907921
Epoch: 52
Loss on hold-out set: 0.006456546977950403５
MeanAbsoluteError value on hold-out data: 0.06298798322677612
Epoch: 53
Loss on hold-out set: 0.004460557632578107
MeanAbsoluteError value on hold-out data: 0.05482480674982071
Epoch: 54

Loss on hold-out set: 0.0036302309196728924
MeanAbsoluteError value on hold-out data: 0.04720117896795273
Epoch: 55
Loss on hold-out set: 0.004393266594538895
MeanAbsoluteError value on hold-out data: 0.04745247960090637
Epoch: 56
Loss on hold-out set: 0.005630911686099493
MeanAbsoluteError value on hold-out data: 0.057056084275245667
Epoch: 57
Loss on hold-out set: 0.0030018729023420466
MeanAbsoluteError value on hold-out data: 0.04061258211731911
Epoch: 58

Loss on hold-out set: 0.004573433785341107
MeanAbsoluteError value on hold-out data: 0.053740378469228745
Epoch: 59
Loss on hold-out set: 0.003480393730569631
MeanAbsoluteError value on hold-out data: 0.043725479394197464
Epoch: 60
Loss on hold-out set: 0.005066317524044559
MeanAbsoluteError value on hold-out data: 0.05375951901078224
Epoch: 61

Loss on hold-out set: 0.0030067085843676557
MeanAbsoluteError value on hold-out data: 0.04282114654779434
Epoch: 62
Loss on hold-out set: 0.004716001809216463
MeanAbsoluteError value on hold-out data: 0.05386412516236305
Epoch: 63
Loss on hold-out set: 0.0038683450100227045
MeanAbsoluteError value on hold-out data: 0.04629974439740181
Epoch: 64
Loss on hold-out set: 0.0032955010940965554
```

```
MeanAbsoluteError value on hold-out data: 0.04227059334516525
Epoch: 65

Loss on hold-out set: 0.003947228047763929
MeanAbsoluteError value on hold-out data: 0.04495283216238022
Epoch: 66
Loss on hold-out set: 0.004661118217672293
MeanAbsoluteError value on hold-out data: 0.04699580743908882
Epoch: 67
Loss on hold-out set: 0.0028930849243456926
MeanAbsoluteError value on hold-out data: 0.04289526864886284
Epoch: 68

Loss on hold-out set: 0.00395417937453693
MeanAbsoluteError value on hold-out data: 0.04573105648159981
Epoch: 69
Loss on hold-out set: 0.003055484665450282
MeanAbsoluteError value on hold-out data: 0.04362652823328972
Epoch: 70
Loss on hold-out set: 0.0031021457308760057
MeanAbsoluteError value on hold-out data: 0.0436469167470932
Epoch: 71
Loss on hold-out set: 0.0038599855123231043
MeanAbsoluteError value on hold-out data: 0.048018984496593475
Epoch: 72

Loss on hold-out set: 0.0038890208278854308
MeanAbsoluteError value on hold-out data: 0.050686098635196686
Epoch: 73
Loss on hold-out set: 0.005109150553695285
MeanAbsoluteError value on hold-out data: 0.053528208285570145
Epoch: 74
Loss on hold-out set: 0.0035581013832527856
MeanAbsoluteError value on hold-out data: 0.04482181370258331
Epoch: 75

Loss on hold-out set: 0.0049288586910384204
MeanAbsoluteError value on hold-out data: 0.05347493290901184
Epoch: 76
Loss on hold-out set: 0.0037729343300900208
MeanAbsoluteError value on hold-out data: 0.04469859227538109
```

```
Epoch: 77
Loss on hold-out set: 0.005306930424502263
MeanAbsoluteError value on hold-out data: 0.05100863799452782
Epoch: 78
Loss on hold-out set: 0.003978157462999941
MeanAbsoluteError value on hold-out data: 0.04336162656545639
Epoch: 79

Loss on hold-out set: 0.004106923579596556
MeanAbsoluteError value on hold-out data: 0.04502229392528534
Epoch: 80
Loss on hold-out set: 0.002386883532520957
MeanAbsoluteError value on hold-out data: 0.03718714043498039
Epoch: 81
Loss on hold-out set: 0.003909630038274022
MeanAbsoluteError value on hold-out data: 0.04295866936445236
Epoch: 82

Loss on hold-out set: 0.004136485593894927
MeanAbsoluteError value on hold-out data: 0.048133932054042816
Epoch: 83
Loss on hold-out set: 0.004585152062085958
MeanAbsoluteError value on hold-out data: 0.051757920533418655
Epoch: 84
Loss on hold-out set: 0.00475588517012791
MeanAbsoluteError value on hold-out data: 0.05339812859892845
Epoch: 85
Loss on hold-out set: 0.004637934563036721
MeanAbsoluteError value on hold-out data: 0.05090240016579628
Epoch: 86

Loss on hold-out set: 0.0036779070908848485
MeanAbsoluteError value on hold-out data: 0.042462121695280075
Epoch: 87
Loss on hold-out set: 0.004606027147159553
MeanAbsoluteError value on hold-out data: 0.05179234594106674
Epoch: 88
Loss on hold-out set: 0.005880492166257822
MeanAbsoluteError value on hold-out data: 0.05098654329776764
Epoch: 89
```

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Loss on hold-out set: 0.005020116688683629
MeanAbsoluteError value on hold-out data: 0.05661005899310112
Epoch: 90
Loss on hold-out set: 0.004362911782943859
MeanAbsoluteError value on hold-out data: 0.04599665105342865
Epoch: 91
Loss on hold-out set: 0.0044844925690155765
MeanAbsoluteError value on hold-out data: 0.04859284311532974
Epoch: 92
Loss on hold-out set: 0.0038587631245788475
MeanAbsoluteError value on hold-out data: 0.042260900139808655
Epoch: 93

Loss on hold-out set: 0.004806665632014091
MeanAbsoluteError value on hold-out data: 0.05480030179023743
Epoch: 94
Loss on hold-out set: 0.004735971299501566
MeanAbsoluteError value on hold-out data: 0.046879831701517105
Epoch: 95
Loss on hold-out set: 0.0037051209857544075
MeanAbsoluteError value on hold-out data: 0.046113163232803345
Epoch: 96

Loss on hold-out set: 0.003673935246367294
MeanAbsoluteError value on hold-out data: 0.04209432750940323
Epoch: 97
Loss on hold-out set: 0.002505723861619257
MeanAbsoluteError value on hold-out data: 0.0382373221218586
Epoch: 98
Loss on hold-out set: 0.006138121189836126
MeanAbsoluteError value on hold-out data: 0.05990922078490257
Epoch: 99
Loss on hold-out set: 0.008641143204071201
MeanAbsoluteError value on hold-out data: 0.075585275888443
Epoch: 100

Loss on hold-out set: 0.006874873589437742
MeanAbsoluteError value on hold-out data: 0.051062725484371185
Epoch: 101
Loss on hold-out set: 0.004981326816890102
MeanAbsoluteError value on hold-out data: 0.0565568245947361
Epoch: 102
```

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Loss on hold-out set: 0.004914191936572583
MeanAbsoluteError value on hold-out data: 0.05335357040166855
Epoch: 103

Loss on hold-out set: 0.007171842968091369
MeanAbsoluteError value on hold-out data: 0.06926225870847702
Epoch: 104
Loss on hold-out set: 0.004993493556797218
MeanAbsoluteError value on hold-out data: 0.04511605203151703
Epoch: 105
Loss on hold-out set: 0.004912783996237872
MeanAbsoluteError value on hold-out data: 0.044989511370658875
Epoch: 106
Loss on hold-out set: 0.004031906096945302
MeanAbsoluteError value on hold-out data: 0.043779801577329636
Epoch: 107

Loss on hold-out set: 0.0046546258292017645
MeanAbsoluteError value on hold-out data: 0.04847685247659683
Epoch: 108
Loss on hold-out set: 0.003981809163143715
MeanAbsoluteError value on hold-out data: 0.04748372733592987
Epoch: 109
Loss on hold-out set: 0.0065139401883173445
MeanAbsoluteError value on hold-out data: 0.06413368880748749
Epoch: 110

Loss on hold-out set: 0.0038864854633664857
MeanAbsoluteError value on hold-out data: 0.049084197729825974
Epoch: 111
Loss on hold-out set: 0.004577120470527846
MeanAbsoluteError value on hold-out data: 0.05426566302776337
Epoch: 112
Loss on hold-out set: 0.0025831603203327036
MeanAbsoluteError value on hold-out data: 0.040709238499403
Epoch: 113
Loss on hold-out set: 0.003927984695809965
MeanAbsoluteError value on hold-out data: 0.04780937731266022
Epoch: 114

Loss on hold-out set: 0.003086680756846013
```

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MeanAbsoluteError value on hold-out data: 0.04106246307492256
Epoch: 115
Loss on hold-out set: 0.0033330478562185397
MeanAbsoluteError value on hold-out data: 0.04241009056568146
Epoch: 116
Loss on hold-out set: 0.003275421322681583
MeanAbsoluteError value on hold-out data: 0.04116019234061241
Epoch: 117

Loss on hold-out set: 0.0030561573310898473
MeanAbsoluteError value on hold-out data: 0.040376223623752594
Epoch: 118
Loss on hold-out set: 0.003469271271919402
MeanAbsoluteError value on hold-out data: 0.044827140867710114
Epoch: 119
Loss on hold-out set: 0.0034703754108005133
MeanAbsoluteError value on hold-out data: 0.041939787566661835
Epoch: 120
Loss on hold-out set: 0.004064240573475568
MeanAbsoluteError value on hold-out data: 0.04453945532441139
Epoch: 121

Loss on hold-out set: 0.004980402246404152
MeanAbsoluteError value on hold-out data: 0.052927304059267044
Epoch: 122
Loss on hold-out set: 0.003574735422332126
MeanAbsoluteError value on hold-out data: 0.042921435087919235
Epoch: 123
Loss on hold-out set: 0.0030777637999003325
MeanAbsoluteError value on hold-out data: 0.04215667396783829
Epoch: 124

Loss on hold-out set: 0.007492351990479689
MeanAbsoluteError value on hold-out data: 0.07229626923799515
Epoch: 125
Loss on hold-out set: 0.005313235711163053
MeanAbsoluteError value on hold-out data: 0.05397241562604904
Epoch: 126
Loss on hold-out set: 0.0051035024404812316
MeanAbsoluteError value on hold-out data: 0.05403092876076698
Epoch: 127
Loss on hold-out set: 0.005098905799408944
```

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MeanAbsoluteError value on hold-out data: 0.051882605999708176
Epoch: 128

Loss on hold-out set: 0.003418461509192219
MeanAbsoluteError value on hold-out data: 0.04488871991634369
Epoch: 129
Loss on hold-out set: 0.0032961978487527142
MeanAbsoluteError value on hold-out data: 0.04248699173331261
Epoch: 130
Loss on hold-out set: 0.0063775042071938515
MeanAbsoluteError value on hold-out data: 0.06459604948759079
Epoch: 131

Loss on hold-out set: 0.003933123886012114
MeanAbsoluteError value on hold-out data: 0.05049465224146843
Epoch: 132
Loss on hold-out set: 0.003933469585787792
MeanAbsoluteError value on hold-out data: 0.04903580620884895
Epoch: 133
Loss on hold-out set: 0.0037898555523357713
MeanAbsoluteError value on hold-out data: 0.04789349064230919
Epoch: 134
Loss on hold-out set: 0.007917304988950491
MeanAbsoluteError value on hold-out data: 0.07521747797727585
Epoch: 135

Loss on hold-out set: 0.004276589141227305
MeanAbsoluteError value on hold-out data: 0.04936649277806282
Epoch: 136
Loss on hold-out set: 0.004168702549157808
MeanAbsoluteError value on hold-out data: 0.04472658783197403
Epoch: 137
Loss on hold-out set: 0.007000873133969994
MeanAbsoluteError value on hold-out data: 0.0672726184129715
Epoch: 138

Loss on hold-out set: 0.003522703433051132
MeanAbsoluteError value on hold-out data: 0.04206495359539986
Epoch: 139
Loss on hold-out set: 0.005303434929094062
MeanAbsoluteError value on hold-out data: 0.05500827729701996
```

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Epoch: 140
Loss on hold-out set: 0.0031262169180151364
MeanAbsoluteError value on hold-out data: 0.043274179100990295
Epoch: 141
Loss on hold-out set: 0.0028654819067854146
MeanAbsoluteError value on hold-out data: 0.04082230105996132
Epoch: 142

Loss on hold-out set: 0.0023434837706960165
MeanAbsoluteError value on hold-out data: 0.03575732186436653
Epoch: 143
Loss on hold-out set: 0.004469530056947126
MeanAbsoluteError value on hold-out data: 0.05582863464951515
Epoch: 144
Loss on hold-out set: 0.004057653893071871
MeanAbsoluteError value on hold-out data: 0.04975772276520729
Epoch: 145

Loss on hold-out set: 0.0027561724888913045
MeanAbsoluteError value on hold-out data: 0.04061528667807579
Epoch: 146
Loss on hold-out set: 0.0035439008811058905
MeanAbsoluteError value on hold-out data: 0.04709269106388092
Epoch: 147
Loss on hold-out set: 0.00436000342373378
MeanAbsoluteError value on hold-out data: 0.050067439675331116
Epoch: 148
Loss on hold-out set: 0.003280221999515421
MeanAbsoluteError value on hold-out data: 0.040504589676856995
Epoch: 149

Loss on hold-out set: 0.007439892989798234
MeanAbsoluteError value on hold-out data: 0.06408705562353134
Epoch: 150
Loss on hold-out set: 0.004028064646543219
MeanAbsoluteError value on hold-out data: 0.051824964582920074
Epoch: 151
Loss on hold-out set: 0.0022663068778526326
MeanAbsoluteError value on hold-out data: 0.03372807055711746
Epoch: 152
```

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Loss on hold-out set: 0.00451250565954699
MeanAbsoluteError value on hold-out data: 0.04733923450112343
Epoch: 153
Loss on hold-out set: 0.005505884845311252
MeanAbsoluteError value on hold-out data: 0.06006118655204773
Epoch: 154
Loss on hold-out set: 0.004623067856300622
MeanAbsoluteError value on hold-out data: 0.04929095134139061
Epoch: 155
Loss on hold-out set: 0.005360481159116786
MeanAbsoluteError value on hold-out data: 0.05580403655767441
Epoch: 156

Loss on hold-out set: 0.0044888510691145295
MeanAbsoluteError value on hold-out data: 0.05205352604389191
Epoch: 157
Loss on hold-out set: 0.002722722030459688
MeanAbsoluteError value on hold-out data: 0.040730156004428864
Epoch: 158
Loss on hold-out set: 0.0038653148982960442
MeanAbsoluteError value on hold-out data: 0.0476195253431797
Epoch: 159

Loss on hold-out set: 0.0066526917418321735
MeanAbsoluteError value on hold-out data: 0.06056724488735199
Epoch: 160
Loss on hold-out set: 0.003390273468819662
MeanAbsoluteError value on hold-out data: 0.046543288975954056
Epoch: 161
Loss on hold-out set: 0.004122942381610091
MeanAbsoluteError value on hold-out data: 0.051998645067214966
Epoch: 162
Loss on hold-out set: 0.00331286379458526
MeanAbsoluteError value on hold-out data: 0.041704416275024414
Epoch: 163

Loss on hold-out set: 0.0032528103194915904
MeanAbsoluteError value on hold-out data: 0.042270783334970474
Epoch: 164
Loss on hold-out set: 0.003186429743296825
MeanAbsoluteError value on hold-out data: 0.042153432965278625
Epoch: 165
```

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Loss on hold-out set: 0.00386424100277229
MeanAbsoluteError value on hold-out data: 0.042894743382930756
Epoch: 166

Loss on hold-out set: 0.0038063628509497414
MeanAbsoluteError value on hold-out data: 0.04444044083356857
Epoch: 167
Loss on hold-out set: 0.005979787029970724
MeanAbsoluteError value on hold-out data: 0.06341817229986191
Epoch: 168
Loss on hold-out set: 0.0034162157233088063
MeanAbsoluteError value on hold-out data: 0.04490537568926811
Epoch: 169
Loss on hold-out set: 0.004453923741283898
MeanAbsoluteError value on hold-out data: 0.05111235752701759
Epoch: 170

Loss on hold-out set: 0.0065328148014556905
MeanAbsoluteError value on hold-out data: 0.0664178729057312
Epoch: 171
Loss on hold-out set: 0.00486055884259538
MeanAbsoluteError value on hold-out data: 0.05028665438294411
Epoch: 172
Loss on hold-out set: 0.0036819486502701272
MeanAbsoluteError value on hold-out data: 0.048672109842300415
Epoch: 173

Loss on hold-out set: 0.0030867750129590812
MeanAbsoluteError value on hold-out data: 0.04172559082508087
Epoch: 174
Loss on hold-out set: 0.004549532260101002
MeanAbsoluteError value on hold-out data: 0.05300070345401764
Epoch: 175
Loss on hold-out set: 0.002845304299486228
MeanAbsoluteError value on hold-out data: 0.03943046182394028
Epoch: 176
Loss on hold-out set: 0.004079745437663335
MeanAbsoluteError value on hold-out data: 0.04714259132742882
Epoch: 177

Loss on hold-out set: 0.004526840634823132
```

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MeanAbsoluteError value on hold-out data: 0.04419316351413727
Epoch: 178
Loss on hold-out set: 0.004643206708491421
MeanAbsoluteError value on hold-out data: 0.05155928432941437
Epoch: 179
Loss on hold-out set: 0.003661631593086685
MeanAbsoluteError value on hold-out data: 0.04361162334680557
Epoch: 180

Loss on hold-out set: 0.004187716918890006
MeanAbsoluteError value on hold-out data: 0.050574470311403275
Epoch: 181
Loss on hold-out set: 0.003559375114631481
MeanAbsoluteError value on hold-out data: 0.0416773222386837
Epoch: 182
Loss on hold-out set: 0.002780117009444019
MeanAbsoluteError value on hold-out data: 0.039119113236665726
Epoch: 183
Loss on hold-out set: 0.00518802659980093
MeanAbsoluteError value on hold-out data: 0.058549895882606506
Epoch: 184

Loss on hold-out set: 0.006944297929294407
MeanAbsoluteError value on hold-out data: 0.06831441074609756
Epoch: 185
Loss on hold-out set: 0.005961160354602795
MeanAbsoluteError value on hold-out data: 0.059225622564554214
Epoch: 186
Loss on hold-out set: 0.005049348065557961
MeanAbsoluteError value on hold-out data: 0.053079258650541306
Epoch: 187

Loss on hold-out set: 0.003988216335598666
MeanAbsoluteError value on hold-out data: 0.0486622229218483
Epoch: 188
Loss on hold-out set: 0.0044328722869977355
MeanAbsoluteError value on hold-out data: 0.051525332033634186
Epoch: 189
Loss on hold-out set: 0.0030211712224767185
MeanAbsoluteError value on hold-out data: 0.03961396589875221
Epoch: 190
Loss on hold-out set: 0.004697443523372595
```

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MeanAbsoluteError value on hold-out data: 0.051180001348257065
Epoch: 191

Loss on hold-out set: 0.003074610384199052
MeanAbsoluteError value on hold-out data: 0.041900478303432465
Epoch: 192
Loss on hold-out set: 0.003859387397264632
MeanAbsoluteError value on hold-out data: 0.046151190996170044
Epoch: 193
Loss on hold-out set: 0.00409351595534155
MeanAbsoluteError value on hold-out data: 0.04938738793134689
Epoch: 194

Loss on hold-out set: 0.006875544992418816
MeanAbsoluteError value on hold-out data: 0.06676111370325089
Epoch: 195
Loss on hold-out set: 0.0033295981612844537
MeanAbsoluteError value on hold-out data: 0.040844548493623734
Epoch: 196
Loss on hold-out set: 0.0034096814969626185
MeanAbsoluteError value on hold-out data: 0.045039188116788864
Epoch: 197
Loss on hold-out set: 0.005564369395590172
MeanAbsoluteError value on hold-out data: 0.04903699457645416
Epoch: 198

Loss on hold-out set: 0.003279577439221052
MeanAbsoluteError value on hold-out data: 0.04256902262568474
Epoch: 199
Loss on hold-out set: 0.006086345779924438
MeanAbsoluteError value on hold-out data: 0.06007128581404686
Epoch: 200
Loss on hold-out set: 0.002653507220272261
MeanAbsoluteError value on hold-out data: 0.03815438970923424
Epoch: 201

Loss on hold-out set: 0.0059420454781502485
MeanAbsoluteError value on hold-out data: 0.059244271367788315
Epoch: 202
Loss on hold-out set: 0.006966000118364508
MeanAbsoluteError value on hold-out data: 0.06533173471689224
```

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Epoch: 203
Loss on hold-out set: 0.003089358448050916
MeanAbsoluteError value on hold-out data: 0.04309865087270737
Epoch: 204
Loss on hold-out set: 0.00467174226203217
MeanAbsoluteError value on hold-out data: 0.05228647217154503
Epoch: 205

Loss on hold-out set: 0.005071546434639738
MeanAbsoluteError value on hold-out data: 0.05344797298312187
Epoch: 206
Loss on hold-out set: 0.004538923045262122
MeanAbsoluteError value on hold-out data: 0.05202151834964752
Epoch: 207
Loss on hold-out set: 0.0035568217639453136
MeanAbsoluteError value on hold-out data: 0.043065186589956284
Epoch: 208

Loss on hold-out set: 0.005476029992748339
MeanAbsoluteError value on hold-out data: 0.05651027709245682
Epoch: 209
Loss on hold-out set: 0.005731610160392637
MeanAbsoluteError value on hold-out data: 0.059367585927248
Epoch: 210
Loss on hold-out set: 0.002879129557046466
MeanAbsoluteError value on hold-out data: 0.03972936421632767
Epoch: 211
Loss on hold-out set: 0.0038470170066620293
MeanAbsoluteError value on hold-out data: 0.044814616441726685
Epoch: 212

Loss on hold-out set: 0.004670971623944262
MeanAbsoluteError value on hold-out data: 0.0545450821518898
Epoch: 213
Loss on hold-out set: 0.006146144981567676
MeanAbsoluteError value on hold-out data: 0.06040523946285248
Epoch: 214
Loss on hold-out set: 0.004539418813342659
MeanAbsoluteError value on hold-out data: 0.04983295127749443
Epoch: 215
```

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Loss on hold-out set: 0.003773332000351869
MeanAbsoluteError value on hold-out data: 0.046628061681985855
Epoch: 216
Loss on hold-out set: 0.004947624115559917
MeanAbsoluteError value on hold-out data: 0.05300294980406761
Epoch: 217
Loss on hold-out set: 0.004434110386332927
MeanAbsoluteError value on hold-out data: 0.04563859477639198
Epoch: 218
Loss on hold-out set: 0.00710817569723496
MeanAbsoluteError value on hold-out data: 0.06855767965316772
Epoch: 219

Loss on hold-out set: 0.003651376871857792
MeanAbsoluteError value on hold-out data: 0.04781585559248924
Epoch: 220
Loss on hold-out set: 0.007539374735922768
MeanAbsoluteError value on hold-out data: 0.07366685569286346
Epoch: 221
Loss on hold-out set: 0.0038736112675486277
MeanAbsoluteError value on hold-out data: 0.04328657686710358
Epoch: 222

Loss on hold-out set: 0.0034198850760451304
MeanAbsoluteError value on hold-out data: 0.04464337229728699
Epoch: 223
Loss on hold-out set: 0.002995883123590969
MeanAbsoluteError value on hold-out data: 0.04240502417087555
Epoch: 224
Loss on hold-out set: 0.006384306981299932
MeanAbsoluteError value on hold-out data: 0.06194474175572395
Epoch: 225
Loss on hold-out set: 0.0030861964198545767
MeanAbsoluteError value on hold-out data: 0.041636522859334946
Epoch: 226

Loss on hold-out set: 0.003755204967232063
MeanAbsoluteError value on hold-out data: 0.04313206672668457
Epoch: 227
Loss on hold-out set: 0.004297308879008947
MeanAbsoluteError value on hold-out data: 0.04431746155023575
Epoch: 228
```

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Loss on hold-out set: 0.0038103445415170146
MeanAbsoluteError value on hold-out data: 0.045786052942276
Epoch: 229

Loss on hold-out set: 0.005904692816189849
MeanAbsoluteError value on hold-out data: 0.06228801608085632
Epoch: 230
Loss on hold-out set: 0.0030403282636633287
MeanAbsoluteError value on hold-out data: 0.04179809242486954
Epoch: 231
Loss on hold-out set: 0.004443802799169834
MeanAbsoluteError value on hold-out data: 0.04467540234327316
Epoch: 232
Loss on hold-out set: 0.0034314030960488776
MeanAbsoluteError value on hold-out data: 0.04592930153012276
Epoch: 233

Loss on hold-out set: 0.0036366530783617725
MeanAbsoluteError value on hold-out data: 0.042730942368507385
Epoch: 234
Loss on hold-out set: 0.0040088788015194814
MeanAbsoluteError value on hold-out data: 0.04459883272647858
Epoch: 235
Loss on hold-out set: 0.0049204062760019535
MeanAbsoluteError value on hold-out data: 0.05495921149849892
Epoch: 236

Loss on hold-out set: 0.004230074879999917
MeanAbsoluteError value on hold-out data: 0.051246341317892075
Epoch: 237
Loss on hold-out set: 0.005273658495682936
MeanAbsoluteError value on hold-out data: 0.050661601126194
Epoch: 238
Loss on hold-out set: 0.004328770213760436
MeanAbsoluteError value on hold-out data: 0.04877790808677673
Epoch: 239
Loss on hold-out set: 0.004079370083323179
MeanAbsoluteError value on hold-out data: 0.046722326427698135
Epoch: 240

Loss on hold-out set: 0.005812134522085006
```

```
MeanAbsoluteError value on hold-out data: 0.0571858212351799
Epoch: 241
Loss on hold-out set: 0.0030381815964714265
MeanAbsoluteError value on hold-out data: 0.0401381254196167
Epoch: 242
Loss on hold-out set: 0.002855550811196176
MeanAbsoluteError value on hold-out data: 0.041719697415828705
Epoch: 243

Loss on hold-out set: 0.003946244053972455
MeanAbsoluteError value on hold-out data: 0.04651964083313942
Epoch: 244
Loss on hold-out set: 0.002853374943907301
MeanAbsoluteError value on hold-out data: 0.03845597431063652
Epoch: 245
Loss on hold-out set: 0.004600428241806535
MeanAbsoluteError value on hold-out data: 0.045745186507701874
Epoch: 246
Loss on hold-out set: 0.002749427700809275
MeanAbsoluteError value on hold-out data: 0.04218337684869766
Epoch: 247

Loss on hold-out set: 0.003373299550730735
MeanAbsoluteError value on hold-out data: 0.04026610404253006
Epoch: 248
Loss on hold-out set: 0.0066314851775622135
MeanAbsoluteError value on hold-out data: 0.06435539573431015
Epoch: 249
Loss on hold-out set: 0.004307621749691092
MeanAbsoluteError value on hold-out data: 0.049565140157938004
Epoch: 250

Loss on hold-out set: 0.0033125394973187493
MeanAbsoluteError value on hold-out data: 0.03980109468102455
Epoch: 251
Loss on hold-out set: 0.004915262003823255
MeanAbsoluteError value on hold-out data: 0.05252928286790848
Epoch: 252
Loss on hold-out set: 0.0027055476474253316
MeanAbsoluteError value on hold-out data: 0.03920293226838112
Epoch: 253
Loss on hold-out set: 0.0029125754887130684
```

```
MeanAbsoluteError value on hold-out data: 0.040483180433511734
Epoch: 254

Loss on hold-out set: 0.004172093525994569
MeanAbsoluteError value on hold-out data: 0.043928250670433044
Epoch: 255
Loss on hold-out set: 0.0033318975026934193
MeanAbsoluteError value on hold-out data: 0.045151643455028534
Epoch: 256
Loss on hold-out set: 0.003915424794495965
MeanAbsoluteError value on hold-out data: 0.04413669928908348
Epoch: 257

Loss on hold-out set: 0.004072117440115947
MeanAbsoluteError value on hold-out data: 0.05165029689669609
Epoch: 258
Loss on hold-out set: 0.004897911415005533
MeanAbsoluteError value on hold-out data: 0.05517003685235977
Epoch: 259
Loss on hold-out set: 0.00393740101180111
MeanAbsoluteError value on hold-out data: 0.04793303832411766
Epoch: 260
Loss on hold-out set: 0.004445620136371313
MeanAbsoluteError value on hold-out data: 0.0496341735124588
Epoch: 261

Loss on hold-out set: 0.0045290474529163195
MeanAbsoluteError value on hold-out data: 0.05247952416539192
Epoch: 262
Loss on hold-out set: 0.0037584597638879833
MeanAbsoluteError value on hold-out data: 0.04191030189394951
Epoch: 263
Loss on hold-out set: 0.0037764668187054875
MeanAbsoluteError value on hold-out data: 0.04402276128530502
Epoch: 264

Loss on hold-out set: 0.003954908371759722
MeanAbsoluteError value on hold-out data: 0.05025990307331085
Epoch: 265
Loss on hold-out set: 0.0040334039949811995
MeanAbsoluteError value on hold-out data: 0.04694296419620514
```

```
Epoch: 266
Loss on hold-out set: 0.0038163510840744353
MeanAbsoluteError value on hold-out data: 0.04702770337462425
Epoch: 267
Loss on hold-out set: 0.00457606992075363
MeanAbsoluteError value on hold-out data: 0.05527668446302414
Epoch: 268

Loss on hold-out set: 0.004688706060943122
MeanAbsoluteError value on hold-out data: 0.04929214343428612
Epoch: 269
Loss on hold-out set: 0.00369805796071887
MeanAbsoluteError value on hold-out data: 0.04613368213176727
Epoch: 270
Loss on hold-out set: 0.004723168909549713
MeanAbsoluteError value on hold-out data: 0.049950722604990005
Epoch: 271

Loss on hold-out set: 0.003862032451881812
MeanAbsoluteError value on hold-out data: 0.045185767114162445
Epoch: 272
Loss on hold-out set: 0.0033166995876504537
MeanAbsoluteError value on hold-out data: 0.03949407860636711
Epoch: 273
Loss on hold-out set: 0.003049555015212928
MeanAbsoluteError value on hold-out data: 0.04028262197971344
Epoch: 274
Loss on hold-out set: 0.004598423310268957
MeanAbsoluteError value on hold-out data: 0.04922008141875267
Epoch: 275

Loss on hold-out set: 0.003962651602565669
MeanAbsoluteError value on hold-out data: 0.04714776948094368
Epoch: 276
Loss on hold-out set: 0.003826218845251088
MeanAbsoluteError value on hold-out data: 0.04488043487071991
Epoch: 277
Loss on hold-out set: 0.004359653577781641
MeanAbsoluteError value on hold-out data: 0.048256851732730865
Epoch: 278
```

```
Loss on hold-out set: 0.002877167658880353
MeanAbsoluteError value on hold-out data: 0.041543468832969666
Epoch: 279
Loss on hold-out set: 0.004648977449575726
MeanAbsoluteError value on hold-out data: 0.0490681417286396
Early stopping at epoch 278
Fold: 6
Epoch: 1
Loss on hold-out set: 0.01438286922012384
MeanAbsoluteError value on hold-out data: 0.09286560118198395
Epoch: 2
Loss on hold-out set: 0.006985089687917095
MeanAbsoluteError value on hold-out data: 0.06773586571216583
Epoch: 3

Loss on hold-out set: 0.005025080078317283
MeanAbsoluteError value on hold-out data: 0.05336806923151016
Epoch: 4
Loss on hold-out set: 0.004400950193834992
MeanAbsoluteError value on hold-out data: 0.051171865314245224
Epoch: 5
Loss on hold-out set: 0.0046806869705995685
MeanAbsoluteError value on hold-out data: 0.052183087915182114
Epoch: 6

Loss on hold-out set: 0.004352738865866111
MeanAbsoluteError value on hold-out data: 0.049372486770153046
Epoch: 7
Loss on hold-out set: 0.0043321892601222945
MeanAbsoluteError value on hold-out data: 0.04890754818916321
Epoch: 8
Loss on hold-out set: 0.003314381680236413
MeanAbsoluteError value on hold-out data: 0.04766617715358734
Epoch: 9
Loss on hold-out set: 0.0020189649434402012
MeanAbsoluteError value on hold-out data: 0.03648700565099716
Epoch: 10

Loss on hold-out set: 0.0031169522956658443
MeanAbsoluteError value on hold-out data: 0.04182145744562149
Epoch: 11
Loss on hold-out set: 0.0033676898254690548
```

```
MeanAbsoluteError value on hold-out data: 0.04461583122611046
Epoch: 12
Loss on hold-out set: 0.0036250488438571873
MeanAbsoluteError value on hold-out data: 0.04553260654211044
Epoch: 13

Loss on hold-out set: 0.0046611876370242005
MeanAbsoluteError value on hold-out data: 0.05573311820626259
Epoch: 14
Loss on hold-out set: 0.002905819511327606
MeanAbsoluteError value on hold-out data: 0.04096407815814018
Epoch: 15
Loss on hold-out set: 0.0029983601819437286
MeanAbsoluteError value on hold-out data: 0.037983499467372894
Epoch: 16
Loss on hold-out set: 0.003242657345253974
MeanAbsoluteError value on hold-out data: 0.03693500906229019
Epoch: 17

Loss on hold-out set: 0.0025889082507301983
MeanAbsoluteError value on hold-out data: 0.040432583540678024
Epoch: 18
Loss on hold-out set: 0.002743527561856004
MeanAbsoluteError value on hold-out data: 0.04297897219657898
Epoch: 19
Loss on hold-out set: 0.0015917980210640682
MeanAbsoluteError value on hold-out data: 0.030048556625843048
Epoch: 20

Loss on hold-out set: 0.0028704213641154077
MeanAbsoluteError value on hold-out data: 0.037324704229831696
Epoch: 21
Loss on hold-out set: 0.002499605600650494
MeanAbsoluteError value on hold-out data: 0.035087212920188904
Epoch: 22
Loss on hold-out set: 0.004246378729406457
MeanAbsoluteError value on hold-out data: 0.05673506110906601
Epoch: 23
Loss on hold-out set: 0.0013316233626728018
MeanAbsoluteError value on hold-out data: 0.027533216401934624
Epoch: 24
```

```
Loss on hold-out set: 0.0024781033145980192
MeanAbsoluteError value on hold-out data: 0.03753391653299332
Epoch: 25
Loss on hold-out set: 0.0018458079564600037
MeanAbsoluteError value on hold-out data: 0.03366316109895706
Epoch: 26
Loss on hold-out set: 0.002432290066141062
MeanAbsoluteError value on hold-out data: 0.03800990805029869
Epoch: 27

Loss on hold-out set: 0.0016757895276756384
MeanAbsoluteError value on hold-out data: 0.030180862173438072
Epoch: 28
Loss on hold-out set: 0.0016108561092271255
MeanAbsoluteError value on hold-out data: 0.03166096657514572
Epoch: 29
Loss on hold-out set: 0.004373079416557
MeanAbsoluteError value on hold-out data: 0.05238938704133034
Epoch: 30
Loss on hold-out set: 0.0014229840106474091
MeanAbsoluteError value on hold-out data: 0.0287800170481205
Epoch: 31

Loss on hold-out set: 0.0021155028505465733
MeanAbsoluteError value on hold-out data: 0.034635066986083984
Epoch: 32
Loss on hold-out set: 0.0017959418831966245
MeanAbsoluteError value on hold-out data: 0.03220739960670471
Epoch: 33
Loss on hold-out set: 0.002423869960833914
MeanAbsoluteError value on hold-out data: 0.036063507199287415
Epoch: 34

Loss on hold-out set: 0.001414331474314587
MeanAbsoluteError value on hold-out data: 0.025754572823643684
Epoch: 35
Loss on hold-out set: 0.003793154234209886
MeanAbsoluteError value on hold-out data: 0.05014412850141525
Epoch: 36
Loss on hold-out set: 0.00351657101418823
MeanAbsoluteError value on hold-out data: 0.047697730362415314
Epoch: 37
```

```
Loss on hold-out set: 0.003034858227832816
MeanAbsoluteError value on hold-out data: 0.03737102448940277
Epoch: 38

Loss on hold-out set: 0.0018851700632904584
MeanAbsoluteError value on hold-out data: 0.034157708287239075
Epoch: 39
Loss on hold-out set: 0.0023493128291402873
MeanAbsoluteError value on hold-out data: 0.03682345524430275
Epoch: 40
Loss on hold-out set: 0.002514758765195998
MeanAbsoluteError value on hold-out data: 0.03387770801782608
Epoch: 41

Loss on hold-out set: 0.00212123147614945
MeanAbsoluteError value on hold-out data: 0.030168727040290833
Epoch: 42
Loss on hold-out set: 0.0031296819573841416
MeanAbsoluteError value on hold-out data: 0.04299439489841461
Epoch: 43
Loss on hold-out set: 0.001868907984596892
MeanAbsoluteError value on hold-out data: 0.03268241509795189
Epoch: 44
Loss on hold-out set: 0.002737303418913283
MeanAbsoluteError value on hold-out data: 0.034004002809524536
Epoch: 45

Loss on hold-out set: 0.0019309399604725724
MeanAbsoluteError value on hold-out data: 0.030024679377675056
Epoch: 46
Loss on hold-out set: 0.00316769168085347
MeanAbsoluteError value on hold-out data: 0.041236139833927155
Epoch: 47
Loss on hold-out set: 0.0011037001319122142
MeanAbsoluteError value on hold-out data: 0.02491970732808113
Epoch: 48

Loss on hold-out set: 0.0019084360951987596
MeanAbsoluteError value on hold-out data: 0.03540338948369026
Epoch: 49
Loss on hold-out set: 0.0019801957062624683
```

```
MeanAbsoluteError value on hold-out data: 0.03504820540547371
Epoch: 50
Loss on hold-out set: 0.002294012170750648
MeanAbsoluteError value on hold-out data: 0.037155888974666595
Epoch: 51
Loss on hold-out set: 0.001948605871383244
MeanAbsoluteError value on hold-out data: 0.03271197900176048
Epoch: 52

Loss on hold-out set: 0.0018153653632347973
MeanAbsoluteError value on hold-out data: 0.02762490324676037
Epoch: 53
Loss on hold-out set: 0.001862322732519645
MeanAbsoluteError value on hold-out data: 0.031197035685181618
Epoch: 54
Loss on hold-out set: 0.0020695501902642157
MeanAbsoluteError value on hold-out data: 0.03345824405550957
Epoch: 55

Loss on hold-out set: 0.0028985003143763887
MeanAbsoluteError value on hold-out data: 0.036420587450265884
Epoch: 56
Loss on hold-out set: 0.0054214693865595525
MeanAbsoluteError value on hold-out data: 0.056187912821769714
Epoch: 57
Loss on hold-out set: 0.0019740407140209125
MeanAbsoluteError value on hold-out data: 0.03005487285554409
Epoch: 58
Loss on hold-out set: 0.002761980845557096
MeanAbsoluteError value on hold-out data: 0.03870360180735588
Epoch: 59

Loss on hold-out set: 0.002211732707040098
MeanAbsoluteError value on hold-out data: 0.03241628780961037
Epoch: 60
Loss on hold-out set: 0.00248266441317705
MeanAbsoluteError value on hold-out data: 0.03760935366153717
Epoch: 61
Loss on hold-out set: 0.0012451991900049436
MeanAbsoluteError value on hold-out data: 0.02519308589398861
Epoch: 62
```

```
Loss on hold-out set: 0.0018637447546307857
MeanAbsoluteError value on hold-out data: 0.0303424671292305
Epoch: 63
Loss on hold-out set: 0.0016258336164845298
MeanAbsoluteError value on hold-out data: 0.028816383332014084
Epoch: 64
Loss on hold-out set: 0.0015666731140719582
MeanAbsoluteError value on hold-out data: 0.029392892494797707
Epoch: 65
Loss on hold-out set: 0.002405739031158961
MeanAbsoluteError value on hold-out data: 0.03549903258681297
Epoch: 66

Loss on hold-out set: 0.0012777501273936091
MeanAbsoluteError value on hold-out data: 0.025838730856776237
Epoch: 67
Loss on hold-out set: 0.003246593291316038
MeanAbsoluteError value on hold-out data: 0.044331103563308716
Epoch: 68
Loss on hold-out set: 0.00228578227912434
MeanAbsoluteError value on hold-out data: 0.031547702848911285
Epoch: 69

Loss on hold-out set: 0.0016059342574758024
MeanAbsoluteError value on hold-out data: 0.03004137985408306
Epoch: 70
Loss on hold-out set: 0.0025213166417625663
MeanAbsoluteError value on hold-out data: 0.04502145200967789
Epoch: 71
Loss on hold-out set: 0.003329865482205955
MeanAbsoluteError value on hold-out data: 0.04779715836048126
Epoch: 72
Loss on hold-out set: 0.0020874448550435521
MeanAbsoluteError value on hold-out data: 0.03863150253891945
Epoch: 73

Loss on hold-out set: 0.0022460779627391067
MeanAbsoluteError value on hold-out data: 0.02956700511276722
Epoch: 74
Loss on hold-out set: 0.005998982215085282
MeanAbsoluteError value on hold-out data: 0.058514393866062164
Epoch: 75
```

```
Loss on hold-out set: 0.0022906173074331423
MeanAbsoluteError value on hold-out data: 0.03389320522546768
Epoch: 76

Loss on hold-out set: 0.0025148642643426475
MeanAbsoluteError value on hold-out data: 0.04067124053835869
Epoch: 77
Loss on hold-out set: 0.0016099459831961072
MeanAbsoluteError value on hold-out data: 0.031717341393232346
Epoch: 78
Loss on hold-out set: 0.0020995315482231
MeanAbsoluteError value on hold-out data: 0.0321219265460968
Epoch: 79
Loss on hold-out set: 0.0019541921624645162
MeanAbsoluteError value on hold-out data: 0.03030235320329666
Epoch: 80

Loss on hold-out set: 0.0022854591907861713
MeanAbsoluteError value on hold-out data: 0.03397056832909584
Epoch: 81
Loss on hold-out set: 0.0011538674600440292
MeanAbsoluteError value on hold-out data: 0.024131467565894127
Epoch: 82
Loss on hold-out set: 0.0023496702062682463
MeanAbsoluteError value on hold-out data: 0.032023169100284576
Epoch: 83

Loss on hold-out set: 0.0013551278109214483
MeanAbsoluteError value on hold-out data: 0.026423027738928795
Epoch: 84
Loss on hold-out set: 0.0019040629838575395
MeanAbsoluteError value on hold-out data: 0.03187258169054985
Epoch: 85
Loss on hold-out set: 0.0018714111043104471
MeanAbsoluteError value on hold-out data: 0.029107365757226944
Epoch: 86
Loss on hold-out set: 0.001401362481724041
MeanAbsoluteError value on hold-out data: 0.023796692490577698
Epoch: 87

Loss on hold-out set: 0.0009419062250974373
```

```
MeanAbsoluteError value on hold-out data: 0.023398645222187042
Epoch: 88
Loss on hold-out set: 0.0029355976103733364
MeanAbsoluteError value on hold-out data: 0.041959065943956375
Epoch: 89
Loss on hold-out set: 0.0020934130835275236
MeanAbsoluteError value on hold-out data: 0.03815486282110214
Epoch: 90

Loss on hold-out set: 0.0014212890080391215
MeanAbsoluteError value on hold-out data: 0.029843389987945557
Epoch: 91
Loss on hold-out set: 0.0040325795640595834
MeanAbsoluteError value on hold-out data: 0.0404348261654377
Epoch: 92
Loss on hold-out set: 0.00155981980676118
MeanAbsoluteError value on hold-out data: 0.02674906700849533
Epoch: 93
Loss on hold-out set: 0.0018839952804578038
MeanAbsoluteError value on hold-out data: 0.033039309084415436
Epoch: 94

Loss on hold-out set: 0.00066434289888443
MeanAbsoluteError value on hold-out data: 0.019890127703547478
Epoch: 95
Loss on hold-out set: 0.002016678246526191
MeanAbsoluteError value on hold-out data: 0.03427021577954292
Epoch: 96
Loss on hold-out set: 0.003284155659807416
MeanAbsoluteError value on hold-out data: 0.03800257667899132
Epoch: 97

Loss on hold-out set: 0.002798426251571912
MeanAbsoluteError value on hold-out data: 0.04069768264889717
Epoch: 98
Loss on hold-out set: 0.002059081251410624
MeanAbsoluteError value on hold-out data: 0.033654600381851196
Epoch: 99
Loss on hold-out set: 0.002555976639716671
MeanAbsoluteError value on hold-out data: 0.03477628529071808
Epoch: 100
Loss on hold-out set: 0.0013994945553489602
```

```
MeanAbsoluteError value on hold-out data: 0.027573537081480026
Epoch: 101

Loss on hold-out set: 0.002660815057774576
MeanAbsoluteError value on hold-out data: 0.0353437103331089
Epoch: 102
Loss on hold-out set: 0.0031937011159383333
MeanAbsoluteError value on hold-out data: 0.03365355357527733
Epoch: 103
Loss on hold-out set: 0.0018572317024406332
MeanAbsoluteError value on hold-out data: 0.031721606850624084
Epoch: 104

Loss on hold-out set: 0.0011798639987738659
MeanAbsoluteError value on hold-out data: 0.02646532468497753
Epoch: 105
Loss on hold-out set: 0.001419917301973328
MeanAbsoluteError value on hold-out data: 0.025692597031593323
Epoch: 106
Loss on hold-out set: 0.002198725392540487
MeanAbsoluteError value on hold-out data: 0.032964978367090225
Epoch: 107
Loss on hold-out set: 0.0021577174305163612
MeanAbsoluteError value on hold-out data: 0.03267982229590416
Epoch: 108

Loss on hold-out set: 0.00218034260503303
MeanAbsoluteError value on hold-out data: 0.03357144445180893
Epoch: 109
Loss on hold-out set: 0.003208696813089773
MeanAbsoluteError value on hold-out data: 0.03677676245570183
Epoch: 110
Loss on hold-out set: 0.0014705934602086647
MeanAbsoluteError value on hold-out data: 0.0275958850979805
Epoch: 111

Loss on hold-out set: 0.001685599653193584
MeanAbsoluteError value on hold-out data: 0.028740745037794113
Epoch: 112
Loss on hold-out set: 0.001339342333197307
MeanAbsoluteError value on hold-out data: 0.029398346319794655
```

```
Epoch: 113
Loss on hold-out set: 0.0034488966652693655
MeanAbsoluteError value on hold-out data: 0.04725680500268936
Epoch: 114
Loss on hold-out set: 0.0012682080761386226
MeanAbsoluteError value on hold-out data: 0.026529718190431595
Epoch: 115

Loss on hold-out set: 0.0015484329107074211
MeanAbsoluteError value on hold-out data: 0.030405128374695778
Epoch: 116
Loss on hold-out set: 0.0015380750606149936
MeanAbsoluteError value on hold-out data: 0.029577944427728653
Epoch: 117
Loss on hold-out set: 0.0013045222596981777
MeanAbsoluteError value on hold-out data: 0.027949441224336624
Epoch: 118

Loss on hold-out set: 0.003009993874002248
MeanAbsoluteError value on hold-out data: 0.038879428058862686
Epoch: 119
Loss on hold-out set: 0.003206830113553084
MeanAbsoluteError value on hold-out data: 0.03579556941986084
Epoch: 120
Loss on hold-out set: 0.0019380529097711237
MeanAbsoluteError value on hold-out data: 0.031539835035800934
Epoch: 121
Loss on hold-out set: 0.0024105357946469807
MeanAbsoluteError value on hold-out data: 0.033202022314071655
Epoch: 122

Loss on hold-out set: 0.003523843721128427
MeanAbsoluteError value on hold-out data: 0.04181986674666405
Epoch: 123
Loss on hold-out set: 0.0011902787507726597
MeanAbsoluteError value on hold-out data: 0.024678539484739304
Epoch: 124
Loss on hold-out set: 0.0019148008275526361
MeanAbsoluteError value on hold-out data: 0.03161802887916565
Epoch: 125
```

```
Loss on hold-out set: 0.0014589836467236567
MeanAbsoluteError value on hold-out data: 0.028834830969572067
Epoch: 126
Loss on hold-out set: 0.0030277733547756304
MeanAbsoluteError value on hold-out data: 0.04375569522380829
Epoch: 127
Loss on hold-out set: 0.0019615131358687696
MeanAbsoluteError value on hold-out data: 0.03558396175503731
Epoch: 128
Loss on hold-out set: 0.00135341863362835
MeanAbsoluteError value on hold-out data: 0.02855648286640644
Epoch: 129

Loss on hold-out set: 0.0018934335944672616
MeanAbsoluteError value on hold-out data: 0.03111179918050766
Epoch: 130
Loss on hold-out set: 0.0022705804305867506
MeanAbsoluteError value on hold-out data: 0.039837706834077835
Epoch: 131
Loss on hold-out set: 0.0017595075590249437
MeanAbsoluteError value on hold-out data: 0.029815170913934708
Epoch: 132

Loss on hold-out set: 0.0027392540628520343
MeanAbsoluteError value on hold-out data: 0.04086080938577652
Epoch: 133
Loss on hold-out set: 0.0018034690650753104
MeanAbsoluteError value on hold-out data: 0.028189413249492645
Epoch: 134
Loss on hold-out set: 0.002018013328779489
MeanAbsoluteError value on hold-out data: 0.03169330954551697
Epoch: 135
Loss on hold-out set: 0.0015800835457272255
MeanAbsoluteError value on hold-out data: 0.03199579566717148
Epoch: 136

Loss on hold-out set: 0.00153481341056669
MeanAbsoluteError value on hold-out data: 0.02842996083199978
Epoch: 137
Loss on hold-out set: 0.003240665322384582
MeanAbsoluteError value on hold-out data: 0.03203391656279564
Epoch: 138
```

```
Loss on hold-out set: 0.00204311735713138
MeanAbsoluteError value on hold-out data: 0.03322184830904007
Epoch: 139

Loss on hold-out set: 0.0010431345133558633
MeanAbsoluteError value on hold-out data: 0.02382332645356655
Epoch: 140
Loss on hold-out set: 0.0022974317588915047
MeanAbsoluteError value on hold-out data: 0.03587718307971954
Epoch: 141
Loss on hold-out set: 0.001890995826285619
MeanAbsoluteError value on hold-out data: 0.034268565475940704
Epoch: 142
Loss on hold-out set: 0.0016493242437718436
MeanAbsoluteError value on hold-out data: 0.023573048412799835
Epoch: 143

Loss on hold-out set: 0.0018753055818916226
MeanAbsoluteError value on hold-out data: 0.029595959931612015
Epoch: 144
Loss on hold-out set: 0.0018569920385534016
MeanAbsoluteError value on hold-out data: 0.03026631660759449
Epoch: 145
Loss on hold-out set: 0.0021347235261390987
MeanAbsoluteError value on hold-out data: 0.03553319349884987
Epoch: 146

Loss on hold-out set: 0.0023999348945485856
MeanAbsoluteError value on hold-out data: 0.03370721638202667
Epoch: 147
Loss on hold-out set: 0.001249190044081143
MeanAbsoluteError value on hold-out data: 0.022627288475632668
Epoch: 148
Loss on hold-out set: 0.001081887220677275
MeanAbsoluteError value on hold-out data: 0.026166711002588272
Epoch: 149
Loss on hold-out set: 0.00221458971589947
MeanAbsoluteError value on hold-out data: 0.0370645672082901
Epoch: 150

Loss on hold-out set: 0.0024304824003663203
```

```
MeanAbsoluteError value on hold-out data: 0.03763285279273987
Epoch: 151
Loss on hold-out set: 0.0016857379299695962
MeanAbsoluteError value on hold-out data: 0.027248715981841087
Epoch: 152
Loss on hold-out set: 0.0020974485893160678
MeanAbsoluteError value on hold-out data: 0.03163892775774002
Epoch: 153

Loss on hold-out set: 0.002303607063367963
MeanAbsoluteError value on hold-out data: 0.032342832535505295
Epoch: 154
Loss on hold-out set: 0.0016150032953681569
MeanAbsoluteError value on hold-out data: 0.02928362600505352
Epoch: 155
Loss on hold-out set: 0.0027533778607343826
MeanAbsoluteError value on hold-out data: 0.04153885319828987
Epoch: 156
Loss on hold-out set: 0.0020580840579126603
MeanAbsoluteError value on hold-out data: 0.032570239156484604
Epoch: 157

Loss on hold-out set: 0.0014299185736140667
MeanAbsoluteError value on hold-out data: 0.02723163552582264
Epoch: 158
Loss on hold-out set: 0.003713205734339471
MeanAbsoluteError value on hold-out data: 0.04075406864285469
Epoch: 159
Loss on hold-out set: 0.003173724985502374
MeanAbsoluteError value on hold-out data: 0.042563632130622864
Epoch: 160

Loss on hold-out set: 0.0021156634589155707
MeanAbsoluteError value on hold-out data: 0.0377945639193058
Epoch: 161
Loss on hold-out set: 0.001701637830522556
MeanAbsoluteError value on hold-out data: 0.029140353202819824
Epoch: 162
Loss on hold-out set: 0.001448614657140122
MeanAbsoluteError value on hold-out data: 0.027144940569996834
Epoch: 163
Loss on hold-out set: 0.003081481182911935
```

```
MeanAbsoluteError value on hold-out data: 0.04189237952232361
Epoch: 164

Loss on hold-out set: 0.0012337584630586207
MeanAbsoluteError value on hold-out data: 0.02491695247590542
Epoch: 165
Loss on hold-out set: 0.0014264872723008292
MeanAbsoluteError value on hold-out data: 0.027628956362605095
Epoch: 166
Loss on hold-out set: 0.0016011874630259206
MeanAbsoluteError value on hold-out data: 0.028070474043488503
Epoch: 167

Loss on hold-out set: 0.0023850586014584852
MeanAbsoluteError value on hold-out data: 0.03601144254207611
Epoch: 168
Loss on hold-out set: 0.0024126985405858318
MeanAbsoluteError value on hold-out data: 0.035556986927986145
Epoch: 169
Loss on hold-out set: 0.0013207415300152765
MeanAbsoluteError value on hold-out data: 0.02428772673010826
Epoch: 170
Loss on hold-out set: 0.004361784307268233
MeanAbsoluteError value on hold-out data: 0.04156743362545967
Epoch: 171

Loss on hold-out set: 0.0016347286515296078
MeanAbsoluteError value on hold-out data: 0.03111959621310234
Epoch: 172
Loss on hold-out set: 0.001685271223183148
MeanAbsoluteError value on hold-out data: 0.029794344678521156
Epoch: 173
Loss on hold-out set: 0.0015337821543933107
MeanAbsoluteError value on hold-out data: 0.027397025376558304
Epoch: 174

Loss on hold-out set: 0.0013245537389033975
MeanAbsoluteError value on hold-out data: 0.026624176651239395
Epoch: 175
Loss on hold-out set: 0.0023455279431520747
MeanAbsoluteError value on hold-out data: 0.032895978540182114
```

```
Epoch: 176
Loss on hold-out set: 0.0014127386518968986
MeanAbsoluteError value on hold-out data: 0.029738901183009148
Epoch: 177
Loss on hold-out set: 0.0019122791037751506
MeanAbsoluteError value on hold-out data: 0.030613208189606667
Epoch: 178

Loss on hold-out set: 0.0010765087566911601
MeanAbsoluteError value on hold-out data: 0.022717202082276344
Epoch: 179
Loss on hold-out set: 0.002861552629978038
MeanAbsoluteError value on hold-out data: 0.0370563268661499
Epoch: 180
Loss on hold-out set: 0.0017493761686357455
MeanAbsoluteError value on hold-out data: 0.031336501240730286
Epoch: 181

Loss on hold-out set: 0.0020430812661428577
MeanAbsoluteError value on hold-out data: 0.030944611877202988
Epoch: 182
Loss on hold-out set: 0.0018098504050822856
MeanAbsoluteError value on hold-out data: 0.028705332428216934
Epoch: 183
Loss on hold-out set: 0.0022592035910257925
MeanAbsoluteError value on hold-out data: 0.029103238135576248
Epoch: 184
Loss on hold-out set: 0.0016740590547739815
MeanAbsoluteError value on hold-out data: 0.027672285214066505
Epoch: 185

Loss on hold-out set: 0.0015004489575333607
MeanAbsoluteError value on hold-out data: 0.029710417613387108
Epoch: 186
Loss on hold-out set: 0.0012512798661751172
MeanAbsoluteError value on hold-out data: 0.025691503658890724
Epoch: 187
Loss on hold-out set: 0.0022080769883289645
MeanAbsoluteError value on hold-out data: 0.032853297889232635
Epoch: 188
```

```
Loss on hold-out set: 0.0015183535511963642
MeanAbsoluteError value on hold-out data: 0.02668990194797516
Epoch: 189
Loss on hold-out set: 0.002083795270524346
MeanAbsoluteError value on hold-out data: 0.03665038198232651
Epoch: 190
Loss on hold-out set: 0.0029853441833088603
MeanAbsoluteError value on hold-out data: 0.03474295511841774
Epoch: 191
Loss on hold-out set: 0.0009725484146306721
MeanAbsoluteError value on hold-out data: 0.022822191938757896
Epoch: 192

Loss on hold-out set: 0.0011394691022220426
MeanAbsoluteError value on hold-out data: 0.01989513449370861
Epoch: 193
Loss on hold-out set: 0.0024122981927715815
MeanAbsoluteError value on hold-out data: 0.03953385725617409
Epoch: 194
Loss on hold-out set: 0.0024857539370154533
MeanAbsoluteError value on hold-out data: 0.03723287954926491
Epoch: 195

Loss on hold-out set: 0.001097882373869652
MeanAbsoluteError value on hold-out data: 0.026178784668445587
Epoch: 196
Loss on hold-out set: 0.002062005617727454
MeanAbsoluteError value on hold-out data: 0.03219333663582802
Epoch: 197
Loss on hold-out set: 0.002129427628040923
MeanAbsoluteError value on hold-out data: 0.03453422710299492
Epoch: 198
Loss on hold-out set: 0.0014184319544046258
MeanAbsoluteError value on hold-out data: 0.024890471249818802
Epoch: 199

Loss on hold-out set: 0.0013748456582946416
MeanAbsoluteError value on hold-out data: 0.025981297716498375
Epoch: 200
Loss on hold-out set: 0.001418604609520676
MeanAbsoluteError value on hold-out data: 0.02825114317238331
Epoch: 201
```

```
Loss on hold-out set: 0.0016522390416447218
MeanAbsoluteError value on hold-out data: 0.02678610570728779
Epoch: 202

Loss on hold-out set: 0.0015425207899310268
MeanAbsoluteError value on hold-out data: 0.026113279163837433
Epoch: 203
Loss on hold-out set: 0.0014042758132116152
MeanAbsoluteError value on hold-out data: 0.02734433487057686
Epoch: 204
Loss on hold-out set: 0.002810996119828465
MeanAbsoluteError value on hold-out data: 0.03938169404864311
Epoch: 205
Loss on hold-out set: 0.0016193126749175673
MeanAbsoluteError value on hold-out data: 0.028412126004695892
Epoch: 206

Loss on hold-out set: 0.0022094833055654396
MeanAbsoluteError value on hold-out data: 0.039003707468509674
Epoch: 207
Loss on hold-out set: 0.0016321189692602134
MeanAbsoluteError value on hold-out data: 0.03005814366042614
Epoch: 208
Loss on hold-out set: 0.0016818696794171745
MeanAbsoluteError value on hold-out data: 0.030193423852324486
Epoch: 209

Loss on hold-out set: 0.0020832613137407373
MeanAbsoluteError value on hold-out data: 0.03273773193359375
Epoch: 210
Loss on hold-out set: 0.0016570760926697403
MeanAbsoluteError value on hold-out data: 0.02645241469144821
Epoch: 211
Loss on hold-out set: 0.0026275992019621367
MeanAbsoluteError value on hold-out data: 0.035256315022706985
Epoch: 212
Loss on hold-out set: 0.0023812868524915897
MeanAbsoluteError value on hold-out data: 0.02940996177494526
Epoch: 213

Loss on hold-out set: 0.0013897166399356837
```

```
MeanAbsoluteError value on hold-out data: 0.03051077201962471
Epoch: 214
Loss on hold-out set: 0.005976597948644597
MeanAbsoluteError value on hold-out data: 0.05630367621779442
Epoch: 215
Loss on hold-out set: 0.0014451669714897154
MeanAbsoluteError value on hold-out data: 0.02864420972764492
Epoch: 216

Loss on hold-out set: 0.0017655012645543767
MeanAbsoluteError value on hold-out data: 0.03372393548488617
Epoch: 217
Loss on hold-out set: 0.0014206869147109012
MeanAbsoluteError value on hold-out data: 0.02863597311079502
Epoch: 218
Loss on hold-out set: 0.0018995170226284803
MeanAbsoluteError value on hold-out data: 0.02860942855477333
Epoch: 219
Loss on hold-out set: 0.0011147557043631633
MeanAbsoluteError value on hold-out data: 0.024516506120562553
Epoch: 220

Loss on hold-out set: 0.0030593995448166076
MeanAbsoluteError value on hold-out data: 0.032286133617162704
Epoch: 221
Loss on hold-out set: 0.0014337285918792565
MeanAbsoluteError value on hold-out data: 0.028080971911549568
Epoch: 222
Loss on hold-out set: 0.0022560089788525007
MeanAbsoluteError value on hold-out data: 0.028760068118572235
Early stopping at epoch 221
Fold: 7
Epoch: 1

Loss on hold-out set: 0.017147164326161146
MeanAbsoluteError value on hold-out data: 0.1055016964673996
Epoch: 2
Loss on hold-out set: 0.01035660390670483
MeanAbsoluteError value on hold-out data: 0.07982943952083588
Epoch: 3
Loss on hold-out set: 0.00653767607246454
MeanAbsoluteError value on hold-out data: 0.060651861131191254
```

```
Epoch: 4
Loss on hold-out set: 0.004922596854157746
MeanAbsoluteError value on hold-out data: 0.0555848702788353
Epoch: 5

Loss on hold-out set: 0.004206586176923548
MeanAbsoluteError value on hold-out data: 0.049332112073898315
Epoch: 6
Loss on hold-out set: 0.0032918854894188163
MeanAbsoluteError value on hold-out data: 0.04169841855764389
Epoch: 7
Loss on hold-out set: 0.0026566143362567974
MeanAbsoluteError value on hold-out data: 0.04112362489104271
Epoch: 8

Loss on hold-out set: 0.0029619988770439075
MeanAbsoluteError value on hold-out data: 0.04094555974006653
Epoch: 9
Loss on hold-out set: 0.0030465614086446855
MeanAbsoluteError value on hold-out data: 0.04082078859210014
Epoch: 10
Loss on hold-out set: 0.0019810152522180802
MeanAbsoluteError value on hold-out data: 0.034106768667697906
Epoch: 11
Loss on hold-out set: 0.00489059469411866
MeanAbsoluteError value on hold-out data: 0.0580953024327755
Epoch: 12

Loss on hold-out set: 0.002474237497573575
MeanAbsoluteError value on hold-out data: 0.03712204843759537
Epoch: 13
Loss on hold-out set: 0.002985127158283901
MeanAbsoluteError value on hold-out data: 0.03975697606801987
Epoch: 14
Loss on hold-out set: 0.0028806082689418243
MeanAbsoluteError value on hold-out data: 0.04071323573589325
Epoch: 15

Loss on hold-out set: 0.002121168958882873
MeanAbsoluteError value on hold-out data: 0.03533078730106354
Epoch: 16
```

```
Loss on hold-out set: 0.004414527372528727
MeanAbsoluteError value on hold-out data: 0.05379556119441986
Epoch: 17
Loss on hold-out set: 0.0027151134205408967
MeanAbsoluteError value on hold-out data: 0.039176877588033676
Epoch: 18
Loss on hold-out set: 0.0029524972286218633
MeanAbsoluteError value on hold-out data: 0.039905767887830734
Epoch: 19

Loss on hold-out set: 0.002615425462583796
MeanAbsoluteError value on hold-out data: 0.03817972168326378
Epoch: 20
Loss on hold-out set: 0.0035908382090453347
MeanAbsoluteError value on hold-out data: 0.04584026336669922
Epoch: 21
Loss on hold-out set: 0.0029249752585131386
MeanAbsoluteError value on hold-out data: 0.0402311235666275
Epoch: 22

Loss on hold-out set: 0.004489848363356521
MeanAbsoluteError value on hold-out data: 0.05433528125286102
Epoch: 23
Loss on hold-out set: 0.00260644972933313
MeanAbsoluteError value on hold-out data: 0.038922522217035294
Epoch: 24
Loss on hold-out set: 0.0022218162059569014
MeanAbsoluteError value on hold-out data: 0.03792846202850342
Epoch: 25
Loss on hold-out set: 0.0013086393636722977
MeanAbsoluteError value on hold-out data: 0.02900642156600952
Epoch: 26

Loss on hold-out set: 0.003473064638316058
MeanAbsoluteError value on hold-out data: 0.04015206918120384
Epoch: 27
Loss on hold-out set: 0.0029112391102199373
MeanAbsoluteError value on hold-out data: 0.04431826248764992
Epoch: 28
Loss on hold-out set: 0.003127223565780486
MeanAbsoluteError value on hold-out data: 0.04315185546875
Epoch: 29
```

```
Loss on hold-out set: 0.0031929678874663436
MeanAbsoluteError value on hold-out data: 0.04049190133810043
Epoch: 30
Loss on hold-out set: 0.003651604181728684
MeanAbsoluteError value on hold-out data: 0.04773695766925812
Epoch: 31
Loss on hold-out set: 0.0025285627119816267
MeanAbsoluteError value on hold-out data: 0.03687245771288872
Epoch: 32
Loss on hold-out set: 0.0025206330509927985
MeanAbsoluteError value on hold-out data: 0.037673648446798325
Epoch: 33

Loss on hold-out set: 0.0018300136658721245
MeanAbsoluteError value on hold-out data: 0.02981928549706936
Epoch: 34
Loss on hold-out set: 0.0015210657147690654
MeanAbsoluteError value on hold-out data: 0.026874613016843796
Epoch: 35
Loss on hold-out set: 0.0023330508377582123
MeanAbsoluteError value on hold-out data: 0.03217275068163872
Epoch: 36

Loss on hold-out set: 0.0025220772658940405
MeanAbsoluteError value on hold-out data: 0.035512495785951614
Epoch: 37
Loss on hold-out set: 0.0024068525078921365
MeanAbsoluteError value on hold-out data: 0.04068204388022423
Epoch: 38
Loss on hold-out set: 0.002203502293783598
MeanAbsoluteError value on hold-out data: 0.03364689275622368
Epoch: 39
Loss on hold-out set: 0.002202635810065728
MeanAbsoluteError value on hold-out data: 0.038010820746421814
Epoch: 40

Loss on hold-out set: 0.0033859780926902136
MeanAbsoluteError value on hold-out data: 0.044013090431690216
Epoch: 41
Loss on hold-out set: 0.002119630105041254
MeanAbsoluteError value on hold-out data: 0.03862553462386131
Epoch: 42
```

```
Loss on hold-out set: 0.0031511511725301924
MeanAbsoluteError value on hold-out data: 0.04667608439922333
Epoch: 43

Loss on hold-out set: 0.0016532155479161213
MeanAbsoluteError value on hold-out data: 0.030332626774907112
Epoch: 44
Loss on hold-out set: 0.0014465445464548583
MeanAbsoluteError value on hold-out data: 0.025870535522699356
Epoch: 45
Loss on hold-out set: 0.0020618511301178774
MeanAbsoluteError value on hold-out data: 0.03239553049206734
Epoch: 46
Loss on hold-out set: 0.0025100308121182024
MeanAbsoluteError value on hold-out data: 0.039767440408468246
Epoch: 47

Loss on hold-out set: 0.0018803310768607145
MeanAbsoluteError value on hold-out data: 0.03197238966822624
Epoch: 48
Loss on hold-out set: 0.0008100504301882421
MeanAbsoluteError value on hold-out data: 0.019598208367824554
Epoch: 49
Loss on hold-out set: 0.002034646830557344
MeanAbsoluteError value on hold-out data: 0.033667679876089096
Epoch: 50

Loss on hold-out set: 0.002106659006900512
MeanAbsoluteError value on hold-out data: 0.035067904740571976
Epoch: 51
Loss on hold-out set: 0.0019556538318283856
MeanAbsoluteError value on hold-out data: 0.02905881404876709
Epoch: 52
Loss on hold-out set: 0.0020609877672261344
MeanAbsoluteError value on hold-out data: 0.03401973843574524
Epoch: 53
Loss on hold-out set: 0.002731451290086485
MeanAbsoluteError value on hold-out data: 0.037772513926029205
Epoch: 54

Loss on hold-out set: 0.0015140257959361547
```

```
MeanAbsoluteError value on hold-out data: 0.030600478872656822
Epoch: 55
Loss on hold-out set: 0.002086315601795482
MeanAbsoluteError value on hold-out data: 0.03321479260921478
Epoch: 56
Loss on hold-out set: 0.0023788910788985398
MeanAbsoluteError value on hold-out data: 0.038616348057985306
Epoch: 57

Loss on hold-out set: 0.002467067167834522
MeanAbsoluteError value on hold-out data: 0.03025229461491108
Epoch: 58
Loss on hold-out set: 0.0025871323193244347
MeanAbsoluteError value on hold-out data: 0.035010505467653275
Epoch: 59
Loss on hold-out set: 0.0017173223918339668
MeanAbsoluteError value on hold-out data: 0.032176416367292404
Epoch: 60
Loss on hold-out set: 0.0019006267763101137
MeanAbsoluteError value on hold-out data: 0.03232038766145706
Epoch: 61

Loss on hold-out set: 0.0027219859139922145
MeanAbsoluteError value on hold-out data: 0.044143691658973694
Epoch: 62
Loss on hold-out set: 0.0026121193301290846
MeanAbsoluteError value on hold-out data: 0.03094540536403656
Epoch: 63
Loss on hold-out set: 0.0015166708483145786
MeanAbsoluteError value on hold-out data: 0.03024177998304367
Epoch: 64

Loss on hold-out set: 0.0012388422406869582
MeanAbsoluteError value on hold-out data: 0.026725294068455696
Epoch: 65
Loss on hold-out set: 0.00206201521303648
MeanAbsoluteError value on hold-out data: 0.038553643971681595
Epoch: 66
Loss on hold-out set: 0.0027567690189103954
MeanAbsoluteError value on hold-out data: 0.03426945582032204
Epoch: 67
Loss on hold-out set: 0.0016700308389352779
```

```
MeanAbsoluteError value on hold-out data: 0.02606414072215557
Epoch: 68

Loss on hold-out set: 0.001176587397752043
MeanAbsoluteError value on hold-out data: 0.025630734860897064
Epoch: 69
Loss on hold-out set: 0.0013577997474035679
MeanAbsoluteError value on hold-out data: 0.026931991800665855
Epoch: 70
Loss on hold-out set: 0.0027966546521593747
MeanAbsoluteError value on hold-out data: 0.035937558859586716
Epoch: 71

Loss on hold-out set: 0.0014297631524431591
MeanAbsoluteError value on hold-out data: 0.030084406957030296
Epoch: 72
Loss on hold-out set: 0.0016361910093110055
MeanAbsoluteError value on hold-out data: 0.028003958985209465
Epoch: 73
Loss on hold-out set: 0.001991410793450016
MeanAbsoluteError value on hold-out data: 0.029579393565654755
Epoch: 74
Loss on hold-out set: 0.0017412956356285857
MeanAbsoluteError value on hold-out data: 0.03084699809551239
Epoch: 75

Loss on hold-out set: 0.0016263110726588191
MeanAbsoluteError value on hold-out data: 0.0256265290081501
Epoch: 76
Loss on hold-out set: 0.0012764203554699914
MeanAbsoluteError value on hold-out data: 0.02413375861942768
Epoch: 77
Loss on hold-out set: 0.0013433249125507874
MeanAbsoluteError value on hold-out data: 0.026269668713212013
Epoch: 78

Loss on hold-out set: 0.0022025547850017366
MeanAbsoluteError value on hold-out data: 0.036195043474435806
Epoch: 79
Loss on hold-out set: 0.0021711123229649206
MeanAbsoluteError value on hold-out data: 0.03794144093990326
```

```
Epoch: 80
Loss on hold-out set: 0.0013698353958226596
MeanAbsoluteError value on hold-out data: 0.02567855268716812
Epoch: 81
Loss on hold-out set: 0.0015031761051012347
MeanAbsoluteError value on hold-out data: 0.02855767495930195
Epoch: 82

Loss on hold-out set: 0.0018585069830386112
MeanAbsoluteError value on hold-out data: 0.031498998403549194
Epoch: 83
Loss on hold-out set: 0.0020445498431889485
MeanAbsoluteError value on hold-out data: 0.028782343491911888
Epoch: 84
Loss on hold-out set: 0.0038027222975730323
MeanAbsoluteError value on hold-out data: 0.039190519601106644
Epoch: 85

Loss on hold-out set: 0.003949907550122589
MeanAbsoluteError value on hold-out data: 0.043926943093538284
Epoch: 86
Loss on hold-out set: 0.0011684147802253182
MeanAbsoluteError value on hold-out data: 0.024897970259189606
Epoch: 87
Loss on hold-out set: 0.0019911795612782813
MeanAbsoluteError value on hold-out data: 0.030159370973706245
Epoch: 88
Loss on hold-out set: 0.0025954203648815076
MeanAbsoluteError value on hold-out data: 0.0366116426885128
Epoch: 89

Loss on hold-out set: 0.0013185135254528946
MeanAbsoluteError value on hold-out data: 0.028554271906614304
Epoch: 90
Loss on hold-out set: 0.0033539265188245247
MeanAbsoluteError value on hold-out data: 0.040562428534030914
Epoch: 91
Loss on hold-out set: 0.001368386222076459
MeanAbsoluteError value on hold-out data: 0.026781179010868073
Epoch: 92
```

```
Loss on hold-out set: 0.004543455657907403
MeanAbsoluteError value on hold-out data: 0.061689458787441254
Epoch: 93
Loss on hold-out set: 0.002036128666636964
MeanAbsoluteError value on hold-out data: 0.029335424304008484
Epoch: 94
Loss on hold-out set: 0.001157871865031596
MeanAbsoluteError value on hold-out data: 0.02445342019200325
Epoch: 95
Loss on hold-out set: 0.0010526088131323026
MeanAbsoluteError value on hold-out data: 0.024232709780335426
Epoch: 96

Loss on hold-out set: 0.0021512476859453064
MeanAbsoluteError value on hold-out data: 0.030129089951515198
Epoch: 97
Loss on hold-out set: 0.0008457247492445346
MeanAbsoluteError value on hold-out data: 0.024558186531066895
Epoch: 98
Loss on hold-out set: 0.001524084661818611
MeanAbsoluteError value on hold-out data: 0.026095427572727203
Epoch: 99

Loss on hold-out set: 0.001535040534620818
MeanAbsoluteError value on hold-out data: 0.03180393576622009
Epoch: 100
Loss on hold-out set: 0.001499788871464821
MeanAbsoluteError value on hold-out data: 0.03011201322078705
Epoch: 101
Loss on hold-out set: 0.0014465879044459702
MeanAbsoluteError value on hold-out data: 0.025361675769090652
Epoch: 102
Loss on hold-out set: 0.0028076376586865922
MeanAbsoluteError value on hold-out data: 0.0419982485473156
Epoch: 103

Loss on hold-out set: 0.003923346969084098
MeanAbsoluteError value on hold-out data: 0.05480140820145607
Epoch: 104
Loss on hold-out set: 0.0019586844092163327
MeanAbsoluteError value on hold-out data: 0.030503930523991585
Epoch: 105
```

```
Loss on hold-out set: 0.001732372425836869
MeanAbsoluteError value on hold-out data: 0.03067229688167572
Epoch: 106

Loss on hold-out set: 0.0022717234678566456
MeanAbsoluteError value on hold-out data: 0.037849780172109604
Epoch: 107
Loss on hold-out set: 0.0020604097024680902
MeanAbsoluteError value on hold-out data: 0.031272754073143005
Epoch: 108
Loss on hold-out set: 0.0018796801719313057
MeanAbsoluteError value on hold-out data: 0.032796744257211685
Epoch: 109
Loss on hold-out set: 0.002137511471608797
MeanAbsoluteError value on hold-out data: 0.031027251854538918
Epoch: 110

Loss on hold-out set: 0.001524752782783113
MeanAbsoluteError value on hold-out data: 0.02910396084189415
Epoch: 111
Loss on hold-out set: 0.002306632711014782
MeanAbsoluteError value on hold-out data: 0.03753601387143135
Epoch: 112
Loss on hold-out set: 0.0012343559882048373
MeanAbsoluteError value on hold-out data: 0.0220953319221735
Epoch: 113

Loss on hold-out set: 0.0013305393244641332
MeanAbsoluteError value on hold-out data: 0.027334876358509064
Epoch: 114
Loss on hold-out set: 0.0015432858938136352
MeanAbsoluteError value on hold-out data: 0.028434019535779953
Epoch: 115
Loss on hold-out set: 0.004960688135515039
MeanAbsoluteError value on hold-out data: 0.0565139502286911
Epoch: 116
Loss on hold-out set: 0.0022631710229548984
MeanAbsoluteError value on hold-out data: 0.03360724076628685
Epoch: 117

Loss on hold-out set: 0.0025180124435932017
```

```
MeanAbsoluteError value on hold-out data: 0.03801891580224037
Epoch: 118
Loss on hold-out set: 0.0020721160309711615
MeanAbsoluteError value on hold-out data: 0.03303765505552292
Epoch: 119
Loss on hold-out set: 0.0028083478727449593
MeanAbsoluteError value on hold-out data: 0.037902288138866425
Epoch: 120

Loss on hold-out set: 0.002084732384761222
MeanAbsoluteError value on hold-out data: 0.031377267092466354
Epoch: 121
Loss on hold-out set: 0.0016641307872934984
MeanAbsoluteError value on hold-out data: 0.028464041650295258
Epoch: 122
Loss on hold-out set: 0.001701620520459703
MeanAbsoluteError value on hold-out data: 0.02995947375893593
Epoch: 123
Loss on hold-out set: 0.0011826320551335812
MeanAbsoluteError value on hold-out data: 0.026216793805360794
Epoch: 124

Loss on hold-out set: 0.0017406835843128366
MeanAbsoluteError value on hold-out data: 0.027746642008423805
Epoch: 125
Loss on hold-out set: 0.0012279900547582656
MeanAbsoluteError value on hold-out data: 0.02447548881173134
Epoch: 126
Loss on hold-out set: 0.0011940078312853496
MeanAbsoluteError value on hold-out data: 0.026921596378087997
Epoch: 127

Loss on hold-out set: 0.0033937970337529597
MeanAbsoluteError value on hold-out data: 0.04703137278556824
Epoch: 128
Loss on hold-out set: 0.0030563103187327776
MeanAbsoluteError value on hold-out data: 0.044138092547655106
Epoch: 129
Loss on hold-out set: 0.0018999824645176816
MeanAbsoluteError value on hold-out data: 0.02907719649374485
Epoch: 130
Loss on hold-out set: 0.0013883988028213095
```

```
MeanAbsoluteError value on hold-out data: 0.025403130799531937
Epoch: 131

Loss on hold-out set: 0.0010628600497371876
MeanAbsoluteError value on hold-out data: 0.021588759496808052
Epoch: 132
Loss on hold-out set: 0.0010540020974496235
MeanAbsoluteError value on hold-out data: 0.02277303673326969
Epoch: 133
Loss on hold-out set: 0.002538966394450444
MeanAbsoluteError value on hold-out data: 0.03613029792904854
Epoch: 134

Loss on hold-out set: 0.0029533488783412254
MeanAbsoluteError value on hold-out data: 0.04470047354698181
Epoch: 135
Loss on hold-out set: 0.0025088155480961385
MeanAbsoluteError value on hold-out data: 0.03897015377879143
Epoch: 136
Loss on hold-out set: 0.0013859509356104983
MeanAbsoluteError value on hold-out data: 0.026251697912812233
Epoch: 137
Loss on hold-out set: 0.0023600383473631856
MeanAbsoluteError value on hold-out data: 0.03688036650419235
Epoch: 138

Loss on hold-out set: 0.001746991002269519
MeanAbsoluteError value on hold-out data: 0.028429608792066574
Epoch: 139
Loss on hold-out set: 0.0017554431911916113
MeanAbsoluteError value on hold-out data: 0.03569139540195465
Epoch: 140
Loss on hold-out set: 0.0019802221079142047
MeanAbsoluteError value on hold-out data: 0.02808571420609951
Epoch: 141

Loss on hold-out set: 0.0011393335634448493
MeanAbsoluteError value on hold-out data: 0.027202574536204338
Epoch: 142
Loss on hold-out set: 0.001694258264391325
MeanAbsoluteError value on hold-out data: 0.02719210833311081
```

```
Epoch: 143
Loss on hold-out set: 0.0013598666320411633
MeanAbsoluteError value on hold-out data: 0.027338629588484764
Epoch: 144
Loss on hold-out set: 0.0036447601607785774
MeanAbsoluteError value on hold-out data: 0.04196476563811302
Epoch: 145

Loss on hold-out set: 0.0030263707113380614
MeanAbsoluteError value on hold-out data: 0.04339684545993805
Epoch: 146
Loss on hold-out set: 0.003315106475313839
MeanAbsoluteError value on hold-out data: 0.04052871838212013
Epoch: 147
Loss on hold-out set: 0.0022138643387454348
MeanAbsoluteError value on hold-out data: 0.03652886301279068
Epoch: 148

Loss on hold-out set: 0.0012409076533423592
MeanAbsoluteError value on hold-out data: 0.027062764391303062
Epoch: 149
Loss on hold-out set: 0.0027455862056320677
MeanAbsoluteError value on hold-out data: 0.04158451408147812
Epoch: 150
Loss on hold-out set: 0.002056595947718821
MeanAbsoluteError value on hold-out data: 0.028280220925807953
Epoch: 151
Loss on hold-out set: 0.002164353312064822
MeanAbsoluteError value on hold-out data: 0.03791111335158348
Epoch: 152

Loss on hold-out set: 0.0019011371074996602
MeanAbsoluteError value on hold-out data: 0.029384884983301163
Epoch: 153
Loss on hold-out set: 0.00263187548933694
MeanAbsoluteError value on hold-out data: 0.03964691981673241
Epoch: 154
Loss on hold-out set: 0.0027280069905548142
MeanAbsoluteError value on hold-out data: 0.043208979070186615
Epoch: 155
```

```
Loss on hold-out set: 0.0018489166059925293
MeanAbsoluteError value on hold-out data: 0.029536476358771324
Epoch: 156
Loss on hold-out set: 0.0015668087244893496
MeanAbsoluteError value on hold-out data: 0.02660341188311577
Epoch: 157
Loss on hold-out set: 0.0014402495715050744
MeanAbsoluteError value on hold-out data: 0.030109109356999397
Epoch: 158
Loss on hold-out set: 0.0020057751434461144
MeanAbsoluteError value on hold-out data: 0.03326570615172386
Epoch: 159

Loss on hold-out set: 0.002601031357279191
MeanAbsoluteError value on hold-out data: 0.041612982749938965
Epoch: 160
Loss on hold-out set: 0.002375890870238296
MeanAbsoluteError value on hold-out data: 0.032495126128196716
Epoch: 161
Loss on hold-out set: 0.0015286781372896468
MeanAbsoluteError value on hold-out data: 0.028511755168437958
Epoch: 162

Loss on hold-out set: 0.0027729392235274785
MeanAbsoluteError value on hold-out data: 0.034888461232185364
Epoch: 163
Loss on hold-out set: 0.0017230039766918009
MeanAbsoluteError value on hold-out data: 0.02838447317481041
Epoch: 164
Loss on hold-out set: 0.0011592759804513592
MeanAbsoluteError value on hold-out data: 0.022534046322107315
Epoch: 165
Loss on hold-out set: 0.0011714914065893167
MeanAbsoluteError value on hold-out data: 0.02277510240674019
Epoch: 166

Loss on hold-out set: 0.00145411164759515
MeanAbsoluteError value on hold-out data: 0.028132222592830658
Epoch: 167
Loss on hold-out set: 0.0015030401924517578
MeanAbsoluteError value on hold-out data: 0.029708199203014374
Epoch: 168
```

```
Loss on hold-out set: 0.0021120780293131247
MeanAbsoluteError value on hold-out data: 0.029473256319761276
Epoch: 169

Loss on hold-out set: 0.0016290122920718903
MeanAbsoluteError value on hold-out data: 0.028830377385020256
Epoch: 170
Loss on hold-out set: 0.0030067731702449517
MeanAbsoluteError value on hold-out data: 0.03286576271057129
Epoch: 171
Loss on hold-out set: 0.0012247709651441814
MeanAbsoluteError value on hold-out data: 0.024193434044718742
Epoch: 172
Loss on hold-out set: 0.001623963937163353
MeanAbsoluteError value on hold-out data: 0.032992374151945114
Epoch: 173

Loss on hold-out set: 0.001625084112255046
MeanAbsoluteError value on hold-out data: 0.03073383867740631
Epoch: 174
Loss on hold-out set: 0.0016829672509070055
MeanAbsoluteError value on hold-out data: 0.02586931176483631
Epoch: 175
Loss on hold-out set: 0.0013275192043063445
MeanAbsoluteError value on hold-out data: 0.029667505994439125
Epoch: 176

Loss on hold-out set: 0.0012308514023271317
MeanAbsoluteError value on hold-out data: 0.02370285429060459
Early stopping at epoch 175
Fold: 8
Epoch: 1
Loss on hold-out set: 0.01188766616038405
MeanAbsoluteError value on hold-out data: 0.08716871589422226
Epoch: 2
Loss on hold-out set: 0.010587021986094233
MeanAbsoluteError value on hold-out data: 0.08278784155845642
Epoch: 3
Loss on hold-out set: 0.008643056230189709
MeanAbsoluteError value on hold-out data: 0.07532081753015518
Epoch: 4
```

```
Loss on hold-out set: 0.006868973087805968
MeanAbsoluteError value on hold-out data: 0.06531725823879242
Epoch: 5
Loss on hold-out set: 0.004477987106208905
MeanAbsoluteError value on hold-out data: 0.05173027515411377
Epoch: 6
Loss on hold-out set: 0.005343641691769545
MeanAbsoluteError value on hold-out data: 0.056994449347257614
Epoch: 7

Loss on hold-out set: 0.00584030941200371
MeanAbsoluteError value on hold-out data: 0.06268937885761261
Epoch: 8
Loss on hold-out set: 0.005858672585768195
MeanAbsoluteError value on hold-out data: 0.06010271608829498
Epoch: 9
Loss on hold-out set: 0.0051767871930049015
MeanAbsoluteError value on hold-out data: 0.05103335529565811
Epoch: 10
Loss on hold-out set: 0.004393413188294149
MeanAbsoluteError value on hold-out data: 0.05031170696020126
Epoch: 11

Loss on hold-out set: 0.005761889463218932
MeanAbsoluteError value on hold-out data: 0.057826608419418335
Epoch: 12
Loss on hold-out set: 0.0051703451810261375
MeanAbsoluteError value on hold-out data: 0.058622900396585464
Epoch: 13
Loss on hold-out set: 0.004213211386321256
MeanAbsoluteError value on hold-out data: 0.04523906111717224
Epoch: 14

Loss on hold-out set: 0.009073882524927076
MeanAbsoluteError value on hold-out data: 0.06554735451936722
Epoch: 15
Loss on hold-out set: 0.005536155649819053
MeanAbsoluteError value on hold-out data: 0.06149263679981232
Epoch: 16
Loss on hold-out set: 0.00290757242608099
MeanAbsoluteError value on hold-out data: 0.039046015590429306
Epoch: 17
```

```
Loss on hold-out set: 0.008919517796200056
MeanAbsoluteError value on hold-out data: 0.07659310102462769
Epoch: 18

Loss on hold-out set: 0.0035462755880032023
MeanAbsoluteError value on hold-out data: 0.04846232384443283
Epoch: 19
Loss on hold-out set: 0.005641191821688643
MeanAbsoluteError value on hold-out data: 0.059155791997909546
Epoch: 20
Loss on hold-out set: 0.002387584222910496
MeanAbsoluteError value on hold-out data: 0.036917153745889664
Epoch: 21

Loss on hold-out set: 0.0034522228659345554
MeanAbsoluteError value on hold-out data: 0.045522090047597885
Epoch: 22
Loss on hold-out set: 0.004394572971460338
MeanAbsoluteError value on hold-out data: 0.04141276702284813
Epoch: 23
Loss on hold-out set: 0.0026107054078378356
MeanAbsoluteError value on hold-out data: 0.03948705643415451
Epoch: 24
Loss on hold-out set: 0.002746376150753349
MeanAbsoluteError value on hold-out data: 0.03937489539384842
Epoch: 25

Loss on hold-out set: 0.0027531660811151736
MeanAbsoluteError value on hold-out data: 0.037743035703897476
Epoch: 26
Loss on hold-out set: 0.00293435503800328
MeanAbsoluteError value on hold-out data: 0.03962748497724533
Epoch: 27
Loss on hold-out set: 0.004080647029555761
MeanAbsoluteError value on hold-out data: 0.04334304854273796
Epoch: 28

Loss on hold-out set: 0.0031428107244070047
MeanAbsoluteError value on hold-out data: 0.03727972134947777
Epoch: 29
Loss on hold-out set: 0.004412887156761896
```

```
MeanAbsoluteError value on hold-out data: 0.05315461754798889
Epoch: 30
Loss on hold-out set: 0.0026479520020075142
MeanAbsoluteError value on hold-out data: 0.03724509850144386
Epoch: 31
Loss on hold-out set: 0.003164025032534622
MeanAbsoluteError value on hold-out data: 0.04479318484663963
Epoch: 32

Loss on hold-out set: 0.0027044639215231515
MeanAbsoluteError value on hold-out data: 0.03740711510181427
Epoch: 33
Loss on hold-out set: 0.0037833500134113887
MeanAbsoluteError value on hold-out data: 0.04732460901141167
Epoch: 34
Loss on hold-out set: 0.0035758021101803305
MeanAbsoluteError value on hold-out data: 0.040881041437387466
Epoch: 35

Loss on hold-out set: 0.0038664183006263697
MeanAbsoluteError value on hold-out data: 0.04185573756694794
Epoch: 36
Loss on hold-out set: 0.00306771699195871
MeanAbsoluteError value on hold-out data: 0.03979907184839249
Epoch: 37
Loss on hold-out set: 0.0033176026504056957
MeanAbsoluteError value on hold-out data: 0.044140882790088654
Epoch: 38
Loss on hold-out set: 0.002698991541714909
MeanAbsoluteError value on hold-out data: 0.037902817130088806
Epoch: 39

Loss on hold-out set: 0.003030344373725641
MeanAbsoluteError value on hold-out data: 0.04366198927164078
Epoch: 40
Loss on hold-out set: 0.004554557551343281
MeanAbsoluteError value on hold-out data: 0.05815177038311958
Epoch: 41
Loss on hold-out set: 0.0034723697642150978
MeanAbsoluteError value on hold-out data: 0.04042455181479454
Epoch: 42
```

```
Loss on hold-out set: 0.0023567361595968786
MeanAbsoluteError value on hold-out data: 0.03668756037950516
Epoch: 43
Loss on hold-out set: 0.0022128258760158834
MeanAbsoluteError value on hold-out data: 0.035437073558568954
Epoch: 44
Loss on hold-out set: 0.002934634631786209
MeanAbsoluteError value on hold-out data: 0.04042544215917587
Epoch: 45
Loss on hold-out set: 0.0022573065406714496
MeanAbsoluteError value on hold-out data: 0.03751753643155098
Epoch: 46

Loss on hold-out set: 0.002543136515529253
MeanAbsoluteError value on hold-out data: 0.03578481078147888
Epoch: 47
Loss on hold-out set: 0.002693658291648787
MeanAbsoluteError value on hold-out data: 0.04048728570342064
Epoch: 48
Loss on hold-out set: 0.001861222683846091
MeanAbsoluteError value on hold-out data: 0.033407438546419144
Epoch: 49

Loss on hold-out set: 0.005772129381791904
MeanAbsoluteError value on hold-out data: 0.06298008561134338
Epoch: 50
Loss on hold-out set: 0.003586218961013051
MeanAbsoluteError value on hold-out data: 0.04403182864189148
Epoch: 51
Loss on hold-out set: 0.001994716379648218
MeanAbsoluteError value on hold-out data: 0.034774087369441986
Epoch: 52
Loss on hold-out set: 0.00212626285233105
MeanAbsoluteError value on hold-out data: 0.03393825143575668
Epoch: 53

Loss on hold-out set: 0.0019338764429378968
MeanAbsoluteError value on hold-out data: 0.03206799179315567
Epoch: 54
Loss on hold-out set: 0.003693007440933098
MeanAbsoluteError value on hold-out data: 0.043774012476205826
Epoch: 55
```

```
Loss on hold-out set: 0.002467269328637765
MeanAbsoluteError value on hold-out data: 0.03923564776778221
Epoch: 56

Loss on hold-out set: 0.004843843590396528
MeanAbsoluteError value on hold-out data: 0.051201868802309036
Epoch: 57
Loss on hold-out set: 0.0022830287075171676
MeanAbsoluteError value on hold-out data: 0.03477579727768898
Epoch: 58
Loss on hold-out set: 0.0019568435785074076
MeanAbsoluteError value on hold-out data: 0.03182251751422882
Epoch: 59
Loss on hold-out set: 0.001641702992716231
MeanAbsoluteError value on hold-out data: 0.02860056236386299
Epoch: 60

Loss on hold-out set: 0.003713156170516203
MeanAbsoluteError value on hold-out data: 0.047338470816612244
Epoch: 61
Loss on hold-out set: 0.004158312481684754
MeanAbsoluteError value on hold-out data: 0.048239607363939285
Epoch: 62
Loss on hold-out set: 0.0032102749459087276
MeanAbsoluteError value on hold-out data: 0.03531934693455696
Epoch: 63

Loss on hold-out set: 0.00249841061528199
MeanAbsoluteError value on hold-out data: 0.03854065015912056
Epoch: 64
Loss on hold-out set: 0.0022437860472844197
MeanAbsoluteError value on hold-out data: 0.03556801378726959
Epoch: 65
Loss on hold-out set: 0.0037338683256306327
MeanAbsoluteError value on hold-out data: 0.04089068993926048
Epoch: 66
Loss on hold-out set: 0.002206626839604444
MeanAbsoluteError value on hold-out data: 0.033370353281497955
Epoch: 67

Loss on hold-out set: 0.00236744605577909
```

```
MeanAbsoluteError value on hold-out data: 0.03297559544444084
Epoch: 68
Loss on hold-out set: 0.0030325750099459235
MeanAbsoluteError value on hold-out data: 0.04033447429537773
Epoch: 69
Loss on hold-out set: 0.003987784636242745
MeanAbsoluteError value on hold-out data: 0.04518965631723404
Epoch: 70

Loss on hold-out set: 0.0022257656808226155
MeanAbsoluteError value on hold-out data: 0.03532172739505768
Epoch: 71
Loss on hold-out set: 0.0043997203219287954
MeanAbsoluteError value on hold-out data: 0.04434022307395935
Epoch: 72
Loss on hold-out set: 0.002418401698098303
MeanAbsoluteError value on hold-out data: 0.03632890805602074
Epoch: 73
Loss on hold-out set: 0.004306712966913788
MeanAbsoluteError value on hold-out data: 0.05055122822523117
Epoch: 74

Loss on hold-out set: 0.0038103652500117626
MeanAbsoluteError value on hold-out data: 0.04351484403014183
Epoch: 75
Loss on hold-out set: 0.0024373686666457127
MeanAbsoluteError value on hold-out data: 0.03984566777944565
Epoch: 76
Loss on hold-out set: 0.0023354307408086383
MeanAbsoluteError value on hold-out data: 0.03801761567592621
Epoch: 77

Loss on hold-out set: 0.0027189440398405376
MeanAbsoluteError value on hold-out data: 0.04043439403176308
Epoch: 78
Loss on hold-out set: 0.0026177970844750795
MeanAbsoluteError value on hold-out data: 0.04015885666012764
Epoch: 79
Loss on hold-out set: 0.003189334269756308
MeanAbsoluteError value on hold-out data: 0.0448557510972023
Epoch: 80
Loss on hold-out set: 0.001917079250023772
```

```
MeanAbsoluteError value on hold-out data: 0.032469771802425385
Epoch: 81

Loss on hold-out set: 0.0026052021690142844
MeanAbsoluteError value on hold-out data: 0.040452953428030014
Epoch: 82
Loss on hold-out set: 0.0038323898737032255
MeanAbsoluteError value on hold-out data: 0.04582921043038368
Epoch: 83
Loss on hold-out set: 0.0030162651584340404
MeanAbsoluteError value on hold-out data: 0.04083075001835823
Epoch: 84

Loss on hold-out set: 0.0035085611721464936
MeanAbsoluteError value on hold-out data: 0.04483405128121376
Epoch: 85
Loss on hold-out set: 0.0033131063593408237
MeanAbsoluteError value on hold-out data: 0.04289108142256737
Epoch: 86
Loss on hold-out set: 0.0028697539819404483
MeanAbsoluteError value on hold-out data: 0.03968026489019394
Epoch: 87
Loss on hold-out set: 0.0038835289440332698
MeanAbsoluteError value on hold-out data: 0.0473872609436512
Epoch: 88

Loss on hold-out set: 0.002671017535389043
MeanAbsoluteError value on hold-out data: 0.04201635718345642
Epoch: 89
Loss on hold-out set: 0.00376235418773901
MeanAbsoluteError value on hold-out data: 0.04638035595417023
Epoch: 90
Loss on hold-out set: 0.004000721714244439
MeanAbsoluteError value on hold-out data: 0.049973390996456146
Epoch: 91

Loss on hold-out set: 0.0038001750452587237
MeanAbsoluteError value on hold-out data: 0.04260755702853203
Epoch: 92
Loss on hold-out set: 0.00317815718993258
MeanAbsoluteError value on hold-out data: 0.043167438358068466
```

```
Epoch: 93
Loss on hold-out set: 0.004782620835332916
MeanAbsoluteError value on hold-out data: 0.052893754094839096
Epoch: 94
Loss on hold-out set: 0.0022120268639320363
MeanAbsoluteError value on hold-out data: 0.033038679510354996
Epoch: 95

Loss on hold-out set: 0.003232017974369228
MeanAbsoluteError value on hold-out data: 0.04381113499403
Epoch: 96
Loss on hold-out set: 0.003335385484835849
MeanAbsoluteError value on hold-out data: 0.044431671500205994
Epoch: 97
Loss on hold-out set: 0.0018659895688940126
MeanAbsoluteError value on hold-out data: 0.03574715554714203
Epoch: 98

Loss on hold-out set: 0.003991585269641991
MeanAbsoluteError value on hold-out data: 0.04553138092160225
Epoch: 99
Loss on hold-out set: 0.0027212162922996166
MeanAbsoluteError value on hold-out data: 0.03839977830648422
Epoch: 100
Loss on hold-out set: 0.00289976620563091
MeanAbsoluteError value on hold-out data: 0.04132441058754921
Epoch: 101
Loss on hold-out set: 0.002481194763766745
MeanAbsoluteError value on hold-out data: 0.03973180800676346
Epoch: 102

Loss on hold-out set: 0.0033629678207664536
MeanAbsoluteError value on hold-out data: 0.04459598660469055
Epoch: 103
Loss on hold-out set: 0.003521024491279744
MeanAbsoluteError value on hold-out data: 0.04544883221387863
Epoch: 104
Loss on hold-out set: 0.003889955275763686
MeanAbsoluteError value on hold-out data: 0.04741128534078598
Epoch: 105
```

```
Loss on hold-out set: 0.004157417722476216
MeanAbsoluteError value on hold-out data: 0.04975517839193344
Epoch: 106
Loss on hold-out set: 0.0027733556209848477
MeanAbsoluteError value on hold-out data: 0.04094134271144867
Epoch: 107
Loss on hold-out set: 0.0043440853926138235
MeanAbsoluteError value on hold-out data: 0.05074884742498398
Epoch: 108
Loss on hold-out set: 0.002887992685338339
MeanAbsoluteError value on hold-out data: 0.041573189198970795
Epoch: 109

Loss on hold-out set: 0.002807661255176824
MeanAbsoluteError value on hold-out data: 0.041031867265701294
Epoch: 110
Loss on hold-out set: 0.0024901880578209576
MeanAbsoluteError value on hold-out data: 0.03883375972509384
Epoch: 111
Loss on hold-out set: 0.002527963473067547
MeanAbsoluteError value on hold-out data: 0.038145218044519424
Epoch: 112

Loss on hold-out set: 0.002241209982177959
MeanAbsoluteError value on hold-out data: 0.036282967776060104
Epoch: 113
Loss on hold-out set: 0.0034861164167523384
MeanAbsoluteError value on hold-out data: 0.04469311237335205
Epoch: 114
Loss on hold-out set: 0.0022746160304030548
MeanAbsoluteError value on hold-out data: 0.03880949318408966
Epoch: 115

Loss on hold-out set: 0.0021547749996758425
MeanAbsoluteError value on hold-out data: 0.036274489015340805
Epoch: 116
Loss on hold-out set: 0.0020837866781780925
MeanAbsoluteError value on hold-out data: 0.0342286191880703
Epoch: 117
Loss on hold-out set: 0.003749553141040871
MeanAbsoluteError value on hold-out data: 0.044133663177490234
Epoch: 118
```

```
Loss on hold-out set: 0.0034444088456579126
MeanAbsoluteError value on hold-out data: 0.04086137190461159
Epoch: 119
Loss on hold-out set: 0.0037558070795897106
MeanAbsoluteError value on hold-out data: 0.04813350737094879
Epoch: 120
Loss on hold-out set: 0.0027866694861306595
MeanAbsoluteError value on hold-out data: 0.04219765216112137
Epoch: 121

Loss on hold-out set: 0.003474748388096207
MeanAbsoluteError value on hold-out data: 0.04987647011876106
Epoch: 122
Loss on hold-out set: 0.00392145484399337
MeanAbsoluteError value on hold-out data: 0.04590271785855293
Epoch: 123
Loss on hold-out set: 0.003726212258558147
MeanAbsoluteError value on hold-out data: 0.04428703337907791
Epoch: 124
Loss on hold-out set: 0.002549363264384178
MeanAbsoluteError value on hold-out data: 0.036671869456768036
Epoch: 125

Loss on hold-out set: 0.0027574995989338136
MeanAbsoluteError value on hold-out data: 0.040809206664562225
Epoch: 126
Loss on hold-out set: 0.0034980526946198484
MeanAbsoluteError value on hold-out data: 0.040518127381801605
Epoch: 127
Loss on hold-out set: 0.0036933564921267903
MeanAbsoluteError value on hold-out data: 0.04111070930957794
Epoch: 128

Loss on hold-out set: 0.0036343894809341202
MeanAbsoluteError value on hold-out data: 0.04482060298323631
Epoch: 129
Loss on hold-out set: 0.002122811695489173
MeanAbsoluteError value on hold-out data: 0.037863053381443024
Epoch: 130
Loss on hold-out set: 0.002945146057754755
MeanAbsoluteError value on hold-out data: 0.04126819968223572
Epoch: 131
```

```
Loss on hold-out set: 0.004275515191973402
MeanAbsoluteError value on hold-out data: 0.04717527702450752
Epoch: 132

Loss on hold-out set: 0.004109855338286322
MeanAbsoluteError value on hold-out data: 0.05014321953058243
Epoch: 133
Loss on hold-out set: 0.0026565479884783807
MeanAbsoluteError value on hold-out data: 0.04124549776315689
Epoch: 134
Loss on hold-out set: 0.003342269465345173
MeanAbsoluteError value on hold-out data: 0.046274419873952866
Epoch: 135

Loss on hold-out set: 0.0023540964108318663
MeanAbsoluteError value on hold-out data: 0.03668100759387016
Epoch: 136
Loss on hold-out set: 0.003351683209005457
MeanAbsoluteError value on hold-out data: 0.042942751199007034
Epoch: 137
Loss on hold-out set: 0.0023872129341515782
MeanAbsoluteError value on hold-out data: 0.03814738243818283
Epoch: 138
Loss on hold-out set: 0.0021512858130825828
MeanAbsoluteError value on hold-out data: 0.03591597452759743
Epoch: 139

Loss on hold-out set: 0.002992107389638057
MeanAbsoluteError value on hold-out data: 0.04302060231566429
Epoch: 140
Loss on hold-out set: 0.0020113298803782808
MeanAbsoluteError value on hold-out data: 0.034527722746133804
Epoch: 141
Loss on hold-out set: 0.00404263545687382
MeanAbsoluteError value on hold-out data: 0.043553031980991364
Epoch: 142

Loss on hold-out set: 0.002928238487444245
MeanAbsoluteError value on hold-out data: 0.04296432435512543
Epoch: 143
Loss on hold-out set: 0.002985746521377363
```

```
MeanAbsoluteError value on hold-out data: 0.033779896795749664
Epoch: 144
Loss on hold-out set: 0.004478154166673238
MeanAbsoluteError value on hold-out data: 0.05453535169363022
Epoch: 145
Loss on hold-out set: 0.00271356257592113
MeanAbsoluteError value on hold-out data: 0.040095262229442596
Epoch: 146

Loss on hold-out set: 0.007512221882979457
MeanAbsoluteError value on hold-out data: 0.07132372260093689
Epoch: 147
Loss on hold-out set: 0.003248314700053575
MeanAbsoluteError value on hold-out data: 0.04173272103071213
Epoch: 148
Loss on hold-out set: 0.004544889249910529
MeanAbsoluteError value on hold-out data: 0.053969576954841614
Epoch: 149

Loss on hold-out set: 0.004316984971340459
MeanAbsoluteError value on hold-out data: 0.041099824011325836
Epoch: 150
Loss on hold-out set: 0.003849748011606817
MeanAbsoluteError value on hold-out data: 0.04418458044528961
Epoch: 151
Loss on hold-out set: 0.0024986012588040186
MeanAbsoluteError value on hold-out data: 0.03685273975133896
Epoch: 152
Loss on hold-out set: 0.003295783750497951
MeanAbsoluteError value on hold-out data: 0.040162719786167145
Epoch: 153

Loss on hold-out set: 0.0037879072613297747
MeanAbsoluteError value on hold-out data: 0.050637174397706985
Epoch: 154
Loss on hold-out set: 0.002700244161622742
MeanAbsoluteError value on hold-out data: 0.03829168155789375
Epoch: 155
Loss on hold-out set: 0.0020124868270403776
MeanAbsoluteError value on hold-out data: 0.035486653447151184
Epoch: 156
```

```
Loss on hold-out set: 0.002854783155131512
MeanAbsoluteError value on hold-out data: 0.03590874373912811
Epoch: 157
Loss on hold-out set: 0.004457146614395942
MeanAbsoluteError value on hold-out data: 0.04251076653599739
Epoch: 158
Loss on hold-out set: 0.0038812481484805737
MeanAbsoluteError value on hold-out data: 0.04380704462528229
Epoch: 159
Loss on hold-out set: 0.0037543502851174427
MeanAbsoluteError value on hold-out data: 0.04999588057398796
Epoch: 160

Loss on hold-out set: 0.003220902115572244
MeanAbsoluteError value on hold-out data: 0.03913533315062523
Epoch: 161
Loss on hold-out set: 0.002340785487411687
MeanAbsoluteError value on hold-out data: 0.037826575338840485
Epoch: 162
Loss on hold-out set: 0.0028291509146443927
MeanAbsoluteError value on hold-out data: 0.039289575070142746
Epoch: 163

Loss on hold-out set: 0.0038739922725094054
MeanAbsoluteError value on hold-out data: 0.04817027226090431
Epoch: 164
Loss on hold-out set: 0.003879088800973617
MeanAbsoluteError value on hold-out data: 0.051561009138822556
Epoch: 165
Loss on hold-out set: 0.0018389592788970242
MeanAbsoluteError value on hold-out data: 0.035066235810518265
Epoch: 166
Loss on hold-out set: 0.003096975059284327
MeanAbsoluteError value on hold-out data: 0.03961838409304619
Epoch: 167

Loss on hold-out set: 0.0029046577759660208
MeanAbsoluteError value on hold-out data: 0.043199051171541214
Epoch: 168
Loss on hold-out set: 0.003167159729954067
MeanAbsoluteError value on hold-out data: 0.04208352044224739
Epoch: 169
```

```
Loss on hold-out set: 0.004013646349239235
MeanAbsoluteError value on hold-out data: 0.04811031371355057
Epoch: 170

Loss on hold-out set: 0.003574029506685642
MeanAbsoluteError value on hold-out data: 0.048094429075717926
Epoch: 171
Loss on hold-out set: 0.004063895688607142
MeanAbsoluteError value on hold-out data: 0.04645808786153793
Epoch: 172
Loss on hold-out set: 0.0024790884837364922
MeanAbsoluteError value on hold-out data: 0.03802455589175224
Epoch: 173
Loss on hold-out set: 0.0022534121302529597
MeanAbsoluteError value on hold-out data: 0.03583672642707825
Epoch: 174

Loss on hold-out set: 0.005352602940267668
MeanAbsoluteError value on hold-out data: 0.05529174953699112
Epoch: 175
Loss on hold-out set: 0.0031527838168235924
MeanAbsoluteError value on hold-out data: 0.03979141637682915
Epoch: 176

Loss on hold-out set: 0.0021443369041662663
MeanAbsoluteError value on hold-out data: 0.03622438758611679
Epoch: 177
Loss on hold-out set: 0.003238300524222163
MeanAbsoluteError value on hold-out data: 0.045195646584033966
Epoch: 178
Loss on hold-out set: 0.0029796620902533713
MeanAbsoluteError value on hold-out data: 0.040979351848363876
Epoch: 179
Loss on hold-out set: 0.005750614863175612
MeanAbsoluteError value on hold-out data: 0.048504844307899475
Epoch: 180

Loss on hold-out set: 0.0032845876367691043
MeanAbsoluteError value on hold-out data: 0.041736818850040436
Epoch: 181
Loss on hold-out set: 0.003070589119138626
```

```
MeanAbsoluteError value on hold-out data: 0.04427385702729225
Epoch: 182

Loss on hold-out set: 0.0038811525222487175
MeanAbsoluteError value on hold-out data: 0.04635884240269661
Epoch: 183
Loss on hold-out set: 0.00358071425356544
MeanAbsoluteError value on hold-out data: 0.04453559219837189
Epoch: 184
Loss on hold-out set: 0.003840343055064575
MeanAbsoluteError value on hold-out data: 0.04426975175738335
Epoch: 185
Loss on hold-out set: 0.004220472241286188
MeanAbsoluteError value on hold-out data: 0.05090634524822235
Epoch: 186
Loss on hold-out set: 0.002798538534149814
MeanAbsoluteError value on hold-out data: 0.04087221622467041

Epoch: 187
Loss on hold-out set: 0.004312335110556047
MeanAbsoluteError value on hold-out data: 0.04252012073993683
Early stopping at epoch 186
Fold: 9
Epoch: 1

Loss on hold-out set: 0.015547919230392346
MeanAbsoluteError value on hold-out data: 0.09931488335132599
Epoch: 2
Loss on hold-out set: 0.010618328833236145
MeanAbsoluteError value on hold-out data: 0.08252687752246857
Epoch: 3
Loss on hold-out set: 0.008315229322761297
MeanAbsoluteError value on hold-out data: 0.06698422133922577
Epoch: 4
Loss on hold-out set: 0.006962201414773097
MeanAbsoluteError value on hold-out data: 0.06631320714950562
Epoch: 5

Loss on hold-out set: 0.008736094227060676
MeanAbsoluteError value on hold-out data: 0.06259341537952423
Epoch: 6
```

```
Loss on hold-out set: 0.003354480705009057
MeanAbsoluteError value on hold-out data: 0.04399023950099945
Epoch: 7

Loss on hold-out set: 0.004011576135571186
MeanAbsoluteError value on hold-out data: 0.04200087487697601
Epoch: 8
Loss on hold-out set: 0.005705350445798383
MeanAbsoluteError value on hold-out data: 0.053097616881132126
Epoch: 9
Loss on hold-out set: 0.004284719273877831
MeanAbsoluteError value on hold-out data: 0.04853866621851921
Epoch: 10
Loss on hold-out set: 0.002990464366470965
MeanAbsoluteError value on hold-out data: 0.04290100559592247
Epoch: 11
Loss on hold-out set: 0.00253275802018694
MeanAbsoluteError value on hold-out data: 0.038714732974767685
Epoch: 12

Loss on hold-out set: 0.003386591005927095
MeanAbsoluteError value on hold-out data: 0.04393322020769119
Epoch: 13
Loss on hold-out set: 0.0024817405859581553
MeanAbsoluteError value on hold-out data: 0.03704296797513962
Epoch: 14

Loss on hold-out set: 0.0030932932321985182
MeanAbsoluteError value on hold-out data: 0.04180620610713959
Epoch: 15
Loss on hold-out set: 0.003675374793461882
MeanAbsoluteError value on hold-out data: 0.0488528236746788
Epoch: 16
Loss on hold-out set: 0.0014142564099389487
MeanAbsoluteError value on hold-out data: 0.028842806816101074
Epoch: 17
Loss on hold-out set: 0.0026824664808093356
MeanAbsoluteError value on hold-out data: 0.03908800333738327
Epoch: 18

Loss on hold-out set: 0.003216504567087843
```

```
MeanAbsoluteError value on hold-out data: 0.041695304214954376
Epoch: 19
Loss on hold-out set: 0.001981133039897451
MeanAbsoluteError value on hold-out data: 0.03382822871208191
Epoch: 20

Loss on hold-out set: 0.002236746990372642
MeanAbsoluteError value on hold-out data: 0.03642924502491951
Epoch: 21
Loss on hold-out set: 0.0030485624581790315
MeanAbsoluteError value on hold-out data: 0.040704112499952316
Epoch: 22
Loss on hold-out set: 0.0018979288960018982
MeanAbsoluteError value on hold-out data: 0.0332922637462616
Epoch: 23
Loss on hold-out set: 0.0031599807060466935
MeanAbsoluteError value on hold-out data: 0.04049552604556084
Epoch: 24
Loss on hold-out set: 0.0021201627700625416
MeanAbsoluteError value on hold-out data: 0.030638491734862328
Epoch: 25

Loss on hold-out set: 0.002414644304036091
MeanAbsoluteError value on hold-out data: 0.03541712835431099
Epoch: 26
Loss on hold-out set: 0.0023590883535619537
MeanAbsoluteError value on hold-out data: 0.03998629376292229
Epoch: 27

Loss on hold-out set: 0.0026172340328160385
MeanAbsoluteError value on hold-out data: 0.03620285168290138
Epoch: 28
Loss on hold-out set: 0.0033364650847103735
MeanAbsoluteError value on hold-out data: 0.04601584002375603
Epoch: 29
Loss on hold-out set: 0.002049096868946575
MeanAbsoluteError value on hold-out data: 0.033494770526885986
Epoch: 30
Loss on hold-out set: 0.003031472093425691
MeanAbsoluteError value on hold-out data: 0.0436549186706543
Epoch: 31
Loss on hold-out set: 0.005293779809457751
```

```
MeanAbsoluteError value on hold-out data: 0.05757936090230942
Epoch: 32

Loss on hold-out set: 0.0038536358893347476
MeanAbsoluteError value on hold-out data: 0.03965366259217262
Epoch: 33
Loss on hold-out set: 0.0014340960478875786
MeanAbsoluteError value on hold-out data: 0.027453113347291946
Epoch: 34

Loss on hold-out set: 0.003275927169642483
MeanAbsoluteError value on hold-out data: 0.04162049666047096
Epoch: 35
Loss on hold-out set: 0.001532977621536702
MeanAbsoluteError value on hold-out data: 0.030136944726109505
Epoch: 36
Loss on hold-out set: 0.0016325469769071788
MeanAbsoluteError value on hold-out data: 0.028113290667533875
Epoch: 37
Loss on hold-out set: 0.0033696712612604294
MeanAbsoluteError value on hold-out data: 0.0401512086391449
Epoch: 38
Loss on hold-out set: 0.0016759998174026036
MeanAbsoluteError value on hold-out data: 0.03274141624569893
Epoch: 39

Loss on hold-out set: 0.0015636514827537422
MeanAbsoluteError value on hold-out data: 0.027843261137604713
Epoch: 40
Loss on hold-out set: 0.0019133054145361083
MeanAbsoluteError value on hold-out data: 0.02778930403292179
Epoch: 41

Loss on hold-out set: 0.004433780155243137
MeanAbsoluteError value on hold-out data: 0.03940310701727867
Epoch: 42
Loss on hold-out set: 0.0030970559500229475
MeanAbsoluteError value on hold-out data: 0.037575263530015945
Epoch: 43
Loss on hold-out set: 0.002234298321687115
MeanAbsoluteError value on hold-out data: 0.03638871759176254
```

```
Epoch: 44
Loss on hold-out set: 0.0016641995977037228
MeanAbsoluteError value on hold-out data: 0.029897604137659073
Epoch: 45

Loss on hold-out set: 0.0017859288939059926
MeanAbsoluteError value on hold-out data: 0.03179125487804413
Epoch: 46
Loss on hold-out set: 0.0018161235583158066
MeanAbsoluteError value on hold-out data: 0.03272263705730438
Epoch: 47

Loss on hold-out set: 0.0026840283087669657
MeanAbsoluteError value on hold-out data: 0.03442804142832756
Epoch: 48
Loss on hold-out set: 0.0026086531937695467
MeanAbsoluteError value on hold-out data: 0.036305204033851624
Epoch: 49
Loss on hold-out set: 0.0020471867464948446
MeanAbsoluteError value on hold-out data: 0.03562646731734276
Epoch: 50
Loss on hold-out set: 0.0018139153342837324
MeanAbsoluteError value on hold-out data: 0.032020725309848785
Epoch: 51

Loss on hold-out set: 0.002594722873674562
MeanAbsoluteError value on hold-out data: 0.0332859642803669
Epoch: 52
Loss on hold-out set: 0.002341068730367204
MeanAbsoluteError value on hold-out data: 0.037693582475185394
Epoch: 53

Loss on hold-out set: 0.002305649617203296
MeanAbsoluteError value on hold-out data: 0.03214866295456886
Epoch: 54
Loss on hold-out set: 0.003266769810579717
MeanAbsoluteError value on hold-out data: 0.0384005643427372
Epoch: 55
Loss on hold-out set: 0.0013915221094906044
MeanAbsoluteError value on hold-out data: 0.02763724885880947
Epoch: 56
```

```
Loss on hold-out set: 0.002083936943493497
MeanAbsoluteError value on hold-out data: 0.03429217264056206
Epoch: 57

Loss on hold-out set: 0.0029808299374193526
MeanAbsoluteError value on hold-out data: 0.042110785841941833
Epoch: 58
Loss on hold-out set: 0.0027252525592652652
MeanAbsoluteError value on hold-out data: 0.03917301073670387
Epoch: 59

Loss on hold-out set: 0.003590687527321279
MeanAbsoluteError value on hold-out data: 0.04919339716434479
Epoch: 60
Loss on hold-out set: 0.002721268101595342
MeanAbsoluteError value on hold-out data: 0.040796712040901184
Epoch: 61
Loss on hold-out set: 0.003665717857074924
MeanAbsoluteError value on hold-out data: 0.03364694491028786
Epoch: 62
Loss on hold-out set: 0.0015384156677800303
MeanAbsoluteError value on hold-out data: 0.02967401035130024
Epoch: 63

Loss on hold-out set: 0.002548291446426167
MeanAbsoluteError value on hold-out data: 0.04081835225224495
Epoch: 64
Loss on hold-out set: 0.0027945895159903625
MeanAbsoluteError value on hold-out data: 0.04227820038795471
Epoch: 65

Loss on hold-out set: 0.0019893083528866274
MeanAbsoluteError value on hold-out data: 0.033874668180942535
Epoch: 66
Loss on hold-out set: 0.0013948684880653252
MeanAbsoluteError value on hold-out data: 0.028182290494441986
Epoch: 67
Loss on hold-out set: 0.0023896692728158087
MeanAbsoluteError value on hold-out data: 0.03735220059752464
Epoch: 68
Loss on hold-out set: 0.003677961877726305
```

```
MeanAbsoluteError value on hold-out data: 0.0427614264190197
Epoch: 69

Loss on hold-out set: 0.00239070856388515
MeanAbsoluteError value on hold-out data: 0.034921616315841675
Epoch: 70
Loss on hold-out set: 0.002858811496900251
MeanAbsoluteError value on hold-out data: 0.03734385222196579
Epoch: 71

Loss on hold-out set: 0.0028003756641947594
MeanAbsoluteError value on hold-out data: 0.0318116657435894
Epoch: 72
Loss on hold-out set: 0.003509051847056701
MeanAbsoluteError value on hold-out data: 0.04607747495174408
Epoch: 73
Loss on hold-out set: 0.00379182209368222
MeanAbsoluteError value on hold-out data: 0.05066416785120964
Epoch: 74
Loss on hold-out set: 0.0022761627445176532
MeanAbsoluteError value on hold-out data: 0.03319898992776871
Epoch: 75

Loss on hold-out set: 0.0024343567358580632
MeanAbsoluteError value on hold-out data: 0.037940140813589096
Epoch: 76
Loss on hold-out set: 0.002514972181345981
MeanAbsoluteError value on hold-out data: 0.03723950311541557
Epoch: 77

Loss on hold-out set: 0.0013781349631384588
MeanAbsoluteError value on hold-out data: 0.02600739896297455
Epoch: 78
Loss on hold-out set: 0.003691423070939401
MeanAbsoluteError value on hold-out data: 0.0424506776034832
Epoch: 79
Loss on hold-out set: 0.0020523244456853718
MeanAbsoluteError value on hold-out data: 0.03235992416739464
Epoch: 80
Loss on hold-out set: 0.002623971287483493
MeanAbsoluteError value on hold-out data: 0.03765500709414482
Epoch: 81
```

```
Loss on hold-out set: 0.002413668432452071
MeanAbsoluteError value on hold-out data: 0.033947400748729706
Epoch: 82
Loss on hold-out set: 0.0019942884716259027
MeanAbsoluteError value on hold-out data: 0.031736232340335846
Epoch: 83

Loss on hold-out set: 0.0015847150442333748
MeanAbsoluteError value on hold-out data: 0.03113151155412197
Epoch: 84
Loss on hold-out set: 0.0015509288328198285
MeanAbsoluteError value on hold-out data: 0.028626512736082077
Epoch: 85
Loss on hold-out set: 0.0024171652755914973
MeanAbsoluteError value on hold-out data: 0.03344475105404854
Epoch: 86
Loss on hold-out set: 0.002583976514870301
MeanAbsoluteError value on hold-out data: 0.036312855780124664
Epoch: 87

Loss on hold-out set: 0.0031748779718047725
MeanAbsoluteError value on hold-out data: 0.04208741709589958
Epoch: 88
Loss on hold-out set: 0.0022816647542640567
MeanAbsoluteError value on hold-out data: 0.037764545530080795
Epoch: 89

Loss on hold-out set: 0.0016267948354092927
MeanAbsoluteError value on hold-out data: 0.02847529575228691
Epoch: 90
Loss on hold-out set: 0.003400855939477109
MeanAbsoluteError value on hold-out data: 0.043602973222732544
Epoch: 91
Loss on hold-out set: 0.002556725409634125
MeanAbsoluteError value on hold-out data: 0.04201248288154602
Epoch: 92
Loss on hold-out set: 0.002851721911261288
MeanAbsoluteError value on hold-out data: 0.04416660964488983
Epoch: 93

Loss on hold-out set: 0.001555906642282095
```

```
MeanAbsoluteError value on hold-out data: 0.03029399923980236
Epoch: 94
Loss on hold-out set: 0.0031567923590325965
MeanAbsoluteError value on hold-out data: 0.04009667783975601
Epoch: 95

Loss on hold-out set: 0.0022789856280164365
MeanAbsoluteError value on hold-out data: 0.03540173918008804
Epoch: 96
Loss on hold-out set: 0.004074343878668374
MeanAbsoluteError value on hold-out data: 0.04370030760765076
Epoch: 97
Loss on hold-out set: 0.0024125747172197756
MeanAbsoluteError value on hold-out data: 0.03166044130921364
Epoch: 98
Loss on hold-out set: 0.0024084698390932037
MeanAbsoluteError value on hold-out data: 0.03607191890478134
Epoch: 99
Loss on hold-out set: 0.003351130439953592
MeanAbsoluteError value on hold-out data: 0.03570295125246048
Epoch: 100

Loss on hold-out set: 0.00259348210798075
MeanAbsoluteError value on hold-out data: 0.03620978444814682
Epoch: 101
Loss on hold-out set: 0.002013954157099271
MeanAbsoluteError value on hold-out data: 0.03405254706740379
Epoch: 102

Loss on hold-out set: 0.002444851071161863
MeanAbsoluteError value on hold-out data: 0.031996067613363266
Epoch: 103
Loss on hold-out set: 0.002314355291533642
MeanAbsoluteError value on hold-out data: 0.03607438504695892
Epoch: 104
Loss on hold-out set: 0.0024968591773918327
MeanAbsoluteError value on hold-out data: 0.03719642385840416
Epoch: 105
Loss on hold-out set: 0.0045922513885531
MeanAbsoluteError value on hold-out data: 0.041238393634557724
Epoch: 106
Loss on hold-out set: 0.002106626477773086
```

```
MeanAbsoluteError value on hold-out data: 0.030606502667069435
Epoch: 107

Loss on hold-out set: 0.0015215473294329757
MeanAbsoluteError value on hold-out data: 0.03126484528183937
Epoch: 108
Loss on hold-out set: 0.003415604650329512
MeanAbsoluteError value on hold-out data: 0.0467192679643631
Epoch: 109

Loss on hold-out set: 0.002629391383379698
MeanAbsoluteError value on hold-out data: 0.037400808185338974
Epoch: 110
Loss on hold-out set: 0.0021297998654727754
MeanAbsoluteError value on hold-out data: 0.03475729748606682
Epoch: 111
Loss on hold-out set: 0.0027292279141525235
MeanAbsoluteError value on hold-out data: 0.03675609081983566
Epoch: 112
Loss on hold-out set: 0.002682887205782418
MeanAbsoluteError value on hold-out data: 0.04177703335881233
Epoch: 113
Loss on hold-out set: 0.001937427486364658
MeanAbsoluteError value on hold-out data: 0.03570539131760597
Epoch: 114

Loss on hold-out set: 0.003061122690828947
MeanAbsoluteError value on hold-out data: 0.0478673093020916
Epoch: 115

Loss on hold-out set: 0.002770339111940792
MeanAbsoluteError value on hold-out data: 0.0370047390460968
Epoch: 116
Loss on hold-out set: 0.0031668161928582075
MeanAbsoluteError value on hold-out data: 0.03940652310848236
Epoch: 117
Loss on hold-out set: 0.0016012936651420135
MeanAbsoluteError value on hold-out data: 0.02861124835908413
Epoch: 118
Loss on hold-out set: 0.003105338179291441
MeanAbsoluteError value on hold-out data: 0.044403333216905594
Epoch: 119
```

```
Loss on hold-out set: 0.002072629064339428
MeanAbsoluteError value on hold-out data: 0.03330256789922714
Epoch: 120
Loss on hold-out set: 0.003042275603197945
MeanAbsoluteError value on hold-out data: 0.03575107455253601
Epoch: 121
Loss on hold-out set: 0.002039279085763085
MeanAbsoluteError value on hold-out data: 0.03239171579480171
Epoch: 122

Loss on hold-out set: 0.0030449878182620383
MeanAbsoluteError value on hold-out data: 0.03974232077598572
Epoch: 123
Loss on hold-out set: 0.002898689910160521
MeanAbsoluteError value on hold-out data: 0.03626219183206558
Epoch: 124
Loss on hold-out set: 0.003758384416309687
MeanAbsoluteError value on hold-out data: 0.045810457319021225
Epoch: 125
Loss on hold-out set: 0.0012602347448521939
MeanAbsoluteError value on hold-out data: 0.026973815634846687
Epoch: 126

Loss on hold-out set: 0.0024598238837475386
MeanAbsoluteError value on hold-out data: 0.038947220891714096
Epoch: 127
Loss on hold-out set: 0.0017804134583387237
MeanAbsoluteError value on hold-out data: 0.034686021506786346
Epoch: 128
Loss on hold-out set: 0.0035504074565743883
MeanAbsoluteError value on hold-out data: 0.039165955036878586
Epoch: 129

Loss on hold-out set: 0.003693128228545762
MeanAbsoluteError value on hold-out data: 0.04403144493699074
Epoch: 130
Loss on hold-out set: 0.0030551817527828882
MeanAbsoluteError value on hold-out data: 0.04273655265569687
Epoch: 131
Loss on hold-out set: 0.0019101645672120727
MeanAbsoluteError value on hold-out data: 0.03609713912010193
Epoch: 132
```

```
Loss on hold-out set: 0.002034085896761658
MeanAbsoluteError value on hold-out data: 0.03875249996781349
Epoch: 133

Loss on hold-out set: 0.003068478809347233
MeanAbsoluteError value on hold-out data: 0.03882250189781189
Epoch: 134
Loss on hold-out set: 0.002307609113184019
MeanAbsoluteError value on hold-out data: 0.03611750528216362
Epoch: 135
Loss on hold-out set: 0.001967748555426414
MeanAbsoluteError value on hold-out data: 0.030416477471590042
Epoch: 136

Loss on hold-out set: 0.002203414794236708
MeanAbsoluteError value on hold-out data: 0.03559904545545578
Epoch: 137
Loss on hold-out set: 0.0029091327003418254
MeanAbsoluteError value on hold-out data: 0.04016481712460518
Epoch: 138
Loss on hold-out set: 0.0015912074595689774
MeanAbsoluteError value on hold-out data: 0.030033551156520844
Epoch: 139
Loss on hold-out set: 0.0031384731051870263
MeanAbsoluteError value on hold-out data: 0.03792358562350273
Epoch: 140

Loss on hold-out set: 0.0021313615770150837
MeanAbsoluteError value on hold-out data: 0.03536541387438774
Epoch: 141
Loss on hold-out set: 0.0025919455578192496
MeanAbsoluteError value on hold-out data: 0.03446716442704201
Epoch: 142
Loss on hold-out set: 0.003920777521740932
MeanAbsoluteError value on hold-out data: 0.04528895020484924
Epoch: 143

Loss on hold-out set: 0.002175990469717922
MeanAbsoluteError value on hold-out data: 0.03572743386030197
Epoch: 144
Loss on hold-out set: 0.0027107518488684525
```

```
MeanAbsoluteError value on hold-out data: 0.042518697679042816
Epoch: 145
Loss on hold-out set: 0.0022116686495092627
MeanAbsoluteError value on hold-out data: 0.035638779401779175
Epoch: 146
Loss on hold-out set: 0.0036347278778871093
MeanAbsoluteError value on hold-out data: 0.041476357728242874
Epoch: 147

Loss on hold-out set: 0.002912720011618848
MeanAbsoluteError value on hold-out data: 0.03652733191847801
Epoch: 148
Loss on hold-out set: 0.0021767382881639954
MeanAbsoluteError value on hold-out data: 0.03235507756471634
Epoch: 149
Loss on hold-out set: 0.0024485870336110774
MeanAbsoluteError value on hold-out data: 0.03831484913825989
Epoch: 150

Loss on hold-out set: 0.0023766578546761032
MeanAbsoluteError value on hold-out data: 0.03604463115334511
Epoch: 151
Loss on hold-out set: 0.004224949247705249
MeanAbsoluteError value on hold-out data: 0.05276957154273987
Epoch: 152
Loss on hold-out set: 0.003178580717828411
MeanAbsoluteError value on hold-out data: 0.043507207185029984
Epoch: 153
Loss on hold-out set: 0.0026323480381576633
MeanAbsoluteError value on hold-out data: 0.03660900145769119
Epoch: 154

Loss on hold-out set: 0.001843521859532652
MeanAbsoluteError value on hold-out data: 0.0329195000231266
Epoch: 155
Loss on hold-out set: 0.0035964831029279875
MeanAbsoluteError value on hold-out data: 0.03813473507761955
Epoch: 156
Loss on hold-out set: 0.002738867555028544
MeanAbsoluteError value on hold-out data: 0.03984633460640907
Epoch: 157
```

```
Loss on hold-out set: 0.001910456850265081
MeanAbsoluteError value on hold-out data: 0.03371715173125267
Epoch: 158
Loss on hold-out set: 0.003016671953866115
MeanAbsoluteError value on hold-out data: 0.040173500776290894
Epoch: 159
Loss on hold-out set: 0.002428078298600247
MeanAbsoluteError value on hold-out data: 0.03275202587246895
Epoch: 160
Loss on hold-out set: 0.0020288519041899303
MeanAbsoluteError value on hold-out data: 0.03454553708434105
Epoch: 161

Loss on hold-out set: 0.0021728027182129715
MeanAbsoluteError value on hold-out data: 0.03535439819097519
Epoch: 162
Loss on hold-out set: 0.0028307832276018765
MeanAbsoluteError value on hold-out data: 0.03882616013288498
Epoch: 163
Loss on hold-out set: 0.0023919838668706897
MeanAbsoluteError value on hold-out data: 0.0316898375749588
Epoch: 164

Loss on hold-out set: 0.0019660438769138777
MeanAbsoluteError value on hold-out data: 0.03409979119896889
Epoch: 165
Loss on hold-out set: 0.0017682411931813336
MeanAbsoluteError value on hold-out data: 0.03338057920336723
Epoch: 166
Loss on hold-out set: 0.0027455240129851378
MeanAbsoluteError value on hold-out data: 0.04230351373553276
Epoch: 167
Loss on hold-out set: 0.0033324660482601477
MeanAbsoluteError value on hold-out data: 0.04327845200896263
Epoch: 168

Loss on hold-out set: 0.0022531005356890652
MeanAbsoluteError value on hold-out data: 0.034265171736478806
Epoch: 169
Loss on hold-out set: 0.002269669306070472
MeanAbsoluteError value on hold-out data: 0.03848596289753914
Epoch: 170
```

```
Loss on hold-out set: 0.0018626807544093865
MeanAbsoluteError value on hold-out data: 0.02935630828142166
Epoch: 171

Loss on hold-out set: 0.0019470313474392663
MeanAbsoluteError value on hold-out data: 0.03194470703601837
Epoch: 172
Loss on hold-out set: 0.002058690634350149
MeanAbsoluteError value on hold-out data: 0.03252160921692848
Epoch: 173
Loss on hold-out set: 0.0034320909225453553
MeanAbsoluteError value on hold-out data: 0.04225773364305496
Epoch: 174
Loss on hold-out set: 0.0032453425564409164
MeanAbsoluteError value on hold-out data: 0.03523678332567215
Epoch: 175

Loss on hold-out set: 0.0017975281270292515
MeanAbsoluteError value on hold-out data: 0.03237538784742355
Epoch: 176
Loss on hold-out set: 0.002196420172157769
MeanAbsoluteError value on hold-out data: 0.03669916093349457
Epoch: 177
Loss on hold-out set: 0.0014992277294648094
MeanAbsoluteError value on hold-out data: 0.02860620804131031
Epoch: 178

Loss on hold-out set: 0.0024450863532435438
MeanAbsoluteError value on hold-out data: 0.04006478190422058
Epoch: 179
Loss on hold-out set: 0.002438640754777365
MeanAbsoluteError value on hold-out data: 0.041096705943346024
Epoch: 180
Loss on hold-out set: 0.0022737626657964517
MeanAbsoluteError value on hold-out data: 0.037476230412721634
Epoch: 181
Loss on hold-out set: 0.0018311082295930157
MeanAbsoluteError value on hold-out data: 0.03223627433180809
Epoch: 182

Loss on hold-out set: 0.001911003068716337
```

```
MeanAbsoluteError value on hold-out data: 0.03133256360888481
Epoch: 183
Loss on hold-out set: 0.0022851651928459224
MeanAbsoluteError value on hold-out data: 0.03193550184369087
Epoch: 184
Loss on hold-out set: 0.0023109710197716663
MeanAbsoluteError value on hold-out data: 0.037005119025707245
Epoch: 185

Loss on hold-out set: 0.0014948051046723356
MeanAbsoluteError value on hold-out data: 0.03025970235466957
Epoch: 186
Loss on hold-out set: 0.0028333889360790355
MeanAbsoluteError value on hold-out data: 0.0392698310315609
Epoch: 187
Loss on hold-out set: 0.0020788385020121215
MeanAbsoluteError value on hold-out data: 0.03287641331553459
Epoch: 188
Loss on hold-out set: 0.0020980489543245104
MeanAbsoluteError value on hold-out data: 0.03468415513634682
Epoch: 189

Loss on hold-out set: 0.0013436693183253878
MeanAbsoluteError value on hold-out data: 0.02748166397213936
Epoch: 190
Loss on hold-out set: 0.002465678384536519
MeanAbsoluteError value on hold-out data: 0.03660173714160919
Epoch: 191
Loss on hold-out set: 0.0020868716371926265
MeanAbsoluteError value on hold-out data: 0.03132334351539612
Epoch: 192

Loss on hold-out set: 0.002035659294611273
MeanAbsoluteError value on hold-out data: 0.031892914324998856
Epoch: 193
Loss on hold-out set: 0.0035344076347358236
MeanAbsoluteError value on hold-out data: 0.04159112274646759
Epoch: 194
Loss on hold-out set: 0.0014888684023529864
MeanAbsoluteError value on hold-out data: 0.02896646410226822
Epoch: 195
Loss on hold-out set: 0.0045701068906614985
```

```
MeanAbsoluteError value on hold-out data: 0.041792917996644974
Epoch: 196

Loss on hold-out set: 0.002714319385212058
MeanAbsoluteError value on hold-out data: 0.033745307475328445
Epoch: 197
Loss on hold-out set: 0.0015805597202135967
MeanAbsoluteError value on hold-out data: 0.030120033770799637
Epoch: 198
Loss on hold-out set: 0.0019621080741322097
MeanAbsoluteError value on hold-out data: 0.031168842688202858
Epoch: 199

Loss on hold-out set: 0.0029382757157481345
MeanAbsoluteError value on hold-out data: 0.03879702091217041
Epoch: 200
Loss on hold-out set: 0.0023145795835611913
MeanAbsoluteError value on hold-out data: 0.0351574569940567
Epoch: 201
Loss on hold-out set: 0.002464585174143744
MeanAbsoluteError value on hold-out data: 0.0334523469209671
Epoch: 202
Loss on hold-out set: 0.0023685992032719348
MeanAbsoluteError value on hold-out data: 0.03569860756397247
Epoch: 203

Loss on hold-out set: 0.003163294275649465
MeanAbsoluteError value on hold-out data: 0.03697862848639488
Epoch: 204
Loss on hold-out set: 0.0022508611526483526
MeanAbsoluteError value on hold-out data: 0.03184736892580986
Epoch: 205
Loss on hold-out set: 0.0038068541750992434
MeanAbsoluteError value on hold-out data: 0.03966277837753296
Epoch: 206

Loss on hold-out set: 0.0026676747634505425
MeanAbsoluteError value on hold-out data: 0.03655970096588135
Epoch: 207
Loss on hold-out set: 0.0027088163098177086
MeanAbsoluteError value on hold-out data: 0.041069287806749344
```

```
Epoch: 208
Loss on hold-out set: 0.0018337470380804287
MeanAbsoluteError value on hold-out data: 0.0323348268866539
Epoch: 209
Loss on hold-out set: 0.0020674627650385867
MeanAbsoluteError value on hold-out data: 0.037860773503780365
Epoch: 210

Loss on hold-out set: 0.0023627250047866255
MeanAbsoluteError value on hold-out data: 0.03495499864220619
Epoch: 211
Loss on hold-out set: 0.0016509754540703187
MeanAbsoluteError value on hold-out data: 0.02929525636136532
Epoch: 212
Loss on hold-out set: 0.0025617255730769383
MeanAbsoluteError value on hold-out data: 0.03555147722363472
Epoch: 213

Loss on hold-out set: 0.002109593949101579
MeanAbsoluteError value on hold-out data: 0.03258643299341202
Epoch: 214
Loss on hold-out set: 0.002085733079673866
MeanAbsoluteError value on hold-out data: 0.03320780768990517
Epoch: 215
Loss on hold-out set: 0.003233546310534271
MeanAbsoluteError value on hold-out data: 0.03863711282610893
Epoch: 216
Loss on hold-out set: 0.0024335896596312523
MeanAbsoluteError value on hold-out data: 0.03841184452176094
Epoch: 217

Loss on hold-out set: 0.0023774081312764725
MeanAbsoluteError value on hold-out data: 0.034722715616226196
Epoch: 218
Loss on hold-out set: 0.002256843677829378
MeanAbsoluteError value on hold-out data: 0.04030494764447212
Epoch: 219
Loss on hold-out set: 0.0018958453930771123
MeanAbsoluteError value on hold-out data: 0.034849751740694046
Epoch: 220
```

```
Loss on hold-out set: 0.0028532948031520042
MeanAbsoluteError value on hold-out data: 0.036731425672769547
Epoch: 221
Loss on hold-out set: 0.0019170734113476311
MeanAbsoluteError value on hold-out data: 0.02955714240670204
Epoch: 222
Loss on hold-out set: 0.0018876608161148257
MeanAbsoluteError value on hold-out data: 0.032270435243844986
Epoch: 223
Loss on hold-out set: 0.0029544355302977446
MeanAbsoluteError value on hold-out data: 0.037482645362615585
Epoch: 224

Loss on hold-out set: 0.0058508738606738355
MeanAbsoluteError value on hold-out data: 0.05486053600907326
Epoch: 225
Loss on hold-out set: 0.0037093359905366716
MeanAbsoluteError value on hold-out data: 0.03843316435813904
Epoch: 226
Loss on hold-out set: 0.0019719276819019937
MeanAbsoluteError value on hold-out data: 0.03258612006902695
Epoch: 227

Loss on hold-out set: 0.001934006364675812
MeanAbsoluteError value on hold-out data: 0.03715309500694275
Epoch: 228
Loss on hold-out set: 0.0016459810184852148
MeanAbsoluteError value on hold-out data: 0.029344987124204636
Epoch: 229
Loss on hold-out set: 0.001982919484502278
MeanAbsoluteError value on hold-out data: 0.030995557084679604
Epoch: 230
Loss on hold-out set: 0.0018257190889786356
MeanAbsoluteError value on hold-out data: 0.03333907201886177
Epoch: 231

Loss on hold-out set: 0.0034730139886960387
MeanAbsoluteError value on hold-out data: 0.040489789098501205
Epoch: 232
Loss on hold-out set: 0.0018102907208510889
MeanAbsoluteError value on hold-out data: 0.0333915650844574
Epoch: 233
```

```
Loss on hold-out set: 0.001900150655553891
MeanAbsoluteError value on hold-out data: 0.035328011959791183
Epoch: 234

Loss on hold-out set: 0.002660809004177841
MeanAbsoluteError value on hold-out data: 0.03776129335165024
Epoch: 235
Loss on hold-out set: 0.003310492920438544
MeanAbsoluteError value on hold-out data: 0.04197085276246071
Epoch: 236
Loss on hold-out set: 0.0024590838337854412
MeanAbsoluteError value on hold-out data: 0.03508324921131134
Epoch: 237
Loss on hold-out set: 0.0037651485673939953
MeanAbsoluteError value on hold-out data: 0.048829685896635056
Epoch: 238

Loss on hold-out set: 0.0040187638772364994
MeanAbsoluteError value on hold-out data: 0.051741957664489746
Epoch: 239
Loss on hold-out set: 0.0035592528919761
MeanAbsoluteError value on hold-out data: 0.04070700705051422
Epoch: 240
Loss on hold-out set: 0.002274324324949143
MeanAbsoluteError value on hold-out data: 0.0335545539855957
Epoch: 241

Loss on hold-out set: 0.0031550301847836147
MeanAbsoluteError value on hold-out data: 0.03427654132246971
Epoch: 242
Loss on hold-out set: 0.003621003415901214
MeanAbsoluteError value on hold-out data: 0.04408255219459534
Epoch: 243
Loss on hold-out set: 0.0022000765445857095
MeanAbsoluteError value on hold-out data: 0.03479328751564026
Epoch: 244
Loss on hold-out set: 0.0017915086534160834
MeanAbsoluteError value on hold-out data: 0.03409957513213158
Epoch: 245

Loss on hold-out set: 0.0020879215981739643
```

```
MeanAbsoluteError value on hold-out data: 0.03175627440214157
Epoch: 246
Loss on hold-out set: 0.005853588433148196
MeanAbsoluteError value on hold-out data: 0.05651333928108215
Epoch: 247
Loss on hold-out set: 0.0032799822511151433
MeanAbsoluteError value on hold-out data: 0.040821876376867294
Epoch: 248

Loss on hold-out set: 0.002179877406608564
MeanAbsoluteError value on hold-out data: 0.03766990453004837
Epoch: 249
Loss on hold-out set: 0.00346226977238145
MeanAbsoluteError value on hold-out data: 0.0447513572871685
Epoch: 250
Loss on hold-out set: 0.003062577331617761
MeanAbsoluteError value on hold-out data: 0.039542779326438904
Epoch: 251
Loss on hold-out set: 0.0024452314156895648
MeanAbsoluteError value on hold-out data: 0.03828094154596329
Epoch: 252

Loss on hold-out set: 0.003592056927468198
MeanAbsoluteError value on hold-out data: 0.04243793338537216
Epoch: 253
Loss on hold-out set: 0.0025713055287129604
MeanAbsoluteError value on hold-out data: 0.033986229449510574
Early stopping at epoch 252
Fold: 10
Epoch: 1
Loss on hold-out set: 0.03018315523289717
MeanAbsoluteError value on hold-out data: 0.14264778792858124
Epoch: 2

Loss on hold-out set: 0.015614461046285354
MeanAbsoluteError value on hold-out data: 0.09581232815980911
Epoch: 3
Loss on hold-out set: 0.008827183682184953
MeanAbsoluteError value on hold-out data: 0.0753406509757042
Epoch: 4
Loss on hold-out set: 0.005825319170701102
MeanAbsoluteError value on hold-out data: 0.0643218457698822
```

```
Epoch: 5
Loss on hold-out set: 0.006925571360625327
MeanAbsoluteError value on hold-out data: 0.07076802104711533
Epoch: 6

Loss on hold-out set: 0.0054749867054992
MeanAbsoluteError value on hold-out data: 0.06011779233813286
Epoch: 7
Loss on hold-out set: 0.005998983847138544
MeanAbsoluteError value on hold-out data: 0.06339890509843826
Epoch: 8
Loss on hold-out set: 0.004134207193811352
MeanAbsoluteError value on hold-out data: 0.04720977321267128
Epoch: 9

Loss on hold-out set: 0.004655222229372997
MeanAbsoluteError value on hold-out data: 0.055180300027132034
Epoch: 10
Loss on hold-out set: 0.0022565135553192636
MeanAbsoluteError value on hold-out data: 0.03809380903840065
Epoch: 11
Loss on hold-out set: 0.0036684519100862625
MeanAbsoluteError value on hold-out data: 0.04420897364616394
Epoch: 12
Loss on hold-out set: 0.0026369252098867525
MeanAbsoluteError value on hold-out data: 0.03863345459103584
Epoch: 13

Loss on hold-out set: 0.0029945845464960886
MeanAbsoluteError value on hold-out data: 0.04065897315740585
Epoch: 14
Loss on hold-out set: 0.004131255066917779
MeanAbsoluteError value on hold-out data: 0.04775198549032211
Epoch: 15
Loss on hold-out set: 0.0031376926165718874
MeanAbsoluteError value on hold-out data: 0.04219801723957062
Epoch: 16

Loss on hold-out set: 0.00491001278323193
MeanAbsoluteError value on hold-out data: 0.05294197425246239
Epoch: 17
```

```
Loss on hold-out set: 0.0024974039988592267
MeanAbsoluteError value on hold-out data: 0.03648735582828522
Epoch: 18
Loss on hold-out set: 0.0026259344841281953
MeanAbsoluteError value on hold-out data: 0.03915898874402046
Epoch: 19
Loss on hold-out set: 0.0034943875283575975
MeanAbsoluteError value on hold-out data: 0.04493389651179314
Epoch: 20

Loss on hold-out set: 0.0034861851197022656
MeanAbsoluteError value on hold-out data: 0.045725516974925995
Epoch: 21
Loss on hold-out set: 0.003161510300392715
MeanAbsoluteError value on hold-out data: 0.04260348901152611
Epoch: 22
Loss on hold-out set: 0.002394764325939692
MeanAbsoluteError value on hold-out data: 0.035396382212638855
Epoch: 23

Loss on hold-out set: 0.002170832344115927
MeanAbsoluteError value on hold-out data: 0.035131338983774185
Epoch: 24
Loss on hold-out set: 0.0028461537529857685
MeanAbsoluteError value on hold-out data: 0.036664243787527084
Epoch: 25
Loss on hold-out set: 0.0032754177496267054
MeanAbsoluteError value on hold-out data: 0.04146486893296242
Epoch: 26
Loss on hold-out set: 0.003147960627057518
MeanAbsoluteError value on hold-out data: 0.045051127672195435
Epoch: 27

Loss on hold-out set: 0.003241223206994339
MeanAbsoluteError value on hold-out data: 0.043713003396987915
Epoch: 28
Loss on hold-out set: 0.002497174781568062
MeanAbsoluteError value on hold-out data: 0.037620190531015396
Epoch: 29
Loss on hold-out set: 0.004477396822319581
MeanAbsoluteError value on hold-out data: 0.05076643079519272
Epoch: 30
```

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Loss on hold-out set: 0.002763637269918735
MeanAbsoluteError value on hold-out data: 0.03925163671374321
Epoch: 31
Loss on hold-out set: 0.0025134752918697465
MeanAbsoluteError value on hold-out data: 0.04102282598614693
Epoch: 32
Loss on hold-out set: 0.003597625208875308
MeanAbsoluteError value on hold-out data: 0.047144513577222824
Epoch: 33
Loss on hold-out set: 0.0049273339010631806
MeanAbsoluteError value on hold-out data: 0.0504300482571125
Epoch: 34

Loss on hold-out set: 0.0024622561669765185
MeanAbsoluteError value on hold-out data: 0.03607892990112305
Epoch: 35
Loss on hold-out set: 0.00298563633651401
MeanAbsoluteError value on hold-out data: 0.045007217675447464
Epoch: 36
Loss on hold-out set: 0.004215933149680495
MeanAbsoluteError value on hold-out data: 0.05212878808379173
Epoch: 37

Loss on hold-out set: 0.004179528159931159
MeanAbsoluteError value on hold-out data: 0.05276094004511833
Epoch: 38
Loss on hold-out set: 0.0034158027892072615
MeanAbsoluteError value on hold-out data: 0.04461020603775978
Epoch: 39
Loss on hold-out set: 0.0038991983299358534
MeanAbsoluteError value on hold-out data: 0.050156544893980026
Epoch: 40
Loss on hold-out set: 0.0019162520318507003
MeanAbsoluteError value on hold-out data: 0.03311243653297424
Epoch: 41

Loss on hold-out set: 0.003542540093454031
MeanAbsoluteError value on hold-out data: 0.0454927533864975
Epoch: 42
Loss on hold-out set: 0.00293688267433586
MeanAbsoluteError value on hold-out data: 0.042161229997873306
Epoch: 43
```

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Loss on hold-out set: 0.003367737781865379
MeanAbsoluteError value on hold-out data: 0.041258230805397034
Epoch: 44

Loss on hold-out set: 0.002629206283017993
MeanAbsoluteError value on hold-out data: 0.03779034689068794
Epoch: 45
Loss on hold-out set: 0.003995617314313467
MeanAbsoluteError value on hold-out data: 0.0474279560148716
Epoch: 46
Loss on hold-out set: 0.0037438139194049514
MeanAbsoluteError value on hold-out data: 0.050101276487112045
Epoch: 47
Loss on hold-out set: 0.0023691960780594786
MeanAbsoluteError value on hold-out data: 0.038144953548908234
Epoch: 48

Loss on hold-out set: 0.0062832874648917755
MeanAbsoluteError value on hold-out data: 0.060633350163698196
Epoch: 49
Loss on hold-out set: 0.003437369014136493
MeanAbsoluteError value on hold-out data: 0.04564173147082329
Epoch: 50
Loss on hold-out set: 0.0028332278687650194
MeanAbsoluteError value on hold-out data: 0.035777147859334946
Epoch: 51

Loss on hold-out set: 0.002346700090968695
MeanAbsoluteError value on hold-out data: 0.036122411489486694
Epoch: 52
Loss on hold-out set: 0.0020059578819200397
MeanAbsoluteError value on hold-out data: 0.03316523879766464
Epoch: 53
Loss on hold-out set: 0.0028705800202890085
MeanAbsoluteError value on hold-out data: 0.038125261664390564
Epoch: 54
Loss on hold-out set: 0.0023481129207469234
MeanAbsoluteError value on hold-out data: 0.033505551517009735
Epoch: 55

Loss on hold-out set: 0.0032053839755602754
```

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MeanAbsoluteError value on hold-out data: 0.03956267610192299
Epoch: 56
Loss on hold-out set: 0.0028179404863084736
MeanAbsoluteError value on hold-out data: 0.03937142714858055
Epoch: 57
Loss on hold-out set: 0.001983262316431277
MeanAbsoluteError value on hold-out data: 0.032092317938804626
Epoch: 58

Loss on hold-out set: 0.00292186934250192
MeanAbsoluteError value on hold-out data: 0.03837182745337486
Epoch: 59
Loss on hold-out set: 0.0030208459043373857
MeanAbsoluteError value on hold-out data: 0.038793373852968216
Epoch: 60
Loss on hold-out set: 0.003635653446858319
MeanAbsoluteError value on hold-out data: 0.04723508283495903
Epoch: 61
Loss on hold-out set: 0.005269007542385505
MeanAbsoluteError value on hold-out data: 0.0535534992814064
Epoch: 62

Loss on hold-out set: 0.002162362583196507
MeanAbsoluteError value on hold-out data: 0.03593979775905609
Epoch: 63
Loss on hold-out set: 0.0022119460358785894
MeanAbsoluteError value on hold-out data: 0.03259066492319107
Epoch: 64
Loss on hold-out set: 0.0031799107315376974
MeanAbsoluteError value on hold-out data: 0.036479268223047256
Epoch: 65

Loss on hold-out set: 0.0019819298714327696
MeanAbsoluteError value on hold-out data: 0.029418664053082466
Epoch: 66
Loss on hold-out set: 0.002002984021181384
MeanAbsoluteError value on hold-out data: 0.032184671610593796
Epoch: 67
Loss on hold-out set: 0.003442513496758273
MeanAbsoluteError value on hold-out data: 0.04636796563863754
Epoch: 68
Loss on hold-out set: 0.002636174926570115
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MeanAbsoluteError value on hold-out data: 0.03598291799426079
Epoch: 69

Loss on hold-out set: 0.003251689786198907
MeanAbsoluteError value on hold-out data: 0.04433472454547882
Epoch: 70
Loss on hold-out set: 0.0022276693399852286
MeanAbsoluteError value on hold-out data: 0.03439313545823097
Epoch: 71
Loss on hold-out set: 0.0033771641767368866
MeanAbsoluteError value on hold-out data: 0.04129590094089508
Epoch: 72

Loss on hold-out set: 0.004507162509701
MeanAbsoluteError value on hold-out data: 0.05148398503661156
Epoch: 73
Loss on hold-out set: 0.002387599325559747
MeanAbsoluteError value on hold-out data: 0.033239781856536865
Epoch: 74
Loss on hold-out set: 0.002107925697390993
MeanAbsoluteError value on hold-out data: 0.03356354683637619
Epoch: 75
Loss on hold-out set: 0.002905724561200119
MeanAbsoluteError value on hold-out data: 0.04054177179932594
Epoch: 76

Loss on hold-out set: 0.0013591403627427868
MeanAbsoluteError value on hold-out data: 0.028319301083683968
Epoch: 77
Loss on hold-out set: 0.0026438313249785165
MeanAbsoluteError value on hold-out data: 0.03380966931581497
Epoch: 78
Loss on hold-out set: 0.0033086063608957026
MeanAbsoluteError value on hold-out data: 0.042040444910526276
Epoch: 79

Loss on hold-out set: 0.002193634286343765
MeanAbsoluteError value on hold-out data: 0.03555593639612198
Epoch: 80
Loss on hold-out set: 0.0021499774324743506
MeanAbsoluteError value on hold-out data: 0.03230419009923935
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Epoch: 81
Loss on hold-out set: 0.0018095979780460207
MeanAbsoluteError value on hold-out data: 0.03215774893760681
Epoch: 82
Loss on hold-out set: 0.0015295293526903081
MeanAbsoluteError value on hold-out data: 0.028412748128175735
Epoch: 83

Loss on hold-out set: 0.0034360815099297236
MeanAbsoluteError value on hold-out data: 0.03875667229294777
Epoch: 84
Loss on hold-out set: 0.0025347759454654385
MeanAbsoluteError value on hold-out data: 0.03765275329351425
Epoch: 85
Loss on hold-out set: 0.0023592316563456105
MeanAbsoluteError value on hold-out data: 0.034181252121925354
Epoch: 86

Loss on hold-out set: 0.0032183466201576474
MeanAbsoluteError value on hold-out data: 0.03746221959590912
Epoch: 87
Loss on hold-out set: 0.0020336061268328475
MeanAbsoluteError value on hold-out data: 0.03584269434213638
Epoch: 88
Loss on hold-out set: 0.003914378784919301
MeanAbsoluteError value on hold-out data: 0.044499412178993225
Epoch: 89
Loss on hold-out set: 0.006189675356906194
MeanAbsoluteError value on hold-out data: 0.0693155974149704
Epoch: 90

Loss on hold-out set: 0.0030308977270928714
MeanAbsoluteError value on hold-out data: 0.04257071390748024
Epoch: 91
Loss on hold-out set: 0.00347899454824913
MeanAbsoluteError value on hold-out data: 0.043947674334049225
Epoch: 92
Loss on hold-out set: 0.0019468159074536883
MeanAbsoluteError value on hold-out data: 0.030738402158021927
Epoch: 93
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Loss on hold-out set: 0.0029268558719195426
MeanAbsoluteError value on hold-out data: 0.04237354174256325
Epoch: 94
Loss on hold-out set: 0.0018182542519823003
MeanAbsoluteError value on hold-out data: 0.032448697835206985
Epoch: 95
Loss on hold-out set: 0.003304691116612118
MeanAbsoluteError value on hold-out data: 0.050743937492370605
Epoch: 96
Loss on hold-out set: 0.0034208937073484636
MeanAbsoluteError value on hold-out data: 0.045221056789159775
Epoch: 97

Loss on hold-out set: 0.0032972368566193976
MeanAbsoluteError value on hold-out data: 0.03787371516227722
Epoch: 98
Loss on hold-out set: 0.0035684302968617817
MeanAbsoluteError value on hold-out data: 0.043037377297878265
Epoch: 99
Loss on hold-out set: 0.002244021586823062
MeanAbsoluteError value on hold-out data: 0.029088232666254044
Epoch: 100

Loss on hold-out set: 0.0020317940663797064
MeanAbsoluteError value on hold-out data: 0.03341194987297058
Epoch: 101
Loss on hold-out set: 0.0033557319727081517
MeanAbsoluteError value on hold-out data: 0.04305720329284668
Epoch: 102
Loss on hold-out set: 0.0014076888182898983
MeanAbsoluteError value on hold-out data: 0.026633907109498978
Epoch: 103
Loss on hold-out set: 0.002526748817987167
MeanAbsoluteError value on hold-out data: 0.03798861429095268

Epoch: 104
Loss on hold-out set: 0.004606880630420234
MeanAbsoluteError value on hold-out data: 0.05402608960866928
Epoch: 105
Loss on hold-out set: 0.00258340288956578
MeanAbsoluteError value on hold-out data: 0.03960093483328819
Epoch: 106
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Loss on hold-out set: 0.0027265164759368277
MeanAbsoluteError value on hold-out data: 0.03748057037591934
Epoch: 107

Loss on hold-out set: 0.00121050662934207
MeanAbsoluteError value on hold-out data: 0.023960480466485023
Epoch: 108
Loss on hold-out set: 0.0027088658534921706
MeanAbsoluteError value on hold-out data: 0.04246829077601433
Epoch: 109
Loss on hold-out set: 0.002077727303213368
MeanAbsoluteError value on hold-out data: 0.031376391649246216
Epoch: 110

Loss on hold-out set: 0.001963829497421662
MeanAbsoluteError value on hold-out data: 0.0320354588329792
Epoch: 111
Loss on hold-out set: 0.002812661699583539
MeanAbsoluteError value on hold-out data: 0.03309488669037819
Epoch: 112
Loss on hold-out set: 0.0021738383802585304
MeanAbsoluteError value on hold-out data: 0.02974349819123745
Epoch: 113
Loss on hold-out set: 0.0020318966103681866
MeanAbsoluteError value on hold-out data: 0.031770382076501846
Epoch: 114

Loss on hold-out set: 0.0020713985028963247
MeanAbsoluteError value on hold-out data: 0.03402085602283478
Epoch: 115
Loss on hold-out set: 0.0029407019073215243
MeanAbsoluteError value on hold-out data: 0.03601635619997978
Epoch: 116
Loss on hold-out set: 0.0032621451693837745
MeanAbsoluteError value on hold-out data: 0.04020525515079498
Epoch: 117

Loss on hold-out set: 0.002737746629953528
MeanAbsoluteError value on hold-out data: 0.03277210146188736
Epoch: 118
Loss on hold-out set: 0.0013180209587937077
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MeanAbsoluteError value on hold-out data: 0.02744215540587902
Epoch: 119
Loss on hold-out set: 0.001584407888003625
MeanAbsoluteError value on hold-out data: 0.029267335310578346
Epoch: 120
Loss on hold-out set: 0.002890271510785589
MeanAbsoluteError value on hold-out data: 0.03623724356293678
Epoch: 121

Loss on hold-out set: 0.0023856145495441384
MeanAbsoluteError value on hold-out data: 0.03380255401134491
Epoch: 122
Loss on hold-out set: 0.002619914379185782
MeanAbsoluteError value on hold-out data: 0.04103279113769531
Epoch: 123
Loss on hold-out set: 0.0025927095602338132
MeanAbsoluteError value on hold-out data: 0.03816039115190506
Epoch: 124

Loss on hold-out set: 0.0023599366138044456
MeanAbsoluteError value on hold-out data: 0.030687596648931503
Epoch: 125
Loss on hold-out set: 0.004087136205411158
MeanAbsoluteError value on hold-out data: 0.039650239050388336
Epoch: 126
Loss on hold-out set: 0.003081804148118513
MeanAbsoluteError value on hold-out data: 0.04063596576452255
Epoch: 127
Loss on hold-out set: 0.0028196012628121446
MeanAbsoluteError value on hold-out data: 0.03680523484945297
Epoch: 128

Loss on hold-out set: 0.0021021838407390392
MeanAbsoluteError value on hold-out data: 0.029393743723630905
Epoch: 129
Loss on hold-out set: 0.0034785801992536737
MeanAbsoluteError value on hold-out data: 0.0416417270898819
Epoch: 130
Loss on hold-out set: 0.002658969910743718
MeanAbsoluteError value on hold-out data: 0.03485951945185661
Epoch: 131
```

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Loss on hold-out set: 0.0022231044108943585
MeanAbsoluteError value on hold-out data: 0.03240688145160675
Epoch: 132
Loss on hold-out set: 0.00199031725507946
MeanAbsoluteError value on hold-out data: 0.03133373335003853
Epoch: 133
Loss on hold-out set: 0.002047210197465924
MeanAbsoluteError value on hold-out data: 0.03144662827253342
Epoch: 134
Loss on hold-out set: 0.0025859362839792785
MeanAbsoluteError value on hold-out data: 0.029817044734954834
Epoch: 135

Loss on hold-out set: 0.002540075027634605
MeanAbsoluteError value on hold-out data: 0.03120502270758152
Epoch: 136
Loss on hold-out set: 0.0027031733199971942
MeanAbsoluteError value on hold-out data: 0.032757628709077835
Epoch: 137
Loss on hold-out set: 0.0037142942735674577
MeanAbsoluteError value on hold-out data: 0.03728187829256058
Epoch: 138

Loss on hold-out set: 0.002473942693681098
MeanAbsoluteError value on hold-out data: 0.035152219235897064
Epoch: 139
Loss on hold-out set: 0.001343441712938679
MeanAbsoluteError value on hold-out data: 0.02765829861164093
Epoch: 140
Loss on hold-out set: 0.003000235302841667
MeanAbsoluteError value on hold-out data: 0.037255823612213135
Epoch: 141
Loss on hold-out set: 0.002169465234216589
MeanAbsoluteError value on hold-out data: 0.035014912486076355
Epoch: 142

Loss on hold-out set: 0.003741920303302602
MeanAbsoluteError value on hold-out data: 0.044485922902822495
Epoch: 143
Loss on hold-out set: 0.002066274970554962
MeanAbsoluteError value on hold-out data: 0.03466149792075157
Epoch: 144
```

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Loss on hold-out set: 0.0017794966339491888
MeanAbsoluteError value on hold-out data: 0.03141301870346069
Epoch: 145

Loss on hold-out set: 0.0026761879248974416
MeanAbsoluteError value on hold-out data: 0.04171138256788254
Epoch: 146
Loss on hold-out set: 0.002370639134404393
MeanAbsoluteError value on hold-out data: 0.03245563805103302
Epoch: 147
Loss on hold-out set: 0.0033945805984191024
MeanAbsoluteError value on hold-out data: 0.04905208945274353
Epoch: 148
Loss on hold-out set: 0.002066564920824021
MeanAbsoluteError value on hold-out data: 0.03500667214393616
Epoch: 149

Loss on hold-out set: 0.0029476618085307283
MeanAbsoluteError value on hold-out data: 0.036936961114406586
Epoch: 150
Loss on hold-out set: 0.00224637736279804
MeanAbsoluteError value on hold-out data: 0.035152141004800797
Epoch: 151
Loss on hold-out set: 0.002069625819925792
MeanAbsoluteError value on hold-out data: 0.03557858616113663
Epoch: 152

Loss on hold-out set: 0.0018398704638597197
MeanAbsoluteError value on hold-out data: 0.03110668435692787
Epoch: 153
Loss on hold-out set: 0.0029560556151689244
MeanAbsoluteError value on hold-out data: 0.03841474652290344
Epoch: 154
Loss on hold-out set: 0.0016354125019950936
MeanAbsoluteError value on hold-out data: 0.03133466839790344
Epoch: 155
Loss on hold-out set: 0.0017727684708706175
MeanAbsoluteError value on hold-out data: 0.030680693686008453
Epoch: 156

Loss on hold-out set: 0.002097449358328819
```

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MeanAbsoluteError value on hold-out data: 0.03218869864940643
Epoch: 157
Loss on hold-out set: 0.0019014720209480191
MeanAbsoluteError value on hold-out data: 0.029599931091070175
Epoch: 158

Loss on hold-out set: 0.002091449304806212
MeanAbsoluteError value on hold-out data: 0.03261755406856537
Epoch: 159
Loss on hold-out set: 0.001820586715789082
MeanAbsoluteError value on hold-out data: 0.02967812493443489
Epoch: 160
Loss on hold-out set: 0.001661327307094605
MeanAbsoluteError value on hold-out data: 0.03224465623497963
Epoch: 161
Loss on hold-out set: 0.0022719790308306422
MeanAbsoluteError value on hold-out data: 0.033259231597185135
Epoch: 162
Loss on hold-out set: 0.0027909015144149843
MeanAbsoluteError value on hold-out data: 0.0344330370426178
Epoch: 163

Loss on hold-out set: 0.0017065377614926547
MeanAbsoluteError value on hold-out data: 0.026768982410430908
Epoch: 164
Loss on hold-out set: 0.003591859424397206
MeanAbsoluteError value on hold-out data: 0.04044580087065697
Epoch: 165

Loss on hold-out set: 0.002152004001590495
MeanAbsoluteError value on hold-out data: 0.03010399080812931
Epoch: 166
Loss on hold-out set: 0.002253143179516953
MeanAbsoluteError value on hold-out data: 0.035422515124082565
Epoch: 167
Loss on hold-out set: 0.003199188728243686
MeanAbsoluteError value on hold-out data: 0.048601649701595306
Epoch: 168
Loss on hold-out set: 0.0019052613956423907
MeanAbsoluteError value on hold-out data: 0.033677347004413605
Epoch: 169
Loss on hold-out set: 0.0019231456524441736
```

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MeanAbsoluteError value on hold-out data: 0.03320161998271942
Epoch: 170

Loss on hold-out set: 0.001711317400734585
MeanAbsoluteError value on hold-out data: 0.030961036682128906
Epoch: 171
Loss on hold-out set: 0.0032705082535707895
MeanAbsoluteError value on hold-out data: 0.040168557316064835
Epoch: 172

Loss on hold-out set: 0.0016991645097732544
MeanAbsoluteError value on hold-out data: 0.028789715841412544
Epoch: 173
Loss on hold-out set: 0.0019738658604462845
MeanAbsoluteError value on hold-out data: 0.027279144152998924
Epoch: 174
Loss on hold-out set: 0.001929699716408952
MeanAbsoluteError value on hold-out data: 0.03345499932765961
Epoch: 175
Loss on hold-out set: 0.002017626574692818
MeanAbsoluteError value on hold-out data: 0.038421228528022766
Epoch: 176
Loss on hold-out set: 0.002384503316044664
MeanAbsoluteError value on hold-out data: 0.03327887877821922
Epoch: 177

Loss on hold-out set: 0.0019577528761986355
MeanAbsoluteError value on hold-out data: 0.03172140568494797
Epoch: 178
Loss on hold-out set: 0.0023702634274601364
MeanAbsoluteError value on hold-out data: 0.035154856741428375
Epoch: 179

Loss on hold-out set: 0.0027164441416971385
MeanAbsoluteError value on hold-out data: 0.04066179692745209
Epoch: 180
Loss on hold-out set: 0.0025515030765046296
MeanAbsoluteError value on hold-out data: 0.03914380446076393
Epoch: 181
Loss on hold-out set: 0.002829204205996715
MeanAbsoluteError value on hold-out data: 0.035919226706027985
```

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Epoch: 182
Loss on hold-out set: 0.002064863598207012
MeanAbsoluteError value on hold-out data: 0.029408548027276993
Epoch: 183
Loss on hold-out set: 0.003069592836814431
MeanAbsoluteError value on hold-out data: 0.039514169096946716
Epoch: 184

Loss on hold-out set: 0.0024498490786824664
MeanAbsoluteError value on hold-out data: 0.0377986878156662
Epoch: 185
Loss on hold-out set: 0.0029416541376401885
MeanAbsoluteError value on hold-out data: 0.03954257816076279
Epoch: 186

Loss on hold-out set: 0.0026754264433223466
MeanAbsoluteError value on hold-out data: 0.03447218984365463
Epoch: 187
Loss on hold-out set: 0.002104247069487778
MeanAbsoluteError value on hold-out data: 0.03641778975725174
Epoch: 188
Loss on hold-out set: 0.0013401405818652934
MeanAbsoluteError value on hold-out data: 0.028256015852093697
Epoch: 189
Loss on hold-out set: 0.0034322177077858495
MeanAbsoluteError value on hold-out data: 0.046317700296640396
Epoch: 190
Loss on hold-out set: 0.002674271415274304
MeanAbsoluteError value on hold-out data: 0.03904959559440613
Epoch: 191

Loss on hold-out set: 0.0032316003030595872
MeanAbsoluteError value on hold-out data: 0.04789399728178978
Epoch: 192
Loss on hold-out set: 0.0025815868754692087
MeanAbsoluteError value on hold-out data: 0.03685687109827995
Epoch: 193

Loss on hold-out set: 0.0017853775319123927
MeanAbsoluteError value on hold-out data: 0.030546342954039574
Epoch: 194
```

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Loss on hold-out set: 0.0020124206471686754
MeanAbsoluteError value on hold-out data: 0.03155790641903877
Epoch: 195
Loss on hold-out set: 0.0019880174950230867
MeanAbsoluteError value on hold-out data: 0.027984458953142166
Epoch: 196
Loss on hold-out set: 0.0024251861569400015
MeanAbsoluteError value on hold-out data: 0.03458284214138985
Epoch: 197
Loss on hold-out set: 0.0017058114731648506
MeanAbsoluteError value on hold-out data: 0.030582226812839508
Epoch: 198

Loss on hold-out set: 0.003868311903296182
MeanAbsoluteError value on hold-out data: 0.04389239847660065
Epoch: 199
Loss on hold-out set: 0.0023133685160876038
MeanAbsoluteError value on hold-out data: 0.032980479300022125
Epoch: 200

Loss on hold-out set: 0.002799271941722299
MeanAbsoluteError value on hold-out data: 0.04271174594759941
Epoch: 201
Loss on hold-out set: 0.0017665230838107304
MeanAbsoluteError value on hold-out data: 0.030493158847093582
Epoch: 202
Loss on hold-out set: 0.0025693628480299734
MeanAbsoluteError value on hold-out data: 0.037554096430540085
Epoch: 203
Loss on hold-out set: 0.0030212435611666967
MeanAbsoluteError value on hold-out data: 0.045402221381664276
Epoch: 204
Loss on hold-out set: 0.0012157656534467465
MeanAbsoluteError value on hold-out data: 0.025488734245300293
Epoch: 205

Loss on hold-out set: 0.00261638711582726
MeanAbsoluteError value on hold-out data: 0.037053998559713364
Epoch: 206
Loss on hold-out set: 0.0019496322537843997
MeanAbsoluteError value on hold-out data: 0.033214058727025986
Epoch: 207
```

```
Loss on hold-out set: 0.001840638869907707
MeanAbsoluteError value on hold-out data: 0.030260957777500153
Epoch: 208
Loss on hold-out set: 0.002126145362406253
MeanAbsoluteError value on hold-out data: 0.0340915322303772
Epoch: 209
Loss on hold-out set: 0.0014661177298806321
MeanAbsoluteError value on hold-out data: 0.027194533497095108
Epoch: 210
Loss on hold-out set: 0.002174091510823928
MeanAbsoluteError value on hold-out data: 0.03088415414094925
Epoch: 211
Loss on hold-out set: 0.0025663198433064213
MeanAbsoluteError value on hold-out data: 0.03589465469121933
Epoch: 212

Loss on hold-out set: 0.002739167228215732
MeanAbsoluteError value on hold-out data: 0.03588921204209328
Epoch: 213
Loss on hold-out set: 0.0026380609152301285
MeanAbsoluteError value on hold-out data: 0.038236282765865326
Epoch: 214

Loss on hold-out set: 0.0018513797213717436
MeanAbsoluteError value on hold-out data: 0.03003821335732937
Epoch: 215
Loss on hold-out set: 0.0018595258275476785
MeanAbsoluteError value on hold-out data: 0.031407564878463745
Epoch: 216
Loss on hold-out set: 0.0019002768139426524
MeanAbsoluteError value on hold-out data: 0.029297009110450745
Epoch: 217
Loss on hold-out set: 0.0017229119156791756
MeanAbsoluteError value on hold-out data: 0.029191521927714348
Epoch: 218
Loss on hold-out set: 0.0036992362472049603
MeanAbsoluteError value on hold-out data: 0.04507416859269142
Epoch: 219

Loss on hold-out set: 0.0014517191134823056
MeanAbsoluteError value on hold-out data: 0.026263168081641197
Epoch: 220
```

```
Loss on hold-out set: 0.0016756674343084272
MeanAbsoluteError value on hold-out data: 0.027579480782151222
Epoch: 221

Loss on hold-out set: 0.00220915997096409
MeanAbsoluteError value on hold-out data: 0.030854128301143646
Epoch: 222
Loss on hold-out set: 0.002503463917841705
MeanAbsoluteError value on hold-out data: 0.03899805620312691
Epoch: 223
Loss on hold-out set: 0.002936206278928484
MeanAbsoluteError value on hold-out data: 0.04050857201218605
Epoch: 224
Loss on hold-out set: 0.001665156493590285
MeanAbsoluteError value on hold-out data: 0.029216181486845016
Epoch: 225
Loss on hold-out set: 0.0028687030650102175
MeanAbsoluteError value on hold-out data: 0.038692545145750046
Epoch: 226

Loss on hold-out set: 0.002781268589807531
MeanAbsoluteError value on hold-out data: 0.037056803703308105
Epoch: 227
Loss on hold-out set: 0.0021158391676950627
MeanAbsoluteError value on hold-out data: 0.03228266164660454
Epoch: 228

Loss on hold-out set: 0.0031311214910461926
MeanAbsoluteError value on hold-out data: 0.03813926875591278
Epoch: 229
Loss on hold-out set: 0.002670840053514649
MeanAbsoluteError value on hold-out data: 0.0353391058743
Epoch: 230
Loss on hold-out set: 0.0024566405112496936
MeanAbsoluteError value on hold-out data: 0.03507119417190552
Epoch: 231
Loss on hold-out set: 0.002313923873141623
MeanAbsoluteError value on hold-out data: 0.03214922919869423
Epoch: 232
Loss on hold-out set: 0.001494509835118571
MeanAbsoluteError value on hold-out data: 0.02997027151286602
Epoch: 233
```

```
Loss on hold-out set: 0.0014795718038490473
MeanAbsoluteError value on hold-out data: 0.02711757831275463
Epoch: 234
Loss on hold-out set: 0.0019359768507106666
MeanAbsoluteError value on hold-out data: 0.029761282727122307
Epoch: 235

Loss on hold-out set: 0.0018098362309571642
MeanAbsoluteError value on hold-out data: 0.02710432931780815
Early stopping at epoch 234
```

```
metric_name = type(fun_control["metric_torch"]).__name__
print(f"loss: {df_eval}, Cross-validated {metric_name}: {df_metrics}")
```

```
loss: 0.0027767302411330795, Cross-validated MeanAbsoluteError: 0.03603934496641159
```

25.18 Detailed Hyperparameter Plots

```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

```
l1:  17.823628210999658
dropout_prob:  11.924820046067637
lr_mult:  100.0
batch_size:  0.08844099220514079
optimizer:  0.04694815852299872
```

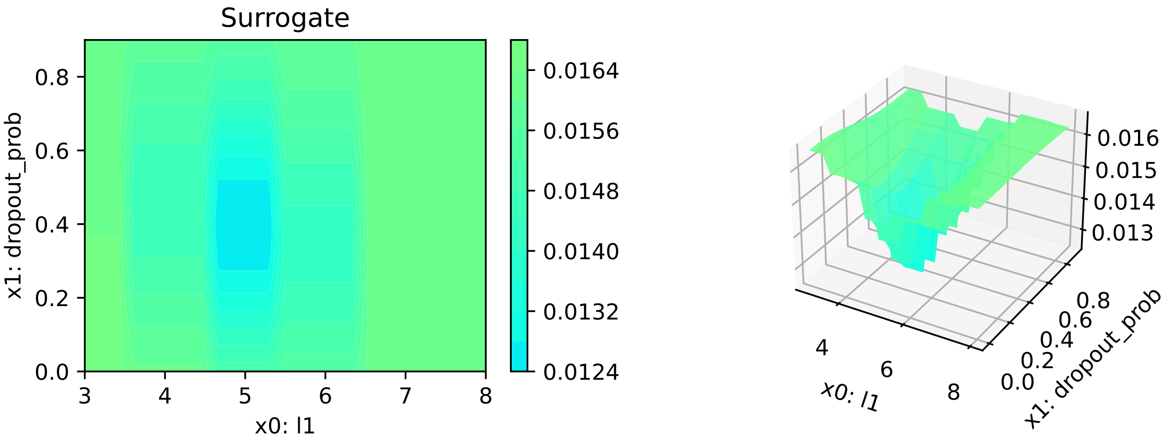
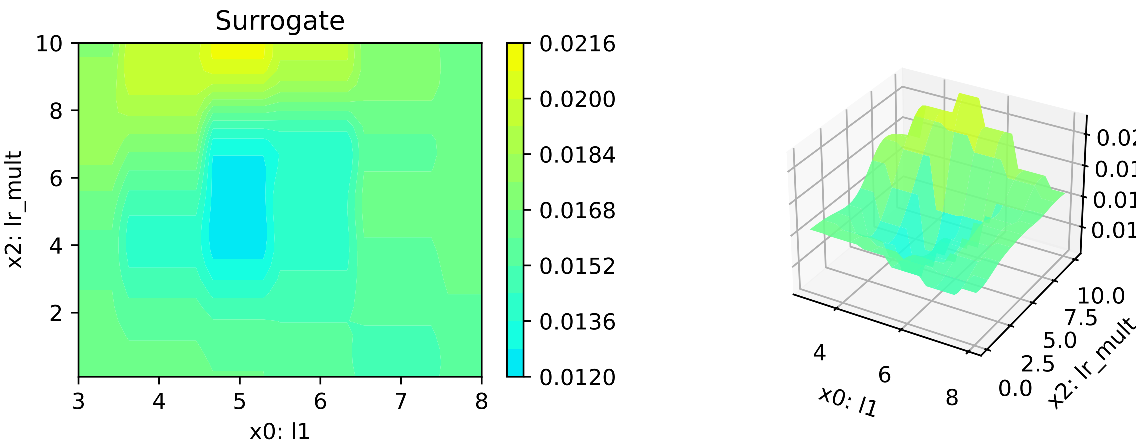
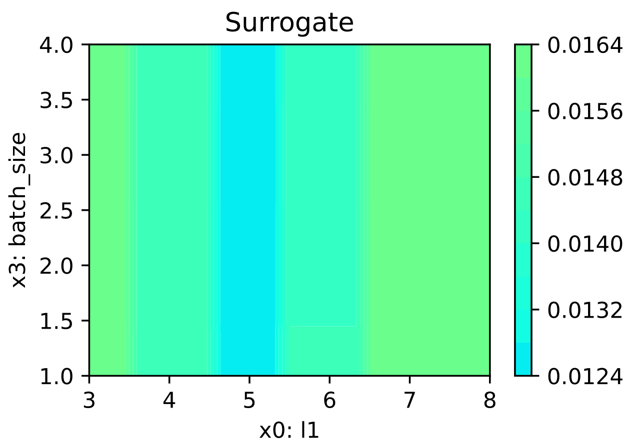
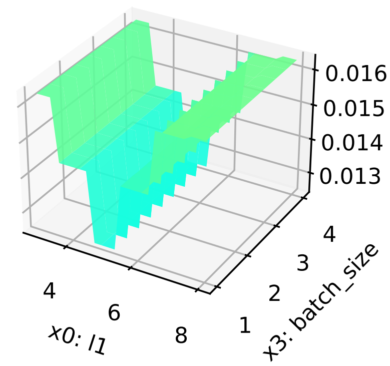
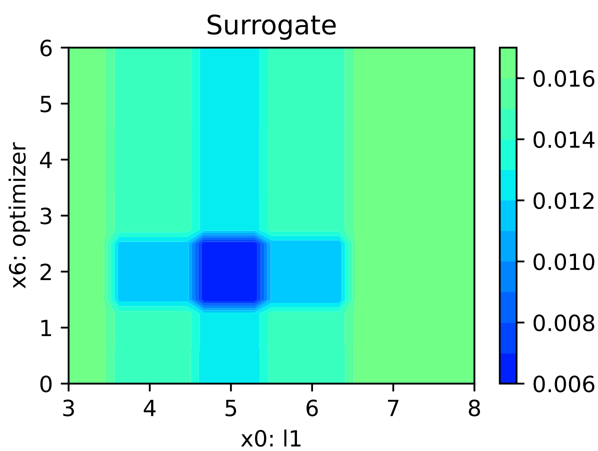


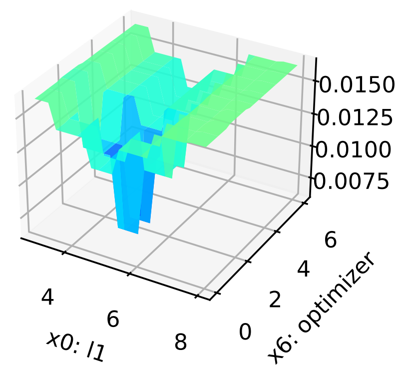
Figure 25.3: Contour plots.

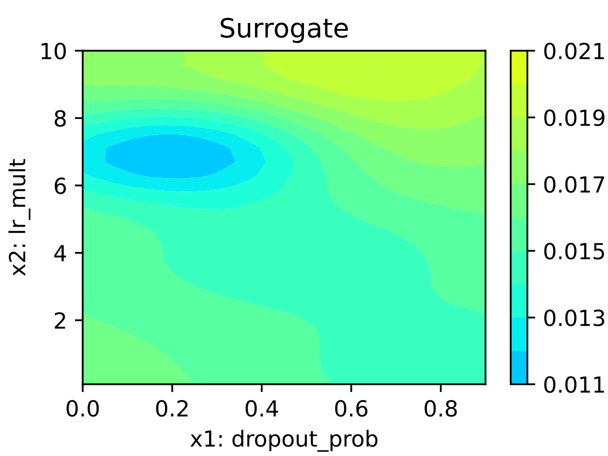


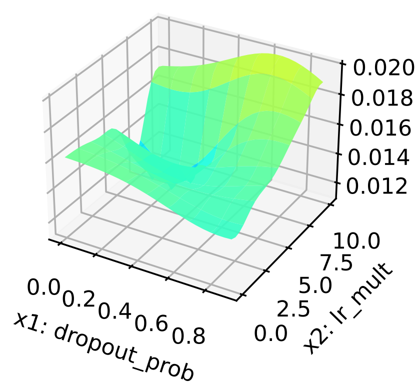

Surrogate
x3: batch_size
x0: l1
0.0164
0.0156
0.0148
0.0140
0.0132
0.0124

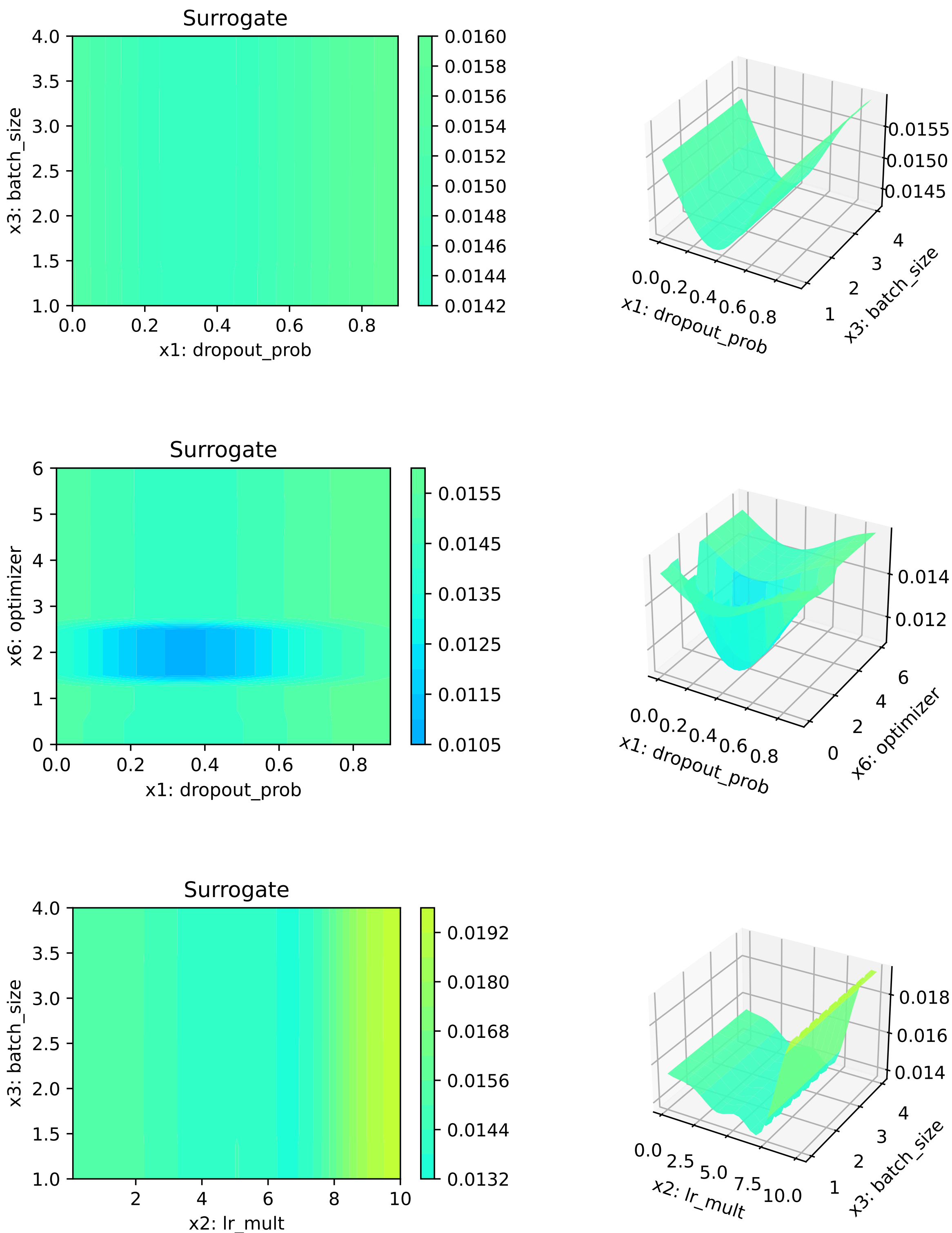

x0: l1
x3: batch_size

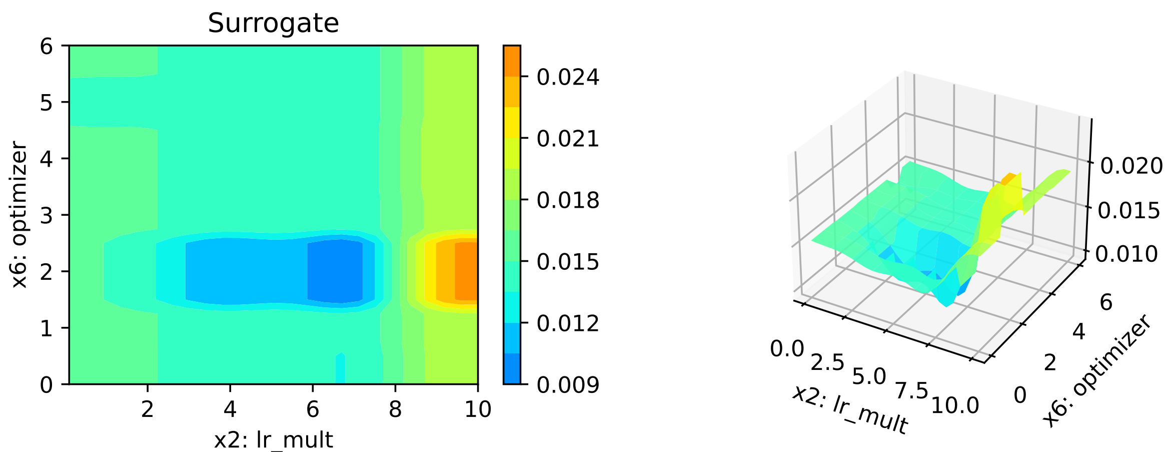

Surrogate
x6: optimizer
x0: l1
0.016
0.014
0.012
0.010
0.008
0.006

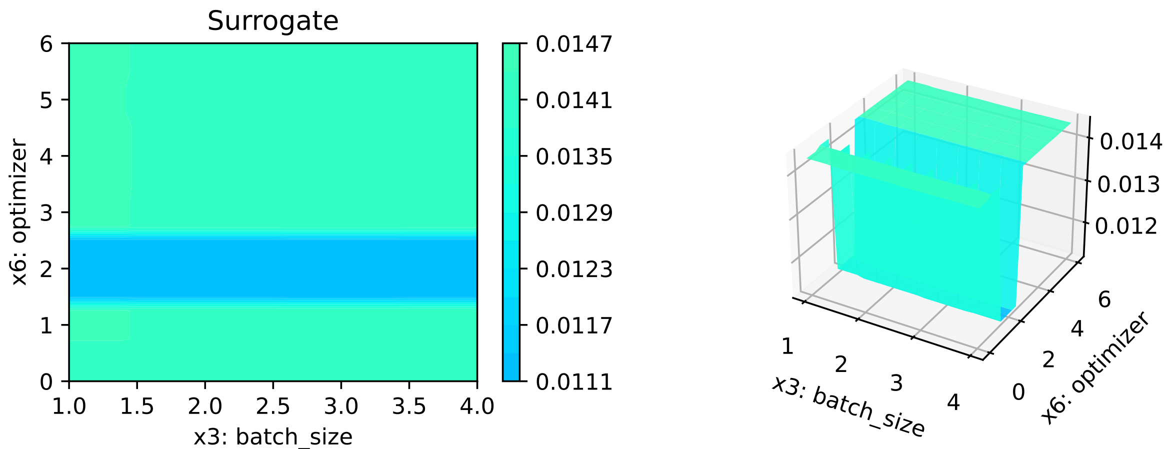

x0: l1
x6: optimizer


Surrogate
x2: lr_mult
x1: dropout_prob
0.021
0.019
0.017
0.015
0.013
0.011


x1: dropout_prob
x2: lr_mult


Surrogate
x3: batch_size
x1: dropout_prob
0.0160
0.0158
0.0156
0.0154
0.0152
0.0150
0.0148
0.0146
0.0144
0.0142
0.0155
0.0150
0.0145
Surrogate
x6: optimizer
x1: dropout_prob
0.0155
0.0145
0.0135
0.0125
0.0115
0.0105
0.014
0.012
Surrogate
x3: batch_size
x2: lr_mult
0.0192
0.0180
0.0168
0.0156
0.0144
0.0132
0.018
0.016
0.014





25.19 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

Parallel coordinates plots

```
Unable to display output for mime type(s): text/html
```

25.20 Summary and Outlook

This tutorial presents the hyperparameter tuning open source software `spotPython` for `PyTorch`. Some of the advantages of `spotPython` are:

- Numerical and categorical hyperparameters.
- Powerful surrogate models.
- Flexible approach and easy to use.
- Simple JSON files for the specification of the hyperparameters.
- Extension of default and user specified network classes.
- Noise handling techniques.
- Online visualization of the hyperparameter tuning process with `tensorboard`.

Currently, only rudimentary parallel and distributed neural network training is possible, but these capabilities will be extended in the future. The next version of `spotPython` will also include a more detailed documentation and more examples.

> **! Important**
>
> Important: This tutorial does not present a complete benchmarking study (Bartz-Beielstein et al. 2020). The results are only preliminary and highly dependent on the local configuration (hard- and software). Our goal is to provide a first impression of the performance of the hyperparameter tuning package `spotPython`. The results should be interpreted with care.

26 HPT: PyTorch With VBDP

In this tutorial, we will show how `spotPython` can be integrated into the `PyTorch` training workflow for a classifiaction task.

> **Note**
>
> Ensure that the correspondiing data is available as `./data/VBDP/train.csv`.

This document refers to the following software versions:

- `python`: 3.10.10
- `torch`: 2.0.1
- `torchvision`: 0.15.0

```
pip list | grep  "spot[RiverPython]"
```

```
spotPython                    0.2.33
spotRiver                     0.0.93
```

```
Note: you may need to restart the kernel to use updated packages.
```

`spotPython` can be installed via pip. Alternatively, the source code can be downloaded from gitHub: https://github.com/sequential-parameter-optimization/spotPython.

```
!pip install spotPython
```

- Uncomment the following lines if you want to for (re-)installation the latest version of `spotPython` from gitHub.

```
# import sys
# !{sys.executable} -m pip install --upgrade build
# !{sys.executable} -m pip install --upgrade --force-reinstall spotPython
```

26.1 Setup

Before we consider the detailed experimental setup, we select the parameters that affect run time, initial design size and the device that is used.

```
MAX_TIME = 60
INIT_SIZE = 10
DEVICE = None # "cpu" # "cuda:0"
```

```
from spotPython.utils.device import getDevice
DEVICE = getDevice(DEVICE)
print(DEVICE)
```

```
mps
```

```
import os
import copy
import socket
from datetime import datetime
from dateutil.tz import tzlocal
start_time = datetime.now(tzlocal())
HOSTNAME = socket.gethostname().split(".")[0]
experiment_name = '25-torch' + "_" + HOSTNAME + "_" + str(MAX_TIME) + "min_" + str(INIT_SI
experiment_name = experiment_name.replace(':', '-')
print(experiment_name)
if not os.path.exists('./figures'):
    os.makedirs('./figures')
```

```
25-torch_p040025_60min_10init_2023-06-17_03-32-14
```

26.2 Initialization of the `fun_control` Dictionary

`spotPython` uses a Python dictionary for storing the information required for the hyperparameter tuning process, which was described in Section 20.2.

```
from spotPython.utils.init import fun_control_init
fun_control = fun_control_init(task="classification",
    tensorboard_path="runs/25_spot_torch_vbdp",
```

```
        device=DEVICE)
```

27 PyTorch Data Loading

27.1 1. Load VBDP Data

```
import pandas as pd
from sklearn.preprocessing import OrdinalEncoder
train_df = pd.read_csv('./data/VBDP/train.csv')
# remove the id column
train_df = train_df.drop(columns=['id'])
n_samples = train_df.shape[0]
n_features = train_df.shape[1] - 1
target_column = "prognosis"
# # Encoder our prognosis labels as integers for easier decoding later
enc = OrdinalEncoder()
train_df[target_column] = enc.fit_transform(train_df[[target_column]])
train_df.head()

# convert all entries to int for faster processing
train_df = train_df.astype(int)
```

```
from spotPython.data.vbdp import combine_features
df_new = train_df.copy()
# save the target column using "target_column" as the column name
target = train_df[target_column]
# remove the target column
df_new = df_new.drop(columns=[target_column])
train_df = combine_features(df_new)
# add the target column back
train_df[target_column] = target
train_df.head()
```

	sudden_fever	headache	mouth_bleed	nose_bleed	muscle_pain	joint_pain	vomiting	rash	diar
0	1	1	0	1	1	1	1	0	1
1	0	0	0	0	0	0	1	0	1

	sudden_fever	headache	mouth_bleed	nose_bleed	muscle_pain	joint_pain	vomiting	rash	diar
2	0	1	1	1	0	1	1	1	1
3	0	0	1	1	1	1	0	1	0
4	0	0	0	0	0	0	0	0	1

- feature engineering: 6112 features

```
from sklearn.model_selection import train_test_split
import numpy as np

n_samples = train_df.shape[0]
n_features = train_df.shape[1] - 1
train_df.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
X_train, X_test, y_train, y_test = train_test_split(train_df.drop(target_column, axis=1),
                                                    random_state=42,
                                                    test_size=0.25,
                                                    stratify=train_df[target_column])
trainset = pd.DataFrame(np.hstack((X_train, np.array(y_train).reshape(-1, 1))))
testset = pd.DataFrame(np.hstack((X_test, np.array(y_test).reshape(-1, 1))))
trainset.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
testset.columns = [f"x{i}" for i in range(1, n_features+1)] + [target_column]
print(train_df.shape)
print(trainset.shape)
print(testset.shape)
```

```
(707, 6113)
(530, 6113)
(177, 6113)
```

```
import torch
from sklearn.model_selection import train_test_split
from spotPython.torch.dataframedataset import DataFrameDataset
dtype_x = torch.float32
dtype_y = torch.long
train_df = DataFrameDataset(train_df, target_column=target_column, dtype_x=dtype_x, dtype_
train = DataFrameDataset(trainset, target_column=target_column, dtype_x=dtype_x, dtype_y=d
test = DataFrameDataset(testset, target_column=target_column, dtype_x=dtype_x, dtype_y=dty
n_samples = len(train)
```

```
# add the dataset to the fun_control
fun_control.update({"data": train_df, # full dataset,
               "train": train,
               "test": test,
               "n_samples": n_samples,
               "target_column": target_column})
```

27.2 The Model (Algorithm) to be Tuned

27.3 Specification of the Preprocessing Model

After the training and test data are specified and added to the `fun_control` dictionary, `spotPython` allows the specification of a data preprocessing pipeline, e.g., for the scaling of the data or for the one-hot encoding of categorical variables, see Section 20.4.1. This feature is not used here, so we do not change the default value (which is `None`).

27.4 Select `algorithm` and `core_model_hyper_dict`

27.4.1 Implementing a Configurable Neural Network With spotPython

`spotPython` includes the `Net_vbdp` class which is implemented in the file `netvbdp.py`. The class is imported here.

This class inherits from the class `Net_Core` which is implemented in the file `netcore.py`, see **?@sec-the-net-core-class-24**.

28 add the nn model to the fun_control dictionary

```
from spotPython.torch.netvbdp import Net_vbdp
from spotPython.data.torch_hyper_dict import TorchHyperDict
from spotPython.hyperparameters.values import add_core_model_to_fun_control
fun_control = add_core_model_to_fun_control(core_model=Net_vbdp,
                              fun_control=fun_control,
                              hyper_dict=TorchHyperDict)
```

28.1 Modifying the Hyperparameters

`spotPython` provides functions for modifying the hyperparameters, their bounds and factors as well as for activating and de-activating hyperparameters without re-compilation of the Python source code. These functions were described in Section 20.5.3.

> **Small number of epochs for demonstration purposes**
>
> - `epochs` is set to 2 and 3 for demonstration purposes. These values are too small for a real application.

```
from spotPython.hyperparameters.values import modify_hyper_parameter_bounds

fun_control = modify_hyper_parameter_bounds(fun_control, "_L0", bounds=[n_features, n_feat
fun_control = modify_hyper_parameter_bounds(fun_control, "l1", bounds=[6, 13])
fun_control = modify_hyper_parameter_bounds(fun_control, "epochs", bounds=[2, 2])
fun_control = modify_hyper_parameter_bounds(fun_control, "patience", bounds=[2, 6])
fun_control = modify_hyper_parameter_bounds(fun_control, "lr_mult", bounds=[1e-3, 1e-3])
fun_control = modify_hyper_parameter_bounds(fun_control, "sgd_momentum", bounds=[0.9, 0.9]
```

```
from spotPython.hyperparameters.values import modify_hyper_parameter_levels
fun_control = modify_hyper_parameter_levels(fun_control, "optimizer",["Adam", "AdamW", "Ad
```

```
# fun_control = modify_hyper_parameter_levels(fun_control, "optimizer", ["Adam"])
# fun_control = modify_hyper_parameter_levels(fun_control, "leaf_model", ["LinearRegressio
# fun_control["core_model_hyper_dict"]
```

```
fun_control = modify_hyper_parameter_bounds(fun_control,
    "lr_mult", bounds=[1e-3, 1e-3])
fun_control = modify_hyper_parameter_bounds(fun_control,
    "sgd_momentum", bounds=[0.9, 0.9])
```

28.1.1 Optimizers

Optimizers are described in Section 20.6.

28.2 Evaluation

The evaluation procedure requires the specification of two elements:

1. the way how the data is split into a train and a test set (see Section 20.7)
2. the loss function (and a metric).

28.2.1 Loss Functions and Metrics

The loss function is specified by the key `"loss_function"`. We will use CrossEntropy loss for the multiclass-classification task.

```
from torch.nn import CrossEntropyLoss
loss_function = CrossEntropyLoss()
fun_control.update({"loss_function": loss_function})
```

28.2.2 Metric

- We will use the MAP@k metric for the evaluation of the model. Here is an example how this metric is calculated.

```
from spotPython.torch.mapk import MAPK
import torch
mapk = MAPK(k=2)
```

```python
target = torch.tensor([0, 1, 2, 2])
preds = torch.tensor(
    [
        [0.5, 0.2, 0.2],  # 0 is in top 2
        [0.3, 0.4, 0.2],  # 1 is in top 2
        [0.2, 0.4, 0.3],  # 2 is in top 2
        [0.7, 0.2, 0.1],  # 2 isn't in top 2
    ]
)
mapk.update(preds, target)
print(mapk.compute()) # tensor(0.6250)
```

```
tensor(0.6250)
```

```python
from spotPython.torch.mapk import MAPK
import torchmetrics
metric_torch = MAPK(k=3)
fun_control.update({"metric_torch": metric_torch})
```

28.3 Preparing the SPOT Call

The following code passes the information about the parameter ranges and bounds to `spot`.

```python
# extract the variable types, names, and bounds
from spotPython.hyperparameters.values import (get_bound_values,
    get_var_name,
    get_var_type,)
var_type = get_var_type(fun_control)
var_name = get_var_name(fun_control)
fun_control.update({"var_type": var_type,
                    "var_name": var_name})
lower = get_bound_values(fun_control, "lower")
upper = get_bound_values(fun_control, "upper")
```

Now, the dictionary `fun_control` contains all information needed for the hyperparameter tuning. Before the hyperparameter tuning is started, it is recommended to take a look at the experimental design. The method `gen_design_table` generates a design table as follows:

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control))
```

```
| name         | type   | default   |    lower |    upper | transform             |
|--------------|--------|-----------|----------|----------|-----------------------|
| _L0          | int    | 64        | 6112     | 6112     | None                  |
| l1           | int    | 8         |    6     |   13     | transform_power_2_int |
| dropout_prob | float  | 0.01      |    0     |    0.9   | None                  |
| lr_mult      | float  | 1.0       |    0.001 |    0.001 | None                  |
| batch_size   | int    | 4         |    1     |    4     | transform_power_2_int |
| epochs       | int    | 4         |    2     |    2     | transform_power_2_int |
| k_folds      | int    | 1         |    1     |    1     | None                  |
| patience     | int    | 2         |    2     |    6     | transform_power_2_int |
| optimizer    | factor | SGD       |    0     |    3     | None                  |
| sgd_momentum | float  | 0.0       |    0.9   |    0.9   | None                  |
```

This allows to check if all information is available and if the information is correct.

28.4 The Objective Function `fun_torch`

The objective function `fun_torch` is selected next. It implements an interface from `PyTorch`'s training, validation, and testing methods to `spotPython`.

```
from spotPython.fun.hypertorch import HyperTorch
fun = HyperTorch().fun_torch
```

```
from spotPython.hyperparameters.values import get_default_hyperparameters_as_array
hyper_dict=TorchHyperDict().load()
X_start = get_default_hyperparameters_as_array(fun_control, hyper_dict)
```

28.5 Starting the Hyperparameter Tuning

The `spotPython` hyperparameter tuning is started by calling the `Spot` function as described in Section 20.12.

```
import numpy as np
from spotPython.spot import spot
from math import inf
```

```python
spot_tuner = spot.Spot(fun=fun,
                   lower = lower,
                   upper = upper,
                   fun_evals = inf,
                   fun_repeats = 1,
                   max_time = MAX_TIME,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type = var_type,
                   var_name = var_name,
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models= False,
                   show_progress= True,
                   fun_control = fun_control,
                   design_control={"init_size": INIT_SIZE,
                                   "repeats": 1},
                   surrogate_control={"noise": True,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": len(var_name),
                                      "model_fun_evals": 10_000,
                                      "log_level": 50
                                      })
spot_tuner.run(X_start=X_start)
```

```
config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.26515610830779995, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397893287517406
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15740744769573212
Epoch: 2

Loss on hold-out set: 2.397889154928702
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.15509261190891266
Epoch: 3
```

```
Loss on hold-out set: 2.3978489946435997
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.16203705966472626
Epoch: 4

Loss on hold-out set: 2.397907610292788
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1566358208656311
Returned to Spot: Validation loss: 2.397907610292788
----------------------------------------------

config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.6368989501775649, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.398129206783367
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1603773832321167
Epoch: 2

Loss on hold-out set: 2.3980937004089355
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16116352379322052
Epoch: 3

Loss on hold-out set: 2.3981953881821543
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16430819034576416
Epoch: 4

Loss on hold-out set: 2.398211789581011
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16194969415664673
Returned to Spot: Validation loss: 2.398211789581011
----------------------------------------------

config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.06795318590380832, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.398724614449267
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1603773534297943
Epoch: 2
```

```
Loss on hold-out set: 2.398697983543828
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.165880486369133
Epoch: 3

Loss on hold-out set: 2.398662598627918
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.17767296731472015
Epoch: 4

Loss on hold-out set: 2.3986606013100102
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.180031418800354
Returned to Spot: Validation loss: 2.3986606013100102
----------------------------------------------

config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.456533346732735, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3979984679312074
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1454402655363083
Epoch: 2

Loss on hold-out set: 2.397998629875903
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14308176934719086
Epoch: 3

Loss on hold-out set: 2.398069647123229
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1454402655363083
Epoch: 4

Loss on hold-out set: 2.3979311439226256
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14308176934719086
Returned to Spot: Validation loss: 2.3979311439226256
----------------------------------------------

config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.435068640608333, 'lr_mult': 0.001, 'batch
Epoch: 1
```

```
Loss on hold-out set: 2.3975678461569325
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.2121913582086563
Epoch: 2

Loss on hold-out set: 2.3974929915534124
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.20756174623966217
Epoch: 3

Loss on hold-out set: 2.3975046299122
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.2083333283662796
Epoch: 4

Loss on hold-out set: 2.39744676484002
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.22067901492118835
Returned to Spot: Validation loss: 2.39744676484002
----------------------------------------------

config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.3175980093998585, 'lr_mult': 0.001, 'batc

Epoch: 1

Loss on hold-out set: 2.397497429037994
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.20518866181373596
Epoch: 2

Loss on hold-out set: 2.396918274321646
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.2704402208328247
Epoch: 3

Loss on hold-out set: 2.396158771694831
Accuracy on hold-out set: 0.2358490566037736
MAPK value on hold-out data: 0.3404087424278259
Epoch: 4
```

```
Loss on hold-out set: 2.395137714889814
Accuracy on hold-out set: 0.20754716981132076
MAPK value on hold-out data: 0.3270440101623535
Returned to Spot: Validation loss: 2.395137714889814
----------------------------------------------

config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.10217787740156026, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3993579899823225
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1288580298423767
Epoch: 2

Loss on hold-out set: 2.3993570539686413
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1288580298423767
Epoch: 3

Loss on hold-out set: 2.3993318522417986
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1288580298423767
Epoch: 4

Loss on hold-out set: 2.3993157104209617
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1288580298423767
Returned to Spot: Validation loss: 2.3993157104209617
----------------------------------------------

config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.5582660802134882, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3981806525477656
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1628086268901825
Epoch: 2

Loss on hold-out set: 2.397937677524708
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17901237308979034
Epoch: 3
```

```
Loss on hold-out set: 2.397788197905929
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1774691492319107
Epoch: 4

Loss on hold-out set: 2.3978777991400824
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17901235818862915
Returned to Spot: Validation loss: 2.3978777991400824
----------------------------------------------

config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.8475085430864048, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3982060900274313
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.14229559898376465
Epoch: 2

Loss on hold-out set: 2.3982583419331966
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.15094341337680817
Epoch: 3

Loss on hold-out set: 2.398305101214715
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1328616440296173
Epoch: 4

Loss on hold-out set: 2.3984907303216323
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.12106918543577194
Returned to Spot: Validation loss: 2.3984907303216323
----------------------------------------------

config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.8086972970888939, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3997920751571655
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.133928582072258
```

```
Epoch: 2
Loss on hold-out set: 2.399610093661717
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1383928507566452
Epoch: 3

Loss on hold-out set: 2.399679728916713
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1391369253396988
Epoch: 4

Loss on hold-out set: 2.3996042353766307
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1346726268529892
Returned to Spot: Validation loss: 2.3996042353766307
----------------------------------------------

config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.05448128192016871, 'lr_mult': 0.001, 'ba

Epoch: 1

Loss on hold-out set: 2.3972368735187457
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.24685530364513397
Epoch: 2

Loss on hold-out set: 2.3963833799902
Accuracy on hold-out set: 0.1509433962264151
MAPK value on hold-out data: 0.24685531854629517
Epoch: 3

Loss on hold-out set: 2.3949847131405235
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.2342766970396042
Epoch: 4

Loss on hold-out set: 2.3923431477456725
Accuracy on hold-out set: 0.1509433962264151
MAPK value on hold-out data: 0.22012577950954437
Returned to Spot: Validation loss: 2.3923431477456725
----------------------------------------------
spotPython tuning: 2.3923431477456725 [----------] 0.32%
```

```
config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.4244133593974528, 'lr_mult': 0.001, 'batc

Epoch: 1

Loss on hold-out set: 2.3972950836397566
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.18396230041980743
Epoch: 2

Loss on hold-out set: 2.397113543636394
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.17688679695129395
Epoch: 3

Loss on hold-out set: 2.396731345158703
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1863207370042801
Epoch: 4

Loss on hold-out set: 2.396209347922847
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.16823899745941162
Returned to Spot: Validation loss: 2.396209347922847
----------------------------------------------
spotPython tuning: 2.3923431477456725 [----------] 0.65%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.0, 'lr_mult': 0.001, 'batch_size': 8, 'ep
Epoch: 1

Loss on hold-out set: 2.397607194052802
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.16589507460594177
Epoch: 2

Loss on hold-out set: 2.397366241172508
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.20216049253940582
Epoch: 3
```

```
Loss on hold-out set: 2.397106726964315
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.23611107468605042
Epoch: 4

Loss on hold-out set: 2.396795158033018
Accuracy on hold-out set: 0.1509433962264151
MAPK value on hold-out data: 0.2430555373430252
Returned to Spot: Validation loss: 2.396795158033018
----------------------------------------------
spotPython tuning: 2.3923431477456725 [----------] 0.73%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.0, 'lr_mult': 0.001, 'batch_size': 4, 'ep

Epoch: 1

Loss on hold-out set: 2.3968683818601213
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.23270440101623535
Epoch: 2

Loss on hold-out set: 2.3956379890441895
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.2492138296365738
Epoch: 3

Loss on hold-out set: 2.3936525335851706
Accuracy on hold-out set: 0.18867924528301888
MAPK value on hold-out data: 0.3042452335357666
Epoch: 4

Loss on hold-out set: 2.3902042137002044
Accuracy on hold-out set: 0.20754716981132076
MAPK value on hold-out data: 0.30267298221588135
Returned to Spot: Validation loss: 2.3902042137002044
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 1.05%
```

```
config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.6524588300121443, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3979117605421276
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1597222238779068
Epoch: 2

Loss on hold-out set: 2.397850107263636
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1597222238779068
Epoch: 3

Loss on hold-out set: 2.398013944979067
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1566358208656311
Epoch: 4

Loss on hold-out set: 2.397941024215133
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15509261190891266
Returned to Spot: Validation loss: 2.397941024215133
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 1.10%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.19312145054644644, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3982377682092055
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14386795461177826
Epoch: 2

Loss on hold-out set: 2.398218532778182
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14386795461177826
Epoch: 3
```

```
Loss on hold-out set: 2.3981657343090705
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14386795461177826
Epoch: 4

Loss on hold-out set: 2.3981454327421368
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14386795461177826
Returned to Spot: Validation loss: 2.3981454327421368
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 1.17%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.37973581627268116, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3980809109551564
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.171875
Epoch: 2
Loss on hold-out set: 2.398037944521223
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.1741071492433548
Epoch: 3

Loss on hold-out set: 2.3981365135737827
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.1755952537059784
Epoch: 4
Loss on hold-out set: 2.3980674913951328
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.1785714328289032
Returned to Spot: Validation loss: 2.3980674913951328
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.20%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.3407833750982233, 'lr_mult': 0.001, 'batc
Epoch: 1
```

```
Loss on hold-out set: 2.3972592488774715
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.18396227061748505
Epoch: 2

Loss on hold-out set: 2.3972436482051633
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.18396224081516266
Epoch: 3

Loss on hold-out set: 2.397222433450087
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.18238992989063263
Epoch: 4

Loss on hold-out set: 2.397091163779205
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.18396224081516266
Returned to Spot: Validation loss: 2.397091163779205
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.29%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.002373071484783551, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3981091465268816
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.162946417927742
Epoch: 2
Loss on hold-out set: 2.398087739944458
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.162946417927742
Epoch: 3

Loss on hold-out set: 2.398068036351885
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1674107015132904
Epoch: 4
```

```
Loss on hold-out set: 2.3980450119291032
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1674107015132904
Returned to Spot: Validation loss: 2.3980450119291032
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.32%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.8032579717749374, 'lr_mult': 0.001, 'bat

Epoch: 1

Loss on hold-out set: 2.3980375235935427
Accuracy on hold-out set: 0.04245283018867924
MAPK value on hold-out data: 0.13522012531757355
Epoch: 2

Loss on hold-out set: 2.39776625723209
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1454402655363083
Epoch: 3

Loss on hold-out set: 2.3976802870912373
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15723270177841187
Epoch: 4

Loss on hold-out set: 2.3975498001530484
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1320755034685135
Returned to Spot: Validation loss: 2.3975498001530484
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.63%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.02088710954248223, 'lr_mult': 0.001, 'ba
Epoch: 1
```

```
Loss on hold-out set: 2.397937684688928
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.18160377442836761
Epoch: 2

Loss on hold-out set: 2.3978435903225304
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.18238995969295502
Epoch: 3

Loss on hold-out set: 2.3977839541885086
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.19025155901908875
Epoch: 4

Loss on hold-out set: 2.397690620062486
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.19811320304870605
Returned to Spot: Validation loss: 2.397690620062486
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.72%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.8462813701054609, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3983169308415166
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15586420893669128
Epoch: 2

Loss on hold-out set: 2.397944035353484
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17824074625968933
Epoch: 3

Loss on hold-out set: 2.398230058175546
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.15354938805103302
Epoch: 4
```

```
Loss on hold-out set: 2.398160033755832
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16512347757816315
Returned to Spot: Validation loss: 2.398160033755832
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.77%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.6582591659263604, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3986084708627664
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1462264358997345
Epoch: 2

Loss on hold-out set: 2.3985325930253514
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1533019095659256
Epoch: 3

Loss on hold-out set: 2.3984897114195913
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15566039085388184
Epoch: 4

Loss on hold-out set: 2.39851646153432
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.16194969415664673
Returned to Spot: Validation loss: 2.39851646153432
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.92%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.5588589317567859, 'lr_mult': 0.001, 'batc
Epoch: 1
```

```
Loss on hold-out set: 2.3981218249709517
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15817901492118835
Epoch: 2

Loss on hold-out set: 2.398073425999394
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16512344777584076
Epoch: 3

Loss on hold-out set: 2.3980330449563487
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.17515431344509125
Epoch: 4

Loss on hold-out set: 2.398208821261371
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15586422383785248
Returned to Spot: Validation loss: 2.398208821261371
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 1.97%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.19609283422959659, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.399726579774101
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.15094341337680817
Epoch: 2

Loss on hold-out set: 2.399720475358783
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.15094341337680817
Epoch: 3

Loss on hold-out set: 2.3997816139796995
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14386793971061707
Epoch: 4
```

```
Loss on hold-out set: 2.3997638315524696
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1462264358997345
Returned to Spot: Validation loss: 2.3997638315524696
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 2.06%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.4050295724771694, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3979019219020627
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.19261007010936737
Epoch: 2

Loss on hold-out set: 2.397852951625608
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.1949685513973236
Epoch: 3

Loss on hold-out set: 2.3978842519364267
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.19811320304870605
Epoch: 4

Loss on hold-out set: 2.3978465413147547
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.2004716992378235
Returned to Spot: Validation loss: 2.3978465413147547
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 2.14%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.6650020573427289, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3979023385930947
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15509261190891266
Epoch: 2
```

```
Loss on hold-out set: 2.397959444257948
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15200617909431458
Epoch: 3

Loss on hold-out set: 2.397755234329789
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.17438270151615143
Epoch: 4

Loss on hold-out set: 2.397836526234945
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.16589504480361938
Returned to Spot: Validation loss: 2.397836526234945
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 2.22%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.0622916840670704, 'lr_mult': 0.001, 'batc

Epoch: 1

Loss on hold-out set: 2.397357018488758
Accuracy on hold-out set: 0.16037735849056603
MAPK value on hold-out data: 0.2562892436981201
Epoch: 2

Loss on hold-out set: 2.3970847309760326
Accuracy on hold-out set: 0.1650943396226415
MAPK value on hold-out data: 0.28694966435432434
Epoch: 3

Loss on hold-out set: 2.396756756980464
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.28852200508117676
Epoch: 4
```

```
Loss on hold-out set: 2.3963987287485375
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2838049530982971
Returned to Spot: Validation loss: 2.3963987287485375
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 2.53%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.5758726471619317, 'lr_mult': 0.001, 'bat

Epoch: 1

Loss on hold-out set: 2.3982503324184776
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.12971699237823486
Epoch: 2

Loss on hold-out set: 2.398244556391014
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.13364781439304352
Epoch: 3

Loss on hold-out set: 2.39813073176258
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.13757863640785217
Epoch: 4

Loss on hold-out set: 2.3982460093948075
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.13757863640785217
Returned to Spot: Validation loss: 2.3982460093948075
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 2.62%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.6654739007524466, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3984663486480713
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1547618955373764
Epoch: 2
```

```
Loss on hold-out set: 2.3984486034938266
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1614583432674408
Epoch: 3

Loss on hold-out set: 2.3984582935060774
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.162202388048172
Epoch: 4

Loss on hold-out set: 2.398333413260324
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1688988208770752
Returned to Spot: Validation loss: 2.398333413260324
----------------------------------------------
spotPython tuning: 2.3902042137002044 [----------] 2.66%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.4103563756313545, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3970122848238264
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1860119253396988
Epoch: 2
Loss on hold-out set: 2.397035445485796
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1860119253396988
Epoch: 3

Loss on hold-out set: 2.396992325782776
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1860119253396988
Epoch: 4
Loss on hold-out set: 2.3969471284321378
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1860119253396988
Returned to Spot: Validation loss: 2.3969471284321378
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 2.69%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.30647708216906094, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3979699346754284
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1388889104127884
Epoch: 2

Loss on hold-out set: 2.397910506637008
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.13503088057041168
Epoch: 3

Loss on hold-out set: 2.3978558911217585
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.13966050744056702
Epoch: 4

Loss on hold-out set: 2.397891945309109
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1427469253540039
Returned to Spot: Validation loss: 2.397891945309109
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 2.74%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.15247167768501327, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3977162837982178
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18518517911434174
Epoch: 2

Loss on hold-out set: 2.397679602658307
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1805555373430252
Epoch: 3
```

```
Loss on hold-out set: 2.397686163584391
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.16898147761821747
Epoch: 4

Loss on hold-out set: 2.397643566131592
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.17824074625968933
Returned to Spot: Validation loss: 2.397643566131592
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 2.80%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.8959848416367596, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3979330403464183
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1808035671710968
Epoch: 2

Loss on hold-out set: 2.3979185479027882
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1674107015132904
Epoch: 3

Loss on hold-out set: 2.397895778928484
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.159226194024086
Epoch: 4

Loss on hold-out set: 2.3978933606828963
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1681547462940216
Returned to Spot: Validation loss: 2.3978933606828963
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 2.85%
```

```
config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.12421626975792852, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3980129383228443
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1566358208656311
Epoch: 2

Loss on hold-out set: 2.3979597003371627
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16435185074806213
Epoch: 3

Loss on hold-out set: 2.3979072394194425
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16203702986240387
Epoch: 4

Loss on hold-out set: 2.397911274874652
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1635802537202835
Returned to Spot: Validation loss: 2.397911274874652
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 2.92%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.1990640559573637, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3976216631115608
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.17216983437538147
Epoch: 2

Loss on hold-out set: 2.3976304890974514
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.17216983437538147
Epoch: 3
```

```
Loss on hold-out set: 2.3975766964678495
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.17216983437538147
Epoch: 4

Loss on hold-out set: 2.3975807495836943
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.17216983437538147
Returned to Spot: Validation loss: 2.3975807495836943
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.01%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.38123802605732315, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3988500612753407
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13348767161369324
Epoch: 2

Loss on hold-out set: 2.398826590290776
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13348767161369324
Epoch: 3

Loss on hold-out set: 2.3988501495785184
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13271605968475342
Epoch: 4

Loss on hold-out set: 2.39886772191083
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13040123879909515
Returned to Spot: Validation loss: 2.39886772191083
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.06%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.3690606739241711, 'lr_mult': 0.001, 'batch
Epoch: 1

Loss on hold-out set: 2.3979472230981895
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16512344777584076
Epoch: 2

Loss on hold-out set: 2.397895194866039
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.166666641831398
Epoch: 3

Loss on hold-out set: 2.397931045956082
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16589505970478058
Epoch: 4

Loss on hold-out set: 2.3979296772568315
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.16743828356266022
Returned to Spot: Validation loss: 2.3979296772568315
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.12%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.2490529292398342, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.398004920394332
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1705247014760971
Epoch: 2

Loss on hold-out set: 2.3979101092727095
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18132716417312622
Epoch: 3
```

```
Loss on hold-out set: 2.3978971198753074
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18981482088565826
Epoch: 4

Loss on hold-out set: 2.397878646850586
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.17978394031524658
Returned to Spot: Validation loss: 2.397878646850586
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.18%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.6899725481860932, 'lr_mult': 0.001, 'bat

Epoch: 1

Loss on hold-out set: 2.397870464145013
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.17845910787582397
Epoch: 2

Loss on hold-out set: 2.397695186003199
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18003146350383759
Epoch: 3

Loss on hold-out set: 2.3976033678594626
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.19889937341213226
Epoch: 4

Loss on hold-out set: 2.397451787624719
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.23113207519054413
Returned to Spot: Validation loss: 2.397451787624719
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.34%
```

```
config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.8754395784486567, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3987081185826717
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18396227061748505
Epoch: 2

Loss on hold-out set: 2.3984688542923838
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1808176040649414
Epoch: 3

Loss on hold-out set: 2.398668833498685
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15566039085388184
Epoch: 4

Loss on hold-out set: 2.3986625536432804
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.16588051617145538
Returned to Spot: Validation loss: 2.3986625536432804
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.44%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.5800401863861032, 'lr_mult': 0.001, 'bat

Epoch: 1

Loss on hold-out set: 2.397948662439982
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14506174623966217
Epoch: 2

Loss on hold-out set: 2.39798351570412
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.15200616419315338
Epoch: 3
```

```
Loss on hold-out set: 2.3979208999209933
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16435186564922333
Epoch: 4

Loss on hold-out set: 2.3978291794105813
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16512344777584076
Returned to Spot: Validation loss: 2.3978291794105813
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.53%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.38034667719743903, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397798722645022
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15566037595272064
Epoch: 2

Loss on hold-out set: 2.3978150700623133
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1588050127029419
Epoch: 3

Loss on hold-out set: 2.3977593340963685
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16588051617145538
Epoch: 4

Loss on hold-out set: 2.397849721728631
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15015724301338196
Returned to Spot: Validation loss: 2.397849721728631
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.62%
```

```
config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.7475409498559539, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3979672665865914
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.19968555867671967
Epoch: 2

Loss on hold-out set: 2.398018517584171
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.194968581199646
Epoch: 3

Loss on hold-out set: 2.3979475408230186
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18553462624549866
Epoch: 4

Loss on hold-out set: 2.3978841574686878
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18317613005638123
Returned to Spot: Validation loss: 2.3978841574686878
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.72%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.31544842331355805, 'lr_mult': 0.001, 'ba

Epoch: 1

Loss on hold-out set: 2.398054095934022
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.13679248094558716
Epoch: 2

Loss on hold-out set: 2.3979973253214135
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.13836480677127838
Epoch: 3
```

```
Loss on hold-out set: 2.3979261056432186
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.1454402655363083
Epoch: 4

Loss on hold-out set: 2.397756666507361
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.16430817544460297
Returned to Spot: Validation loss: 2.397756666507361
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.87%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.8650619774359263, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3982071966495155
Accuracy on hold-out set: 0.04245283018867924
MAPK value on hold-out data: 0.11477986723184586
Epoch: 2

Loss on hold-out set: 2.397947090976643
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.13128933310508728
Epoch: 3

Loss on hold-out set: 2.3977805398545176
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.14072327315807343
Epoch: 4

Loss on hold-out set: 2.3978433788947338
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1383647918701172
Returned to Spot: Validation loss: 2.3978433788947338
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 3.99%
```

```
config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.2139388439945934, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3981762285585755
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1635802835226059
Epoch: 2

Loss on hold-out set: 2.398085037867228
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17129631340503693
Epoch: 3

Loss on hold-out set: 2.398095625418204
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.17515434324741364
Epoch: 4

Loss on hold-out set: 2.3980621850049055
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1805555671453476
Returned to Spot: Validation loss: 2.3980621850049055
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 4.05%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.03738935860756178, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3971903526558065
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17138364911079407
Epoch: 2

Loss on hold-out set: 2.397178402486837
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17138364911079407
Epoch: 3
```

```
Loss on hold-out set: 2.397183562224766
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17138364911079407
Epoch: 4

Loss on hold-out set: 2.3971717492589413
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16981132328510284
Returned to Spot: Validation loss: 2.3971717492589413
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 4.21%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.21688592886999503, 'lr_mult': 0.001, 'ba

Epoch: 1

Loss on hold-out set: 2.397676094523016
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18317611515522003
Epoch: 2

Loss on hold-out set: 2.397526466621543
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.195754736661911
Epoch: 3

Loss on hold-out set: 2.3974470642377748
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18867924809455872
Epoch: 4

Loss on hold-out set: 2.3972568601932167
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.20676103234291077
Returned to Spot: Validation loss: 2.3972568601932167
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 4.37%
```

```
config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.06922100003001834, 'lr_mult': 0.001, 'ba

Epoch: 1

Loss on hold-out set: 2.397542989478921
Accuracy on hold-out set: 0.1509433962264151
MAPK value on hold-out data: 0.24449680745601654
Epoch: 2

Loss on hold-out set: 2.3974031997176835
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.23742136359214783
Epoch: 3

Loss on hold-out set: 2.3973418541674345
Accuracy on hold-out set: 0.1509433962264151
MAPK value on hold-out data: 0.2492138147354126
Epoch: 4

Loss on hold-out set: 2.397229595004388
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.2547169327735901
Returned to Spot: Validation loss: 2.397229595004388
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 4.53%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.444431018534004, 'lr_mult': 0.001, 'batc

Epoch: 1

Loss on hold-out set: 2.3976328372955322
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.19598764181137085
Epoch: 2
```

```
Loss on hold-out set: 2.3976286517249212
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.21450616419315338
Epoch: 3

Loss on hold-out set: 2.3974817682195595
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.21990740299224854
Epoch: 4

Loss on hold-out set: 2.3973834691224276
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.2222222238779068
Returned to Spot: Validation loss: 2.3973834691224276
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 4.71%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.15079665343745283, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3983615974210344
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1666666567325592
Epoch: 2

Loss on hold-out set: 2.3983281176045255
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.16588051617145538
Epoch: 3

Loss on hold-out set: 2.3981262647880697
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1674528270959854
Epoch: 4

Loss on hold-out set: 2.3982026464534254
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15801888704299927
Returned to Spot: Validation loss: 2.3982026464534254
----------------------------------------------
```

```
spotPython tuning: 2.3902042137002044 [----------] 4.88%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.42628859210850506, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3969340324401855
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2142857164144516
Epoch: 2

Loss on hold-out set: 2.396990350314549
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2113095223903656
Epoch: 3

Loss on hold-out set: 2.3968645334243774
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2105654776096344
Epoch: 4

Loss on hold-out set: 2.396924138069153
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2090773582458496
Returned to Spot: Validation loss: 2.396924138069153
----------------------------------------------

spotPython tuning: 2.3902042137002044 [----------] 4.92%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.7667268926608277, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.399276744644597
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13679246604442596
Epoch: 2
```

```
Loss on hold-out set: 2.3992446413579978
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13836480677127838
Epoch: 3

Loss on hold-out set: 2.399198833501564
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13600631058216095
Epoch: 4

Loss on hold-out set: 2.3992248301236136
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.13522015511989594
Returned to Spot: Validation loss: 2.3992248301236136
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 5.09%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.6178629615502382, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397128703459254
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.21305032074451447
Epoch: 2

Loss on hold-out set: 2.3970908218959592
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.19889935851097107
Epoch: 3

Loss on hold-out set: 2.3970928462046497
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.23270435631275177
Epoch: 4

Loss on hold-out set: 2.3970571329008856
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.2138364613056183
Returned to Spot: Validation loss: 2.3970571329008856
----------------------------------------------
```

```
spotPython tuning: 2.3902042137002044 [#---------] 5.19%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.8582308761741295, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3985623121261597
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.177827388048172
Epoch: 2
Loss on hold-out set: 2.3984107800892422
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1785714477300644
Epoch: 3

Loss on hold-out set: 2.3984053986413136
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1852678507566452
Epoch: 4
Loss on hold-out set: 2.398341485432216
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1837797462940216
Returned to Spot: Validation loss: 2.398341485432216
----------------------------------------------


spotPython tuning: 2.3902042137002044 [#---------] 5.24%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.05364579986179592, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.39724526090442
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16273584961891174
Epoch: 2

Loss on hold-out set: 2.397166117182318
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16273584961891174
Epoch: 3
```

```
Loss on hold-out set: 2.397099166546228
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16273584961891174
Epoch: 4

Loss on hold-out set: 2.3970724231791944
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16273584961891174
Returned to Spot: Validation loss: 2.3970724231791944
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 5.41%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.29870458505732056, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3983688894307837
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16902516782283783
Epoch: 2

Loss on hold-out set: 2.3983764378529675
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16116352379322052
Epoch: 3

Loss on hold-out set: 2.3983428073379227
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1745283007621765
Epoch: 4

Loss on hold-out set: 2.3983071210249416
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16981130838394165
Returned to Spot: Validation loss: 2.3983071210249416
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 5.51%
```

```
config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.36981876582984996, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.396951754887899
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16589508950710297
Epoch: 2

Loss on hold-out set: 2.3970307067588523
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16512346267700195
Epoch: 3

Loss on hold-out set: 2.3969799677530923
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.17824074625968933
Epoch: 4

Loss on hold-out set: 2.3969112943719932
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.17592591047286987
Returned to Spot: Validation loss: 2.3969112943719932
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 5.58%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.6133830604749207, 'lr_mult': 0.001, 'bat

Epoch: 1

Loss on hold-out set: 2.398000637690226
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.14891977608203888
Epoch: 2

Loss on hold-out set: 2.397866213763202
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1604938507080078
Epoch: 3
```

```
Loss on hold-out set: 2.397804781242653
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.17283950746059418
Epoch: 4

Loss on hold-out set: 2.3978490829467773
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16203702986240387
Returned to Spot: Validation loss: 2.3978490829467773
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 5.67%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.0, 'lr_mult': 0.001, 'batch_size': 4, 'ep

Epoch: 1

Loss on hold-out set: 2.397478405034767
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.15723270177841187
Epoch: 2

Loss on hold-out set: 2.3965847717141204
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.20204398036003113
Epoch: 3

Loss on hold-out set: 2.3951667479748995
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.2209119200706482
Epoch: 4

Loss on hold-out set: 2.393680419561998
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.21698112785816193
Returned to Spot: Validation loss: 2.393680419561998
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 6.02%
```

```
config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.37470910898533233, 'lr_mult': 0.001, 'ba

Epoch: 1

Loss on hold-out set: 2.3978786378536583
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.14150944352149963
Epoch: 2

Loss on hold-out set: 2.3975352881089695
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.20518866181373596
Epoch: 3

Loss on hold-out set: 2.3973273016371817
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1745283156633377
Epoch: 4

Loss on hold-out set: 2.396782395974645
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.18632076680660248
Returned to Spot: Validation loss: 2.396782395974645
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 6.62%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.4169749444557389, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3975974983639188
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.19135801494121552
Epoch: 2

Loss on hold-out set: 2.39769298058969
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.20756174623966217
Epoch: 3
```

```
Loss on hold-out set: 2.3976384180563466
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.21682097017765045
Epoch: 4

Loss on hold-out set: 2.397593100865682
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.22608023881912231
Returned to Spot: Validation loss: 2.397593100865682
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 6.68%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.3287296306006683, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3982885378711627
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1525157392024994
Epoch: 2

Loss on hold-out set: 2.398271050093309
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15801888704299927
Epoch: 3

Loss on hold-out set: 2.3981895244346476
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.14937110245227814
Epoch: 4

Loss on hold-out set: 2.398146573102699
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15094341337680817
Returned to Spot: Validation loss: 2.398146573102699
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 6.88%
```

```
config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.5849085505052557, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397509129542225
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.18238994479179382
Epoch: 2

Loss on hold-out set: 2.3976406331332223
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.16037733852863312
Epoch: 3

Loss on hold-out set: 2.397495449713941
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.18160377442836761
Epoch: 4

Loss on hold-out set: 2.3975137134767928
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.17845910787582397
Returned to Spot: Validation loss: 2.3975137134767928
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 7.04%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.25238335392942374, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397889015809545
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1871069073677063
Epoch: 2

Loss on hold-out set: 2.3976756941597417
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18553459644317627
Epoch: 3
```

```
Loss on hold-out set: 2.397412857919369
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.21540877223014832
Epoch: 4

Loss on hold-out set: 2.3971962816310377
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.21619495749473572
Returned to Spot: Validation loss: 2.3971962816310377
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 7.38%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.7734262466913263, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3978522530308477
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18209877610206604
Epoch: 2

Loss on hold-out set: 2.3976448553579823
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1705247014760971
Epoch: 3

Loss on hold-out set: 2.3977484084941723
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1635802537202835
Epoch: 4

Loss on hold-out set: 2.397601295400549
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.17824074625968933
Returned to Spot: Validation loss: 2.397601295400549
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 7.47%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.8251819533674807, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3976553161189242
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.2138364315032959
Epoch: 2

Loss on hold-out set: 2.397522229068684
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.2342766970396042
Epoch: 3

Loss on hold-out set: 2.397534710056377
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.21776728332042694
Epoch: 4

Loss on hold-out set: 2.3976767310556375
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.20676100254058838
Returned to Spot: Validation loss: 2.3976767310556375
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 7.73%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.18607520166859973, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3995202439171925
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1488095372915268
Epoch: 2
Loss on hold-out set: 2.3995340040751865
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1488095372915268
Epoch: 3
```

```
Loss on hold-out set: 2.3994877508708408
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1488095372915268
Epoch: 4
Loss on hold-out set: 2.399522168295724
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1488095372915268
Returned to Spot: Validation loss: 2.399522168295724
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 7.82%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.3548477190453426, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3988576105662753
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.1205357164144516
Epoch: 2
Loss on hold-out set: 2.398854443005153
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.1257440447807312
Epoch: 3

Loss on hold-out set: 2.3988588537488664
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.1183035746216774
Epoch: 4
Loss on hold-out set: 2.398709297180176
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.1257440596818924
Returned to Spot: Validation loss: 2.398709297180176
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 7.93%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.6733290439584552, 'lr_mult': 0.001, 'batc
Epoch: 1
```

```
Loss on hold-out set: 2.3976404846839183
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16509436070919037
Epoch: 2

Loss on hold-out set: 2.397629126062933
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16430819034576416
Epoch: 3

Loss on hold-out set: 2.397641105471917
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.14937107264995575
Epoch: 4

Loss on hold-out set: 2.397527537255917
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16509434580802917
Returned to Spot: Validation loss: 2.397527537255917
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.08%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.12066571665703325, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3966660146360046
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.19290123879909515
Epoch: 2

Loss on hold-out set: 2.3966779620559127
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1875000298023224
Epoch: 3

Loss on hold-out set: 2.3966449631585016
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18904323875904083
Epoch: 4
```

```
Loss on hold-out set: 2.3966579260649503
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1944444626569748
Returned to Spot: Validation loss: 2.3966579260649503
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.20%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.0, 'lr_mult': 0.001, 'batch_size': 16, '

Epoch: 1

Loss on hold-out set: 2.397775411605835
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.184523805975914
Epoch: 2

Loss on hold-out set: 2.397400821958269
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.2068452537059784
Epoch: 3

Loss on hold-out set: 2.3969461066382274
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2261904776096344
Epoch: 4

Loss on hold-out set: 2.396379232406616
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.2574404776096344
Returned to Spot: Validation loss: 2.396379232406616
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.37%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.5246536981733558, 'lr_mult': 0.001, 'batc
Epoch: 1
```

```
Loss on hold-out set: 2.3976845111487046
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.21226412057876587
Epoch: 2

Loss on hold-out set: 2.397659661634913
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.21226412057876587
Epoch: 3

Loss on hold-out set: 2.397609490268635
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.20676098763942719
Epoch: 4

Loss on hold-out set: 2.397493263460555
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.21226412057876587
Returned to Spot: Validation loss: 2.397493263460555
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.53%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.19311516116081714, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.397541914346083
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18160377442836761
Epoch: 2

Loss on hold-out set: 2.3975334077511192
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18160377442836761
Epoch: 3

Loss on hold-out set: 2.3975322606428615
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18160377442836761
Epoch: 4
```

```
Loss on hold-out set: 2.397515737785483
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18160377442836761
Returned to Spot: Validation loss: 2.397515737785483
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.68%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.1605886907273366, 'lr_mult': 0.001, 'batch
Epoch: 1

Loss on hold-out set: 2.3987159047807967
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1696428507566452
Epoch: 2
Loss on hold-out set: 2.3986917563847134
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1696428507566452
Epoch: 3

Loss on hold-out set: 2.3987131118774414
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.168898805975914
Epoch: 4
Loss on hold-out set: 2.398716517857143
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1674107164144516
Returned to Spot: Validation loss: 2.398716517857143
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.78%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.353749515623391, 'lr_mult': 0.001, 'batch_


Epoch: 1
```

```
Loss on hold-out set: 2.397682751928057
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.2068452537059784
Epoch: 2
Loss on hold-out set: 2.3977892228535245
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2038690596818924
Epoch: 3

Loss on hold-out set: 2.397778187479292
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.1994047462940216
Epoch: 4
Loss on hold-out set: 2.397680878639221
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.2016369104385376
Returned to Spot: Validation loss: 2.397680878639221
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.88%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.30247202575852844, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397214821406773
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1629464477300644
Epoch: 2
Loss on hold-out set: 2.3971866880144392
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1636904776096344
Epoch: 3

Loss on hold-out set: 2.3972993237631663
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1569940596818924
Epoch: 4
Loss on hold-out set: 2.397200039454869
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1569940596818924
```

```
Returned to Spot: Validation loss: 2.397200039454869
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 8.99%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.41703000491938125, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.399106361247875
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1496913731098175
Epoch: 2

Loss on hold-out set: 2.3990773183328136
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.14814816415309906
Epoch: 3

Loss on hold-out set: 2.3990366282286466
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.14814816415309906
Epoch: 4

Loss on hold-out set: 2.399074430818911
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.14814816415309906
Returned to Spot: Validation loss: 2.399074430818911
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 9.10%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.5007096828230319, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3974773164065377
Accuracy on hold-out set: 0.16037735849056603
MAPK value on hold-out data: 0.22641511261463165
Epoch: 2
```

```
Loss on hold-out set: 2.3974739200664015
Accuracy on hold-out set: 0.16037735849056603
MAPK value on hold-out data: 0.23742136359214783
Epoch: 3

Loss on hold-out set: 2.3973639776121893
Accuracy on hold-out set: 0.1792452830188679
MAPK value on hold-out data: 0.24528302252292633
Epoch: 4

Loss on hold-out set: 2.397431751467147
Accuracy on hold-out set: 0.19339622641509435
MAPK value on hold-out data: 0.2507861256599426
Returned to Spot: Validation loss: 2.397431751467147
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 9.28%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.5901227741854255, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3989903245653426
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.119791679084301
Epoch: 2
Loss on hold-out set: 2.399070382118225
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1168154925107956
Epoch: 3

Loss on hold-out set: 2.399145722389221
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.113839291036129
Epoch: 4
Loss on hold-out set: 2.3990736859185353
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.109375
Returned to Spot: Validation loss: 2.3990736859185353
----------------------------------------------
```

```
spotPython tuning: 2.3902042137002044 [#---------] 9.38%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.1692224028272108, 'lr_mult': 0.001, 'batc


Epoch: 1

Loss on hold-out set: 2.3986098541403718
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.1257861852645874
Epoch: 2

Loss on hold-out set: 2.3985007573973456
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.1250000149011612
Epoch: 3

Loss on hold-out set: 2.398487833310973
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.1257861852645874
Epoch: 4

Loss on hold-out set: 2.398363662215899
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.12893083691596985
Returned to Spot: Validation loss: 2.398363662215899
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 9.54%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.6947457353404383, 'lr_mult': 0.001, 'batc


Epoch: 1

Loss on hold-out set: 2.398826095293153
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1533018797636032
Epoch: 2
```

```
Loss on hold-out set: 2.398910828356473
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16430819034576416
Epoch: 3

Loss on hold-out set: 2.398792568242775
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1595912128686905
Epoch: 4

Loss on hold-out set: 2.3987025584814683
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15723271667957306
Returned to Spot: Validation loss: 2.3987025584814683
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 9.80%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.5504065863953703, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3983427556055896
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.15408805012702942
Epoch: 2

Loss on hold-out set: 2.398341808678969
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.14937107264995575
Epoch: 3

Loss on hold-out set: 2.3982659735769594
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.15566037595272064
Epoch: 4

Loss on hold-out set: 2.398339995798075
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1533019095659256
Returned to Spot: Validation loss: 2.398339995798075
----------------------------------------------
```

```
spotPython tuning: 2.3902042137002044 [#---------] 10.05%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.45465871034437755, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397736650592876
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.20204398036003113
Epoch: 2

Loss on hold-out set: 2.3976942053381003
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.1863207370042801
Epoch: 3

Loss on hold-out set: 2.3975393794617563
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.22012574970722198
Epoch: 4

Loss on hold-out set: 2.397543232395964
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.22484277188777924
Returned to Spot: Validation loss: 2.397543232395964
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 10.33%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.28625995911126134, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3982129715107106
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15586420893669128
Epoch: 2
```

```
Loss on hold-out set: 2.398104914912471
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15740740299224854
Epoch: 3

Loss on hold-out set: 2.3980824329234935
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15586420893669128
Epoch: 4

Loss on hold-out set: 2.3980617699799716
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15740740299224854
Returned to Spot: Validation loss: 2.3980617699799716
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 10.45%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.3745499929545773, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397679032019849
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1729559749364853
Epoch: 2

Loss on hold-out set: 2.3975020894464456
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.19182389974594116
Epoch: 3

Loss on hold-out set: 2.3973632803503073
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.18867923319339752
Epoch: 4

Loss on hold-out set: 2.3972903152681746
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.18474844098091125
Returned to Spot: Validation loss: 2.3972903152681746
----------------------------------------------
```

```
spotPython tuning: 2.3902042137002044 [#---------] 10.63%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.2846344264989007, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3979833744190358
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.14891976118087769
Epoch: 2

Loss on hold-out set: 2.3978700637817383
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15354938805103302
Epoch: 3

Loss on hold-out set: 2.3978267775641546
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15509261190891266
Epoch: 4

Loss on hold-out set: 2.3977641529507108
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1535494029521942
Returned to Spot: Validation loss: 2.3977641529507108
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 10.77%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.5601421884338609, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.398010589458324
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16589505970478058
Epoch: 2
```

```
Loss on hold-out set: 2.3980492132681386
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.14814817905426025
Epoch: 3

Loss on hold-out set: 2.398044294781155
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.15200617909431458
Epoch: 4

Loss on hold-out set: 2.397984928554959
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.14197532832622528
Returned to Spot: Validation loss: 2.397984928554959
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 10.90%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.6345094073291901, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3979648572427257
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17824074625968933
Epoch: 2

Loss on hold-out set: 2.3980982656832093
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.1458333283662796
Epoch: 3

Loss on hold-out set: 2.397967886041712
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15046298503875732
Epoch: 4

Loss on hold-out set: 2.397998297656024
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15432099997997284
Returned to Spot: Validation loss: 2.397998297656024
----------------------------------------------
```

```
spotPython tuning: 2.3902042137002044 [#---------] 11.03%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.2650199780970888, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3982418466497353
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1458333432674408
Epoch: 2

Loss on hold-out set: 2.3982120443273476
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.14660492539405823
Epoch: 3

Loss on hold-out set: 2.398201492097643
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15046297013759613
Epoch: 4

Loss on hold-out set: 2.3982035054100885
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15123456716537476
Returned to Spot: Validation loss: 2.3982035054100885
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 11.18%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.5209544887449145, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3981302295412337
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1428571492433548
Epoch: 2
```

```
Loss on hold-out set: 2.398073196411133
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1517857164144516
Epoch: 3

Loss on hold-out set: 2.3981550250734602
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1443452537059784
Epoch: 4

Loss on hold-out set: 2.398073502949306
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1644345223903656
Returned to Spot: Validation loss: 2.398073502949306
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 11.37%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.8586493837448784, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.3975763208461256
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.18867924809455872
Epoch: 2

Loss on hold-out set: 2.3974926314263976
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.18946540355682373
Epoch: 3

Loss on hold-out set: 2.3973856017274677
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.19811320304870605
Epoch: 4

Loss on hold-out set: 2.3973484286722146
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.19575469195842743
Returned to Spot: Validation loss: 2.3973484286722146
----------------------------------------------
```

```
spotPython tuning: 2.3902042137002044 [#---------] 11.66%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.24290493766298485, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3975142726191767
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.16049383580684662
Epoch: 2

Loss on hold-out set: 2.3974769115448
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1635802537202835
Epoch: 3

Loss on hold-out set: 2.397496064503988
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.16512346267700195
Epoch: 4

Loss on hold-out set: 2.3974589065269187
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1705247014760971
Returned to Spot: Validation loss: 2.3974589065269187
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 11.81%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.24744039117570946, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.397326802307705
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.17531447112560272
Epoch: 2
```

```
Loss on hold-out set: 2.3972722179484816
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17452828586101532
Epoch: 3

Loss on hold-out set: 2.3973231225643516
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.17059747874736786
Epoch: 4

Loss on hold-out set: 2.3973703384399414
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.17688675224781036
Returned to Spot: Validation loss: 2.3973703384399414
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 11.98%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.36166713512245846, 'lr_mult': 0.001, 'batc


Epoch: 1

Loss on hold-out set: 2.396768961312636
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.22641509771347046
Epoch: 2

Loss on hold-out set: 2.3967626679618403
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.22562891244888306
Epoch: 3

Loss on hold-out set: 2.3967366218566895
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.23034590482711792
Epoch: 4
```

```
Loss on hold-out set: 2.396678033864723
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.22562892735004425
Returned to Spot: Validation loss: 2.396678033864723
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 12.15%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.635876752247523, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3985510817113913
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.13050316274166107
Epoch: 2

Loss on hold-out set: 2.398397387198682
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.13050316274166107
Epoch: 3

Loss on hold-out set: 2.3985333622626537
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1328616440296173
Epoch: 4

Loss on hold-out set: 2.3985817792280666
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.12893083691596985
Returned to Spot: Validation loss: 2.3985817792280666
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 12.32%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.7375228404052402, 'lr_mult': 0.001, 'batcl
Epoch: 1
```

```
Loss on hold-out set: 2.3976266451601713
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.19811318814754486
Epoch: 2

Loss on hold-out set: 2.3978559386055425
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.19261004030704498
Epoch: 3

Loss on hold-out set: 2.397794208436642
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.19025154411792755
Epoch: 4

Loss on hold-out set: 2.3977680296268105
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18003146350383759
Returned to Spot: Validation loss: 2.3977680296268105
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 12.59%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.6636720624894283, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3976789015644
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17138366401195526
Epoch: 2

Loss on hold-out set: 2.397848716321981
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1595912128686905
Epoch: 3

Loss on hold-out set: 2.3976497695131123
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16352200508117676
Epoch: 4
```

```
Loss on hold-out set: 2.397602375948204
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18238990008831024
Returned to Spot: Validation loss: 2.397602375948204
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 12.84%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.26672173915176056, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397974801513384
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15723271667957306
Epoch: 2

Loss on hold-out set: 2.397957608384906
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1595912128686905
Epoch: 3

Loss on hold-out set: 2.39795166141582
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17138367891311646
Epoch: 4

Loss on hold-out set: 2.3978121235685528
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1603773981332779
Returned to Spot: Validation loss: 2.3978121235685528
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 13.03%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.5311666261240556, 'lr_mult': 0.001, 'batc
Epoch: 1
```

```
Loss on hold-out set: 2.3992932427604243
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.1871069073677063
Epoch: 2

Loss on hold-out set: 2.3993096351623535
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1737421452999115
Epoch: 3

Loss on hold-out set: 2.399196872171366
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.17059749364852905
Epoch: 4

Loss on hold-out set: 2.3992410021008186
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.17138364911079407
Returned to Spot: Validation loss: 2.3992410021008186
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 13.22%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.6720642722540953, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.398352582499666
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15172958374023438
Epoch: 2

Loss on hold-out set: 2.3982741787748516
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1462264358997345
Epoch: 3

Loss on hold-out set: 2.398248897408539
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15094339847564697
Epoch: 4
```

```
Loss on hold-out set: 2.3982048709437533
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15172958374023438
Returned to Spot: Validation loss: 2.3982048709437533
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 13.43%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.5106081473860101, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3979286967583424
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17138361930847168
Epoch: 2

Loss on hold-out set: 2.3978238690574214
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18553456664085388
Epoch: 3

Loss on hold-out set: 2.397673118789241
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.165880486369133
Epoch: 4

Loss on hold-out set: 2.3977490056235835
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.17531447112560272
Returned to Spot: Validation loss: 2.3977490056235835
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 13.70%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.26866001434299325, 'lr_mult': 0.001, 'bat
Epoch: 1
```

```
Loss on hold-out set: 2.3972308860634857
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16352201998233795
Epoch: 2

Loss on hold-out set: 2.397194889356505
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16352201998233795
Epoch: 3

Loss on hold-out set: 2.3971977998625555
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16352201998233795
Epoch: 4

Loss on hold-out set: 2.397198602838336
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16430819034576416
Returned to Spot: Validation loss: 2.397198602838336
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 14.02%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.4588211163113285, 'lr_mult': 0.001, 'batc

Epoch: 1

Loss on hold-out set: 2.397672688519513
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17206791043281555
Epoch: 2

Loss on hold-out set: 2.3977677998719393
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17283950746059418
Epoch: 3
```

```
Loss on hold-out set: 2.3976991529817933
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17283953726291656
Epoch: 4

Loss on hold-out set: 2.3975955645243325
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.16820991039276123
Returned to Spot: Validation loss: 2.3975955645243325
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 14.17%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.4939890315481321, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3973462536649883
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.2020440250635147
Epoch: 2

Loss on hold-out set: 2.3972430499094837
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.2004716843366623
Epoch: 3

Loss on hold-out set: 2.397336168109246
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.2004716843366623
Epoch: 4

Loss on hold-out set: 2.397126665655172
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.2012578696012497
Returned to Spot: Validation loss: 2.397126665655172
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 14.37%
```

```
config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.07515077793269308, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.396389603614807
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.203125
Epoch: 2
Loss on hold-out set: 2.3963564123426164
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.203125
Epoch: 3

Loss on hold-out set: 2.396305135318211
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.203125
Epoch: 4

Loss on hold-out set: 2.39634530884879
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.203125
Returned to Spot: Validation loss: 2.39634530884879
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#---------] 14.51%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.4355605400650228, 'lr_mult': 0.001, 'batc

Epoch: 1

Loss on hold-out set: 2.3976666927337646
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.20597483217716217
Epoch: 2

Loss on hold-out set: 2.3974278602959975
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.23742136359214783
Epoch: 3
```

```
Loss on hold-out set: 2.3974145920771472
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.23899370431900024
Epoch: 4

Loss on hold-out set: 2.397259775197731
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.24685531854629517
Returned to Spot: Validation loss: 2.397259775197731
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 15.23%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.11654668035810149, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.39832375730787
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1443452537059784
Epoch: 2

Loss on hold-out set: 2.3983423369271413
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1473214477300644
Epoch: 3

Loss on hold-out set: 2.39826922757285
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1443452537059784
Epoch: 4

Loss on hold-out set: 2.398247071674892
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.146577388048172
Returned to Spot: Validation loss: 2.398247071674892
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 15.38%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.29882397975966435, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3978269010219933
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.17688679695129395
Epoch: 2

Loss on hold-out set: 2.3978829113942273
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16823899745941162
Epoch: 3

Loss on hold-out set: 2.397865133465461
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.18396227061748505
Epoch: 4

Loss on hold-out set: 2.3977660278104387
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18396222591400146
Returned to Spot: Validation loss: 2.3977660278104387
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 15.60%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.3789121100285406, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397589479173933
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1941964328289032
Epoch: 2

Loss on hold-out set: 2.3976379122052873
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1741071492433548
Epoch: 3
```

```
Loss on hold-out set: 2.3975687537874495
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.177827388048172
Epoch: 4

Loss on hold-out set: 2.3974748168672835
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1703868955373764
Returned to Spot: Validation loss: 2.3974748168672835
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 15.77%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.4942477208150857, 'lr_mult': 0.001, 'batcl

Epoch: 1

Loss on hold-out set: 2.398834784825643
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.16358023881912231
Epoch: 2

Loss on hold-out set: 2.398810589755023
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1496913731098175
Epoch: 3

Loss on hold-out set: 2.3988358268031367
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15586420893669128
Epoch: 4

Loss on hold-out set: 2.3987788182717784
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1566358208656311
Returned to Spot: Validation loss: 2.3987788182717784
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 15.98%
```

```
config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.8368900341925468, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3978119237082347
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.1964285671710968
Epoch: 2

Loss on hold-out set: 2.397740909031459
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1964285671710968
Epoch: 3
Loss on hold-out set: 2.397888047354562
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.1889880895614624
Epoch: 4

Loss on hold-out set: 2.397826978138515
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.171875
Returned to Spot: Validation loss: 2.397826978138515
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 16.16%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.6167127713201095, 'lr_mult': 0.001, 'batc

Epoch: 1

Loss on hold-out set: 2.3987539016975545
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.1399371325969696
Epoch: 2

Loss on hold-out set: 2.3986634263452493
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.14072328805923462
Epoch: 3
```

```
Loss on hold-out set: 2.3986424072733463
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1462264358997345
Epoch: 4

Loss on hold-out set: 2.3987978404422976
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.13836480677127838
Returned to Spot: Validation loss: 2.3987978404422976
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 16.52%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.8244723629938487, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3979532100536205
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16975310444831848
Epoch: 2

Loss on hold-out set: 2.3979541195763483
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.18518520891666412
Epoch: 3

Loss on hold-out set: 2.3981277677747936
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1597222238779068
Epoch: 4

Loss on hold-out set: 2.3979006784933583
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.19675923883914948
Returned to Spot: Validation loss: 2.3979006784933583
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 16.72%
```

```
config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.13156632137109295, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3975904347761623
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.19654089212417603
Epoch: 2

Loss on hold-out set: 2.397472084693189
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.20676101744174957
Epoch: 3

Loss on hold-out set: 2.397426135135147
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.20676100254058838
Epoch: 4

Loss on hold-out set: 2.397266817542742
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.21776728332042694
Returned to Spot: Validation loss: 2.397266817542742
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 17.03%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.6812460730725531, 'lr_mult': 0.001, 'bat

Epoch: 1

Loss on hold-out set: 2.3979199922309733
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16352201998233795
Epoch: 2

Loss on hold-out set: 2.397885853389524
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.16588053107261658
Epoch: 3
```

```
Loss on hold-out set: 2.3978281785857
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1603773534297943
Epoch: 4

Loss on hold-out set: 2.397732289332264
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15959122776985168
Returned to Spot: Validation loss: 2.397732289332264
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 17.49%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.8867448701875924, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.397872492119118
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.16743828356266022
Epoch: 2

Loss on hold-out set: 2.397682225262677
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.16898147761821747
Epoch: 3

Loss on hold-out set: 2.3979232664461487
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18904322385787964
Epoch: 4

Loss on hold-out set: 2.3977354720786765
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.19907405972480774
Returned to Spot: Validation loss: 2.3977354720786765
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 17.69%
```

```
config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.5803931428770518, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397924094829919
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17610062658786774
Epoch: 2

Loss on hold-out set: 2.397965485194944
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.17216980457305908
Epoch: 3

Loss on hold-out set: 2.397957190027777
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.17531447112560272
Epoch: 4

Loss on hold-out set: 2.398007289418634
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.19103771448135376
Returned to Spot: Validation loss: 2.398007289418634
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 17.97%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.11548907270294066, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3981352382236056
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.15123456716537476
Epoch: 2

Loss on hold-out set: 2.398007384052983
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.14737655222415924
Epoch: 3
```

```
Loss on hold-out set: 2.39789820600439
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.14737655222415924
Epoch: 4

Loss on hold-out set: 2.3977920126031944
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1388888955116272
Returned to Spot: Validation loss: 2.3977920126031944
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 18.21%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.1094005407566867, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397827296886804
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.18238992989063263
Epoch: 2

Loss on hold-out set: 2.397760751112452
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.18317611515522003
Epoch: 3

Loss on hold-out set: 2.3977438278917997
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.19025155901908875
Epoch: 4

Loss on hold-out set: 2.3977198015968755
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.19575472176074982
Returned to Spot: Validation loss: 2.3977198015968755
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 18.49%
```

```
config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.49831961495583466, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3981354943028204
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16435185074806213
Epoch: 2

Loss on hold-out set: 2.3981304875126592
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.15586420893669128
Epoch: 3

Loss on hold-out set: 2.3981431501883046
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1527777910232544
Epoch: 4

Loss on hold-out set: 2.398089223437839
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.15740740299224854
Returned to Spot: Validation loss: 2.398089223437839
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 18.73%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.478245760294912, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.398087297167097
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1651785671710968
Epoch: 2
Loss on hold-out set: 2.3981213058744157
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1473214328289032
Epoch: 3
```

```
Loss on hold-out set: 2.3981143747057234
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1622023731470108
Epoch: 4
Loss on hold-out set: 2.397971374647958
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.1711309403181076
Returned to Spot: Validation loss: 2.397971374647958
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 18.95%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.6132967326351793, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397539701101915
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.21069185435771942
Epoch: 2

Loss on hold-out set: 2.397521383357498
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.21383647620677948
Epoch: 3

Loss on hold-out set: 2.3973407430468865
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.21147798001766205
Epoch: 4

Loss on hold-out set: 2.3972816017438783
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.2287735641002655
Returned to Spot: Validation loss: 2.3972816017438783
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 19.24%
```

```
config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.23276754880203154, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3976698236645393
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18238992989063263
Epoch: 2

Loss on hold-out set: 2.3977011644615316
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18238992989063263
Epoch: 3

Loss on hold-out set: 2.3976170611831376
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18238992989063263
Epoch: 4

Loss on hold-out set: 2.397673026570734
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.18238992989063263
Returned to Spot: Validation loss: 2.397673026570734
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 19.52%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.2431173831408648, 'lr_mult': 0.001, 'batch
Epoch: 1

Loss on hold-out set: 2.397927233151027
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.162946417927742
Epoch: 2
Loss on hold-out set: 2.397885356630598
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1584821492433548
Epoch: 3
```

```
Loss on hold-out set: 2.3978703192302158
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1629464328289032
Epoch: 4
Loss on hold-out set: 2.397885322570801
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1733630895614624
Returned to Spot: Validation loss: 2.397885322570801
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 19.73%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.01513589825644096, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3977033507149175
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15487425029277802
Epoch: 2

Loss on hold-out set: 2.3976822979045362
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15487425029277802
Epoch: 3

Loss on hold-out set: 2.397660646798476
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15487425029277802
Epoch: 4

Loss on hold-out set: 2.3976404824346864
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15487425029277802
Returned to Spot: Validation loss: 2.3976404824346864
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 20.08%
```

```
config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.31016441943384926, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397874985422407
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1473214328289032
Epoch: 2

Loss on hold-out set: 2.397680333682469
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1547619104385376
Epoch: 3

Loss on hold-out set: 2.3975264515195573
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1875
Epoch: 4

Loss on hold-out set: 2.3973787682397023
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1800595223903656
Returned to Spot: Validation loss: 2.3973787682397023
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 20.32%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.10123541888783366, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397994218049226
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.18287037312984467
Epoch: 2

Loss on hold-out set: 2.3979415275432445
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1766975373029709
Epoch: 3
```

```
Loss on hold-out set: 2.397900378262555
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1766975373029709
Epoch: 4

Loss on hold-out set: 2.397847776059751
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1766975373029709
Returned to Spot: Validation loss: 2.397847776059751
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 21.32%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.42913010110548067, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3975454636339872
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.18553459644317627
Epoch: 2

Loss on hold-out set: 2.3976307275160305
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.17531447112560272
Epoch: 3

Loss on hold-out set: 2.3975423911832414
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.18474844098091125
Epoch: 4

Loss on hold-out set: 2.3976163099396905
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.18553458154201508
Returned to Spot: Validation loss: 2.3976163099396905
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 22.20%
```

```
config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.3275022803848954, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.39790255682809
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.159226194024086
Epoch: 2

Loss on hold-out set: 2.3979016712733676
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.159226194024086
Epoch: 3

Loss on hold-out set: 2.3977448088782176
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1800595223903656
Epoch: 4

Loss on hold-out set: 2.3976878779275075
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1696428507566452
Returned to Spot: Validation loss: 2.3976878779275075
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 23.03%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.42897294251890355, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3979523496807746
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.14386793971061707
Epoch: 2

Loss on hold-out set: 2.397962102350199
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.14308176934719086
Epoch: 3
```

```
Loss on hold-out set: 2.3980225347123056
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.138364776968956
Epoch: 4

Loss on hold-out set: 2.3979325204525352
Accuracy on hold-out set: 0.04716981132075472
MAPK value on hold-out data: 0.14858491718769073
Returned to Spot: Validation loss: 2.3979325204525352
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 23.88%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.46996641442364834, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3966413893789613
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.14858494699001312
Epoch: 2

Loss on hold-out set: 2.3967035311572955
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15172956883907318
Epoch: 3

Loss on hold-out set: 2.396566624911326
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.15094341337680817
Epoch: 4

Loss on hold-out set: 2.396790378498581
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.15408805012702942
Returned to Spot: Validation loss: 2.396790378498581
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##--------] 24.81%
```

```
config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.009699514739187665, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397638201713562
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17924527823925018
Epoch: 2

Loss on hold-out set: 2.3975867887712874
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17924527823925018
Epoch: 3

Loss on hold-out set: 2.3975271593849614
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17924527823925018
Epoch: 4

Loss on hold-out set: 2.3974670689061
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17924527823925018
Returned to Spot: Validation loss: 2.3974670689061
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 25.80%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.1397217765002243, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3978253625473887
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.14308178424835205
Epoch: 2

Loss on hold-out set: 2.397835232176871
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1399371176958084
Epoch: 3
```

```
Loss on hold-out set: 2.397744912021565
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1399371325969696
Epoch: 4

Loss on hold-out set: 2.397723715260344
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.14386793971061707
Returned to Spot: Validation loss: 2.397723715260344
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 26.65%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.11001746050022188, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397850697895266
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.17216983437538147
Epoch: 2

Loss on hold-out set: 2.3977306518914565
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17845915257930756
Epoch: 3

Loss on hold-out set: 2.3976314067840576
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18238994479179382
Epoch: 4

Loss on hold-out set: 2.397530645694373
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18474844098091125
Returned to Spot: Validation loss: 2.397530645694373
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 27.57%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.4172288580201352, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3983165633003667
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15487420558929443
Epoch: 2

Loss on hold-out set: 2.398278623257043
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15644654631614685
Epoch: 3

Loss on hold-out set: 2.398328241312279
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1603773534297943
Epoch: 4

Loss on hold-out set: 2.3982995231196567
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.16352200508117676
Returned to Spot: Validation loss: 2.3982995231196567
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 28.47%


config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.27704058285336897, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.399774038566733
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.15172956883907318
Epoch: 2

Loss on hold-out set: 2.3997422209325827
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.14937108755111694
Epoch: 3
```

```
Loss on hold-out set: 2.3997483028555817
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1533018797636032
Epoch: 4

Loss on hold-out set: 2.399688851158574
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.15172956883907318
Returned to Spot: Validation loss: 2.399688851158574
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 29.34%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.3881890452915246, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3981060666858025
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1603773534297943
Epoch: 2

Loss on hold-out set: 2.3979302284852513
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.15408805012702942
Epoch: 3

Loss on hold-out set: 2.3979185302302524
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15566037595272064
Epoch: 4

Loss on hold-out set: 2.3977738326450564
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.19103772938251495
Returned to Spot: Validation loss: 2.3977738326450564
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 30.35%
```

```
config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.36895509123433334, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3994112284678333
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1533019095659256
Epoch: 2

Loss on hold-out set: 2.3992445154010125
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1533019095659256
Epoch: 3

Loss on hold-out set: 2.3993381216840923
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.15723271667957306
Epoch: 4

Loss on hold-out set: 2.399350308022409
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15487422049045563
Returned to Spot: Validation loss: 2.399350308022409
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 31.30%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.7935318995459109, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397728988102504
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1875
Epoch: 2

Loss on hold-out set: 2.397856150354658
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1800595223903656
Epoch: 3
```

```
Loss on hold-out set: 2.3976219722202847
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.209077388048172
Epoch: 4

Loss on hold-out set: 2.39758631161281
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1889880895614624
Returned to Spot: Validation loss: 2.39758631161281
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 32.18%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.4710472795678196, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.397166614179258
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.19598764181137085
Epoch: 2

Loss on hold-out set: 2.3970942585556596
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.19212962687015533
Epoch: 3

Loss on hold-out set: 2.397097905476888
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1944444477558136
Epoch: 4

Loss on hold-out set: 2.397112581464979
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1975308507680893
Returned to Spot: Validation loss: 2.397112581464979
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 33.05%
```

```
config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.8195974031663599, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3980048782420607
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.12735849618911743
Epoch: 2

Loss on hold-out set: 2.3978255739751853
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.13600631058216095
Epoch: 3

Loss on hold-out set: 2.397891930814059
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.16823899745941162
Epoch: 4

Loss on hold-out set: 2.3977184385623573
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16430817544460297
Returned to Spot: Validation loss: 2.3977184385623573
----------------------------------------------

spotPython tuning: 2.3902042137002044 [###-------] 34.02%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.485316841383955, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3974357888383686
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.21383647620677948
Epoch: 2

Loss on hold-out set: 2.3975933565283722
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.20833329856395721
Epoch: 3
```

```
Loss on hold-out set: 2.3976434806607805
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.21226412057876587
Epoch: 4

Loss on hold-out set: 2.397354305915113
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.2216980904340744
Returned to Spot: Validation loss: 2.397354305915113
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 35.16%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.5521541276635835, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.398275663267891
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.1391509473323822
Epoch: 2

Loss on hold-out set: 2.3982314658614823
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.138364776968956
Epoch: 3

Loss on hold-out set: 2.398273508503752
Accuracy on hold-out set: 0.05660377358490566
MAPK value on hold-out data: 0.13364781439304352
Epoch: 4

Loss on hold-out set: 2.3982168098665633
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.12971700727939606
Returned to Spot: Validation loss: 2.3982168098665633
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 36.13%
```

```
config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.4286259094831192, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.397925367895162
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16430819034576416
Epoch: 2

Loss on hold-out set: 2.3978680439715117
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1666666716337204
Epoch: 3

Loss on hold-out set: 2.397842805340605
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16902515292167664
Epoch: 4

Loss on hold-out set: 2.3978557541685284
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.16902515292167664
Returned to Spot: Validation loss: 2.3978557541685284
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 37.15%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.4976005796813294, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3974842760297985
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1913580298423767
Epoch: 2

Loss on hold-out set: 2.3974397623980486
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1983024775981903
Epoch: 3
```

```
Loss on hold-out set: 2.3974183400472007
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.20216049253940582
Epoch: 4

Loss on hold-out set: 2.397331794102987
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.19675925374031067
Returned to Spot: Validation loss: 2.397331794102987
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 38.07%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.14496135146071007, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.397730747858683
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17515429854393005
Epoch: 2

Loss on hold-out set: 2.397618231949983
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1805555671453476
Epoch: 3

Loss on hold-out set: 2.397555121669063
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.18209877610206604
Epoch: 4

Loss on hold-out set: 2.3974722491370306
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.19367285072803497
Returned to Spot: Validation loss: 2.3974722491370306
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 38.96%
```

```
config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.13836940708432457, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.397435075831863
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1611635684967041
Epoch: 2

Loss on hold-out set: 2.3974114993833147
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1611635684967041
Epoch: 3

Loss on hold-out set: 2.3973211882249363
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1611635684967041
Epoch: 4

Loss on hold-out set: 2.397363833661349
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.1611635684967041
Returned to Spot: Validation loss: 2.397363833661349
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 39.98%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.5801902947427491, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.398190178961124
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1674528270959854
Epoch: 2

Loss on hold-out set: 2.398198478626755
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1666666567325592
Epoch: 3
```

```
Loss on hold-out set: 2.398295371037609
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16823898255825043
Epoch: 4

Loss on hold-out set: 2.3982581777392693
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1666666567325592
Returned to Spot: Validation loss: 2.3982581777392693
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 40.98%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.17042327589486472, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3975246672360404
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.17610065639019012
Epoch: 2

Loss on hold-out set: 2.397397536151814
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.1603773534297943
Epoch: 3

Loss on hold-out set: 2.3972327259351625
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.16352201998233795
Epoch: 4

Loss on hold-out set: 2.396936745013831
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.18396222591400146
Returned to Spot: Validation loss: 2.396936745013831
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 42.03%
```

```
config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.6944080618643941, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.397896722511009
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16203702986240387
Epoch: 2

Loss on hold-out set: 2.3977690714376942
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16203702986240387
Epoch: 3

Loss on hold-out set: 2.397875220687301
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16203702986240387
Epoch: 4

Loss on hold-out set: 2.397785787229185
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16203702986240387
Returned to Spot: Validation loss: 2.397785787229185
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 42.90%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.18151742556849865, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.397193585123335
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1287202388048172
Epoch: 2
Loss on hold-out set: 2.397168380873544
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1331845372915268
Epoch: 3
```

```
Loss on hold-out set: 2.397194266319275
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1302083283662796
Epoch: 4
Loss on hold-out set: 2.397180812699454
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1302083283662796
Returned to Spot: Validation loss: 2.397180812699454
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 43.76%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.845806549101736, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3981295426686606
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1736111342906952
Epoch: 2

Loss on hold-out set: 2.3981412340093544
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1666666716337204
Epoch: 3

Loss on hold-out set: 2.3981462054782443
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16743828356266022
Epoch: 4

Loss on hold-out set: 2.3982342967280634
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1635802537202835
Returned to Spot: Validation loss: 2.3982342967280634
----------------------------------------------

spotPython tuning: 2.3902042137002044 [####------] 44.75%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.6819098090533308, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3970033857557507
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.20601850748062134
Epoch: 2

Loss on hold-out set: 2.397075061444883
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.20601847767829895
Epoch: 3

Loss on hold-out set: 2.3970775957460755
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.2075617015361786
Epoch: 4

Loss on hold-out set: 2.3971067976068565
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.2044752985239029
Returned to Spot: Validation loss: 2.3971067976068565
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 45.64%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.7823474508265778, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3998645146687827
Accuracy on hold-out set: 0.05188679245283019
MAPK value on hold-out data: 0.12654320895671844
Epoch: 2

Loss on hold-out set: 2.3998593577632197
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.13271605968475342
Epoch: 3
```

```
Loss on hold-out set: 2.3999909118369773
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.13040123879909515
Epoch: 4

Loss on hold-out set: 2.399887102621573
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.13425926864147186
Returned to Spot: Validation loss: 2.399887102621573
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 46.55%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.13146501575689384, 'lr_mult': 0.001, 'ba

Epoch: 1

Loss on hold-out set: 2.3977129459381104
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1793154776096344
Epoch: 2

Loss on hold-out set: 2.397614053317479
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1793154627084732
Epoch: 3

Loss on hold-out set: 2.3974887473242625
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.1815476268529892
Epoch: 4

Loss on hold-out set: 2.39740058353969
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.18824402987957
Returned to Spot: Validation loss: 2.39740058353969
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 47.55%
```

```
config: {'_L0': 6112, 'l1': 64, 'dropout_prob': 0.2446977986186115, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.399412600499279
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.12735851109027863
Epoch: 2

Loss on hold-out set: 2.3993779668268167
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.13286162912845612
Epoch: 3

Loss on hold-out set: 2.399328776125638
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.13050314784049988
Epoch: 4

Loss on hold-out set: 2.3992513125797488
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.12971697747707367
Returned to Spot: Validation loss: 2.3992513125797488
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 48.56%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.08398712704828415, 'lr_mult': 0.001, 'ba
Epoch: 1

Loss on hold-out set: 2.3977577774612993
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18518517911434174
Epoch: 2

Loss on hold-out set: 2.3977483025303594
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1805555522441864
Epoch: 3
```

```
Loss on hold-out set: 2.3977019963441073
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18364198505878448
Epoch: 4

Loss on hold-out set: 2.397665827362626
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18672838807106018
Returned to Spot: Validation loss: 2.397665827362626
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 49.50%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.741680944794142, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3970870476848676
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.2075471580028534
Epoch: 2

Loss on hold-out set: 2.396780684309186
Accuracy on hold-out set: 0.14150943396226415
MAPK value on hold-out data: 0.22720122337341309
Epoch: 3

Loss on hold-out set: 2.3971783575021997
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.19889935851097107
Epoch: 4

Loss on hold-out set: 2.3969393946089834
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.21226415038108826
Returned to Spot: Validation loss: 2.3969393946089834
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 50.48%
```

```
config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.6118972948552678, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3984304622367576
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1427469253540039
Epoch: 2

Loss on hold-out set: 2.3985359757034868
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1427469253540039
Epoch: 3

Loss on hold-out set: 2.398448838127984
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.14120371639728546
Epoch: 4

Loss on hold-out set: 2.3984469484399864
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1427469253540039
Returned to Spot: Validation loss: 2.3984469484399864
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 52.09%


config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.8836040809557936, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.397219810845717
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.19261005520820618
Epoch: 2

Loss on hold-out set: 2.397331561682359
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1878930777311325
Epoch: 3
```

```
Loss on hold-out set: 2.3974678066541566
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.18474839627742767
Epoch: 4

Loss on hold-out set: 2.3972930548326024
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.20597484707832336
Returned to Spot: Validation loss: 2.3972930548326024
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#####-----] 53.66%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.6828598557259881, 'lr_mult': 0.001, 'bat

Epoch: 1

Loss on hold-out set: 2.397495942295722
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.2138364613056183
Epoch: 2

Loss on hold-out set: 2.3974736096724025
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.20361633598804474
Epoch: 3

Loss on hold-out set: 2.3974587265050635
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.21698114275932312
Epoch: 4

Loss on hold-out set: 2.397343203706561
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.22169813513755798
Returned to Spot: Validation loss: 2.397343203706561
----------------------------------------------

spotPython tuning: 2.3902042137002044 [######----] 55.68%
```

```
config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.2048863228384369, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3973266056605746
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2135416567325592
Epoch: 2

Loss on hold-out set: 2.3972513675689697
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2105654925107956
Epoch: 3

Loss on hold-out set: 2.3971908603395735
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2120535671710968
Epoch: 4

Loss on hold-out set: 2.3971628291266307
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.2150297611951828
Returned to Spot: Validation loss: 2.3971628291266307
----------------------------------------------

spotPython tuning: 2.3902042137002044 [######----] 57.14%


config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.25734725660463714, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.396787370954241
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1860118955373764
Epoch: 2
Loss on hold-out set: 2.396839039666312
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1897321194410324
Epoch: 3
```

```
Loss on hold-out set: 2.3968742234366283
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1852678805589676
Epoch: 4
Loss on hold-out set: 2.3968630858830045
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1897321492433548
Returned to Spot: Validation loss: 2.3968630858830045
----------------------------------------------

spotPython tuning: 2.3902042137002044 [######----] 58.62%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.0, 'lr_mult': 0.001, 'batch_size': 2, 'ep

Epoch: 1

Loss on hold-out set: 2.3972377507191784
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.19968552887439728
Epoch: 2

Loss on hold-out set: 2.3965774122274146
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.2272012084722519
Epoch: 3

Loss on hold-out set: 2.395705322049699
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.29402512311935425
Epoch: 4

Loss on hold-out set: 2.394494306366399
Accuracy on hold-out set: 0.16981132075471697
MAPK value on hold-out data: 0.32154080271720886
Returned to Spot: Validation loss: 2.394494306366399
----------------------------------------------

spotPython tuning: 2.3902042137002044 [######----] 60.36%
```

```
config: {'_L0': 6112, 'l1': 128, 'dropout_prob': 0.8133574987740698, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.398046855573301
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.1766975373029709
Epoch: 2

Loss on hold-out set: 2.3978320051122597
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1913580298423767
Epoch: 3

Loss on hold-out set: 2.3980574519545943
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.16589505970478058
Epoch: 4

Loss on hold-out set: 2.397911451481007
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1705246865749359
Returned to Spot: Validation loss: 2.397911451481007
----------------------------------------------

spotPython tuning: 2.3902042137002044 [######----] 61.96%


config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.7205640272201753, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3972875277201333
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.21836422383785248
Epoch: 2

Loss on hold-out set: 2.397379000981649
Accuracy on hold-out set: 0.1650943396226415
MAPK value on hold-out data: 0.2361111342906952
Epoch: 3
```

```
Loss on hold-out set: 2.397274370546694
Accuracy on hold-out set: 0.14622641509433962
MAPK value on hold-out data: 0.22453702986240387
Epoch: 4

Loss on hold-out set: 2.3973646605456316
Accuracy on hold-out set: 0.1650943396226415
MAPK value on hold-out data: 0.2330247014760971
Returned to Spot: Validation loss: 2.3973646605456316
----------------------------------------------

spotPython tuning: 2.3902042137002044 [######----] 63.50%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.4659097463315249, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3977778182839447
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.16588051617145538
Epoch: 2

Loss on hold-out set: 2.397798290792501
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.1745283007621765
Epoch: 3

Loss on hold-out set: 2.397653138862466
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.17767298221588135
Epoch: 4

Loss on hold-out set: 2.397563880344607
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.19182388484477997
Returned to Spot: Validation loss: 2.397563880344607
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#######---] 65.20%
```

```
config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.26100947890737286, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3975224359980167
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.23034588992595673
Epoch: 2

Loss on hold-out set: 2.3974381347872176
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.2358490377664566
Epoch: 3

Loss on hold-out set: 2.397486830657383
Accuracy on hold-out set: 0.13679245283018868
MAPK value on hold-out data: 0.23113204538822174
Epoch: 4

Loss on hold-out set: 2.3974846219116785
Accuracy on hold-out set: 0.1509433962264151
MAPK value on hold-out data: 0.23899370431900024
Returned to Spot: Validation loss: 2.3974846219116785
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#######---] 66.49%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.14133324996300126, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.397508003093578
Accuracy on hold-out set: 0.06132075471698113
MAPK value on hold-out data: 0.15432099997997284
Epoch: 2

Loss on hold-out set: 2.3974840905931263
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.16049383580684662
Epoch: 3
```

```
Loss on hold-out set: 2.3974933977480286
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.16049383580684662
Epoch: 4

Loss on hold-out set: 2.3974753574088767
Accuracy on hold-out set: 0.07075471698113207
MAPK value on hold-out data: 0.15740740299224854
Returned to Spot: Validation loss: 2.3974753574088767
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#######---] 67.83%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.4170417014598732, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3986815191664785
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.17767296731472015
Epoch: 2

Loss on hold-out set: 2.3985044911222637
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18317610025405884
Epoch: 3

Loss on hold-out set: 2.3985716306938314
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1808176189661026
Epoch: 4

Loss on hold-out set: 2.398504873491683
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.17767296731472015
Returned to Spot: Validation loss: 2.398504873491683
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#######---] 69.15%
```

```
config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.842083400118517, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.397791266441345
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1729559749364853
Epoch: 2

Loss on hold-out set: 2.3976001132209346
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.15487420558929443
Epoch: 3

Loss on hold-out set: 2.397475505774876
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.15880507230758667
Epoch: 4

Loss on hold-out set: 2.3977351818444594
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.16902516782283783
Returned to Spot: Validation loss: 2.3977351818444594
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#######---] 70.69%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.45265126172387354, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3976814835159868
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18518517911434174
Epoch: 2

Loss on hold-out set: 2.397609330989696
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.19058643281459808
Epoch: 3
```

```
Loss on hold-out set: 2.3976711255532726
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18518516421318054
Epoch: 4

Loss on hold-out set: 2.3976512220170765
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18827159702777863
Returned to Spot: Validation loss: 2.3976512220170765
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#######---] 72.49%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.6521375725215124, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.3977796413280346
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.1805555522441864
Epoch: 2

Loss on hold-out set: 2.397735560381854
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18981482088565826
Epoch: 3

Loss on hold-out set: 2.3978831591429532
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.1628086268901825
Epoch: 4

Loss on hold-out set: 2.3976104436097323
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.17901232838630676
Returned to Spot: Validation loss: 2.3976104436097323
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#######---] 74.32%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.3383016235198576, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.397430040218212
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1736110895872116
Epoch: 2

Loss on hold-out set: 2.397418746241817
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.17438271641731262
Epoch: 3

Loss on hold-out set: 2.3974168212325484
Accuracy on hold-out set: 0.07547169811320754
MAPK value on hold-out data: 0.16820989549160004
Epoch: 4

Loss on hold-out set: 2.3973486158582897
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.17824071645736694
Returned to Spot: Validation loss: 2.3973486158582897
----------------------------------------------

spotPython tuning: 2.3902042137002044 [########--] 76.11%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.5557762868147353, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.397580759865897
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1733630895614624
Epoch: 2
Loss on hold-out set: 2.3975538866860524
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.169642835855484
Epoch: 3
```

```
Loss on hold-out set: 2.3975383043289185
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1741071492433548
Epoch: 4
Loss on hold-out set: 2.397577796663557
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1726190596818924
Returned to Spot: Validation loss: 2.397577796663557
----------------------------------------------

spotPython tuning: 2.3902042137002044 [########--] 77.92%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.3960656185686954, 'lr_mult': 0.001, 'batcl
Epoch: 1

Loss on hold-out set: 2.398147432892411
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1496913731098175
Epoch: 2

Loss on hold-out set: 2.398108817912914
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.15200617909431458
Epoch: 3

Loss on hold-out set: 2.3981803788079157
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.1496913880109787
Epoch: 4

Loss on hold-out set: 2.398163574713248
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.14891976118087769
Returned to Spot: Validation loss: 2.398163574713248
----------------------------------------------

spotPython tuning: 2.3902042137002044 [########--] 79.81%
```

```
config: {'_L0': 6112, 'l1': 1024, 'dropout_prob': 0.7197427001001562, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3986228571997747
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.13811728358268738
Epoch: 2

Loss on hold-out set: 2.398661013002749
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.14120370149612427
Epoch: 3

Loss on hold-out set: 2.3983423798172563
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.14814814925193787
Epoch: 4

Loss on hold-out set: 2.398359033796522
Accuracy on hold-out set: 0.0660377358490566
MAPK value on hold-out data: 0.14891977608203888
Returned to Spot: Validation loss: 2.398359033796522
----------------------------------------------

spotPython tuning: 2.3902042137002044 [########--] 81.66%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.2646409009865908, 'lr_mult': 0.001, 'batch
Epoch: 1

Loss on hold-out set: 2.397777116523599
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1682390421628952
Epoch: 2

Loss on hold-out set: 2.397796536391636
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16981135308742523
Epoch: 3
```

```
Loss on hold-out set: 2.397752323240604
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16509436070919037
Epoch: 4

Loss on hold-out set: 2.3977390730156087
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.16194970905780792
Returned to Spot: Validation loss: 2.3977390730156087
----------------------------------------------

spotPython tuning: 2.3902042137002044 [########--] 83.62%


config: {'_L0': 6112, 'l1': 2048, 'dropout_prob': 0.5248603612218159, 'lr_mult': 0.001, 'bat
Epoch: 1

Loss on hold-out set: 2.397766302216728
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.165880486369133
Epoch: 2

Loss on hold-out set: 2.397733319480464
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.16273584961891174
Epoch: 3

Loss on hold-out set: 2.397822676964526
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.15172958374023438
Epoch: 4

Loss on hold-out set: 2.397603174425521
Accuracy on hold-out set: 0.08962264150943396
MAPK value on hold-out data: 0.1737421303987503
Returned to Spot: Validation loss: 2.397603174425521
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#########-] 85.50%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.09102790307682074, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.398026713618526
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.16898147761821747
Epoch: 2

Loss on hold-out set: 2.397984857912417
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1697530895471573
Epoch: 3

Loss on hold-out set: 2.3979783058166504
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.17129629850387573
Epoch: 4

Loss on hold-out set: 2.3979638947380915
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1705246865749359
Returned to Spot: Validation loss: 2.3979638947380915
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#########-] 87.44%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.27743146585565065, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3987128646285445
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.17206791043281555
Epoch: 2

Loss on hold-out set: 2.398590052569354
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.17206791043281555
Epoch: 3
```

```
Loss on hold-out set: 2.3985890635737666
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.17438270151615143
Epoch: 4

Loss on hold-out set: 2.398565504286024
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.1736111044883728
Returned to Spot: Validation loss: 2.398565504286024
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#########-] 89.39%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.629242067183181, 'lr_mult': 0.001, 'batcl

Epoch: 1

Loss on hold-out set: 2.39798447063991
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.1636904776096344
Epoch: 2

Loss on hold-out set: 2.397762417793274
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.159226194024086
Epoch: 3

Loss on hold-out set: 2.397850343159267
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1837797462940216
Epoch: 4

Loss on hold-out set: 2.39785213129861
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.1875
Returned to Spot: Validation loss: 2.39785213129861
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#########-] 91.32%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.293693815474021, 'lr_mult': 0.001, 'batch_
Epoch: 1

Loss on hold-out set: 2.3970746409218266
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.20361635088920593
Epoch: 2

Loss on hold-out set: 2.397069769085578
Accuracy on hold-out set: 0.12264150943396226
MAPK value on hold-out data: 0.21776726841926575
Epoch: 3

Loss on hold-out set: 2.3969887067686835
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.21069180965423584
Epoch: 4

Loss on hold-out set: 2.397068482524944
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.2075471729040146
Returned to Spot: Validation loss: 2.397068482524944
----------------------------------------------

spotPython tuning: 2.3902042137002044 [#########-] 93.27%


config: {'_L0': 6112, 'l1': 256, 'dropout_prob': 0.4062621046778781, 'lr_mult': 0.001, 'batch
Epoch: 1

Loss on hold-out set: 2.397450361611708
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.1863207370042801
Epoch: 2

Loss on hold-out set: 2.397417779238719
Accuracy on hold-out set: 0.10849056603773585
MAPK value on hold-out data: 0.18317610025405884
Epoch: 3
```

```
Loss on hold-out set: 2.3974153838067687
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.18553456664085388
Epoch: 4

Loss on hold-out set: 2.3972904997051887
Accuracy on hold-out set: 0.1320754716981132
MAPK value on hold-out data: 0.1949685513973236
Returned to Spot: Validation loss: 2.3972904997051887
----------------------------------------------

spotPython tuning: 2.3902042137002044 [##########] 95.27%


config: {'_L0': 6112, 'l1': 8192, 'dropout_prob': 0.0, 'lr_mult': 0.001, 'batch_size': 2, 'ep

Epoch: 1

Loss on hold-out set: 2.3967885543715277
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.21226412057876587
Epoch: 2

Loss on hold-out set: 2.3951775780263937
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.21855342388153076
Epoch: 3

Loss on hold-out set: 2.392407349820407
Accuracy on hold-out set: 0.09433962264150944
MAPK value on hold-out data: 0.21855337917804718
Epoch: 4

Loss on hold-out set: 2.3887657849293835
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.23820750415325165
Returned to Spot: Validation loss: 2.3887657849293835
----------------------------------------------

spotPython tuning: 2.3887657849293835 [##########] 97.47%
```

```
config: {'_L0': 6112, 'l1': 512, 'dropout_prob': 0.03867052194446709, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3977508544921875
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.13050316274166107
Epoch: 2

Loss on hold-out set: 2.3977252987195863
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.12893083691596985
Epoch: 3

Loss on hold-out set: 2.3977012274400242
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.13522015511989594
Epoch: 4

Loss on hold-out set: 2.3976765308740005
Accuracy on hold-out set: 0.08490566037735849
MAPK value on hold-out data: 0.1336478292942047
Returned to Spot: Validation loss: 2.3976765308740005
----------------------------------------------

spotPython tuning: 2.3887657849293835 [##########] 99.22%


config: {'_L0': 6112, 'l1': 4096, 'dropout_prob': 0.3929002392549308, 'lr_mult': 0.001, 'batc
Epoch: 1

Loss on hold-out set: 2.3977273950036966
Accuracy on hold-out set: 0.08018867924528301
MAPK value on hold-out data: 0.18474841117858887
Epoch: 2

Loss on hold-out set: 2.3975204656708917
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.19732703268527985
Epoch: 3
```

```
Loss on hold-out set: 2.3972781874098867
Accuracy on hold-out set: 0.09905660377358491
MAPK value on hold-out data: 0.24371063709259033
Epoch: 4

Loss on hold-out set: 2.3970412173361146
Accuracy on hold-out set: 0.1179245283018868
MAPK value on hold-out data: 0.23191821575164795
Returned to Spot: Validation loss: 2.3970412173361146
----------------------------------------------

spotPython tuning: 2.3887657849293835 [##########] 100.00% Done...

<spotPython.spot.spot.Spot at 0x2ba21b700>
```

28.6 Tensorboard

The textual output shown in the console (or code cell) can be visualized with Tensorboard as described in Section 20.13.

28.7 Results

After the hyperparameter tuning run is finished, the results can be analyzed as described in Section 20.14.

```
spot_tuner.plot_progress(log_y=False,
    filename="./figures/" + experiment_name+"_progress.png")
```

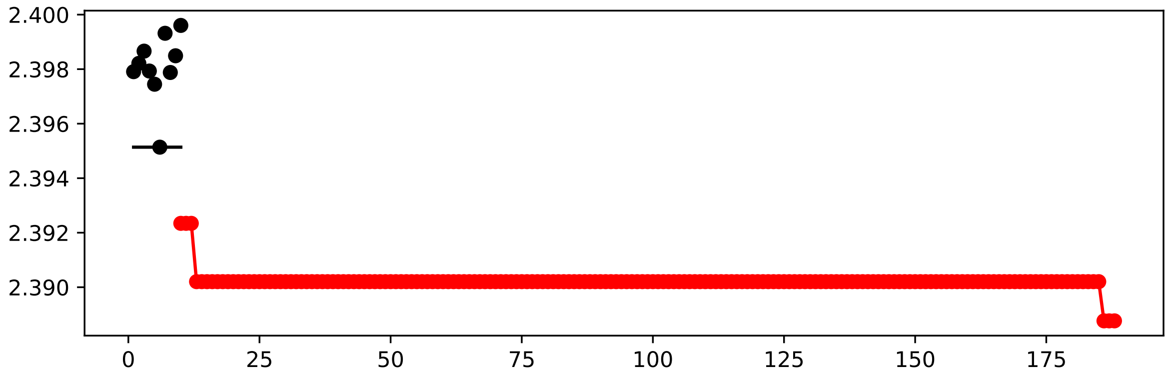


Figure 28.1: Progress plot. *Black* dots denote results from the initial design. *Red* dots illustrate the improvement found by the surrogate model based optimization.

```
from spotPython.utils.eda import gen_design_table
print(gen_design_table(fun_control=fun_control, spot=spot_tuner))
```

```
| name         | type   | default   |    lower |    upper |    tuned | transform             |
|--------------|--------|-----------|----------|----------|----------|-----------------------|--
| _L0          | int    | 64        |   6112.0 |   6112.0 |   6112.0 | None                  |
| l1           | int    | 8         |      6.0 |     13.0 |     13.0 | transform_power_2_int |
| dropout_prob | float  | 0.01      |      0.0 |      0.9 |      0.0 | None                  |
| lr_mult      | float  | 1.0       |    0.001 |    0.001 |    0.001 | None                  |
| batch_size   | int    | 4         |      1.0 |      4.0 |      1.0 | transform_power_2_int |
| epochs       | int    | 4         |      2.0 |      2.0 |      2.0 | transform_power_2_int |
| k_folds      | int    | 1         |      1.0 |      1.0 |      1.0 | None                  |
| patience     | int    | 2         |      2.0 |      6.0 |      2.0 | transform_power_2_int |
| optimizer    | factor | SGD       |      0.0 |      3.0 |      3.0 | None                  |
| sgd_momentum | float  | 0.0       |      0.9 |      0.9 |      0.9 | None                  |
```

```
spot_tuner.plot_importance(threshold=0.025,
    filename="./figures/" + experiment_name+"_importance.png")
```

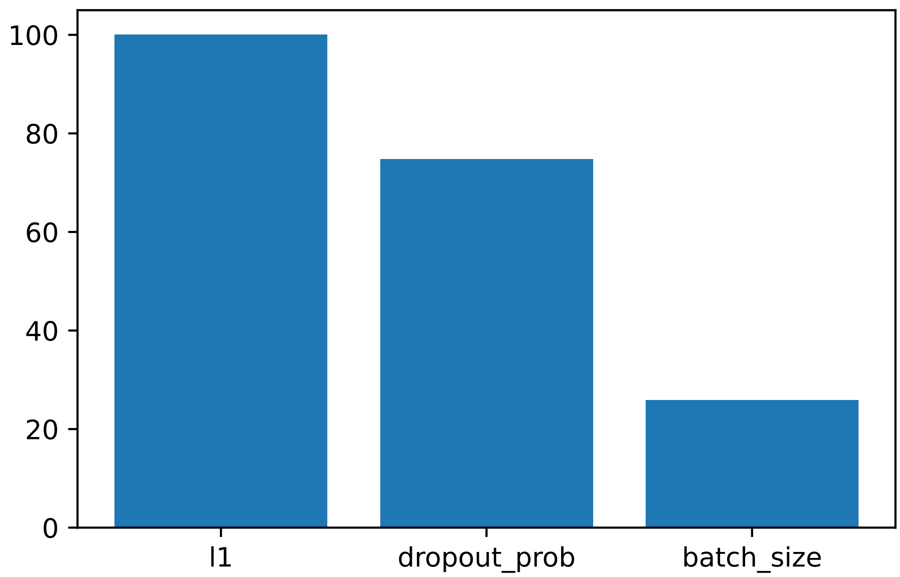


Figure 28.2: Variable importance plot, threshold 0.025.

28.8 Get the Tuned Architecture

```
from spotPython.hyperparameters.values import get_one_core_model_from_X
X = spot_tuner.to_all_dim(spot_tuner.min_X.reshape(1,-1))
model_spot = get_one_core_model_from_X(X, fun_control)
model_spot
```

```
Net_vbdp(
  (fc1): Linear(in_features=6112, out_features=8192, bias=True)
  (fc2): Linear(in_features=8192, out_features=4096, bias=True)
  (fc3): Linear(in_features=4096, out_features=2048, bias=True)
  (fc4): Linear(in_features=2048, out_features=1024, bias=True)
  (fc5): Linear(in_features=1024, out_features=11, bias=True)
  (relu): ReLU()
  (softmax): Softmax(dim=1)
  (dropout1): Dropout(p=0.0, inplace=False)
  (dropout2): Dropout(p=0.0, inplace=False)
)
```

28.9 Evaluation of the Tuned Architecture

```
from spotPython.torch.traintest import (
    train_tuned,
    test_tuned,
    )
train_tuned(net=model_spot, train_dataset=train,
        loss_function=fun_control["loss_function"],
        metric=fun_control["metric_torch"],
        shuffle=True,
        device = fun_control["device"],
        path=None,
        task=fun_control["task"],)
```

```
Epoch: 1

Loss on hold-out set: 2.3967876321864576
Accuracy on hold-out set: 0.10377358490566038
MAPK value on hold-out data: 0.23977984488010406
Epoch: 2

Loss on hold-out set: 2.3950762096441016
Accuracy on hold-out set: 0.11320754716981132
MAPK value on hold-out data: 0.23663519322872162
Epoch: 3

Loss on hold-out set: 2.391287713680627
Accuracy on hold-out set: 0.12735849056603774
MAPK value on hold-out data: 0.2539307773113251
Epoch: 4

Loss on hold-out set: 2.385185846742594
Accuracy on hold-out set: 0.15566037735849056
MAPK value on hold-out data: 0.26572325825691223
Returned to Spot: Validation loss: 2.385185846742594
----------------------------------------------
```

If `path` is set to a filename, e.g., `path = "model_spot_trained.pt"`, the weights of the trained model will be loaded from this file.

```
test_tuned(net=model_spot, test_dataset=test,
            shuffle=False,
            loss_function=fun_control["loss_function"],
            metric=fun_control["metric_torch"],
            device = fun_control["device"],
            task=fun_control["task"],)
```

```
Loss on hold-out set: 2.3718109291591003
Accuracy on hold-out set: 0.2033898305084746
MAPK value on hold-out data: 0.3389512896537781
Final evaluation: Validation loss: 2.3718109291591003
Final evaluation: Validation metric: 0.3389512896537781
----------------------------------------------

(2.3718109291591003, nan, tensor(0.3390))
```

28.10 Cross-validated Evaluations

- This is the evaluation that will be used in the comparison (evaluatecv has to be updated before, to get metric vlaues!):

```
from spotPython.torch.traintest import evaluate_cv
# modify k-kolds:
setattr(model_spot, "k_folds",  10)
df_eval, df_preds, df_metrics = evaluate_cv(net=model_spot,
    dataset=fun_control["data"],
    loss_function=fun_control["loss_function"],
    metric=fun_control["metric_torch"],
    task=fun_control["task"],
    writer=fun_control["writer"],
    writerId="model_spot_cv",
    device = fun_control["device"])
```

```
Fold: 1
Epoch: 1

Loss on hold-out set: 2.3933568464385138
Accuracy on hold-out set: 0.2676056338028169
MAPK value on hold-out data: 0.36574074625968933
Epoch: 2
```

```
Loss on hold-out set: 2.3774237897661
Accuracy on hold-out set: 0.29577464788732394
MAPK value on hold-out data: 0.3888889253139496
Epoch: 3

Loss on hold-out set: 2.3241657416025796
Accuracy on hold-out set: 0.30985915492957744
MAPK value on hold-out data: 0.42592594027519226
Epoch: 4

Loss on hold-out set: 2.273661663134893
Accuracy on hold-out set: 0.29577464788732394
MAPK value on hold-out data: 0.42824074625968933
Fold: 2
Epoch: 1

Loss on hold-out set: 2.3945583369996815
Accuracy on hold-out set: 0.11267605633802817
MAPK value on hold-out data: 0.256944477558136
Epoch: 2

Loss on hold-out set: 2.387409382396274
Accuracy on hold-out set: 0.16901408450704225
MAPK value on hold-out data: 0.30092594027519226
Epoch: 3

Loss on hold-out set: 2.3676116466522217
Accuracy on hold-out set: 0.28169014084507044
MAPK value on hold-out data: 0.3750000298023224
Epoch: 4

Loss on hold-out set: 2.338133308622572
Accuracy on hold-out set: 0.2535211267605634
MAPK value on hold-out data: 0.3402777910232544
Fold: 3
Epoch: 1

Loss on hold-out set: 2.3943201767073736
Accuracy on hold-out set: 0.15492957746478872
MAPK value on hold-out data: 0.28703704476356506
Epoch: 2
```

```
Loss on hold-out set: 2.3831001851293774
Accuracy on hold-out set: 0.15492957746478872
MAPK value on hold-out data: 0.3472222685813904
Epoch: 3

Loss on hold-out set: 2.3664084474245706
Accuracy on hold-out set: 0.2535211267605634
MAPK value on hold-out data: 0.3958333730697632
Epoch: 4

Loss on hold-out set: 2.3332113491164312
Accuracy on hold-out set: 0.29577464788732394
MAPK value on hold-out data: 0.4143518805503845
Fold: 4
Epoch: 1

Loss on hold-out set: 2.3954552345805697
Accuracy on hold-out set: 0.056338028169014086
MAPK value on hold-out data: 0.18287034332752228
Epoch: 2

Loss on hold-out set: 2.3918683462672763
Accuracy on hold-out set: 0.08450704225352113
MAPK value on hold-out data: 0.2013888955116272
Epoch: 3

Loss on hold-out set: 2.3802516725328235
Accuracy on hold-out set: 0.14084507042253522
MAPK value on hold-out data: 0.27314814925193787
Epoch: 4

Loss on hold-out set: 2.3675330612394543
Accuracy on hold-out set: 0.19718309859154928
MAPK value on hold-out data: 0.27314814925193787
Fold: 5
Epoch: 1

Loss on hold-out set: 2.396555006504059
Accuracy on hold-out set: 0.07042253521126761
MAPK value on hold-out data: 0.15740741789340973
Epoch: 2
```

```
Loss on hold-out set: 2.397719257407718
Accuracy on hold-out set: 0.04225352112676056
MAPK value on hold-out data: 0.15509259700775146
Epoch: 3

Loss on hold-out set: 2.388966156376733
Accuracy on hold-out set: 0.1267605633802817
MAPK value on hold-out data: 0.24537035822868347
Epoch: 4

Loss on hold-out set: 2.362861898210314
Accuracy on hold-out set: 0.2676056338028169
MAPK value on hold-out data: 0.35879629850387573
Fold: 6
Epoch: 1

Loss on hold-out set: 2.395356986257765
Accuracy on hold-out set: 0.09859154929577464
MAPK value on hold-out data: 0.3009259104728699
Epoch: 2

Loss on hold-out set: 2.390418291091919
Accuracy on hold-out set: 0.09859154929577464
MAPK value on hold-out data: 0.26851850748062134
Epoch: 3

Loss on hold-out set: 2.3812276985910206
Accuracy on hold-out set: 0.16901408450704225
MAPK value on hold-out data: 0.3333333730697632
Epoch: 4

Loss on hold-out set: 2.3561646540959678
Accuracy on hold-out set: 0.23943661971830985
MAPK value on hold-out data: 0.37731483578681946
Fold: 7
Epoch: 1

Loss on hold-out set: 2.3951981928613453
Accuracy on hold-out set: 0.16901408450704225
MAPK value on hold-out data: 0.305555522441864
Epoch: 2
```

```
Loss on hold-out set: 2.3880330986446805
Accuracy on hold-out set: 0.2112676056338028
MAPK value on hold-out data: 0.31018519401550293
Epoch: 3

Loss on hold-out set: 2.3734221988254123
Accuracy on hold-out set: 0.2535211267605634
MAPK value on hold-out data: 0.3263888955116272
Epoch: 4

Loss on hold-out set: 2.3323421676953635
Accuracy on hold-out set: 0.23943661971830985
MAPK value on hold-out data: 0.3333333730697632
Fold: 8
Epoch: 1

Loss on hold-out set: 2.395358235495431
Accuracy on hold-out set: 0.07142857142857142
MAPK value on hold-out data: 0.1904761791229248
Epoch: 2

Loss on hold-out set: 2.3871613706861226
Accuracy on hold-out set: 0.12857142857142856
MAPK value on hold-out data: 0.22380949556827545
Epoch: 3

Loss on hold-out set: 2.3737708364214214
Accuracy on hold-out set: 0.21428571428571427
MAPK value on hold-out data: 0.3023809790611267
Epoch: 4

Loss on hold-out set: 2.3381921972547257
Accuracy on hold-out set: 0.3142857142857143
MAPK value on hold-out data: 0.38809525966644287
Fold: 9
Epoch: 1

Loss on hold-out set: 2.395046983446394
Accuracy on hold-out set: 0.12857142857142856
MAPK value on hold-out data: 0.2142857015132904
Epoch: 2
```

```
Loss on hold-out set: 2.3870510646275114
Accuracy on hold-out set: 0.15714285714285714
MAPK value on hold-out data: 0.25238093733787537
Epoch: 3

Loss on hold-out set: 2.373319162641253
Accuracy on hold-out set: 0.2
MAPK value on hold-out data: 0.29285717010498047
Epoch: 4

Loss on hold-out set: 2.340468086515154
Accuracy on hold-out set: 0.22857142857142856
MAPK value on hold-out data: 0.3571428656578064
Fold: 10
Epoch: 1

Loss on hold-out set: 2.395347091129848
Accuracy on hold-out set: 0.18571428571428572
MAPK value on hold-out data: 0.273809552192688
Epoch: 2

Loss on hold-out set: 2.3893857887813024
Accuracy on hold-out set: 0.11428571428571428
MAPK value on hold-out data: 0.28809523582458496
Epoch: 3

Loss on hold-out set: 2.3748300892966134
Accuracy on hold-out set: 0.2857142857142857
MAPK value on hold-out data: 0.40714284777641296
Epoch: 4

Loss on hold-out set: 2.3467297077178957
Accuracy on hold-out set: 0.2714285714285714
MAPK value on hold-out data: 0.3857142925262451
```

```python
metric_name = type(fun_control["metric_torch"]).__name__
print(f"loss: {df_eval}, Cross-validated {metric_name}: {df_metrics}")
```

```
loss: 2.338929809360277, Cross-validated MAPK: 0.3656415641307831
```

28.11 Detailed Hyperparameter Plots

```
filename = "./figures/" + experiment_name
spot_tuner.plot_important_hyperparameter_contour(filename=filename)
```

```
l1:  99.99999999999999
dropout_prob:  74.83218781717349
batch_size:  25.83156857337036
```

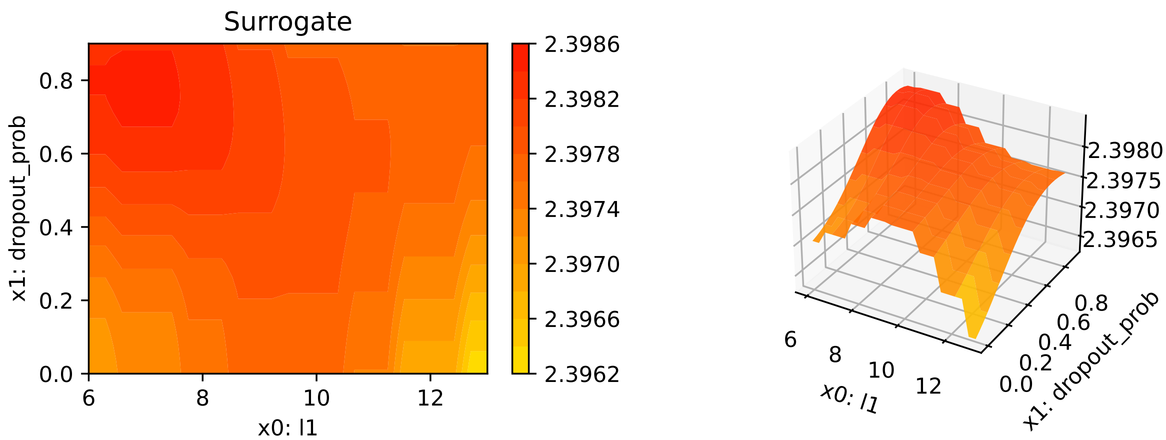
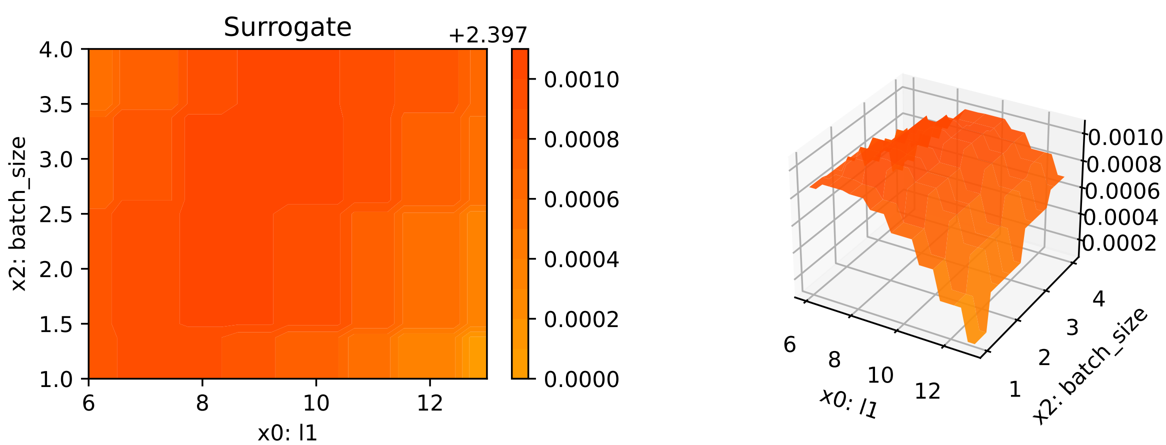
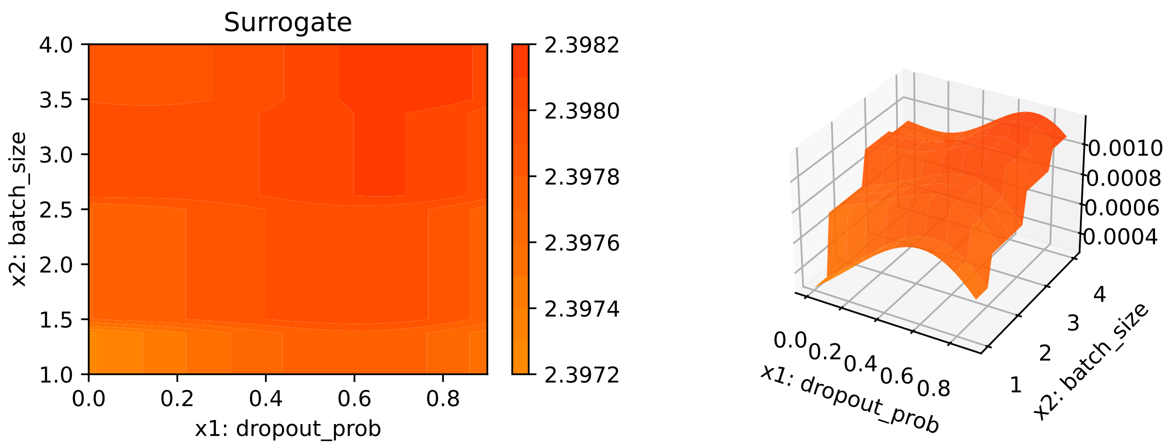


Figure 28.3: Contour plots.





28.12 Parallel Coordinates Plot

```
spot_tuner.parallel_plot()
```

```
Unable to display output for mime type(s): text/html
```

Parallel coordinates plots

```
Unable to display output for mime type(s): text/html
```

```
# close tensorbaoard writer
if fun_control["writer"] is not None:
    fun_control["writer"].close()
```

28.13 Plot all Combinations of Hyperparameters

- Warning: this may take a while.

```
PLOT_ALL = False
if PLOT_ALL:
    n = spot_tuner.k
    for i in range(n-1):
        for j in range(i+1, n):
```

```
        spot_tuner.plot_contour(i=i, j=j, min_z=min_z, max_z = max_z)
```

29 Documentation of the Sequential Parameter Optimization

This document describes the `Spot` features.

29.1 Example: spot

```
import numpy as np
from math import inf
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
from scipy.optimize import shgo
from scipy.optimize import direct
from scipy.optimize import differential_evolution
import matplotlib.pyplot as plt
```

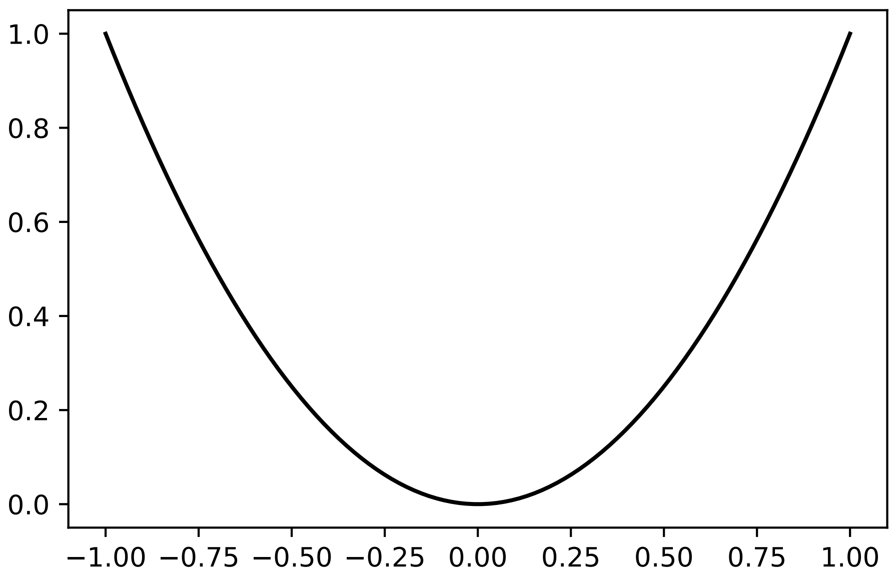
29.1.1 The Objective Function

The `spotPython` package provides several classes of objective functions. We will use an analytical objective function, i.e., a function that can be described by a (closed) formula:

$$f(x) = x^2$$

```
fun = analytical().fun_sphere
```

```
x = np.linspace(-1,1,100).reshape(-1,1)
y = fun(x)
plt.figure()
plt.plot(x,y, "k")
plt.show()
```




```
spot_1 = spot.Spot(fun=fun,
                   lower = np.array([-10]),
                   upper = np.array([100]),
                   fun_evals = 7,
                   fun_repeats = 1,
                   max_time = inf,
                   noise = False,
                   tolerance_x = np.sqrt(np.spacing(1)),
                   var_type=["num"],
                   infill_criterion = "y",
                   n_points = 1,
                   seed=123,
                   log_level = 50,
                   show_models=True,
                   fun_control = {},
                   design_control={"init_size": 5,
                                   "repeats": 1},
                   surrogate_control={"noise": False,
                                      "cod_type": "norm",
                                      "min_theta": -4,
                                      "max_theta": 3,
                                      "n_theta": 1,
                                      "model_optimizer": differential_evolution,
                                      "model_fun_evals": 1000,
```

```
})
```

`spot`'s `__init__` method sets the control parameters. There are two parameter groups:

1. external parameters can be specified by the user
2. internal parameters, which are handled by `spot`.

29.1.2 External Parameters

external parameter	type	description	default	mandatory
`fun`	object	objective function		yes
`lower`	array	lower bound		yes
`upper`	array	upper bound		yes
`fun_evals`	int	number of function evaluations	15	no
`fun_evals`	int	number of function evaluations	15	no
`fun_control`	dict	noise etc.	{}	n
`max_time`	int	max run time budget	`inf`	no
`noise`	bool	if repeated evaluations of `fun` results in different values, then `noise` should be set to `True`.	`False`	no

external parameter	type	description	default	mandatory
`tolerance_x`	float	tolerance for new x solutions. Minimum distance of new solutions, generated by `suggest_new_X`, to already existing solutions. If zero (which is the default), every new solution is accepted.	`0`	no
`var_type`	list	list of type information, can be either `"num"` or `"factor"`	`["num"]`	no
`infill_criterion`	string	Can be `"y"`, `"s"`, `"ei"` (negative expected improvement), or `"all"`	`"y"`	no
`n_points`	int	number of infill points	1	no
`seed`	int	initial seed. If `Spot.run()` is called twice, different results will be generated. To reproduce results, the `seed` can be used.	`123`	no

external parameter	type	description	default	mandatory
`log_level`	int	log level with the following settings: `NOTSET` (`0`), `DEBUG` (`10`: Detailed information, typically of interest only when diagnosing problems.), `INFO` (`20`: Confirmation that things are working as expected.), `WARNING` (`30`: An indication that something unexpected happened, or indicative of some problem in the near future (e.g. 'disk space low'). The software is still working as expected.), `ERROR` (`40`: Due to a more serious problem, the software has not been able to perform some function.), and `CRITICAL` (`50`: A serious error, indicating that the program itself may be unable to continue running.)	`50`	no

external parameter	type	description	default	mandatory
`show_models`	bool	Plot model. Currently only 1-dim functions are supported	`False`	no
`design`	object	experimental design	`None`	no
`design_control`	dict	control parameters	see below	no
`surrogate`		surrogate model	`kriging`	no
`surrogate_control`	dict	control parameters	see below	no
`optimizer`	object	optimizer	see below	no
`optimizer_control`	dict	control parameters	see below	no

- Besides these single parameters, the following parameter dictionaries can be specified by the user:
  - `fun_control`
  - `design_control`
  - `surrogate_control`
  - `optimizer_control`

29.2 The `fun_control` Dictionary

external parameter	type	description	default	mandatory
`sigma`	float	noise: standard deviation	`0`	yes
`seed`	int	seed for rng	`124`	yes

29.3 The `design_control` Dictionary

external parameter	type	description	default	mandatory
`init_size`	int	initial sample size	`10`	yes

external parameter	type	description	default	mandatory
`repeats`	int	number of repeats of the initial sammples	`1`	yes

29.4 The `surrogate_control` Dictionary

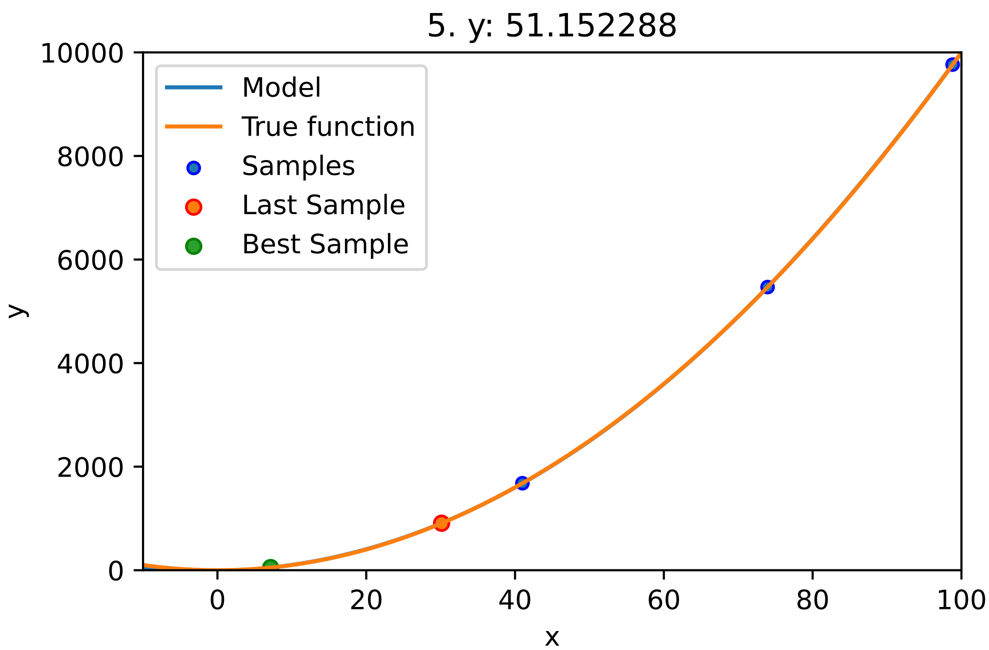
external parameter	type	description	default	mandatory
`noise`				
`model_optimizer`	object	optimizer	`differential_evolution`	no
`model_fun_evals`				
`min_theta`			`-3.`	
`max_theta`			`3.`	
`n_theta`			`1`	
`n_p`			`1`	
`optim_p`			`False`	
`cod_type`			`"norm"`	
`var_type`				
`use_cod_y`	bool		`False`	

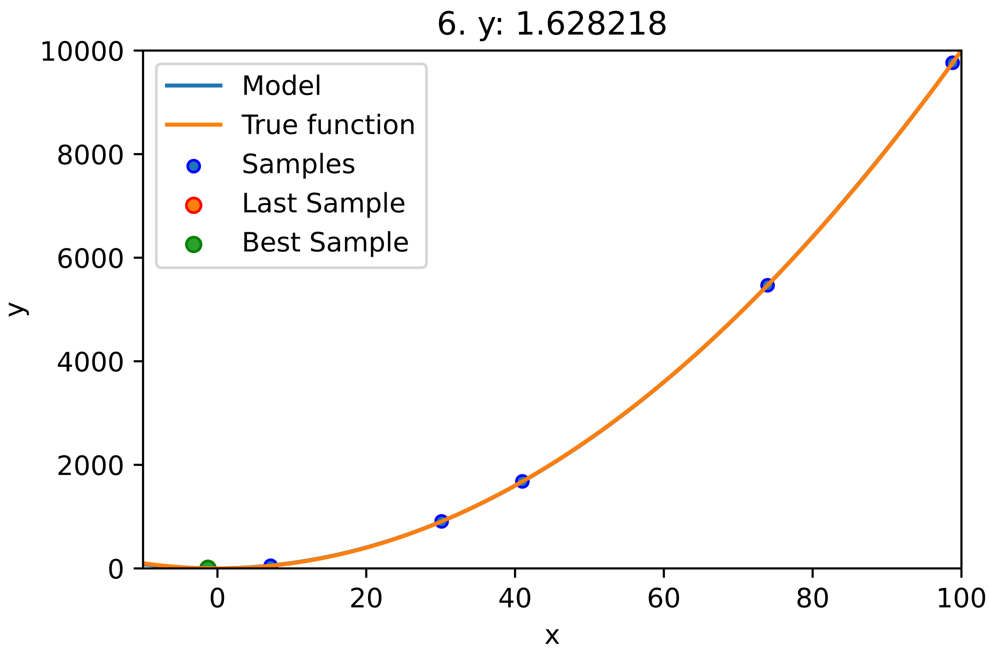
29.5 The `optimizer_control` Dictionary

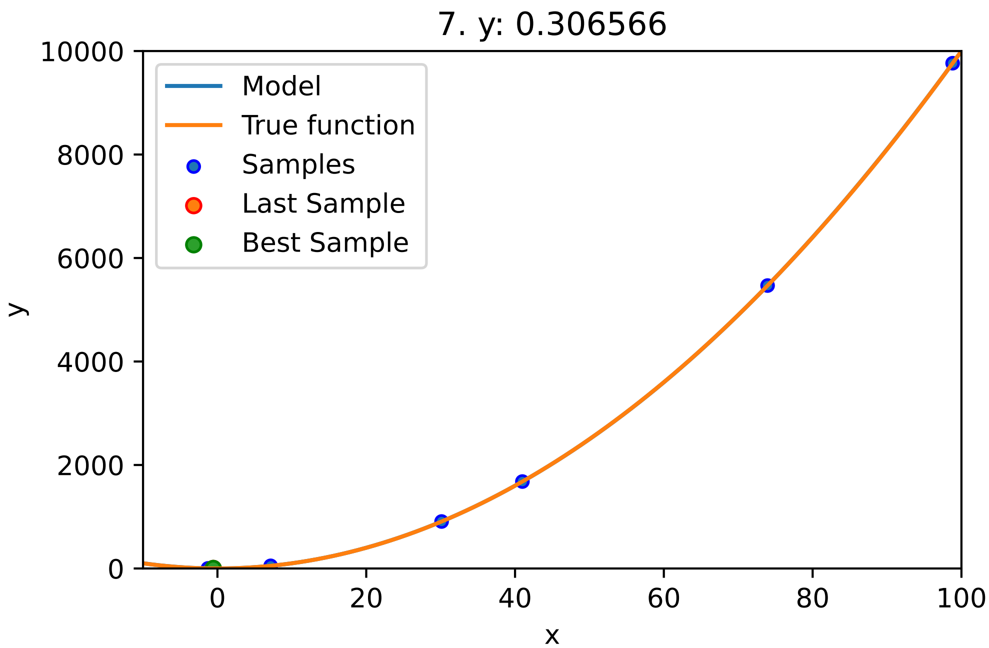
external parameter	type	description	default	mandatory
`max_iter`	int	max number of iterations. Note: these are the cheap evaluations on the surrogate.	`1000`	no

29.6 Run

```
spot_1.run()
```








```
<spotPython.spot.spot.Spot at 0x1424867d0>
```

29.7 Print the Results

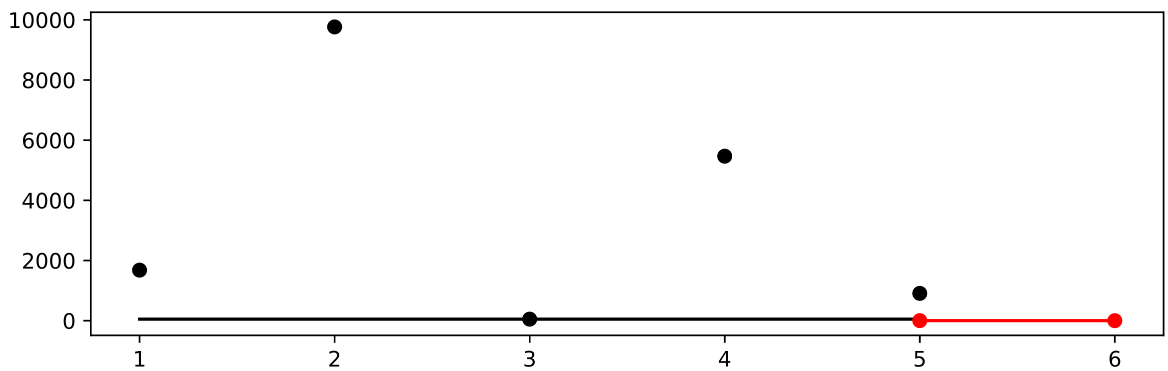
```
spot_1.print_results()
```

```
min y: 0.30656551286610595
x0: -0.5536835855126157
```

```
[['x0', -0.5536835855126157]]
```

29.8 Show the Progress

```
spot_1.plot_progress()
```

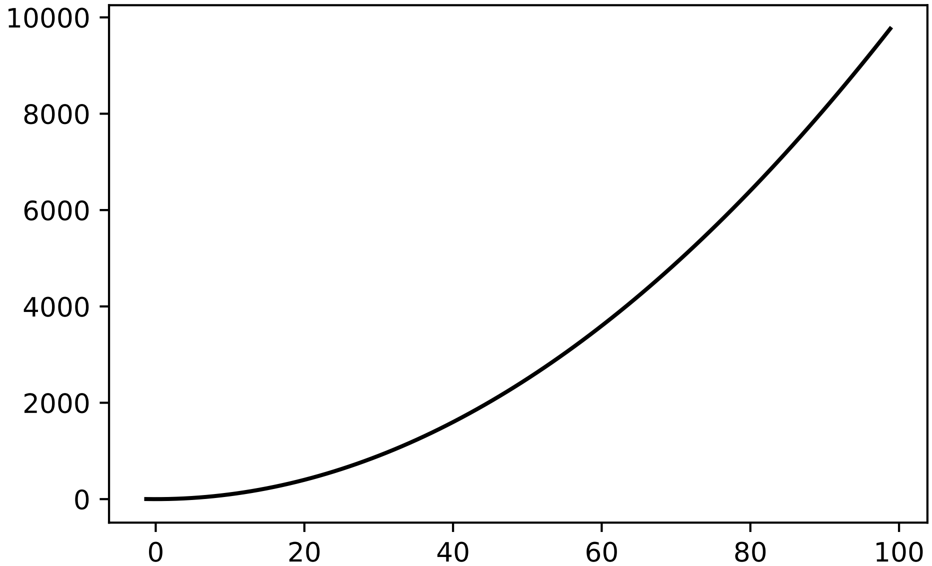


29.9 Visualize the Surrogate

- The plot method of the `kriging` surrogate is used.
- Note: the plot uses the interval defined by the ranges of the natural variables.

```
spot_1.surrogate.plot()
```

```
<Figure size 2700x1800 with 0 Axes>
```



29.10 Init: Build Initial Design

```
from spotPython.design.spacefilling import spacefilling
from spotPython.build.kriging import Kriging
from spotPython.fun.objectivefunctions import analytical
gen = spacefilling(2)
rng = np.random.RandomState(1)
lower = np.array([-5,-0])
upper = np.array([10,15])
fun = analytical().fun_branin
fun_control = {"sigma": 0,
               "seed": 123}

X = gen.scipy_lhd(10, lower=lower, upper = upper)
print(X)
y = fun(X, fun_control=fun_control)
print(y)
```

```
[[ 8.97647221 13.41926847]
 [ 0.66946019  1.22344228]
 [ 5.23614115 13.78185824]
 [ 5.6149825  11.5851384 ]
```

```
 [-1.72963184  1.66516096]
 [-4.26945568  7.1325531 ]
 [ 1.26363761 10.17935555]
 [ 2.88779942  8.05508969]
 [-3.39111089  4.15213772]
 [ 7.30131231  5.22275244]]
[128.95676449  31.73474356 172.89678121 126.71295908  64.34349975
  70.16178611  48.71407916  31.77322887  76.91788181  30.69410529]
```

29.11 Replicability

Seed

```
gen = spacefilling(2, seed=123)
X0 = gen.scipy_lhd(3)
gen = spacefilling(2, seed=345)
X1 = gen.scipy_lhd(3)
X2 = gen.scipy_lhd(3)
gen = spacefilling(2, seed=123)
X3 = gen.scipy_lhd(3)
X0, X1, X2, X3
```

```
(array([[0.77254938, 0.31539299],
        [0.59321338, 0.93854273],
        [0.27469803, 0.3959685 ]]),
 array([[0.78373509, 0.86811887],
        [0.06692621, 0.6058029 ],
        [0.41374778, 0.00525456]]),
 array([[0.121357  , 0.69043832],
        [0.41906219, 0.32838498],
        [0.86742658, 0.52910374]]),
 array([[0.77254938, 0.31539299],
        [0.59321338, 0.93854273],
        [0.27469803, 0.3959685 ]]))
```

29.12 Surrogates

29.12.1 A Simple Predictor

The code below shows how to use a simple model for prediction. Assume that only two (very costly) measurements are available:

1. f(0) = 0.5
2. f(2) = 2.5

We are interested in the value at $x_0 = 1$, i.e., $f(x_0 = 1)$, but cannot run an additional, third experiment.

```
from sklearn import linear_model
X = np.array([[0], [2]])
y = np.array([0.5, 2.5])
S_lm = linear_model.LinearRegression()
S_lm = S_lm.fit(X, y)
X0 = np.array([[1]])
y0 = S_lm.predict(X0)
print(y0)
```

```
[1.5]
```

Central Idea: Evaluation of the surrogate model `S_lm` is much cheaper (or / and much faster) than running the real-world experiment f.

29.13 Demo/Test: Objective Function Fails

SPOT expects `np.nan` values from failed objective function values. These are handled. Note: SPOT's counter considers only successful executions of the objective function.

```
import numpy as np
from spotPython.fun.objectivefunctions import analytical
from spotPython.spot import spot
import numpy as np
from math import inf
# number of initial points:
ni = 20
# number of points
n = 30
```

```python
fun = analytical().fun_random_error
lower = np.array([-1])
upper = np.array([1])
design_control={"init_size": ni}

spot_1 = spot.Spot(fun=fun,
            lower = lower,
            upper= upper,
            fun_evals = n,
            show_progress=False,
            design_control=design_control,)
spot_1.run()
# To check whether the run was successfully completed,
# we compare the number of evaluated points to the specified
# number of points.
assert spot_1.y.shape[0] == n
```

```
[ 0.53176481 -0.9053821  -0.02203599 -0.21843718  0.78240941 -0.58120945
         nan  0.67234256         nan -0.68898927 -0.75129705  0.97550354
  0.41757584  0.0786237   0.82585329  0.23700598 -0.49274073 -0.82319082
 -0.17991251  0.1481835 ]
[-1.]

[0.95541987]
[0.17335968]

[-0.58552368]
[-0.20126111]

[nan]
[nan]

[-0.60100809]
[-0.97897336]

[-0.2748985]
[0.8359486]

[0.99035591]
[0.01641232]
[0.5629346]
```

29.14 PyTorch: Detailed Description of the Data Splitting

29.14.1 Description of the "train_hold_out" Setting

The "train_hold_out" setting is used by default. It uses the loss function specfied in fun_control and the metric specified in fun_control.

1. First, the method HyperTorch().fun_torch is called.
2. fun_torc(), which is implemented in the file hypertorch.py, calls evaluate_hold_out() as follows:

```
df_eval, _ = evaluate_hold_out(
    model,
    train_dataset=fun_control["train"],
    shuffle=self.fun_control["shuffle"],
    loss_function=self.fun_control["loss_function"],
    metric=self.fun_control["metric_torch"],
    device=self.fun_control["device"],
    show_batch_interval=self.fun_control["show_batch_interval"],
    path=self.fun_control["path"],
    task=self.fun_control["task"],
    writer=self.fun_control["writer"],
    writerId=config_id,
)
```

Note: Only the data set fun_control["train"] is used for training and validation. It is used in evaluate_hold_out as follows:

```
trainloader, valloader = create_train_val_data_loaders(
                dataset=train_dataset, batch_size=batch_size_instance, shuffle=shuffle
            )
```

create_train_val_data_loaders() splits the train_dataset into trainloader and valloader using torch.utils.data.random_split() as follows:

```
def create_train_val_data_loaders(dataset, batch_size, shuffle, num_workers=0):
    test_abs = int(len(dataset) * 0.6)
    train_subset, val_subset = random_split(dataset, [test_abs, len(dataset) - test_abs])
    trainloader = torch.utils.data.DataLoader(
        train_subset, batch_size=int(batch_size), shuffle=shuffle, num_workers=num_workers
    )
    valloader = torch.utils.data.DataLoader(
```

```
        val_subset, batch_size=int(batch_size), shuffle=shuffle, num_workers=num_workers
    )
    return trainloader, valloader
```

The optimizer is set up as follows:

```
optimizer_instance = net.optimizer
lr_mult_instance = net.lr_mult
sgd_momentum_instance = net.sgd_momentum
optimizer = optimizer_handler(
    optimizer_name=optimizer_instance,
    params=net.parameters(),
    lr_mult=lr_mult_instance,
    sgd_momentum=sgd_momentum_instance,
)
```

3. `evaluate_hold_out()` sets the `net` attributes such as `epochs`, `batch_size`, `optimizer`, and `patience`. For each epoch, the methods `train_one_epoch()` and `validate_one_epoch()` are called, the former for training and the latter for validation and early stopping. The validation loss from the last epoch (not the best validation loss) is returned from `evaluate_hold_out`.
4. The method `train_one_epoch()` is implemented as follows:

```
def train_one_epoch(
    net,
    trainloader,
    batch_size,
    loss_function,
    optimizer,
    device,
    show_batch_interval=10_000,
    task=None,
):
    running_loss = 0.0
    epoch_steps = 0
    for batch_nr, data in enumerate(trainloader, 0):
        input, target = data
        input, target = input.to(device), target.to(device)
        optimizer.zero_grad()
        output = net(input)
        if task == "regression":
```

```
            target = target.unsqueeze(1)
            if target.shape == output.shape:
                loss = loss_function(output, target)
            else:
                raise ValueError(f"Shapes of target and output do not match:
                 {target.shape} vs {output.shape}")
        elif task == "classification":
            loss = loss_function(output, target)
        else:
            raise ValueError(f"Unknown task: {task}")
        loss.backward()
        torch.nn.utils.clip_grad_norm_(net.parameters(), max_norm=1.0)
        optimizer.step()
        running_loss += loss.item()
        epoch_steps += 1
        if batch_nr % show_batch_interval == (show_batch_interval - 1):
            print(
                "Batch: %5d. Batch Size: %d. Training Loss (running): %.3f"
                % (batch_nr + 1, int(batch_size), running_loss / epoch_steps)
            )
            running_loss = 0.0
    return loss.item()
```

5. The method `validate_one_epoch()` is implemented as follows:

```
def validate_one_epoch(net, valloader, loss_function, metric, device, task):
    val_loss = 0.0
    val_steps = 0
    total = 0
    correct = 0
    metric.reset()
    for i, data in enumerate(valloader, 0):
        # get batches
        with torch.no_grad():
            input, target = data
            input, target = input.to(device), target.to(device)
            output = net(input)
            # print(f"target: {target}")
            # print(f"output: {output}")
            if task == "regression":
                target = target.unsqueeze(1)
```

```
                if target.shape == output.shape:
                    loss = loss_function(output, target)
                else:
                    raise ValueError(f"Shapes of target and output
                        do not match: {target.shape} vs {output.shape}")
                metric_value = metric.update(output, target)
            elif task == "classification":
                loss = loss_function(output, target)
                metric_value = metric.update(output, target)
                _, predicted = torch.max(output.data, 1)
                total += target.size(0)
                correct += (predicted == target).sum().item()
            else:
                raise ValueError(f"Unknown task: {task}")
            val_loss += loss.cpu().numpy()
            val_steps += 1
    loss = val_loss / val_steps
    print(f"Loss on hold-out set: {loss}")
    if task == "classification":
        accuracy = correct / total
        print(f"Accuracy on hold-out set: {accuracy}")
    # metric on all batches using custom accumulation
    metric_value = metric.compute()
    metric_name = type(metric).__name__
    print(f"{metric_name} value on hold-out data: {metric_value}")
    return metric_value, loss
```

29.14.1.1 Description of the `"test_hold_out"` Setting

It uses the loss function specfied in `fun_control` and the metric specified in `fun_control`.

1. First, the method `HyperTorch().fun_torch` is called.
2. `fun_torc()` calls `spotPython.torch.traintest.evaluate_hold_out()` similar to the `"train_hold_out"` setting with one exception: It passes an additional `test` data set to `evaluate_hold_out()` as follows:

```
test_dataset=fun_control["test"]
```

`evaluate_hold_out()` calls `create_train_test_data_loaders` instead of `create_train_val_data_loaders`: The two data sets are used in `create_train_test_data_loaders` as follows:

```
def create_train_test_data_loaders(dataset, batch_size, shuffle, test_dataset,
        num_workers=0):
    trainloader = torch.utils.data.DataLoader(
        dataset, batch_size=int(batch_size), shuffle=shuffle,
        num_workers=num_workers
    )
    testloader = torch.utils.data.DataLoader(
        test_dataset, batch_size=int(batch_size), shuffle=shuffle,
        num_workers=num_workers
    )
    return trainloader, testloader
```

3. The following steps are identical to the `"train_hold_out"` setting. Only a different data loader is used for testing.

29.14.1.2 Detailed Description of the `"train_cv"` Setting

It uses the loss function specfied in `fun_control` and the metric specified in `fun_control`.

1. First, the method `HyperTorch().fun_torch` is called.
2. `fun_torc()` calls `spotPython.torch.traintest.evaluate_cv()` as follows (Note: Only the data set `fun_control["train"]` is used for CV.):

```
df_eval, _ = evaluate_cv(
    model,
    dataset=fun_control["train"],
    shuffle=self.fun_control["shuffle"],
    device=self.fun_control["device"],
    show_batch_interval=self.fun_control["show_batch_interval"],
    task=self.fun_control["task"],
    writer=self.fun_control["writer"],
    writerId=config_id,
)
```

3. In ‘evaluate_cv(), the following steps are performed: The optimizer is set up as follows:

```
optimizer_instance = net.optimizer
lr_instance = net.lr
sgd_momentum_instance = net.sgd_momentum
optimizer = optimizer_handler(optimizer_name=optimizer_instance,
     params=net.parameters(), lr_mult=lr_mult_instance)
```

`evaluate_cv()` sets the `net` attributes such as `epochs`, `batch_size`, `optimizer`, and `patience`. CV is implemented as follows:

```
def evaluate_cv(
    net,
    dataset,
    shuffle=False,
    loss_function=None,
    num_workers=0,
    device=None,
    show_batch_interval=10_000,
    metric=None,
    path=None,
    task=None,
    writer=None,
    writerId=None,
):
    lr_mult_instance = net.lr_mult
    epochs_instance = net.epochs
    batch_size_instance = net.batch_size
    k_folds_instance = net.k_folds
    optimizer_instance = net.optimizer
    patience_instance = net.patience
    sgd_momentum_instance = net.sgd_momentum
    removed_attributes, net = get_removed_attributes_and_base_net(net)
    metric_values = {}
    loss_values = {}
    try:
        device = getDevice(device=device)
        if torch.cuda.is_available():
            device = "cuda:0"
            if torch.cuda.device_count() > 1:
                print("We will use", torch.cuda.device_count(), "GPUs!")
                net = nn.DataParallel(net)
        net.to(device)
        optimizer = optimizer_handler(
            optimizer_name=optimizer_instance,
            params=net.parameters(),
            lr_mult=lr_mult_instance,
            sgd_momentum=sgd_momentum_instance,
        )
        kfold = KFold(n_splits=k_folds_instance, shuffle=shuffle)
```

```
for fold, (train_ids, val_ids) in enumerate(kfold.split(dataset)):
    print(f"Fold: {fold + 1}")
    train_subsampler = torch.utils.data.SubsetRandomSampler(train_ids)
    val_subsampler = torch.utils.data.SubsetRandomSampler(val_ids)
    trainloader = torch.utils.data.DataLoader(
        dataset, batch_size=batch_size_instance,
        sampler=train_subsampler, num_workers=num_workers
    )
    valloader = torch.utils.data.DataLoader(
        dataset, batch_size=batch_size_instance,
        sampler=val_subsampler, num_workers=num_workers
    )
    # each fold starts with new weights:
    reset_weights(net)
    # Early stopping parameters
    best_val_loss = float("inf")
    counter = 0
    for epoch in range(epochs_instance):
        print(f"Epoch: {epoch + 1}")
        # training loss from one epoch:
        training_loss = train_one_epoch(
            net=net,
            trainloader=trainloader,
            batch_size=batch_size_instance,
            loss_function=loss_function,
            optimizer=optimizer,
            device=device,
            show_batch_interval=show_batch_interval,
            task=task,
        )
        # Early stopping check. Calculate validation loss from one epoch:
        metric_values[fold], loss_values[fold] = validate_one_epoch(
            net, valloader=valloader, loss_function=loss_function,
            metric=metric, device=device, task=task
        )
        # Log the running loss averaged per batch
        metric_name = "Metric"
        if metric is None:
            metric_name = type(metric).__name__
            print(f"{metric_name} value on hold-out data:
                {metric_values[fold]}")
```

```
                if writer is not None:
                    writer.add_scalars(
                        "evaluate_cv fold:" + str(fold + 1) +
                        ". Train & Val Loss and Val Metric" + writerId,
                        {"Train loss": training_loss, "Val loss":
                        loss_values[fold], metric_name: metric_values[fold]},
                        epoch + 1,
                    )
                    writer.flush()
                if loss_values[fold] < best_val_loss:
                    best_val_loss = loss_values[fold]
                    counter = 0
                    # save model:
                    if path is not None:
                        torch.save(net.state_dict(), path)
                else:
                    counter += 1
                    if counter >= patience_instance:
                        print(f"Early stopping at epoch {epoch}")
                        break
        df_eval = sum(loss_values.values()) / len(loss_values.values())
        df_metrics = sum(metric_values.values()) / len(metric_values.values())
        df_preds = np.nan
    except Exception as err:
        print(f"Error in Net_Core. Call to evaluate_cv() failed. {err=},
            {type(err)=}")
        df_eval = np.nan
        df_preds = np.nan
    add_attributes(net, removed_attributes)
    if writer is not None:
        metric_name = "Metric"
        if metric is None:
            metric_name = type(metric).__name__
        writer.add_scalars(
            "CV: Val Loss and Val Metric" + writerId,
            {"CV-loss": df_eval, metric_name: df_metrics},
            epoch + 1,
        )
        writer.flush()
    return df_eval, df_preds, df_metrics
```

4. The method `train_fold()` is implemented as shown above.

5. The method validate_one_epoch() is implemented as shown above. In contrast to the hold-out setting, it is called for each of the k folds. The results are stored in a dictionaries metric_values and loss_values. The results are averaged over the k folds and returned as df_eval.

29.14.1.3 Detailed Description of the "test_cv" Setting

It uses the loss function specfied in fun_control and the metric specified in fun_control.

1. First, the method HyperTorch().fun_torch is called.
2. fun_torc() calls spotPython.torch.traintest.evaluate_cv() as follows:

```
df_eval, _ = evaluate_cv(
    model,
    dataset=fun_control["test"],
    shuffle=self.fun_control["shuffle"],
    device=self.fun_control["device"],
    show_batch_interval=self.fun_control["show_batch_interval"],
    task=self.fun_control["task"],
    writer=self.fun_control["writer"],
    writerId=config_id,
)
```

Note: The data set fun_control["test"] is used for CV. The rest is the same as for the "train_cv" setting.

29.14.1.4 Detailed Description of the Final Model Training and Evaluation

There are two methods that can be used for the final evaluation of a Pytorch model:

1. "train_tuned and
2. "test_tuned".

train_tuned() is just a wrapper to evaluate_hold_out using the train data set. It is implemented as follows:

```
def train_tuned(
    net,
    train_dataset,
    shuffle,
    loss_function,
    metric,
```

```
    device=None,
    show_batch_interval=10_000,
    path=None,
    task=None,
    writer=None,
):
    evaluate_hold_out(
        net=net,
        train_dataset=train_dataset,
        shuffle=shuffle,
        test_dataset=None,
        loss_function=loss_function,
        metric=metric,
        device=device,
        show_batch_interval=show_batch_interval,
        path=path,
        task=task,
        writer=writer,
    )
```

The `test_tuned()` procedure is implemented as follows:

```
def test_tuned(net, shuffle, test_dataset=None, loss_function=None,
    metric=None, device=None, path=None, task=None):
    batch_size_instance = net.batch_size
    removed_attributes, net = get_removed_attributes_and_base_net(net)
    if path is not None:
        net.load_state_dict(torch.load(path))
        net.eval()
    try:
        device = getDevice(device=device)
        if torch.cuda.is_available():
            device = "cuda:0"
            if torch.cuda.device_count() > 1:
                print("We will use", torch.cuda.device_count(), "GPUs!")
                net = nn.DataParallel(net)
        net.to(device)
        valloader = torch.utils.data.DataLoader(
            test_dataset, batch_size=int(batch_size_instance),
            shuffle=shuffle,
            num_workers=0
        )
```

```
        metric_value, loss = validate_one_epoch(
            net, valloader=valloader, loss_function=loss_function,
            metric=metric, device=device, task=task
        )
        df_eval = loss
        df_metric = metric_value
        df_preds = np.nan
    except Exception as err:
        print(f"Error in Net_Core. Call to test_tuned() failed. {err=},
            {type(err)=}")
        df_eval = np.nan
        df_metric = np.nan
        df_preds = np.nan
    add_attributes(net, removed_attributes)
    print(f"Final evaluation: Validation loss: {df_eval}")
    print(f"Final evaluation: Validation metric: {df_metric}")
    print("----------------------------------------------")
    return df_eval, df_preds, df_metric
```

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