pyCGNS.intro/Manual

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pyCGNS is a Python package for the *CGNS* standard.

The package gathers various tools and libraries for end-users and Python application developpers. The main object of *pyCGNS* is to provide the application developpers with a Python interface to *CGNS/SIDS*, the data model. The *MAP* and *PAT* modules are dedicated to this goal: map the *CGNS/SIDS* data model to a *Python implementation*. The *WRA* module contains wrapper on *CGNS/MLL* and a *MLL-like* set of functions that uses the *CGNS/Python* mapping as implementation.

The package uses *numpy* and *HDF5* you should install before pyCGNS. The *CGNS.NAV* tools has an optional *VTK* viewer which requires the *VTK lib* and its python interface.

The *CGNS/SIDS* data model has a mapping the *HDF5* for file storage. The *MAP* module uses *CHLone* instead of *CGNS/MLL* to map its *CGNS/Python* trees to *HDF5*.

Note: The *pyCGNS* python package is released under LGPL2 license and hosted by sourceforge where you can find source download, help forum, wiki and bug tracking.

CHAPTER

ONE

CONTENTS

1.1 About pyCGNS

1.1.1 Package contents

The pyCGNS Python module is a collection of 7 modules around the CGNS standard. Before v4, these modules were independent Python modules with more or less dependancies to each other. We gather all of them to have a common build/install/doc and test process, moreover this insures a better consistency between them.

The pyCGNS module now includes (former package names)

MAP, the Mapper, new in v4 gives basic load/save function from/to *CGNS/SIDS* and *CGNS/HDF5*. This very sinple module is able to read/write GCNS/HDF5 files and translate them to CGNS/Python. This is the main feature of pyCGNS v4.0.

PAT, the PatterMaker, a full *CGNS/SIDS* patterns using the *CGNS/Python* mapping. This is pure python module, it creates and modify CGNS/Python trees without the help of any HDF5 or even ADf calls.

NAV, the Navigater (pyS7), a graphical browser that can handle *CGNS/Python*, *CGNS/HDF5* and *CGNS/ADF* file formats. It is slightly different to *adfviewer* because it actually a tree editor, you can copy/cut/paste CGNS/Python trees and quickly draft or modify your CGNS tree.

WRA, the Wrapper (pyCGNS), is a *CGNS/MLL* and *CGNS/ADF* Python wrapping. All the CGNS/MLL functions are mapped to their Python clone.

VAL,the Validater (pyC5), an XML grammar based validation of a *CGNS/Python* tree, for example produced using *MAP* or *PAT*. *Unsuable in v4.0*

TRA, the Translater (pyCRAB), a set of translators from/to various formats. *Unsuable in v4.0*

DAT, the DataTracer (pyDAX), some DBMS services for *CGNS/HDF5* files. *Unsuable in v4.0*

1.1.2 Quick start

Loading a CGNS/HDF file with MAP

The *CGNS.MAP* module implements the *CGNS/Python* mapping. You can load/save a *CGNS/HDF5* file using the simple *MAP* functions (below, the >>> string is the python interpreter prompt):

```
 >>>import CGNS.MAP
 >>>(tree,links)=CGNS.MAP.load("./001Disk.hdf",CGNS.MAP.S2P_FOLLOWLINKS)
 >>>print tree
 ['CGNSTree', None, [['CGNSLibraryVersion',array([ 2.4000001],dtype=float32),
 [], 'CGNSLibraryVersion_t'], ['Disk', array([3, 3], dtype=int32),
[['.Solver#Command', ...
```

Now `tree` is a Python list with the whole‘‘ ./001Disk.hdf‘‘ CGNS tree into, with the data structure as described in *SIDS-to-Python*.

Using PAT to modify a CGNS tree

The previously loaded *CGNS/Python* tree is modified using plain Python functions and types. The *CGNS.APP* module contains utilities, we use the `getNodeByPath` function which returns a *CGNS/Python* node with the target tree and the target node path as parameters.:

```
import CGNS.APP.path_utils as U

node=U.getNodeByPath("/Disk/zone1/ZoneBC/ext1/PointRange",tree)
```

The returned node is a list of 4 Python values, the name (a string), the value of the node (a *Numpy* array), the list of children and the CGNS type of the node (string).

Using PAT to create a CGNS tree

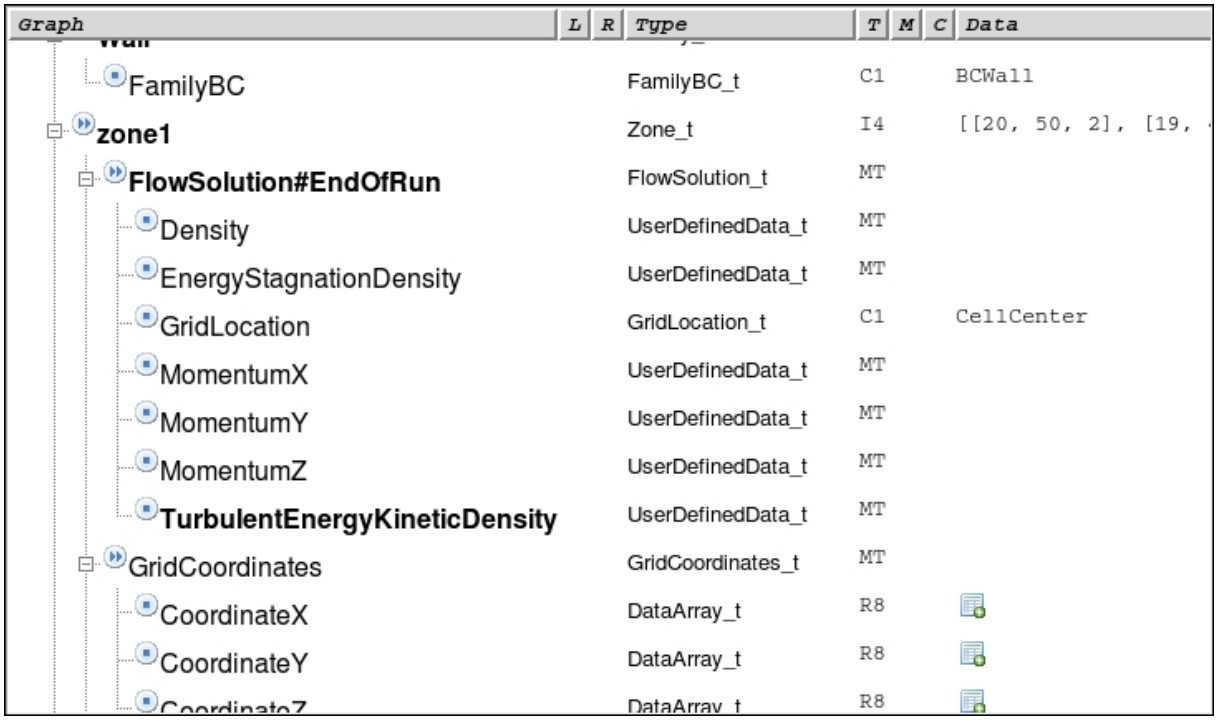
We want to create a *CGNS/HDF5* file with a simple *base* and a *reference state*:

```
import CGNS.MAP
import CGNS.PAT

T=CGNS.PAT.newCGNS()
CGNS.PAT.newBase(T,'Test Case 01',3,3) # name, physical dim, topological dim
CGNS.PAT.newSimulationType(T)
CGNS.PAT.newReferenceState(T)
```

Browsing your CGNS tree with NAV

The CGNS.NAV tool is a CGNS tree brower. You start it typing `CGNS.NAV` and you can open several views on your file.



Re-using your CGNS/MLL scripts

If you really want to use CGNS/MLL, for example if you have a large toolbox with old pyCGNS scripts, you can import CGNS.WRA but you have to change your imports:

```
import CGNS.WRA.wrapper

filesol=CGNS.WRA.wrapper.pyCGNS(sname,CGNS.WRA.wrapper.MODE_WRITE)
filesol.basewrite('Base',3,3)
filesol.close()
```

1.2 Build and Install

1.2.1 Required libraries

The first step of the installation is to make sure you have the required libraries. The mandatory libs are *Python*, *numpy*, *HDF5* and *CHLone*. Then, if you wan to build *CGNS.WRA* (we recommend to do so), you need *libcgns*.

Warning: **OUPS !** you mean I don't need *libcgns* for the *CGNS/Python* mapping ?
NO you don't, *CGNS* is a data model (so-called *CGNS/SIDS*) and some mapping definitions of this model (such as *CGNS/HDF* for example). *pyCGNS* uses *'CHLone <http://chlone.sourceforge.net>'_* which is another *CGNS/HDF5* compliant implementation.

- Python (starting from v2.4)
- numpy (v1.1 +)
- hdf5 (v1.8.5 +)
- CHLone (v0.4 +)
- tktreectrl (v2.2 +)

1.2.2 Optional libraries

The so-called *mid-level* library is not mandatory, the *WRA module* is the only one to have dependancies on. The *NAV module* also uses *CGNS/MLL* as optional if you want to be able to read *CGNS/ADF* files (see *File formats*)

- CGNS/MLL (libcgns) (starting v3.0)

1.2.3 Installation process

Once you have these installed you can proceed with pyCGNS. You go into the top directory and you edit the `pyCGNSconfig.py.in` (see *Configuration file contents*). You have to set the correct paths and various values such as directory search libs or flags.

Then you run:

```
python setup.py build
```

and then:

```
python setup.py install
```

or:

```
python setup.py install --prefix=/local/tools/installation
```

All the modules of the pyCGNS package are installed and you can now proceed with tutorial examples.

1.2.4 Single module installation

You can ask for a single module installation:

```
python setup.py build --single-module=MAP
python setup.py install
```

You have to check that this installation doesn't overwrite an existing installation with the other pyCGNS modules.

1.2.5 Configuration file contents

The `pyCGNSconfig_user.py` should work with no modification if you have a standard installation. All you have to declare is the directory in which we can find *Python/numpy/hdf5/CHLone/cgns* libraries.

If you have specific installations you can change some paths/flags for each external library: *hdf5*, *numpy*, *CGNS/MLL* and *CHLone*. The configuration file is a Python file, it is imported after the default configuration. The changes you make in the configuration file will overwrite the defaults:

```
# --- stuff to add for HDF5

#HDF5_VERSION          = ''
HDF5_PATH_INCLUDES    = ['/home/myself/hdf5/include']
HDF5_PATH_LIBRARIES   = ['/home/myself/hdf5/lib']
#HDF5_LINK_LIBRARIES   = []
#HDF5_EXTRA_ARGS       = []
```

To avoid overwriting, use Python to update the config:

```
# --- stuff to add for HDF5

#HDF5_VERSION          = ''
HDF5_PATH_INCLUDES    = ['/home/myself/hdf5/include']
HDF5_PATH_LIBRARIES   = ['/home/myself/hdf5/lib']
#HDF5_LINK_LIBRARIES   = []
HDF5_EXTRA_ARGS       = HDF5_EXTRA_ARGS + ['-DMYFLAG']
```

Release Notes

> Many changes in this v4 release, you can only use MAP, WRA, PAT and NAV. The other modules, VAL, TRA and DAT are present for archival/development purpose but you should NOT use them.
>
> Please go to *http://www.python-science.org/projects/pyCGNS* to have the version/tickets list.

Module dependancies

The pyCGNS modules have dependancies with their brothers. The list below gives you the required modules (or optional) for each of them.

- MAP : None
- PAT : MAP
- WRA : PAT MAP
- APP : PAT MAP
- NAV : PAT MAP APP (WRA)

1.2.6 NAV depends

The *TkTreectrl* module is required. You first need to install *tktreectrl* (last version tested is *tktreectrl-2.3) and *TkinterTreectrl* to map it to Python (last version tested is *TkinterTreectrl-1.0*). You may have to add the *tktreectrl* path into a *TCLLIBPATH* shell variable (maybe you should add a *LD_LIBRARY_PATH* as well).

1.2.7 MAP depends

The *CHLone* librarie is required and thus *HDF5* is required.

1.2.8 WRA depends

CGNS/MLL and *CGNS/ADF* libraries are required. You should build the CGNS libraries with the `CG_BUILD_SCOPE` set to `True`. To do so, edit your `CMakeCache.txt` file and set the following variable to `ON`.

```
//Enable or disable scoping of enumeration values
ENABLE_SCOPING:BOOL=ON
```

1.3 Tests

1.3.1 Cross Matrix for data integrity

WRA can read/write C|NS/ADF and CGNS/HDF5 files. MAP can read/write CGNS/HDF and CGNS/Python files PAT can read/write CGNS/Python files. APP can read/write CGNS/Python files. NAV can read/write all CGNS formats (using previous modules)

The matrix here after shows the tested translations.

write: WRA/ADF WRA/HDF MAP/HDF MAP/PY PAT/PY APP/PY NAV/ADF NAV/HDF NAV/PY

read: WRA/ADF | x WRA/HDF | x MAP/HDF | MAP/PY | PAT/PY | APP/PY | NAV/ADF | NAV/HDF | NAV/PY |

1.4 Glossary

CGNS The specific purpose of the CFD General Notation System (CGNS) project is to provide a standard for recording and recovering computer data associated with the numerical solution of the equations of fluid dynamics. Read more here....

CGNS/SIDS The *Standard Interface Data Structure* is the specification of the data model. This public document describes the syntax and the semantics of all tree-structured data required or proposed for a CFD simulation. Both an HTML and a PDF version are available here.

CGNS/MLL The *Mid-Level Library* is an example implementation of *CGNS/SIDS* on top of *CGNS/ADF* and *CGNS/HDF5* mappings. This library has a C and a Fortran API.

CGNS/ADF The *Advanced Data Format CGNS/SIDS* implementation. A binary storage format and its companion library, developped by *Boeing*.

CGNS/HDF5 The *Hierarchical Data Format CGNS/SIDS* implementation. A binary storage format and its companion library (see below).

CGNS/Python The Python programming language *CGNS/SIDS* implementation. See the *SIDS-to-Python* page.

CHLone A *CGNS/HDF5* compliant implementation. The CHLone library is available on SourceForge.

HDF5 A powerful storage system for large data. The HDF5 library should be seen as a middleware system with a lot of powerful features related to efficient, portable and trustable storage mean.

numpy The numerical library for Python. *Numpy* is used to store the data in Python arrays which have a direct memory mapping to actual C or Fortran memory.

VTK A visualization toolkit used to display 3D objects ni *CGNS.NAV*.

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- PAT manual
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