Forest Agent

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1 Introduction

The Supply Chain Management League (SCML) one-shot track is a competition within the larger context of the ANAC (Automated Negotiating Agents Competition) that focuses on testing the negotiation skills and abilities of autonomous agents in the domain of supply chain management. The SCML one-shot track challenges agents to negotiate a one-time deal for a product set between two companies with no prior relationship or history. To reach a mutually beneficial agreement, agents must navigate a complex and dynamic environment with multiple stakeholders, including customers, suppliers, and competitors.

2 Forest Agent

2.1 Random Forest Algorithm

Random forest is a popular machine learning algorithm that uses decision trees to create an ensemble of models. It is a powerful algorithm that is widely used for classification and regression tasks. In random forest, multiple decision trees are built on different subsets of the data, and the results are combined to make a final prediction. Each decision tree in the forest is trained on a random sample of the training data and a random subset of features. This ensures that the trees are diverse and reduces the risk of overfitting.

2.2 Agent's Design

The Forest Agent is an adaptive agent that is designed to improve negotiations over time. The agent is an improvement over one of the given agents from the one-shot documentation, and it is inspired by the solution of one of the finalists from last year's competition "EveAgent." The Forest Agent's design improves upon the solution by predicting the price ranges using Random Forest regressor.

The benefits of using Random Forest over linear regression are that it provides a more accurate representation of the real world, which is crucial in negotiations. The Forest Agent uses a strategy of exponential moving average to train the model. Exponential moving average is used to give more weight to recent negotiations.

2.2.1 Experiments and Learning Process

We started with a basic random forest algorithm that takes into account only the time of the step and offers a price as a result, afterwards we've added some smoothing methods such exponential moving average and we've added warm-start parameter for the model to learn every time from the new data instead of going over all the data. Afterwards we've added adjustable min and max prices in order for the model to adjust it's offer based on the quantity it needed to buy, if we have a lot of units we lowered the price because we have the leverage of quantity. After doing some experiments we saw that taking extreme values its not a good strategy. So, we tried to adjust our price (using a weight parameter) by the average of the current offers of our contenders.

Eventually it seems that the simplest solution is the one that brought us the highest (as described above at the Agent's Design section).

2.3 Strategy

The Forest Agent's negotiation strategy is based on learning the price ranges based on previous negotiations' outcomes. The agent handles the non-linearity behavior of the world changes, which can be challenging in negotiations. By predicting price ranges using Random Forest and adapting the model based on past negotiations, the Forest Agent is capable of improving negotiations over time. The agent provides a more accurate representation of the real world.

3 Evaluation

For the evaluation part, we tested our model not only against the given agents from SCML but also against an ensemble comprising all the winning agents from the competition held last year.

3.1 Building An Ensemble Agent

We used *PatientAgent*, *SASAgent* and *GentleS* the winners from last year to build our ensemble agent. The Ensemble Agent proposes a new method where all the agents' proposes are gathered, and the best possible outcome tuple is extracted. The outcome tuple includes the quantity, delivery time, and unit price. The extracted quantity is the one that gives the minimum gap from the needed quantity, the longest delivery time, and the maximum price as a seller. In the respond method, a voting strategy is used, and the Ensemble Agent responds with the most common response from the agents. The Ensemble Agent's strategy is an effective way to combine the strengths of multiple agents and improve negotiation outcomes. Also, it helps us in the evaluation process to understand where we are standing in comparison to the winners agents.

3.2 Results

As it can be seen in Table 1, Forest Agent get the best scores among the other agents that been tested including the Ensemble Agent.

Idx	Agent Type	Count	Mean	Std	Min	25%	Median	75%	Max
0	EnsembleAgent	40.00	0.68	0.31	0.01	0.51	0.78	0.94	1.08
1	GreedySingleAgreementAgent	40.00	0.69	0.09	0.52	0.62	0.70	0.77	0.85
2	AdaptiveAgent	40.00	1.05	0.23	0.41	0.92	1.10	1.17	1.49
3	BetterAgent	40.00	0.93	0.26	0.34	0.75	0.94	1.12	1.46
4	ForestAgent	40.00	1.08	0.22	0.56	0.92	1.12	1.18	1.54

Table 1: Agents Statistics.

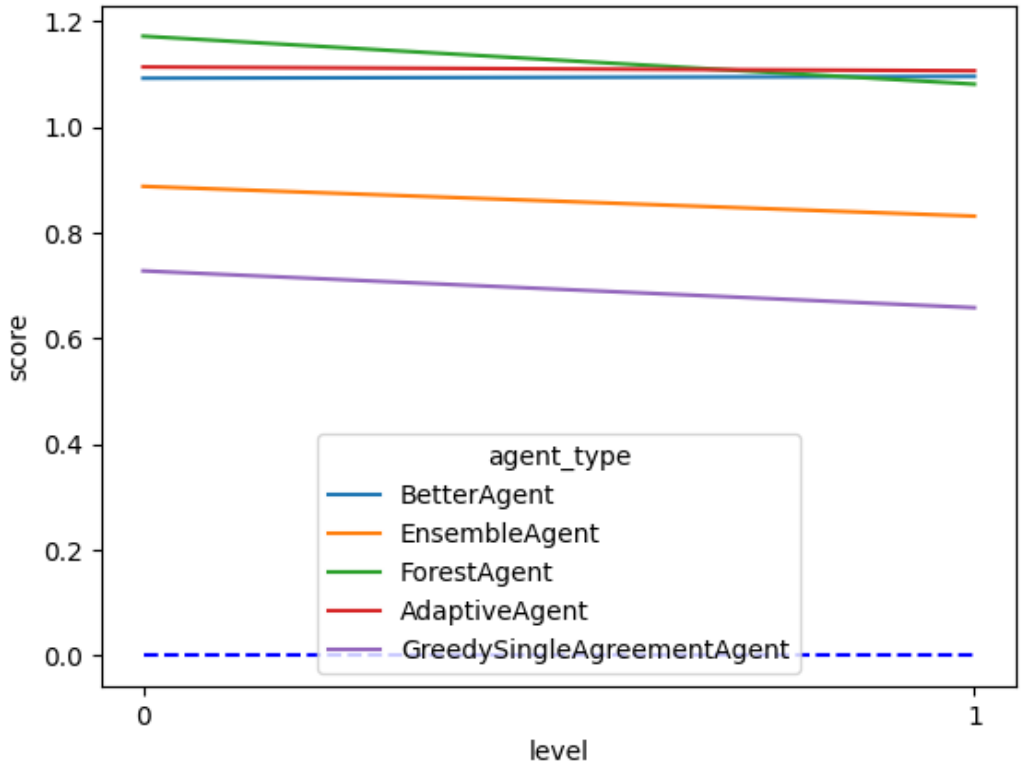

Figure 1: Forest Agent performances in comparison to other agents.

4 Conclusion

In conclusion, random forest is a powerful machine learning algorithm that can be used for negotiations. The algorithm can be trained on historical data and used to predict price ranges for new products. The algorithm is highly accurate, robust, and fast, which makes it ideal for handling real-world data. By improving negotiations over time, the Forest Agent is capable of providing a more advanced negotiation experience.