COMP3004

Design Intelligent Agents

Coursework Report

**1 Introduction**

Stock trading refers to the purchase and sale of shares in the financial markets. The topic of stock trading using financial trading agents has been of great interest in the past decades in both academic and practitioners’ studies. Computer giants such as IBM and Hewlett-Packard have each invested significant research efforts in this area and have made remarkable progress. Numerous studies have proven that current trading agents, such as MGD and ZIP, can consistently outperform human traders, which elevates the importance of this topic to a new level.

However, the dynamic nature of the stock market introduces additional complexity to traders' decisions. For the majority of studies, little specific attention has been paid to the impact of real-world disturbances on trading, despite showing statistically significant performance improvements compared to established baseline strategies. To bridge this non-negligible gap, this report will focus on the impact of real-world factors, more specifically, noise and delays, on the performance of trading agents. The study used several of the best-known algorithms to explore their robustness to each of these factors and analyse the potential causes of the results. The purpose is to provide direction and inspiration for subsequent researchers and to lay the foundations for further studies.

**2 Literature Review**

The core of this report explores the adaptation of different agents to real-world disturbances. Regarding methods for dealing with imperfect information, most previous studies have almost exclusively focused on the utilisation of advanced ML/AI algorithms. For instance, Badr, Ouhbi and Frikh in 2020 proposed a new Deep Reinforcement Learning (DRL) approach [1] that balances action selection and state uncertainty with the help of the advantage function to progressively improve the quality of actions. The agent was shown to be able to absorb essential knowledge and provide stable performance in a variety of dynamic and complex environments.

However, in this report, we go beyond AI-based agents and also explore the robustness of agents without intelligence in noisy/latency environments, which has been assessed only to a very limited extend in the previous studies. This research is of great interest because reaction-based agents can outperform AI-based agents in some cases, such as in the Bristol Stock Exchange (BSE) environment with dynamically changing equilibrium prices, where the simple Giveaway algorithm dominates the three AI-based algorithms, ZIC, ZIP and GDX, as demonstrated in the 2020 study by Cliff and Rollins [2].

In terms of the trading agents themselves, studies on them are well documented. In the 2001 study by Tesauro and Das [3], a high-performance bidding agent for continuous two-person auctions was proposed, which at once became the strongest trading strategy at the time (according to the authors' claims). This algorithm is based on the previous "GD" (Gjerstad and Dickhaut, 1998) trading strategy, which uses recent market activity to estimate the probability that a bid or offer at any given price will be traded. In the authors' experiments, this trading strategy has shown better performance than other strategies in terms of efficiency, stability and many other aspects.

Furthermore, in the following year, in a study by Tesauro and Bredin [4], an extended adaptation to MGD, GDX, was proposed. GDX utilises Dynamic Programming (DP) to develop its bidding strategy in a broad class of auctions featuring sequential bidding and sequential clearing, optimising the cumulative long-term discounted yield and further improving performance compared to MGD. As the state-of-the-art algorithm compared to the ones that come with the project, GDX was implemented and introduced into our system.

**3 Methodology**

3.1 Environment and Agents

3.2 Technologies and Challenges

**4 Experiments**

**5 Results**

**6 Discussion**

**7 Conclusion**

**References**

1. Badr, H., Ouhbi, B., & Frikh, B. (2020, November). Rules Based Policy for Stock Trading: A New Deep Reinforcement Learning Method. In *2020 5th International Conference on Cloud Computing and Artificial Intelligence: Technologies and Applications (CloudTech)* (pp. 1-6). IEEE.
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3. Tesauro, G., & Das, R. (2001, October). High-performance bidding agents for the continuous double auction. In *Proceedings of the 3rd ACM Conference on Electronic Commerce* (pp. 206-209).
4. Tesauro, G., & Bredin, J. L. (2002, July). Strategic sequential bidding in auctions using dynamic programming. In *Proceedings of the first international joint conference on Autonomous agents and multiagent systems: part 2* (pp. 591-598).