

Reinforcement hedging

After Spring 2019, when the first paper on the application of deep neural networks in the hedging problem was introduced to the finance literature, there has been more interest in further studying this subject in the financial community. Although many papers have been authored since then, there had not been any that study reinforcement learning (RL) [1,2]. The current project is the first one and is introduced jointly by MUFG bank within an MSc project at the University of Liverpool. In this project, the celebrated DDPG method has been used to find out how the machine can learn about hedging a call option as part of a game-playing approach where the episodes are the asset price trajectory and the penalty is the deviation from the final pay-off. The actions in this game are continuous and are chosen to update the value of the asset, risk-free, and a portfolio of them. We implement simulations of the Black-Scholes model [3] to quantify how much the DDPG method can replicate the delta hedging as a benchmark. The study shows the model training solely cannot properly solve the problem, and that one needs to use other machine learning methods like ensembling.

For ensembling, 100 learning trials were implemented and within each learning trial the networks used thousands of episodes to learn. CAIS worked to obtain these results by porting our previous working environment to utilize the University's main HPC resource, Barkla. The results show how learning can improve by increasing the number of learning trials and using modified ensembling. By executing many trials in parallel, it was possible to complete all 100 trials significantly faster than if they were run on a single machine. The main challenges are first a long time spent before calculating the penalty, and second, the high computational power needed for each learning trial.

We are thankful to CAIS at the University of Liverpool in helping us to get the results on this project. For further information on how CAIS can work with you to deliver appropriate AI software solutions, please contact us:

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References

[1] Deepsense.ai. 2020. What is reinforcement learning? The complete guide. [online] Available at: <<https://deepsense.ai/what-is-reinforcement-learning-the-complete-guide/>> [Accessed: 24 July 2020].

[2] H. Buehler, L. Gonon, J. Teichmann & B. Wood, Deep hedging, *Quantitative Finance* Volume 19, 2019 - Issue 8

[3] Hull, John C. (1997). *Options, Futures, and Other Derivatives*. Prentice Hall.