Deep Q-Learning and its application for stock trading

Project proposal

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Objective

The main objective of the project is to explain the concepts and frameworks of Q-Learning and deep Q-Learning. The frameworks will then be contextualized to the problem of stock trading, which will be used throughout the project to help explain and visualize the concepts better. The stock trading problem definition and implementation will be inspired by works from Yang et al. (2020). Finally, to introduce important concepts of Q-Learning and deep Q-Learning incrementally, the stock trading problem will be presented in three parts of increasing complexity.

Methodology

Part 1: Simplified discrete stock trading problem

The first problem consists of trading with two stocks, using a single discrete technical indicator for each stock as the state vector. The discrete technical indicator will be the direction of the trend. The agent will choose from 4 possible actions at each time step, namely buying or selling one of the two stocks. The reward will be the growth of the total portfolio value. This problem will be solved with Q-Learning and will be used to explain its key concepts. The final Q-value table will be used to explain what the agent has learned from its environment and how it used that knowledge to solve the problem it was tasked with.

Part 2: Simplified continuous stock trading problem

The second problem consists of trading with two stocks, using a single continuous technical indicator for each stock as the state vector. The continuous technical indicator will be the quantitative value of the trend. The actions and rewards are the same as for the previous problem. The switch from a discrete state space to a continuous state space will be used to introduce function approximation, and how it is used to transition from Q-Learning to deep Q-Learning. The final Q-value surface (with the x and y axis being the two continuous state variables, and the z axis being the learned Q-value) will be used to explain what the agent has learned from its environment and how it used that knowledge to solve the problem it was tasked with.

Part 3: Complete continuous stock trading problem

The third problem consists of trading with multiple stocks, using multiple continuous technical indicators for each stock as the state vector. The continuous technical indicators will be chosen from (Technical Analysis Library in Python). The actions and rewards are the same as for the previous problem. The addition of multiple technical indicators will be used to show how the deep Q-Learning framework is expanded to higher dimensional state spaces, and how more information about its environment (hopefully) increases its performance.

References

Technical Analysis Library in Python. Documentation - Technical Analysis Library in Python 0.1.4 documentation. (n.d.). https://technical-analysis-library-in-python.readthedocs.io/en/latest/ta.html

Yang, H., Liu, X.-Y., Zhong, S., & Walid, A. (2020). Deep Reinforcement Learning for Automated Stock Trading: An ensemble strategy. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3690996