

PROJECT PROPOSAL: Reinforcement Learning Agents for Optimal Portfolio Management

In recent years, there has been a significant increase in interest in the use of Reinforcement Learning in financial applications. Harnessing their ability for sequential decision making in the problem of asset allocation, this project aims to build and compare model-free reinforcement learning agents on the task of optimal portfolio management. This is a dynamic and intertemporal process of determining optimal weights for the portfolio in order to maximize expected returns for a given level of risk.

More specifically, this project will compare a value based approach to portfolio optimization with a policy based method by working with an algorithm from each of these areas. The chosen algorithms for this are the Deep Q-Network (DQN) and Deep Deterministic Policy Gradient (DDPG). Together, these make 2 of the most widely researched methods in this task.

The DQN implementation will follow the work done in [1] at optimizing cryptocurrency portfolios and apply it to financial stock markets. Another resource that implements DQN, this time in the management of stock portfolios, is [2] and may be used for reference. This method will allow us to measure the agent's performance in a discrete action space.

DDPG is the continuous action space variant of DQN. The DDPG approach will mainly build on research conducted by Jiang et al. [3] and Liang et al. [4] in building an actor-critic agent that can operate in a continuous action space.

Given enough time, the list of algorithms used could be expanded to include others such as DDQN, REINFORCE, PPO, etc.

The agents will be built using Gym (<https://gym.openai.com/>), OpenAI's open source toolkit for developing and comparing RL agents. This would be in line with the various Trading Gyms (eg. <https://github.com/thedimlebowski/Trading-Gym>, <https://github.com/hackthemarket/gym-trading>) that have been built on top of Gym for RL agents in the context of trading.

Finally, the trained agents will be tested on simulated and real market data and their overall performance measured using popular financial indicators such as the Sharpe Ratio and Annualized and Cumulative returns.

List of Papers

1. "A deep Q-learning portfolio management framework for the cryptocurrency market"
https://www.researchgate.net/publication/344431914_A_deep_Q-learning_portfolio_management_framework_for_the_cryptocurrency_market
2. "Application of Deep Q-Network in Portfolio Management"
<https://arxiv.org/ftp/arxiv/papers/2003/2003.06365.pdf>
3. "A Deep Reinforcement Learning Framework for the Financial Portfolio Management Problem " <https://arxiv.org/pdf/1706.10059.pdf>
4. "Adversarial Deep Reinforcement Learning in Portfolio Management"
<https://arxiv.org/pdf/1808.09940.pdf>