

Topic: Reinforcement learning for stock trading

Project Motivation

In the world of stock trading, timing is everything. It's no secret that the stock market is unpredictable, with prices rising and falling based on everything from global events to social media trends. Recently, stocks like Bitcoin, Dogecoin, GameStop and Tesla have captured the attention of investors and the general public alike [1,2]. Whether it's buying low and selling high or knowing when to hold onto a stock for the long term, making the right decision can mean the difference between profit and loss. But how can traders stay on top of market trends and make informed decisions in such a volatile environment? One answer is reinforcement learning (RL), a type of machine learning algorithm that enables an agent to learn how to make decisions based on rewards and punishments. It involves an agent interacting with an environment, taking actions, receiving feedback, and adjusting its behavior based on that feedback [3, 4]. The goal of RL is to optimize the agent's behavior to maximize the cumulative reward it receives over time. In this project, we'll explore how to train RL algorithms to make trading decisions in a financial market

What is Reinforcement Learning?

Reinforcement learning (RL) is a machine learning method, also classified as a subdomain of deep learning [5]. The goal of RL is to learn from interaction in order to achieve a desired goal [6]. The model defined learns from the agent, otherwise known as the “decision maker.” The agent then interacts with components outside of itself, referred to as the “environment.” The agent and environment continually interact with each other, with the agent choosing actions and the environment acknowledging the actions. Through this process, the environment informs the agent of any new situations. Additionally, the environment is capable of giving rise to rewards, or “numerical values that the agent tries to maximize over time” [7].

Outline for Final Project Post

- 1) Introduction/Motivation
- 2) What is Reinforcement Learning
 - a) Key Elements of RL
 - b) Advantages of RL
 - c) Challenges of RL
- 3) Reinforcement Learning Algorithms
 - Model-Based/Value-Based/Policy-Based/ Hybrid Reinforcement Learning Algorithms:
 - a) Q-Learning
 - b) State-Action-Reward-State-Action (SARSA)
 - c) Deep Q Network (DQN)
- 4) Application of RL Algorithms to stock data
 - a) Data sets to be used
 - b) Methods implemented (Q-learning, SARSA & DQN)

- c) Results
- d) Performance Measures
- 5) Discussion and Conclusion
- 6) References

List of resources we intend to use

Data sources

1. Yahoo Finance API: Yahoo Finance provides an API that allows one to download historical stock data that can be used to train our RL models
2. Alpha Vantage API: Alpha Vantage provides an API that allows one to download historical stock data as well as real-time stock data. We can use this data to train and test our RL models
3. Stock examples, perhaps three
 - a. "AAPL" - stock data for Apple
 - b. "AMZN" - amazon stock data
 - c. "JNJ" - Johnson & Johnson stock data

Relevant articles

1. Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction. MIT Press. <https://web.stanford.edu/class/psych209/Readings/SuttonBartoIPRLBook2ndEd.pdf>
2. Mnih, V., Kavukcuoglu, K., Silver, D., Rusu, A. A., Veness, J., Bellemare, M. G., ... & Petersen, S. (2015). Human-level control through deep reinforcement learning. *Nature*, 518(7540), 529-533. <https://www.nature.com/articles/nature14236>
3. [Reinforcement Learning 101](#)
4. Liu, Q. (2021, December 9). Stock trader with Q-Learning - qian liu - Medium. *Medium*. <https://medium.com/@nyxqianl/stock-trader-with-q-learning-91e70161762b>
5. Chakole, J. B., Kolhe, M. S., Mahapurush, G. D., Yadav, A., & Kurhekar, M. P. (2021). A Q-learning agent for automated trading in equity stock markets. *Expert Systems With Applications*, 163, 113761. <https://doi.org/10.1016/j.eswa.2020.113761>

Relevant packages

1. ReinforcementLearning: <https://cran.r-project.org/web/packages/ReinforcementLearning/index.html>
2. Quantmod: <https://cran.r-project.org/web/packages/quantmod/quantmod.pdf>
3. Ggplot2: For visualizing stock market data. For instance, plotting the stock prices through a time series chart.