

Machine Learning Based Real-Time Stock Trading Bot

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Abstract—This paper aims to create a stock trading bot that can successfully mimic a well-seasoned stock trader's strategy. The trading bot is trained using Deep Reinforcement Learning, specifically Deep Q-learning. To ensure a more educated and highly analyzed output, the bot generates buy and sell signals using technical indicators and sentiments for that stock. Making money in the stock market requires a laborious process of market analysis, regular trend monitoring, and thorough scraped data analysis before to buying, selling, or holding positions. Without incurring the expense of emotive human intervention when not necessary, it aids in the optimization of long-term success in the stock market.

I. INTRODUCTION

Stock trading bots are financial instruments developed to distribute the risk of participating in a market and optimally utilize stagnant wealth. Owning stocks in various different companies can help build savings, protect money against inflation, protect from additional taxes, and maximize income from savings and investments. From company's perspective distributing securities brings in capital utilized for the growth of the company, which subsequently creates more job opportunities, efficient manufacturing, and hence cheaper products. Trading ensures the flexibility of the economy during delivery of benefits for both the issuer and holder.

As a result, stock trading has become an efficient and popular investment method over the several years. However, the trading environment is vastly complex and is subject to more than just technical indicators, the market is heavily influenced by public sentiment which is heavily reflected in performance of company stocks. This makes it exceedingly difficult for beginners or those without time-commitment to take advantage of the benefits provided by investing in the stock market without the help of expert traders and in depth knowledge. Adaptive systems are hence developed to utilize the market while simultaneously reducing the risk that can be incurred to stagnant wealth by making the wrong decisions in the fast-paced, highly volatile market.

II. PROBLEM STATEMENT

Given the highly complex nature of the stock trading environment that takes into account technical and sentimental factors, it has become increasingly difficult to mitigate potential risks to stagnant investable wealth and optimizing profits

through stock trading. The paper aims to create a stock trading bot that takes into consideration both technical and sentimental analysis.

- Under technical analysis the paper implements indicators like the moving average (Simple and Exponential), MACD, RSI, PPO, ADI, Parabolic SAR, etc
- Under sentimental analysis information of positive, negative and neutral indicators are gauged from Twitter tweets.

III. DATASET

The dataset is sourced from Yahoo! Finance Nifty50 (2007-2022) for training, the companies used in the dataset in the paper specifically are:

- Apple (APPL)
- Amazon (AMZ)
- Google (GOOG)
- Hewlett-Packard Company (HPQ)
- Microsoft (MSFT)
- IBM (IBM)
- Netflix (NFLX)
- Tesla (TSLA)

This data is available for the years 2018 and 2019. The dataset used is from the years 2018 and 2019 as we have already set trends and performance data from those years and it's easier to compare results of the trading bot to check efficiency of the proposed stock trading bot model.

TABLE III. COMPANY TWEET COUNTS

COMPANY	POSITIVE	NEGATIVE	NEUTRAL	TOTAL
AAPL	25	14	61	100
GOOG	28	8	64	90
YHOO	35	4	61	100
MSFT	20	8	72	100
GS	17	15	68	98

Fig. 1

IV. METHODOLOGY

A. Deep Q learning

Deep Reinforcement learning has been gaining popularity over the years for its ability to learn actions similar to the human experience. It is a category of machine learning and artificial intelligence which combines artificial neural networks with a framework of reinforcement learning. It integrates function approximation and target optimization, mapping states and actions to the end product that they aim for. The success has extended to the financial industry, i.e. stock trading, as it is apt to process the large amount of data that is generated by the market every day which can be used to extract useful discoveries using neural networks.

Deep Q-learning, which is the type of Model-free Deep Reinforcement learning the paper utilizes, uses experience replay to learn about the stock environment and update main and target networks. Main networks train based on batches of past experiences. Deep Q-learning uses deep neural networks to make non-harmful approximate values while preserving the relative importance of all pieces of data.

The stock trading bot proposed by the paper at a given episode, an agent in current state selects and performs buy, sell, or hold, observes the consequent state, receives a certain reward signal and adjusts parameters based on the gradient of the loss computed.

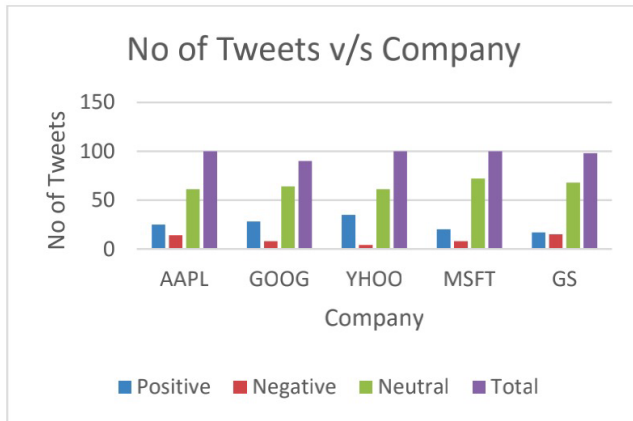


Fig. 2

B. Sentiment Analysis

There is a strong connection between the investors sentiment and market performance, which is reflected in stock prices and trends. It's vital in making sound decisions while trading stocks, and sentiment analysis can provide valuable insights into the stock market's future.

Sentiment analysis or opinion mining essentially is the scrapping of renowned news sources (the project uses twitter for the same) and subsequent natural language processing (NLP) in order to identify and extract the subjective information by the analysis of user opinions, evaluations, sentiments, and attitude. The current automated versions available to use

have seen an 80-85 agreement with human analysts. It can give both an overall idea (whether the market is bearish or bullish) and individual insight into individual company performance.

Short term trading is heavily reliant on both technical and sentimental indicators. Sentiments are valuable in such instances (similarly to this paper) as it influences the technical indicators that are used to measure and make profit from the short-term price movements that's often a result of investor attitudes towards a security.

The graph above depicts the correlation between tweet corpus and stock prices. This goes to show how sentiments and trends reflect on the performance of the stock market. This paper will scrape Twitter to extract useful information for sentimental analysis. Tweet sentiments are predicted and identified as three classes positive, negative, and neutral tweets.

Correlation between tweet corpus and stock prices

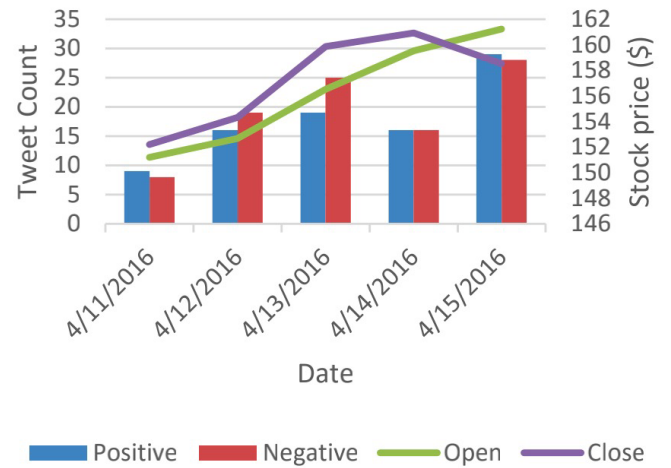


Fig. 3

C. Technical Analysis

Technical analysis is the study of financial market action. The technician looks at price changes that occur on a day-to-day or week-to-week basis or over any other constant time period displayed in graphic form, called charts. Hence the name chart analysis. We will implement indicators like the moving average (Simple and Exponential), MACD, RSI, PPO, ADI, Parabolic SAR, etc. Moving averages are popular and versatile for identifying price trends. They smooth out fluctuations in market prices, thereby making it easier to determine underlying trends. Their other function is to signal significant changes in direction as early as possible. We will see which indicators when combined together give the most correlation and accuracy. Mapping Technical indicators to specified weightings which determine whether a signal (BUY/SELL) is generated. If an overall weighting threshold is met, based on generated signals, an order is created. The bot currently supports both

live trading (paper account recommended!) and historical back testing Test and train different supervised learning ML models to see which one works best. Add sentimental analysis model to this ML model and get the final project product.

V. IMPLEMENTATION

This paper uses Deep Q-learning, which is the type of Model-free Deep Reinforcement learning the paper utilizes, uses experience replay to learn about the stock environment and update main and target networks. The stock trading bot proposed by the paper at a given episode, an agent in current state selects and performs buy, sell, or hold, observes the consequent state, receives a certain reward signal and adjusts parameters based on the gradient of the loss computed.

The Q-learning algorithm has been subjected to various improvements over the years and the paper takes it to account to ensure maximum efficiency from the algorithm. The three main changes that have been implemented in the project are:

- Vanilla DQN
- DQN with fixed target distribution
- Double DQN

To simplify the trading problem of deciding how much stocks to buy/sell for portfolio distribution, a given state, only one stock is bought or sold at a time. The n-day window feature is represented by a vector of following differences in the adjusted closing price of the currently being traded stock. This is followed up by a sigmoid operation to normalize the values to the range of [0,1].

For the sentiment analysis the paper follows the following. Twitter data and yahoo finance data for given company, and specified keywords are scrapped. Tweets for a given company are collected and stored in a text file. A csv file that separates tweet time and tweet text is made , and are processed and stop words are removed and training data is created. Training data and test classified model on test data are done for tweet sentiment analysis. The total number of tweets, positive tweet, negative tweet and neutral tweets are the calculated. Then generate dataset for stock prediction which contain feature set as tweet sentiment statistics and target set as stock up or down direction. Classify stock prediction dataset and predict upcoming stock direction.

VI. RESULT

The stock trading bot trained on GOOG 2010-17 stock data. The graph shows the result for when it was tested on the input year 2019 (2019 is chosen as data of real trends are already available and hence easier to test result and compare) with a profit of 1141.45, in comparison to 2018 with profit of \$ 863.41.

VII. CONCLUSION

The stock trading bot proposed by the paper successfully implements both technical analysis and sentimental analysis, to trade in real time buying or selling stocks one at a time

```
1/1 [=====] - 0s 16ms/step
2022-11-17 23:39:35 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Buy at: $1312.99
1/1 [=====] - 0s 14ms/step
2022-11-17 23:39:35 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Buy at: $1304.96
1/1 [=====] - 0s 14ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Buy at: $1289.92
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1295.28 | Position: -$7.77
1/1 [=====] - 0s 16ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1328.13 | Position: +$26.78
1/1 [=====] - 0s 15ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1340.62 | Position: +$45.28
1/1 [=====] - 0s 17ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1343.56 | Position: +$30.81
1/1 [=====] - 0s 16ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1344.66 | Position: +$31.67
1/1 [=====] - 0s 14ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1345.02 | Position: +$40.86
1/1 [=====] - 0s 14ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1350.27 | Position: +$60.35
1/1 [=====] - 0s 16ms/step
1/1 [=====] - 0s 16ms/step
1/1 [=====] - 0s 15ms/step
1/1 [=====] - 0s 15ms/step
1/1 [=====] - 0s 16ms/step
1/1 [=====] - 0s 16ms/step
1/1 [=====] - 0s 16ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Buy at: $1348.84
1/1 [=====] - 0s 17ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] DEBUC Sell at: $1343.56 | Position: -$5.28
1/1 [=====] - 0s 17ms/step
1/1 [=====] - 0s 14ms/step
2022-11-17 23:39:36 Shlok-Yoga-Slin-7-1411L05 root[381349] INFO model_dqn_C00G_50: +$1111.66
```

Fig. 4

to maximise profit generated in investing the stagnant wealth into the stock market. Together with the information sources from Twitter to generate a sentiment analysis score and the algorithmic predictions from the Deep Q-learning which is a type of Deep Reinforcement learning the stock trading bot can help users overcome the complexity of the stock trading environment and give access to those that cannot afford a stock broker or those that aim to optimize their stock trading practices and make maximum profit in the field. Stock trading bots are financial instruments developed to distribute the risk of participating in a market and optimally utilize stagnant wealth. Owning stocks in various different companies can help build savings, protect money against inflation, protect from additional taxes, and maximize income from savings and investments. From company's perspective distributing securities brings in capital utilized for the growth of the company, which subsequently creates more job opportunities, efficient manufacturing, and hence cheaper products. Trading ensures the flexibility of the economy during delivery of benefits for both the issuer and holder. An efficient stock trading bot can reap the benefits of successful trading strategies in the stock trading environment and meet the aforementioned expectations.



Fig. 5

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