Algorithmic Trading Using Sentiment Analysis and Reinforcement Learning

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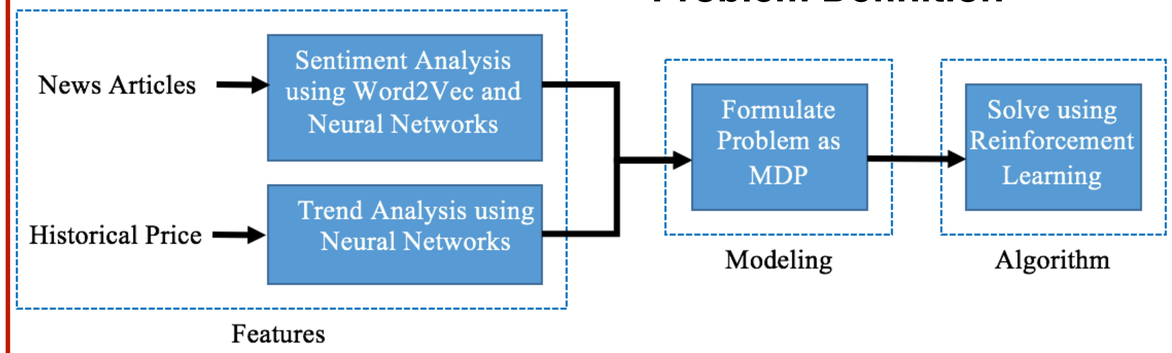
Motivation

- Algorithmic trading has had limited adoption due to complexity in creating trading strategies.
- A trading strategy typically involves creating rules or methods to identify scenarios under which we should buy or sell stocks.
- Can we build a ML agent that tries to learn an optimal trading strategy using reinforcement learning?

MDP Formulation

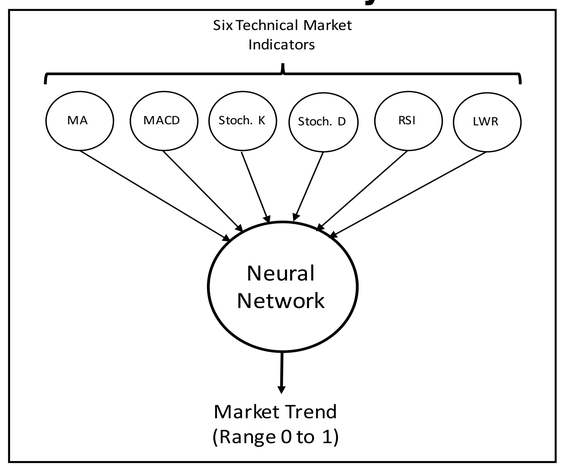
- **MDP Definition**
  - **STATE**: *[# of Stocks for each asset in portfolio, Stock Price of each asset, Cash in Hand, (Current trend of each asset), (Sentiment Score of each asset)]*
  - **INITIAL STATE**: *[(0,0,..), (Initial Stock Price for each asset), Initial Amount of investment = $10,000, (1,1,..), (1,1,..)]*
  - **ACTION** : *[BUY , SELL or HOLD for each asset in portfolio]*
  - **REWARDS**: *Current Value of the Portfolio - Initial Amount Invested*
  - **TRANSITION PROBABILITY**: *1*
- **Solve the MDP using Q-Learning using Functional Approximations**

Problem Definition

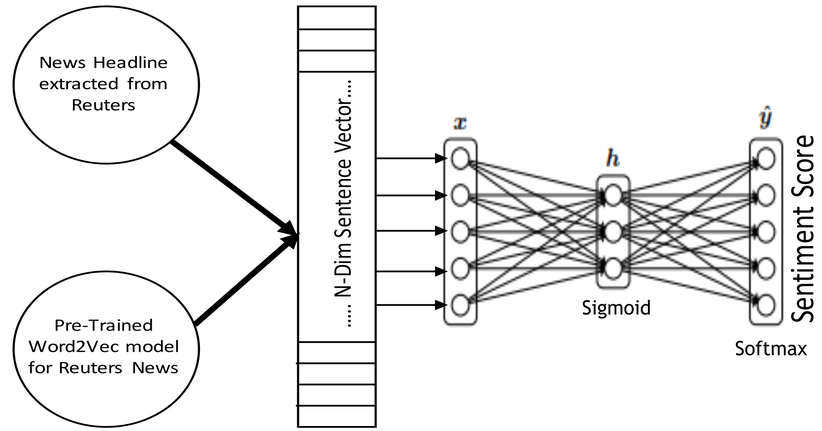


Train a ML agent to learn an optimal trading strategy based on historical data and stock market news in order to maximize the generated profits / Sharpe Ratio.

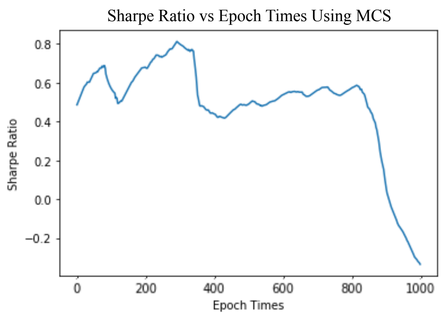
Trend Analysis



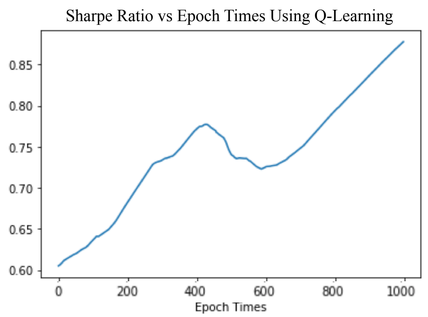
Sentiment Analysis



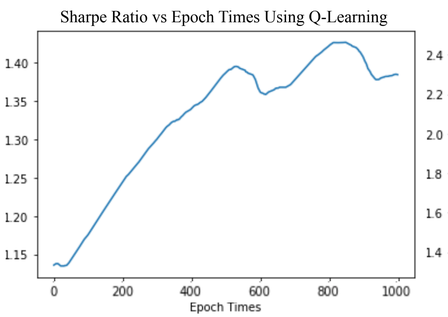
RESULTS & ANALYSIS



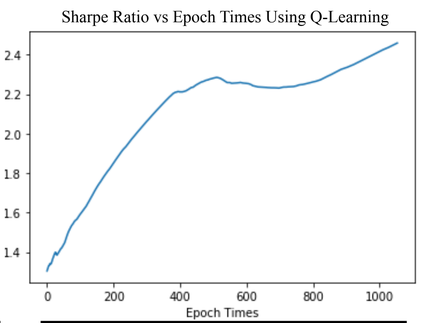
Sharpe Ratio using Monte-Carlo simulation



Sharpe Ratio with Reinforcement learning without trend information and sentiment analysis



Sharpe Ratio with Reinforcement learning with trend information but no sentiment analysis



Sharpe Ratio with Reinforcement learning with trend information and sentiment analysis

- The performance criterion is based on Sharpe Ratio that is calculated as average of profits normalized over standard deviation.Usually, any Sharpe ratio greater than 1 is considered acceptable to good by investors. A ratio higher than 2 is rated as very good, and a ratio of 3 or higher is considered excellent.
- As can be observed that all RL, RL+Trend and RL+Trend+Sentiment Analysis successfully learn profit-making trading strategies.
- Adding Trend Information and Sentiment Score helps improve learning capability of the algorithm i.e increases Sharpe Ratio.

Summary

Methods	Sharpe Ratio
Baseline : Monte-Carlo	-0.2
RL only	0.85
RL + Trend	1.4
RL + Trend + Sentiment Score	2.4

Data: Period - 2011-2016
- Stocks = {QCOM, MSFT}
- Historical Data obtained from Yahoo Finance
- News Articles from Reuters Key Development Corpus

Challenges & Next Steps

- Increasing # of assets increases state space exponentially which in turn increases run-time significantly.
- Next Steps
  - Extend the presented trading strategy framework to incorporate large number of stocks.
  - Improve the performance of Sentiment and Trend Analysis.