NotBeta

A Deep Reinforcement Learning Framework

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Data Used: Quandl, Refinitiv, Storm Events Database

Themes: Theme 1 and 3

Experiments conducted on local machine

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Theme 1: How can we model the impact of extreme weather events (e.g. drought, flooding, hurricanes) on pricing in insurance, listed equity, and bond markets?

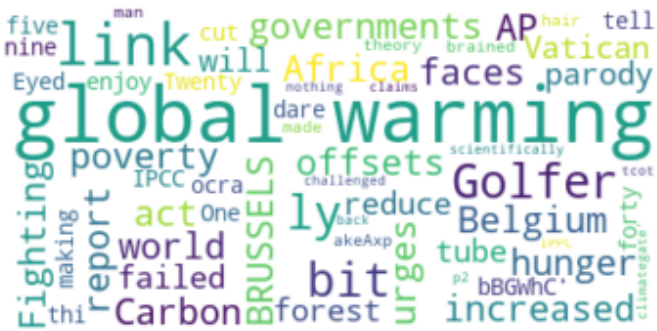

Figure: Twitter Wordcloud

Theme 2: How can we use social media sentiment to predict company returns?

Idea

- **Requirements**
  - Needs to learn the optimal action
  - Adapt to market conditions
  - Consider extreme events (in terms of climate change), social media analytics which have influence over stock prices
- **Solution**
  - Develop a deep reinforcement learning framework to maximise alpha generation
  - Leverage alternative datasets to feed in as the environment in the reinforcement learning model

Background

- **Financial Signal Processing:** Using ARIMA and GARCH models to analyse time-series data, and forecast next day returns by using model parameters
- **Machine Learning Approaches:** Time-series forecasting using state-of-the-art neural networks hold predictive power to predict next day returns; however may not maximise alpha

Novelty

Modelling the Financial Market as a Discrete-Time Stochastic Dynamical System

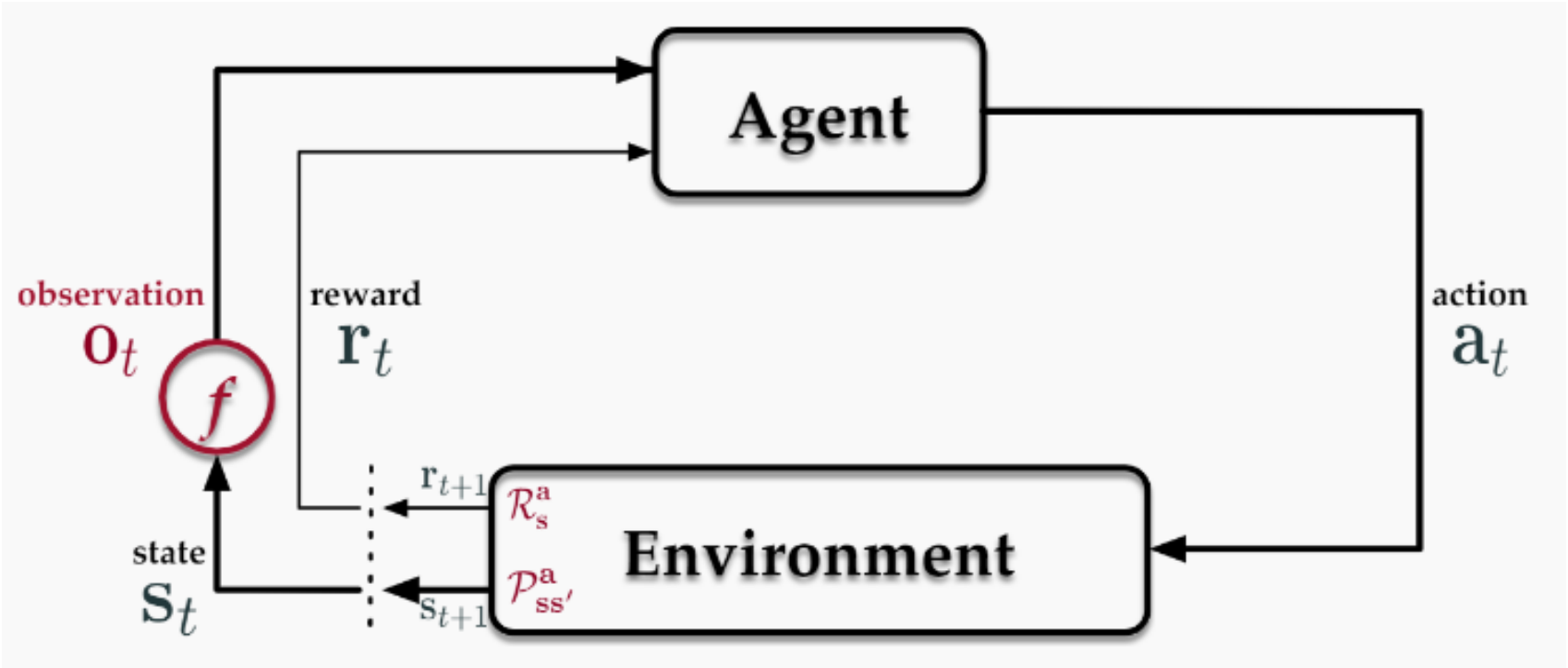

Figure: Partially Observable Markov Decision Process

Data

Social Media, Extreme Events, Financial Data Sources

- **Social Media Analytics:** Retreived from Quandl
- **US Stocks Closing Prices:** Retrieved from Quandl
- **S&P500:** Yahoo Finance
- **Sentiment Social Media Data:** Retrieved from Refinitiv
- **Storm Events Database:** Retrieved from National Centers for Environmental Information

- Data ETL
- Data Pre-Processing: Data Cleaning, Wrangling, Visualisation
- Merging multiple datasets
- Feature selection
- Checking for stationarity (AD Fuller Test)

Experiments

Agent Trading Behaviour

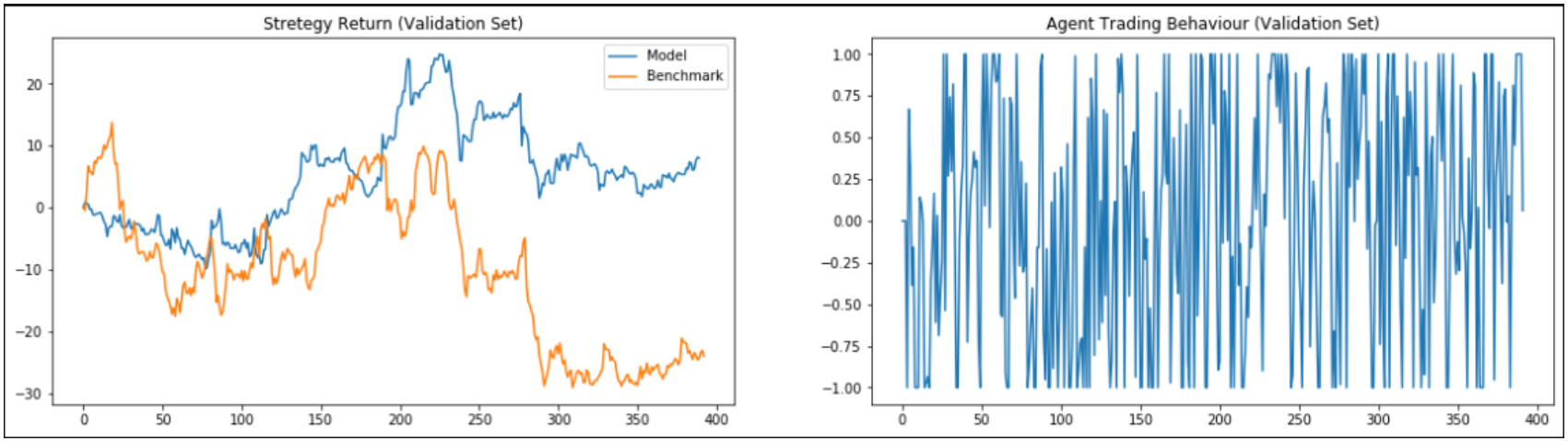

Figure: Plotting Agent Actions

Experiments

CVS Health Corp (NYSE:CVS)

Strategy Alpha: 0.255765, Strategy Beta: -0.171047

Figure: CVS Health Corp % Returns (Jan 2018 - July 2019)

Experiments

CVS Health Corp (NYSE:CVS)

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CVS Results

Model
-------------------------
Cumulative Return: 43.93%
Annual Return: 26.61%
Max Drawdown: -19.42%
Sharpe ratio: 1.21
Sortino ratio: 1.89
Omega ratio: 1.27
-------------------------

Benchmark
-------------------------
Cumulative Return: -28.78%
Annual Return: -19.74%
Max Drawdown: -37.67%
Sharpe ratio: -0.64
Sortino ratio: -0.85
Omega ratio: 0.9
-------------------------
```

Figure: CVS Health Corp Financial Metrics (Jan 2018 - July 2019)

Experiments

ExxonMobil (NYSE:XOM)

Strategy Alpha: 0.000579, Strategy Beta: -0.194104

Figure: ExxonMobil % Returns (Jan 2018 - July 2019)

Experiments

ExxonMobil (NYSE:XOM)

```
XOM Results

Model
-------------------------
Cumulative Return: 0.64%
Annual Return: 0.42%
Max Drawdown: -12.66%
Sharpe ratio: 0.1
Sortino ratio: 0.15
Omega ratio: 1.02
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Benchmark
-------------------------
Cumulative Return: -14.28%
Annual Return: -9.55%
Max Drawdown: -26.45%
Sharpe ratio: -0.39
Sortino ratio: -0.53
Omega ratio: 0.94
-------------------------
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Figure: ExxonMobil Financial Metrics (Jan 2018 - July 2019)

Conclusion

- **Alpha Gen:** Reward function is to maximise cumulative returns
- **Viability:** Pipeline proof-of-concept built; can be leveraged into existing systems using Python environments
- **Originality:** Using novelty in policy gradient optimisation in tandem with alternative datasets
- **Expandable:** Multi-agent reinforcement learning and diversity in datasets; can be applied into multiple asset classes and stocks
- **Performance:** Proof-of-concept of two different stocks as a starting point; adapts to market conditions