

Course Code : RME 3211

Course Name : Intelligent Systems and Robotics Lab

Project Name : Automatic Stock Trading Using Approximate Q Learning

Group Number : 03

Group Members :

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Project Goal

Training and back testing a stock trading agent which can trade a portfolio stocks trained using approximate Q learning

Stocks worked with

Company Name	Ticker Symbol
• Grameenphone Ltd	GP
• Square Pharmaceuticals Ltd	SQURPHARMA
• ACI Formulations Ltd	ACIFORMULA

Features used

- Price [per stock]
- Volume [per stock]
- Moving Average Convergence Divergence (MACD) [per stock]
- Relative Strength Index (RSI) [per stock]
- Commodity Channel Index (CCI) [per stock]
- Average Directional Index (ADX) [per stock]
- Stock owned at a time step [per stock]
- Cash in hand per time step

Description of Technical Indicators

Moving Average Convergence Divergence (MACD)

Moving average convergence divergence (MACD) is a trend-following momentum indicator that shows the relationship between two moving averages of a security's price. The MACD is calculated by subtracting the 26-period exponential moving average (EMA) from the 12-period EMA. The result of that calculation is the MACD line. A nine-day EMA of the MACD called the "signal line" is then plotted on top of the MACD line, which can function as a trigger for buy and sell signals. Traders may buy the security when the MACD crosses above its signal line and sell the security when the MACD crosses below the signal line.

Relative Strength Index (RSI)

The RSI, or relative strength index, is a popular form of technical analysis that helps investors predict price movements and identify trends. It provides a framework for identifying when stocks have been overbought or oversold, thus indicating a possible reversal of price movement momentum.

Commodity Channel Index (CCI)

The Commodity Channel Index (CCI) is a technical indicator that measures the difference between the current price and the historical average price. When the CCI is above zero, it indicates the price is above the historic average. Conversely, when the CCI is below zero, the price is below the historic average. The CCI is an unbounded oscillator, meaning it can go higher or lower indefinitely. For this reason, overbought and oversold levels are typically determined for each individual asset by looking at historical extreme CCI levels where the price reversed from.

Average Directional Index (ADX)

Average Directional Movement Index can be used to help measure the overall strength of a trend. A strong trend is present when ADX is above 25 and no trend is present when below 20. If the ADX is rising then the market is showing a strengthening trend. The value of the ADX is proportional to the slope of the trend. The slope of the ADX line is proportional to the acceleration of the price movement (changing trend slope). If the trend is a constant slope then the ADX value tends to flatten out. If the ADX is declining, it could be an indication that the market is becoming less directional, and the current trend is weakening.

Additional Information

Initial Investment : 200000

Training Episodes : 1200

State Space Size or Feature Size : $(\text{num_feature} + \text{num_stock} + 1) = 22$

Including COVID 19 Period:

Total no of business days with covid period : 2989

Start : 18 November 2009 **End :** 04 September 2022

Excluding COVID 19 Period:

Total no of business days without covid period : 2427

Start: 18 November, 2009 **End:** 27 February, 2020

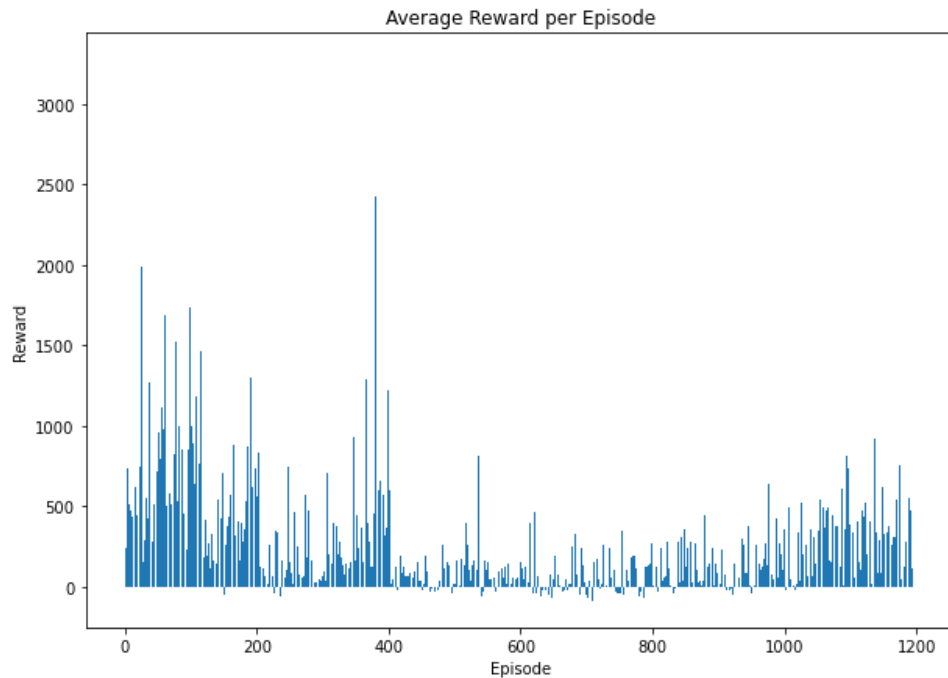
Train Test Split : 75 / 25

Results Found - Excluding COVID 19

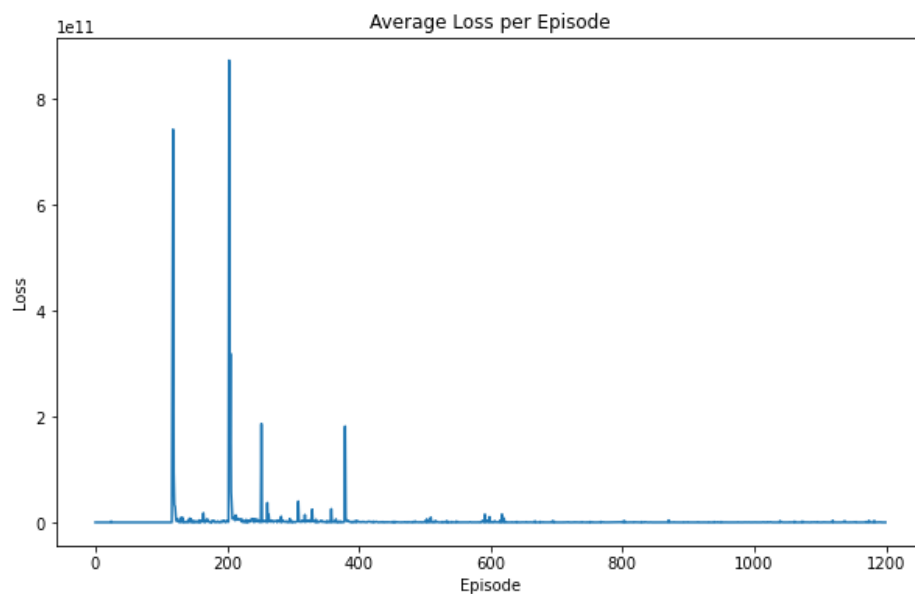
Portfolio value of train:

Maximum: 6160521.070021578
Minimum: 47078.70000000028
Mean: 651719.4952250213
Standard Deviation: 578890.9381313598

Reward Graph - Train



Loss Graph - Train



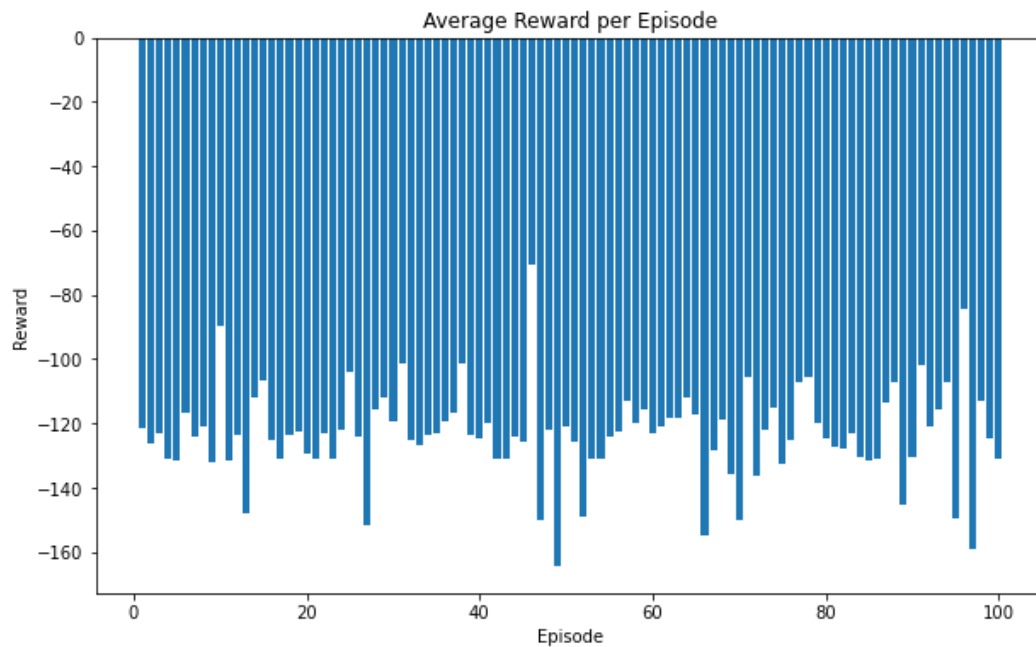
Portfolio value of test:

Maximum:	157224.69000001295
Minimum:	100145.24999999555
Mean:	125066.80930000496
Standard Deviation:	8631.064956283572

ROI(return on investment): -37.46659534999752

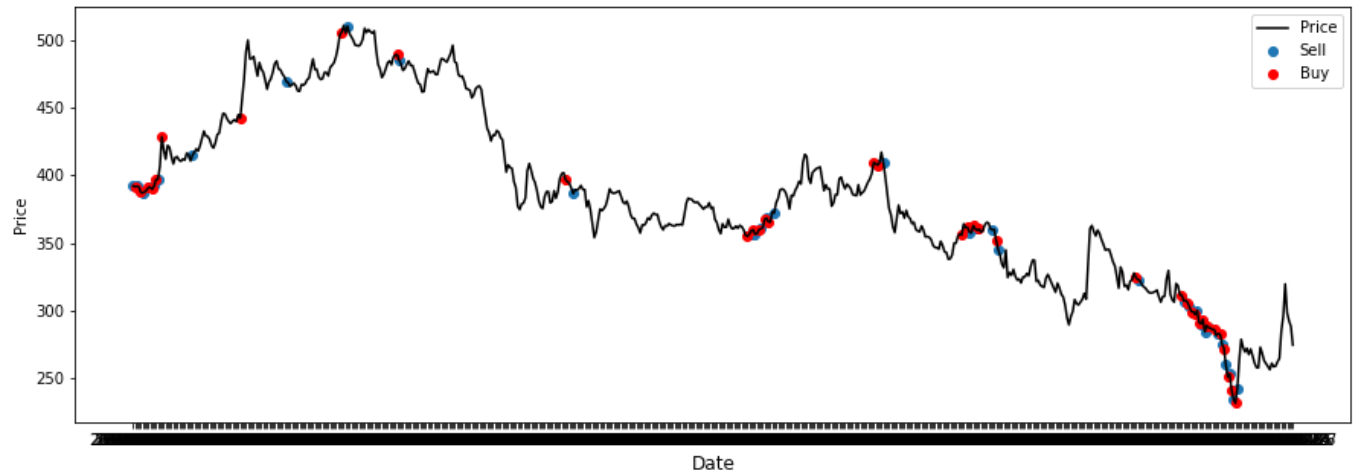
Reward Graph - Test

Average reward all episode: -1234.4841960460471

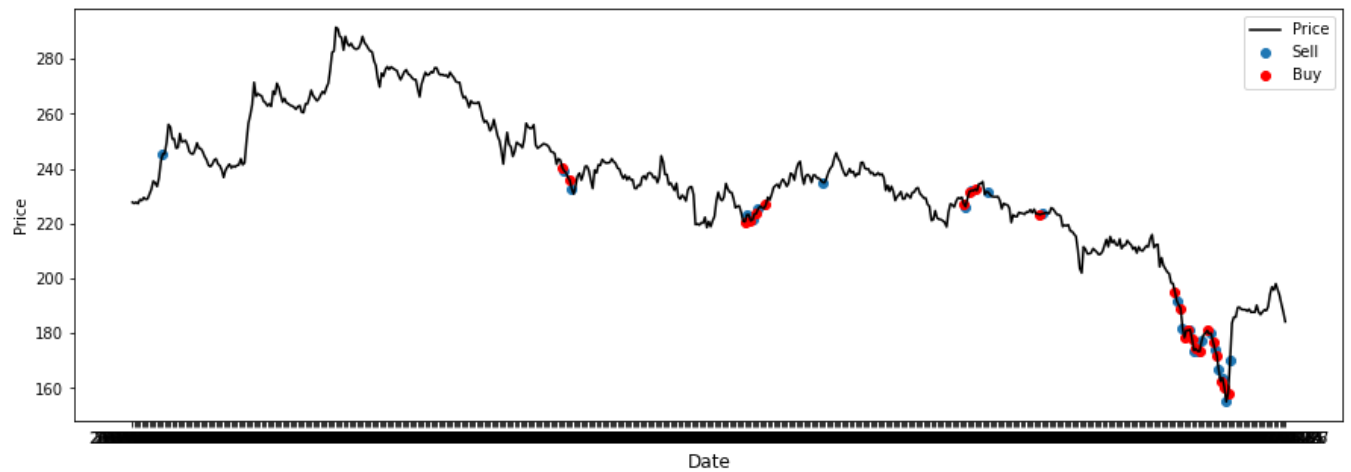


Test Result on 3 stocks

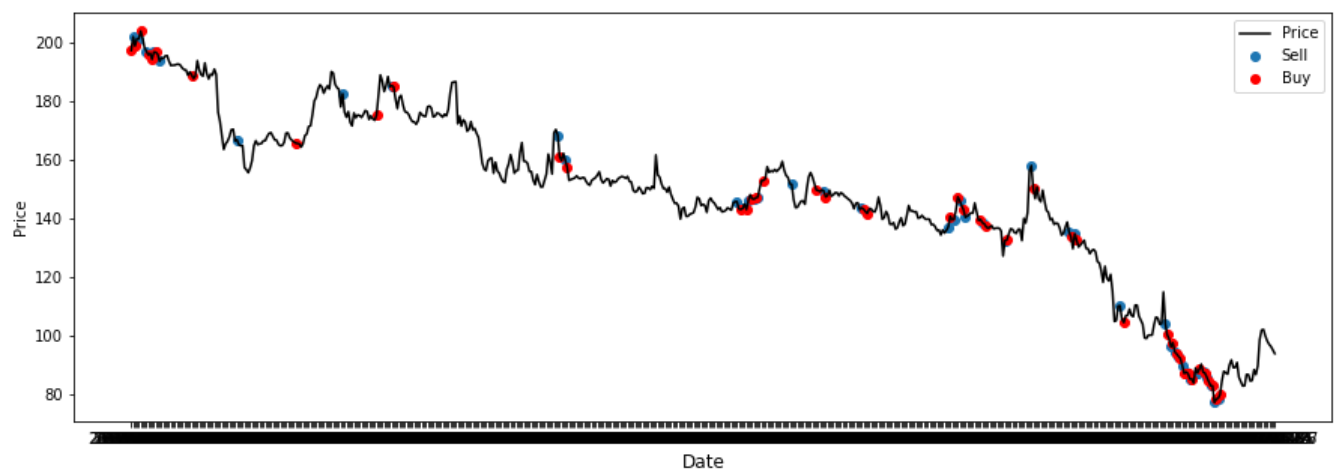
Grameenphone Ltd



Square Pharmaceuticals Ltd



ACI Formulations Ltd

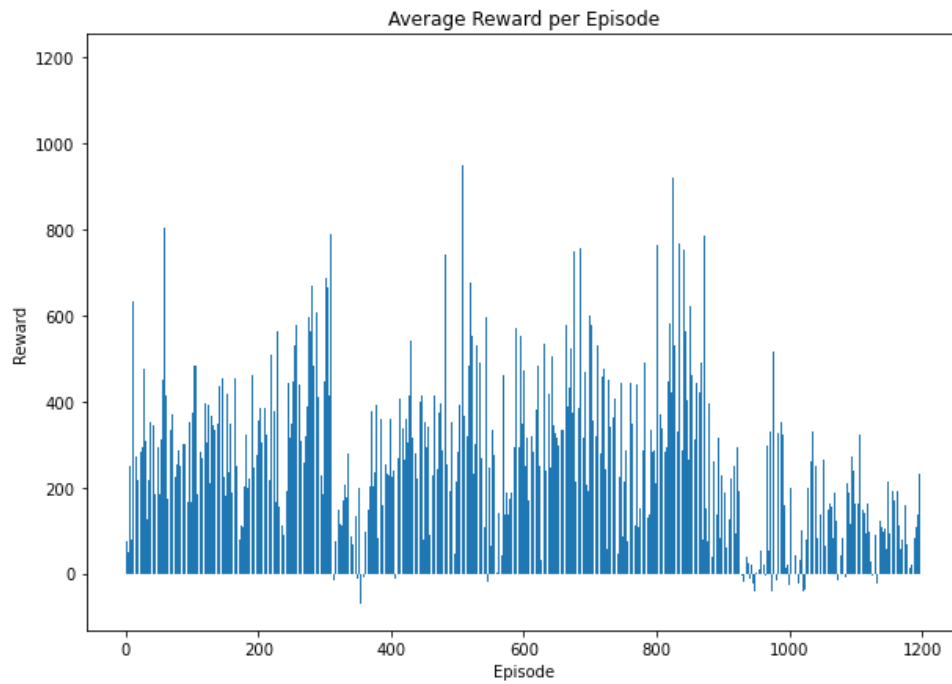


Results Found - Including COVID 19

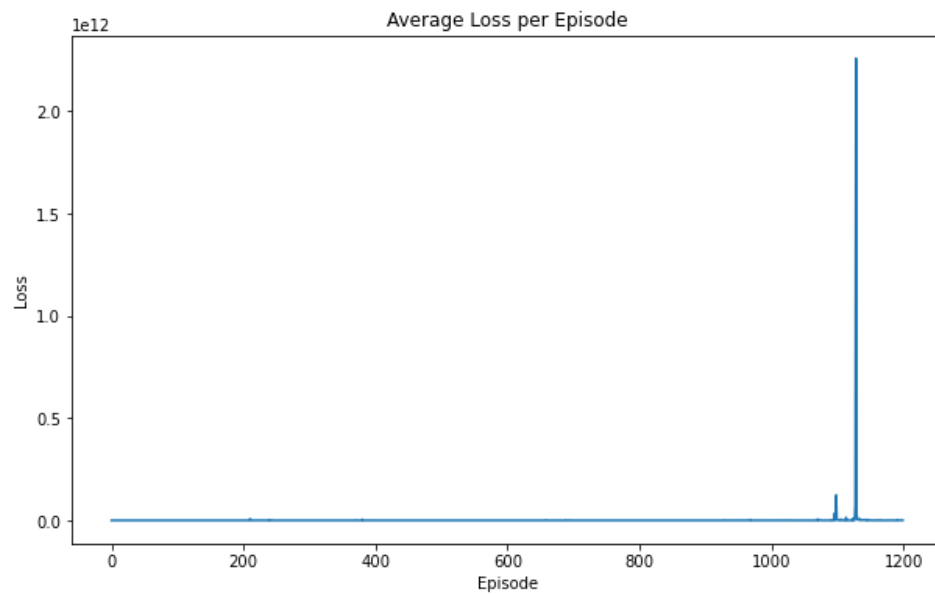
Portfolio value of train:

Maximum:	2870482.28000128
Minimum:	44774.22999999823
Mean:	789177.9265749882
Standard Deviation:	432216.2955223902

Reward Graph - Train



Loss Graph - Train



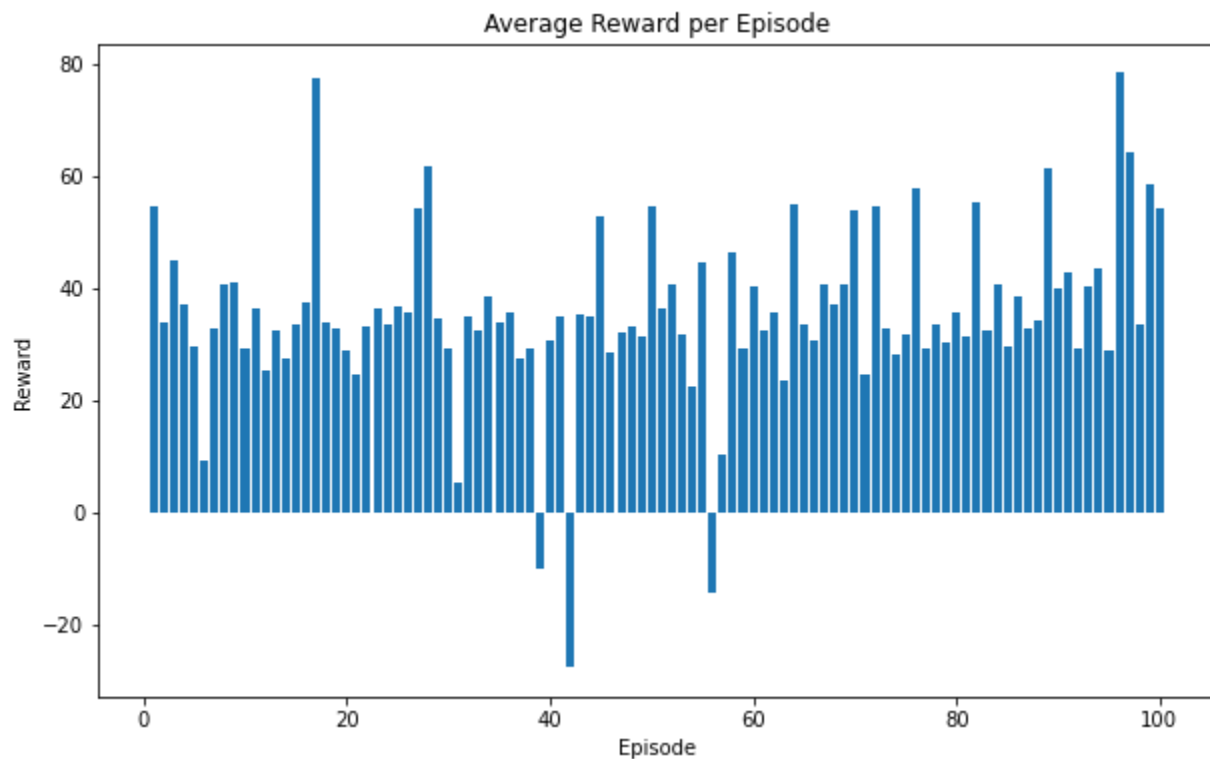
Portfolio value of test:

Maximum:	258463.0600000262
Minimum:	179438.81999999462
Mean:	226585.69390002874
Standard Deviation:	11309.638721424319

ROI(return on investment): 13.29284695001437 %

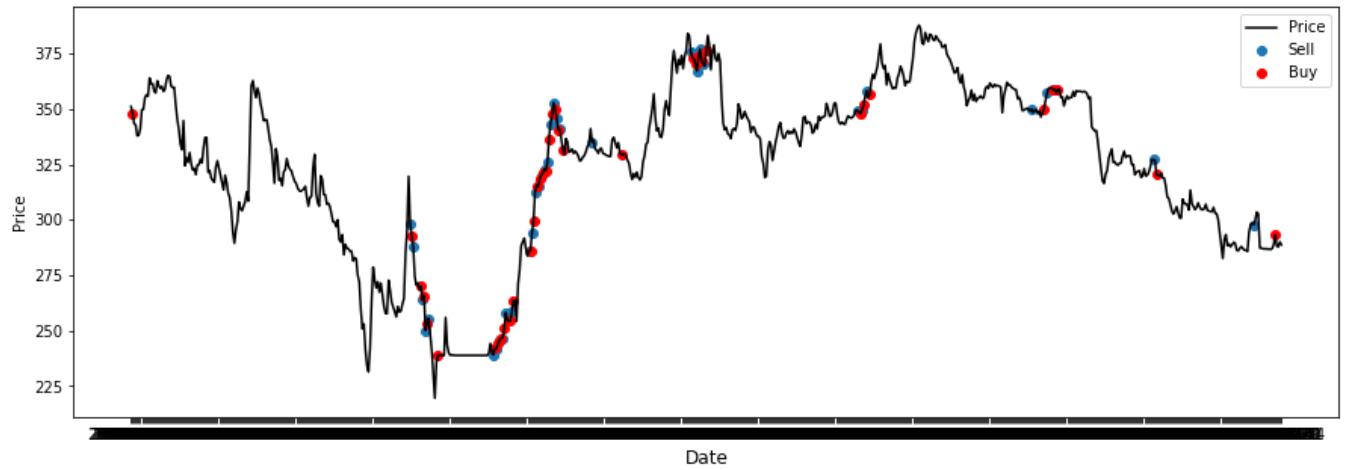
Reward Graph - Test

Average reward all episode: 355.8995167339849

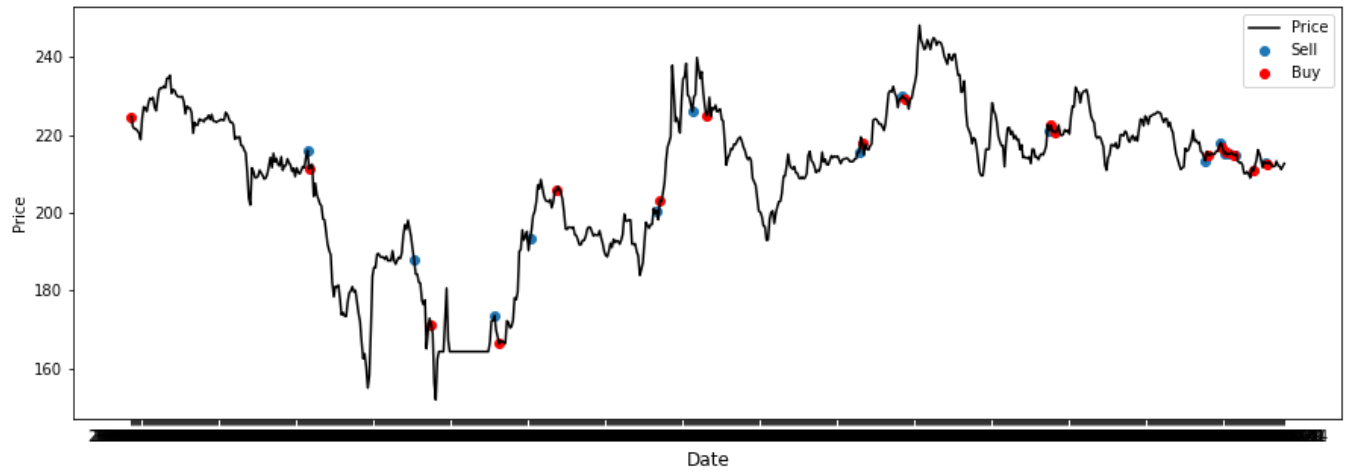


Test Result on 3 stocks

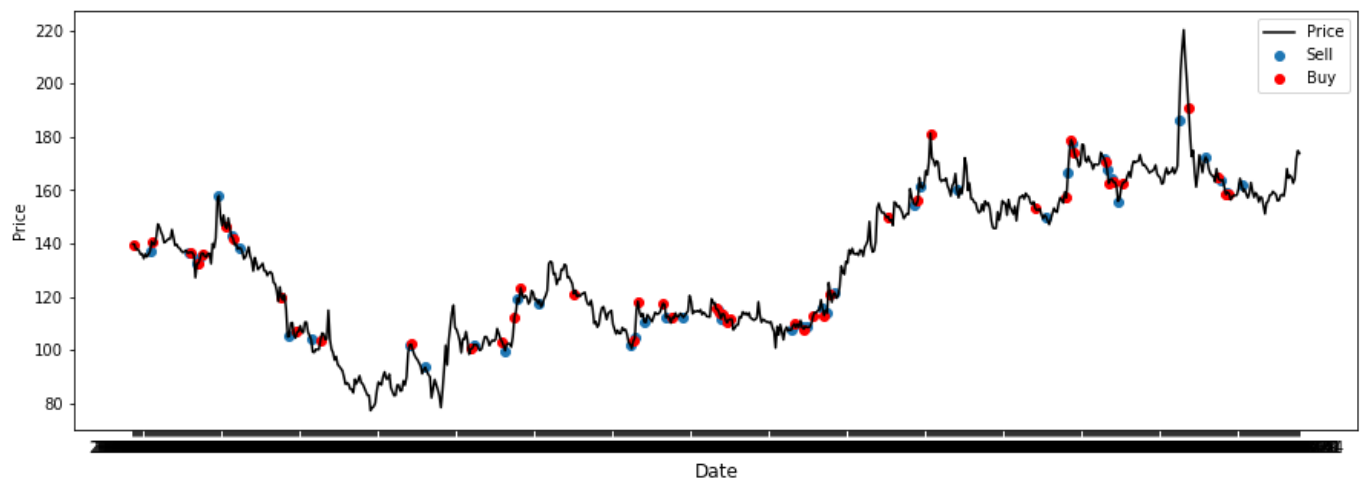
Grameenphone Ltd



Square Pharmaceuticals Ltd



ACI Formulations Ltd



Current Limitations

- Result doesn't meet expectations. As the agent is losing money when we let it trade during the testing period.
- We are using a linear model to calculate the q values which might not fit well using a linear model. Which might be the cause for the agent to perform poorly when it comes to testing.

Further Improvement

- Implement the project using deep reinforcement learning.

References

- Data Collection - <https://www.investing.com/>
- Technical Indicators Idea - <https://towardsdatascience.com/deep-reinforcement-learning-for-automated-stock-trading-f1dad0126a02>
- Moving Average Convergence Divergence (MACD)- <https://www.investopedia.com/terms/m/macd.asp>
- Relative Strength Index (RSI) - <https://finance.zacks.com/read-rsi-10069.html>
- Commodity Channel Index (CCI) - <https://www.investopedia.com/terms/c/commoditychannelindex.asp>
- Average Directional Index (ADX) - <https://www.fidelity.com/learning-center/trading-investing/technical-analysis/technical-indicator-guide/adx>
- https://github.com/KonstantinosNikolakis/Stock-Trading-Reinforcement_Learning