Title: Algorithmic trading using Fourier analysis

Abstract:

This project uses Fourier analysis to test the effectiveness of mathematics in stock market trading. Fourier transform is applied on the days vs stock price graph to find the cycles which have the most effect and analysis is done on those days to find out upcoming trends. This could be very useful to remind traders to keep a look at those time intervals so that they do not miss out on trends.

Introduction:

Stock trading is a process where the trader tries to buy a share(part) of a company at a lower price to sell it at a higher price expecting to make profits out of it. However, this is not that simple as the price of a stock generally is volatile in nature. It is difficult to predict if the price goes up or down. There are chances that the trader makes a loss if the stock price decreases due to market conditions.

Due to the above-said reasons, the trader has to keep a look at the stock prices always. However, that may not be possible to monitor each stock in the portfolio always.

This project aims to reduce those efforts by predicting when the stock movement might occur and alerting the trader to check out the stock. This could significantly reduce the time the trader requires to monitor the stock price and make the trader more efficient.

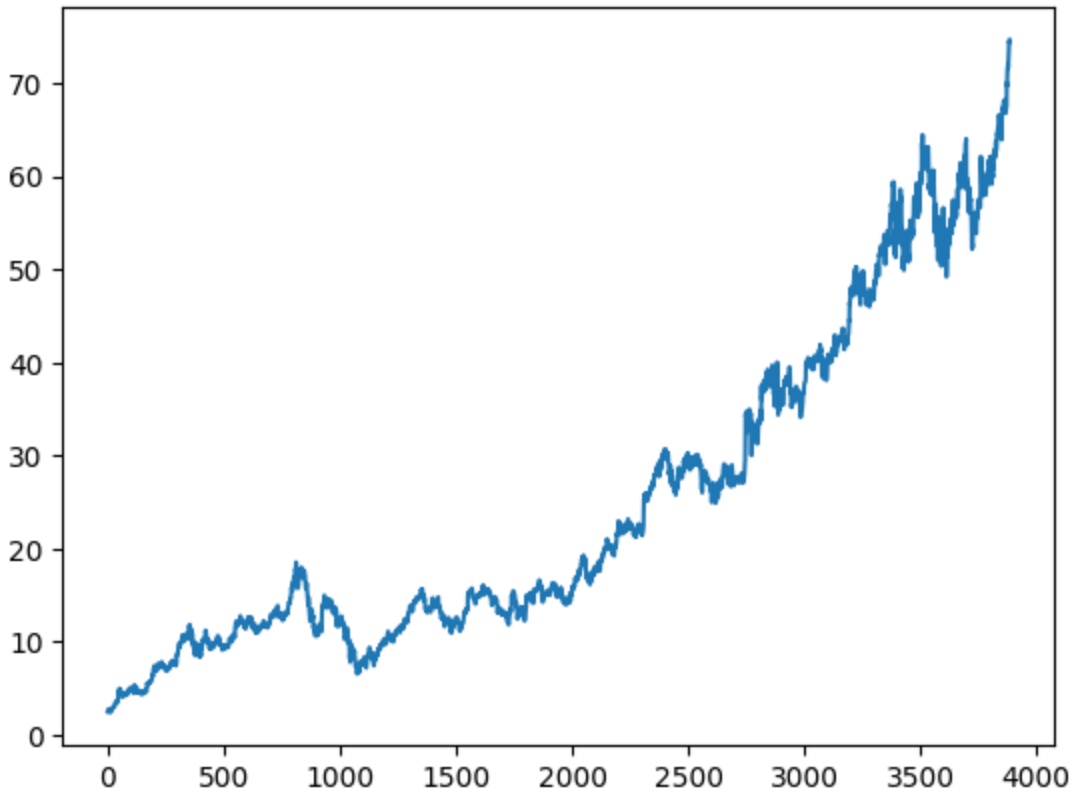
Methods:

The data from Yahoo Finance has been used for this project. Yahoo Finance is a popular and trusted repository where many investors and analysts conduct analyses. All the data provided is real, accurate and monitored by the stock exchanges.

The stock data over a minimum of 2 years had been selected. There are no legal restrictions to using this data.

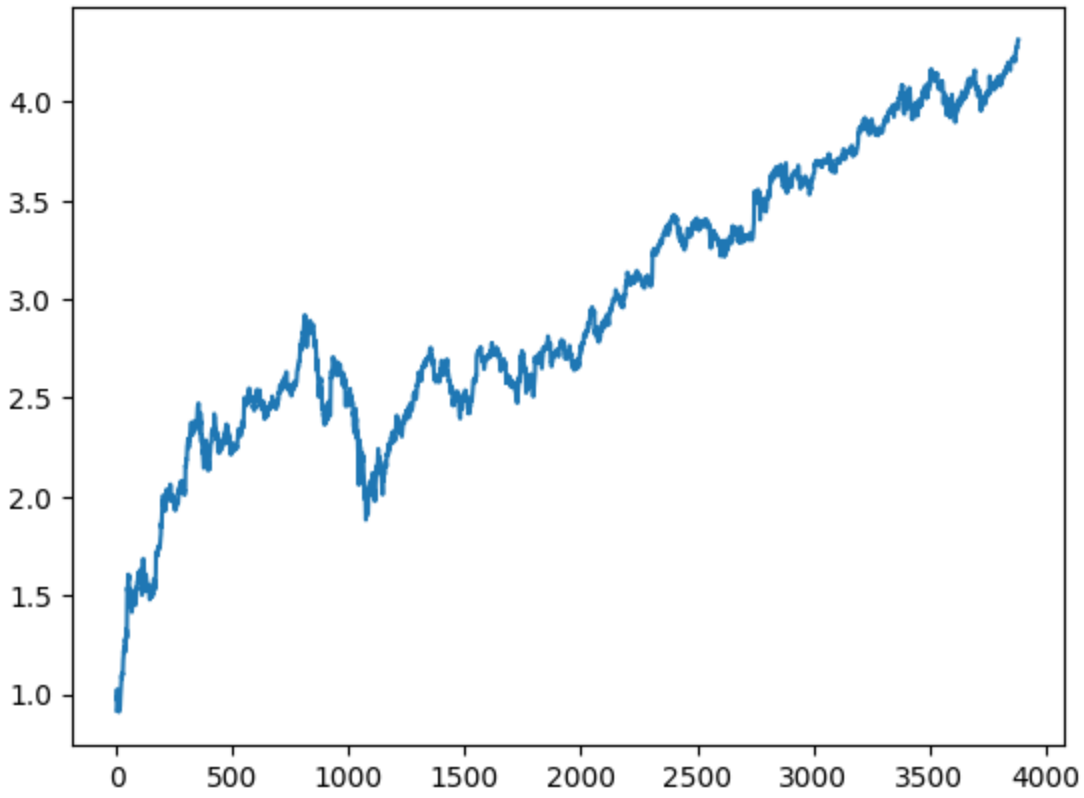
Data Collection:

The stock price data used for analysis is of Google stock which has the ticker “GOOGL”. The everyday open prices are considered from 1st January 2000 to 25th January 2022. The open prices when plotted over time are shown below

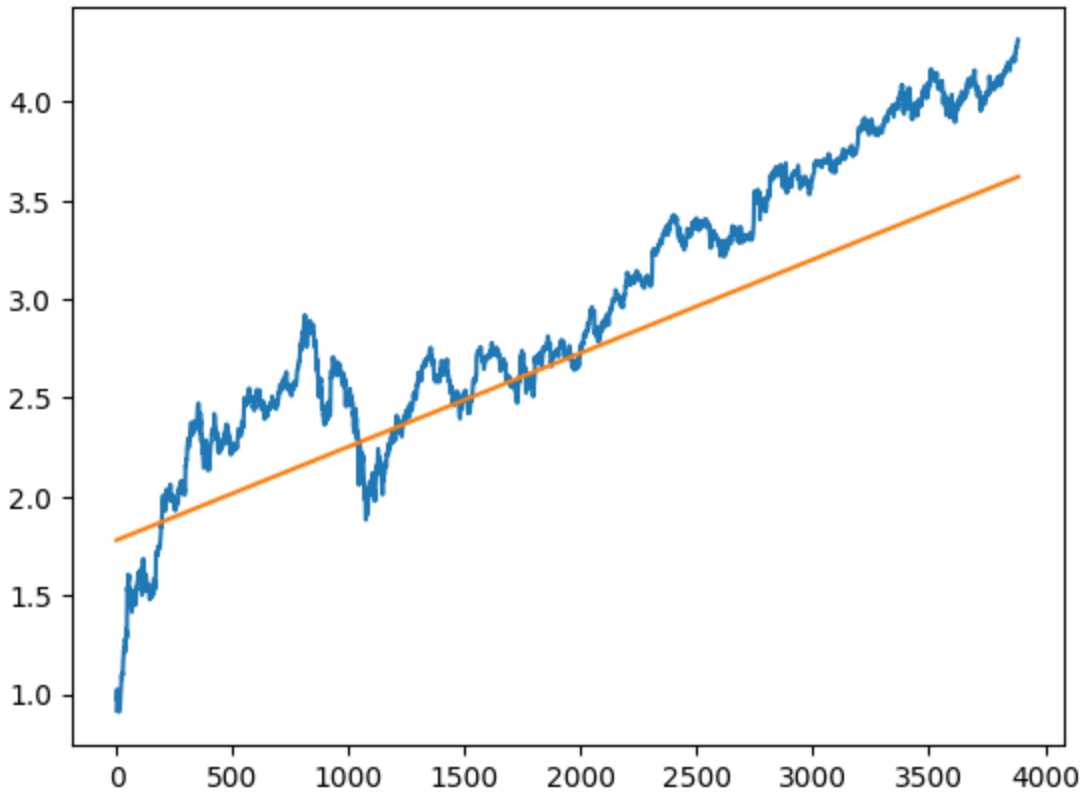


Preprocessing - Standardization:

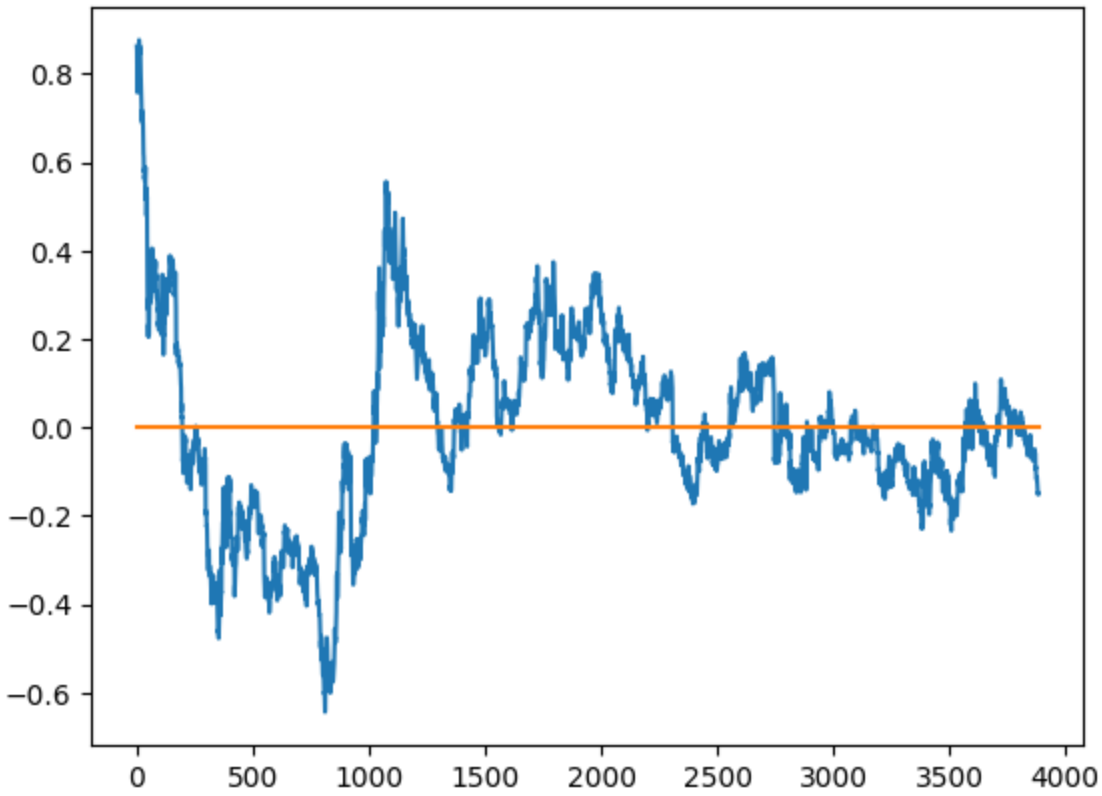
As we can see, this graph looks like a exponential graph. This is because all the natural growths happen exponentially. However fourier transform performs the best if the graph looks more like a wave. Therefore, we reduce the graph's exponentility by applying log function to it. The expectation is that it will create a linearly increasing wave, so that when we rotate the increasing wave, we will get a wave oscillating over x-axis. The graphs looks as follows after applying logarithmic function.



We can now it a line passing through this increasing wave. The line looks as shown below

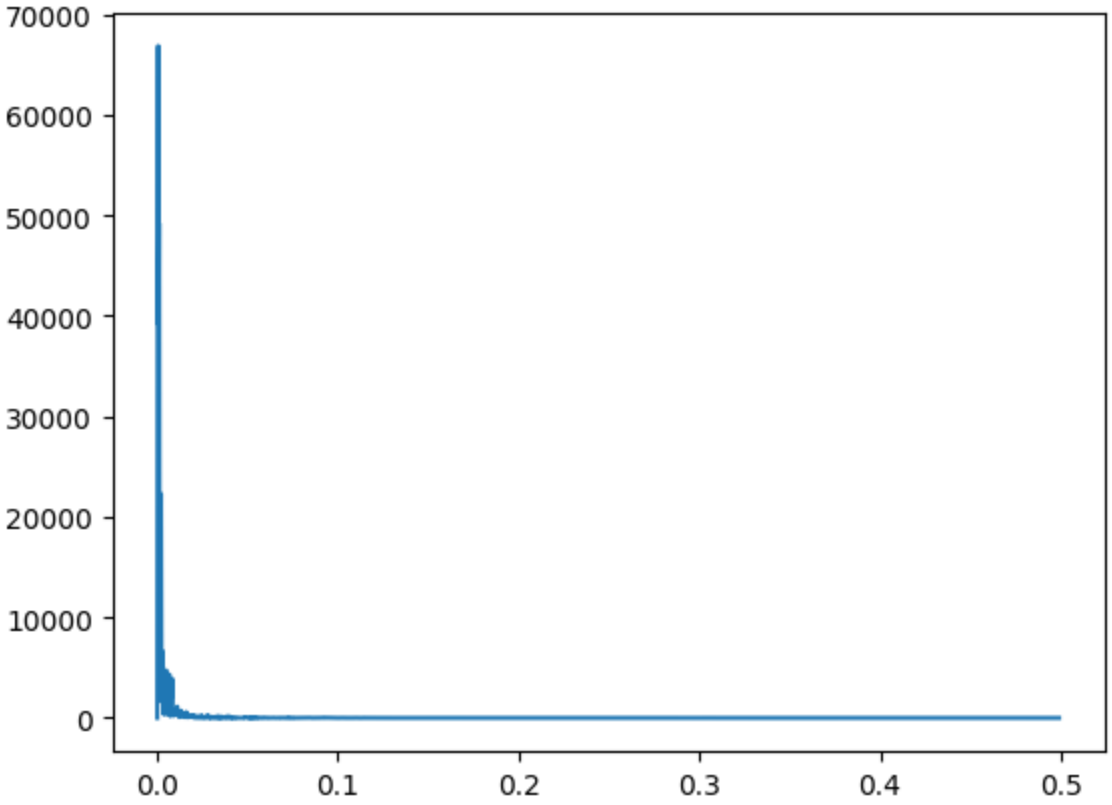


Now, we should rotate the x-axis to this newly obtained line. We can do this by finding the perpendicular distances of points from this line and taking them as y values. The resulting wave is as show below



We can observe that this is a wave oscillating above and below our axis.

Fourier Transform:
Applying Fourier transform, we get the intensity vs frequency graph as shown below



When we filter the frequencies with a threshold, we found out lower frequencies like 8 days, 11 days etc showed good intensity. This is expected because the stock prices often fluctuate to lower frequent days due to market sentiments. We can choose a dominating frequency (11 days in our case) and split the wave in intervals of 11 days. This way we know the data within this 11 day period is dependent. The code below performs this action and creates the dataset for us

```
def create_dataset(open_prices, f):
  dataset = [open_prices[i:i+f] for i in range(len(open_prices - f)) ]

  dataset = [[j/max(i) for j in i] for i in dataset  ]
  X = dataset[:-1]
  y = dataset[1:]
  return X, y

X,y = create_dataset(open_prices, freq)
```

Machine learning Model:

The dataset prepared has scaled stock prices as x and y. We create an LSTM which takes stock prices of the last 11 days and predicts the next day's stock price.

Results comparison:

Fourier transform based LSTM stock prediction model under oil shocks

This paper analyzed the impact of oil shocks on stock price using an LSTM and fourier analysis—the paper used per-day stock price data of S&P 50 stock index and WTI oil futures contract.
Five oil shock measurements were taken as inputs:

1. Net price increase
2. Asymmetric net price change
3. Symmetric net price change
4. Large price increase
5. Net price increase indicator

The paper took RVt as a measure of volatility

$$RV_t = \sum_{j=1}^{M} r_{t,j}^2$$

M is the index of samples in month t, rt, j acts as the jth daily return of month t.

The paper calculated RVt and plotted it over time. It was observed that there is a certain frequency where the changes are happening. Then it applied fourier analysis to find the frequency at which these changes are happening. Then the data at those particular time period are taken for consideration. Then the data is fed into the LSTM

LSTM architecture:

- 3 layer structure
- 1st layer - 512 neurons
- 2nd layer - 128 neurons with sigmoid
- 3rd layer - 128 neurons
- 1500 epochs

The paper trained a Fourier transform based LSTM model and evaluated results using different stock price data. The results showed varied trends in different stock prices correlated in various ways with oil prices. The usage of Fourier analysis based LSTM showed to be robust enough in predicting the price trends. Additional analysis and evaluation were done to reassure the robustness of the model.

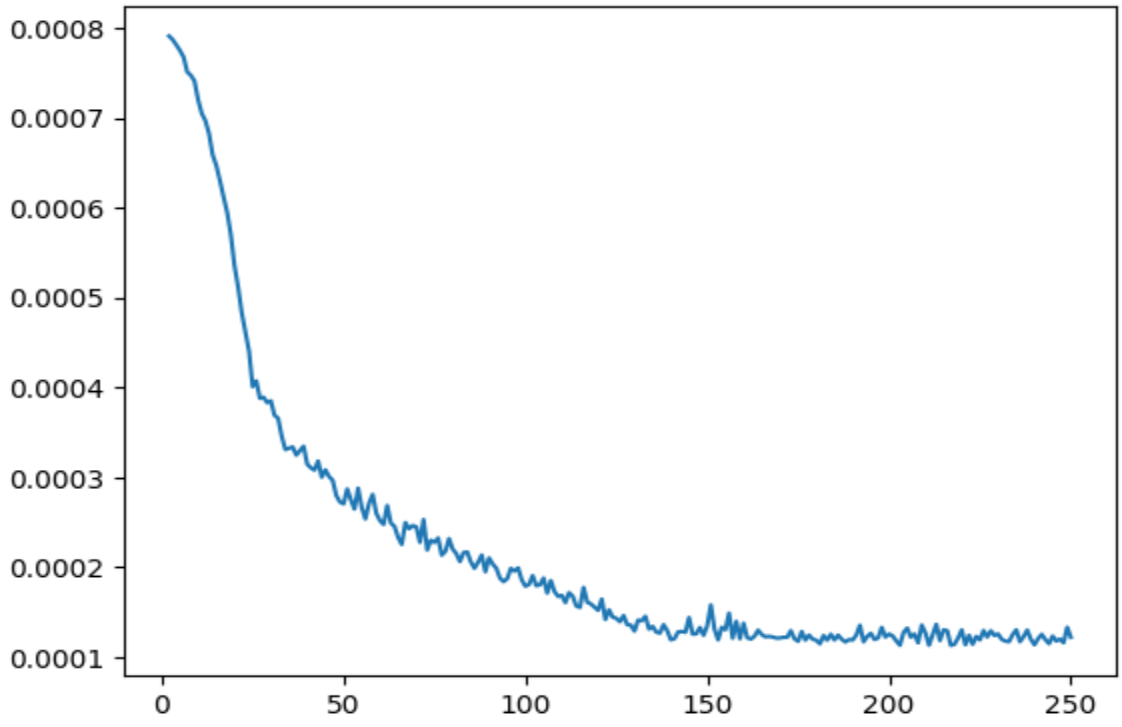
Our model:
We have used the existing prices of the stocks instead of these other parameters. This simplifies the data collection part during training and also while making predictions. This way, the users will not have to worry about unavailable complicated stock data.
Our model consists of less number of layers
LSTM architecture:

- 3 layer structure
- 1st layer - 50 neurons
- 2nd layer - Flatten layer
- 3rd layer - 11 neurons with ReLU
- 250 epochs

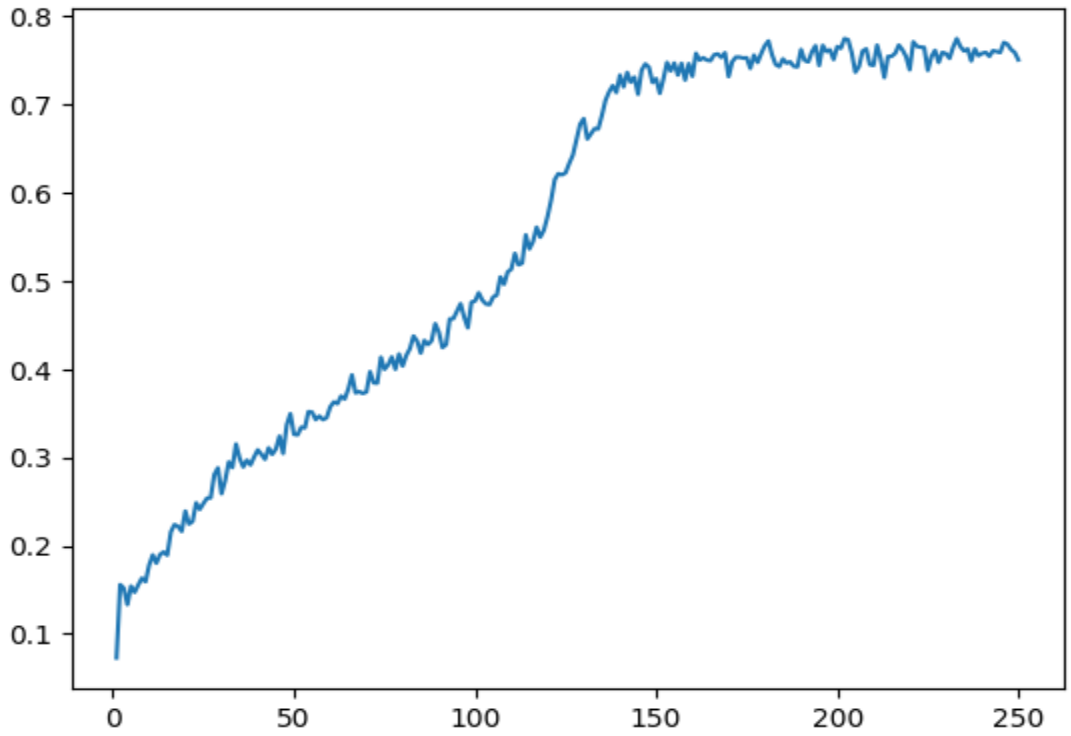
Accuracy comparison:
The model presented in the paper obtained 57.2% accuracy. Whereas, the model developed in this project obtained above 75% accuracy in comparatively less number of epochs and a model with lesser number of neurons

Results and analysis:

Epochs vs Loss graph:



Epochs vs accuracy graph:



We can observe that the loss and accuracies have finally converged at nearly 70percent. It is a pretty good accuracy when compared to many products available. However, blackjacks can always affect the stock price so that further research has to be done before purchasing the stocks

Conclusion:

We observe the most of the existing projects do not use standardization, they rather apply fourier analysis directly. However, after using the standardization methods we observe that we are able to obtain pretty good results.

However, as the stock price is influenced by various external factors, we can not solely depend upon the ML model for investments. It is recommended to use these models for a initial idea and perform further due diligence before actually placing the order.

Acknowledgements:

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