STOCK MARKET PRICE PREDICTION USING LSTM ALGORITHM

Project report in fulfilment of the requirement for the award of the degree of

Bachelor of Technology

In

COMPUTER SCIENCE & ENGINEERING

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CERTIFICATE

This is to certify that the project titled "**Stock Market Price Prediction Using LSTM Algorithm**" submitted by **Soumik Chatterjee (Enrollment No: 12016009001244), Ayan Guin (Enrollment No: 12016009001345)**, **Avik Bose (Enrollment No: 12016009001233)**, **Swarnendu Ghosh (Enrollment No: 12016009001339)** , **Arnab Ray (Enrollment No: 12016009001227)**, **Deepraj Rudra (Enrollment No: 12016009001317)** students of UNIVERSITY OF ENGINEERING & MANAGEMENT, KOLKATA, in fulfilment of requirement for the degree of Bachelor of Computer Science & Engineering is a bona fide work carried out by them under the supervision and guidance of Prof. Moumita Basu during 7th and 8th Semester of academic session of 2019-2020. The content of this report has not been submitted to any other university or institute for the award of any other degree.

I am glad to inform that the work is entirely original and its performance is found to be quite satisfactory.

_____   _____

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Last but not the least, we would like to extend our warm regards to our families and peers who have kept supporting us and always had faith in our work.

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<u>ABSTRACT</u>

The procedure of predicting the prices of the stock market is a tough task for lot of researchers, analysts and investors. Factually, Investors are always fascinated in the estimation and analysis and forecasting of stock price. For a productive investment, investors are inclined to know the pattern of current and the future situation of the stock market. Proper and distinctive forecasting systems for stock market help traders, investors, and analyst by providing processed and estimated data and thereby deciphering various useful patterns like the future direction of the stock market and probabilities of economic ups and downs. Forecasting prices in the stock market is a complicated task that incorporates humungously techno-intensive human-computer interaction. There are numerous forecasting procedures for prediction of share prices.

In this project we create our own dataset using Web Scraping. We choose the https://finance.yahoo.com/ website to scrap the historical stock data of any desired company chosen by the user. As the solution to the problem, we are using the implementation LSTM Machine Learning Algorithm for efficient and accurate prediction of stock price.

INTRODUCTION

Ever since its inception the prediction of the stock market has been a necessary yet tough task for the investors. The dependency of the rise and fall of the companies, the profit and loss of the investors and even the economic conditions rest of the stock market and the predictability of its boom and bust. A correct, distinctive prediction of the situations in the stock market promise the investors and the companies glaring prosperity. No wonder that the stock market instantly gets all the public attention in merest of its fluctuations. And to support this statement we can look at the 2008 financial crisis. A lot of films and documentaries also show evident facts about the same. In all those works we saw a common theme, a common problem, that a very limited number of people knew about the market procedures, operations, fluctuations and reactions. We cannot deny the chances of such events occurring again in future, hence gaining proper knowledge and information gives us a proper vigilance over the stock market and proper predictability which in turn enables us to deal with its fluctuations.

Types of Stock Market Analysis:

As we proceed towards implementation part of the project we first have to know the problem we are working on. Broadly we demarcate Stock market analysis in two categories the fundamental analysis and the technical analysis.

Fundamental Analysts mainly work on the company concerned with the stock itself. They analyse a company's past performances and also the strength and credibility of its accounts. This process mainly involves predicting company's future probable performances after evaluating its current business scenario and past records.

Technical Analysts or Chartists on the other hand, are not concerned with the company and its performances. Technical Analysis, is more concerned about the stock market as these analysts evaluate the stock market charts and stock market statistical figures to make their prediction.

In this project, we would mainly work with the technical analysis part.

Our first step is concerned with extraction of the data from the desired website by web scraping.

What is Web Scraping ?

Web Scraping/ Harvesting/Data Extraction is a method of data scraping used for extraction of information from various desired websites. Web scraping software accesses the World Wide Web either directly using the Hypertext Transfer Protocol, or through a web browser. While manually web Scraping is also possible, but an automated processes implemented using a bot or web crawler is much easier. It is a form of extracting data, in which specific data is collected and extracted from the web, and stored into a central local database or spread-sheet, for later evaluation, analysis and prediction.

What is LSTM?

LSTM is the abbreviation for Long Short Term Memory which is actually a recurrent neural network unique in nature because while the other neural networks have feed-forward connections LSTM has works with feedback connection. It is mainly used in the field of deep learning. LSTM networks are acquainted with identifying, classifying and processing time series data overcoming the problems of lag and unknown interruptions in the duration of important events.

LITERATURE SURVEY

Stock market or equity market has a profound impact in today's economy. A rise or fall in the share price has an important role in determining the investor's gain. Predicting stock market prices is a complex task, financial markets being highly volatile. There is a huge uncertainty and risk associated with them. These kinds of predictions are tech-dependent, which means it has an extensive human –computer interaction. In this work we use different deep learning architectures for the price prediction various and compare their performance. Experimental results shows that distributed representations of textual information are better than the numerical-data-only methods and Bag-of-Words based methods, LSTM is capable of capturing time series influence of input data than other models, and considering the companies in the same industry is effective for stock price prediction.

After a brief search of generic solutions to the above mentioned problem of price prediction in stock market we decided to work on the LSTM neural network to perform stock prediction. This will provide more accurate results when compared to existing stock prediction algorithm. We have consulted the following papers:

Akita et al, in their paper about Deep Learning for Stock Prediction using numerical and textual information proposed a novel application of deep learning models, Paragraph Vector, and Long Short-Term Memory (LSTM), to financial time series forecasting. [3].

Chen et al, in their paper of predicting the stock market of China using LSTM, found out that the result is mechanical yet much more unpredictable [5].

 Minami et al, in their paper about Predicting Equity Price with Corporate Action Events Using LSTM-RNN found out that sequential learning model is expected to be a promising method in the stock price prediction of a single stock with variables like corporate action and corporate publishing. [2].

Nandakumar et al, in their paper of Stock Price Prediction Using Long Short Term Memory demonstrated an online learning algorithm that utilizes a kind of recurrent neural network (RNN) called Long Short Term Memory (LSTM), where the weights are adjusted for individual data points using stochastic gradient descent [6].

Deorukhkar et al, in their paper about Stock Price Prediction using combination of LSTM Neural Network ARIMA and Sentiment Analysis present an innovative method to predict next day closing price of stocks using combination of deep learning approach using Long Short-Term Memory (LSTM, architecture of Recurrent Neural Networks (RNN), Auto Regressive Integrated Moving Average (ARIMA) time series model and Sentiment analysis model to predict next day closing prices of stocks [4].

PROBLEM STATEMENT

Stock Market Prediction can be described as a process of understanding the value of stocks and providing the concerned people such as investors, companies and their competitors a detailed knowledge so as to predict the market situations and the prices of the stock. Usually stock market predictions are presented with the help of the quarterly financial ratio using various datasets. Depending on a single dataset might not provide sufficient information which in turn produces faulty results. Thus we come in accordance with machine learning with amalgamation of various data sets and integrate them to predict a pattern of the stock market and values and prices. The problem with estimating the stock price will remain a problem if a better stock market prediction algorithm is not proposed. Predicting the pattern of stock market performance is a hindrance. The stock market fluctuation are usually determined by the inclination of a humungous number of investors. Stock market prediction evidently needs an ability to predict reaction of the investors on recent events. These events can be political events like a political leader's statement, a piece of news on scam etc. International events like sharp movements in currencies and commodity etc can also cause stock market fluctuations. These events affect the revenues of the corporate, which in turn affects the inclination of investors to invest. It is beyond the capability of almost any investors to accurately and consistently predict these hyper-parameters. So these factors altogether make Stock market Prediction tough. Once data is collected correctly, the tasks like training a machine and generating a predictive result can be done using it.

PROPOSED SOLUTION

This project is mainly bifurcated into four categories. The classified categories are as follows :

a) Identification and Gathering of the raw data with the help of Web-Scraping.

b) Classification and Evaluation of the data obtained.

c) Processing and Estimating the Evaluated Data and,

d) Prediction and Interpretation of the required Information.

To understand the solution we will proceed categorically. The categories are:

A) <u>Identification and Gathering of the raw data with the help of Web-Scraping :</u>

The identification and gathering of the raw data is done through four steps:

1. Get the link of the required stock market historical data through web scraping. We choose Yahoo Finance Website, best for scraping the historical stock data of any desired company.
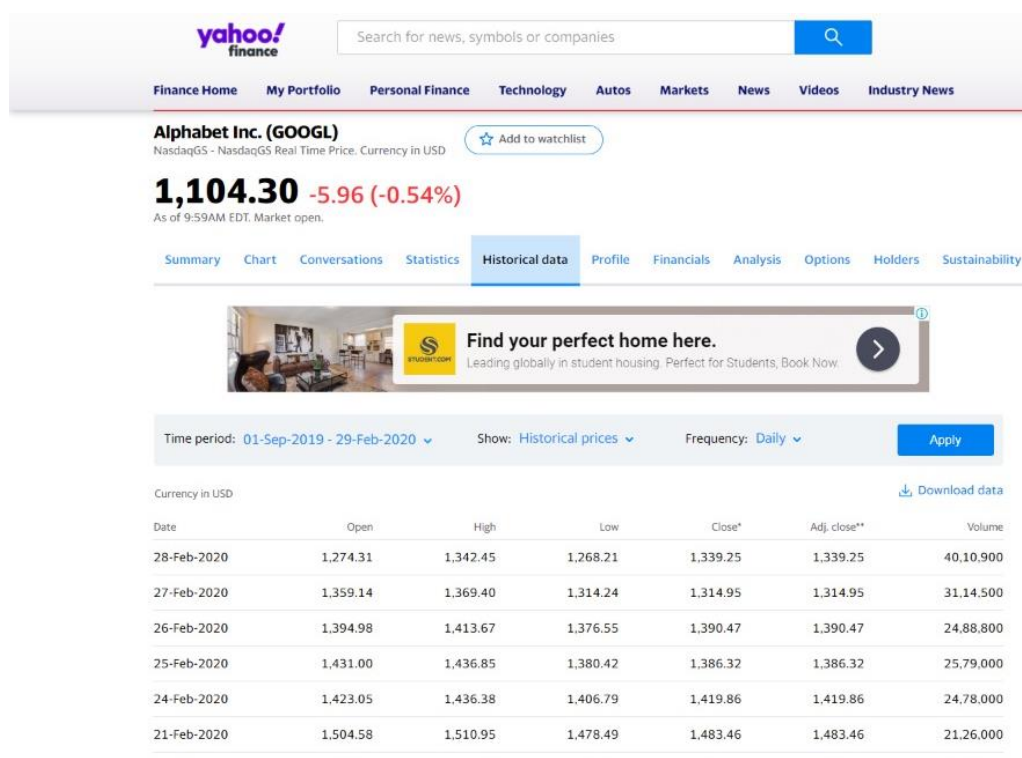
Figure:- Yahoo Finance Website from where the Training Data is taken.
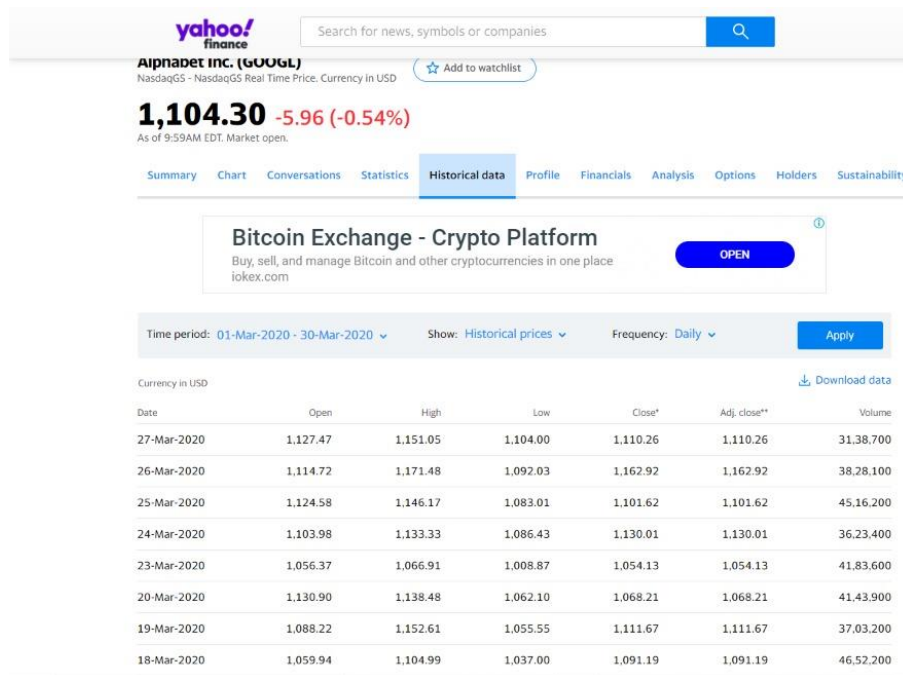
Figure:- Yahoo Finance Website from where the Testing Data is taken.

2. Extracting the data from the link using Beautiful Soup 4, which is a Python library for pulling data out of HTML and XML files. It works with our favourite parser to provide idiomatic ways of navigating, searching, and modifying the parse tree. It commonly saves programmers hours or days of work.

3. Dividing the data into Training data and Testing data, training data and testing data are among the prominent aspects in machine learning. Training Data consists of the observations in the training set form the experience that the algorithm uses to learn. In supervised learning problems, each observation consists of an observed output variable and one or more observed input variables. The test set is a set of observations used to evaluate the performance of the model using some performance metric. It is important that no observations from the training set are included in the test set.

4. Save the data in CSV format, the CSV (Comma Separated Values) format is the most common import and export format for spread-sheets and databases.

Date	Open	High	Low	Close	Adj. close	Volume
28-Feb-20	1,277.50	1,341.14	1,271.00	1,339.33	1,339.33	37,90,600
27-Feb-20	1,362.06	1,371.70	1,317.17	1,318.09	1,318.09	29,78,300
26-Feb-20	1,396.14	1,415.70	1,379.00	1,393.18	1,393.18	22,02,400
25-Feb-20	1,433.00	1,438.14	1,382.40	1,388.45	1,388.45	24,78,300
24-Feb-20	1,426.11	1,436.97	1,411.39	1,421.59	1,421.59	28,67,100
21-Feb-20	1,508.03	1,512.21	1,480.44	1,485.11	1,485.11	17,31,700
20-Feb-20	1,522.00	1,529.64	1,506.82	1,518.15	1,518.15	10,96,600
19-Feb-20	1,525.07	1,532.11	1,521.40	1,526.69	1,526.69	9,49,300
18-Feb-20	1,515.00	1,531.63	1,512.59	1,519.67	1,519.67	11,20,700
14-Feb-20	1,515.60	1,520.74	1,507.34	1,520.74	1,520.74	11,97,800
13-Feb-20	1,512.69	1,527.18	1,504.60	1,514.66	1,514.66	9,29,500
12-Feb-20	1,514.48	1,520.69	1,508.11	1,518.27	1,518.27	11,67,600
11-Feb-20	1,511.81	1,529.63	1,505.64	1,508.79	1,508.79	13,44,600
10-Feb-20	1,474.32	1,509.50	1,474.32	1,508.68	1,508.68	14,19,900
07-Feb-20	1,467.30	1,485.84	1,466.35	1,479.23	1,479.23	11,72,300
06-Feb-20	1,450.33	1,482.00	1,449.57	1,476.23	1,476.23	16,79,400
05-Feb-20	1,462.42	1,463.84	1,430.56	1,448.23	1,448.23	19,86,200
04-Feb-20	1,457.07	1,469.50	1,426.30	1,447.07	1,447.07	39,33,000
03-Feb-20	1,462.00	1,490.00	1,458.99	1,485.94	1,485.94	30,55,200
31-Jan-20	1,468.90	1,470.13	1,428.53	1,434.23	1,434.23	24,17,200
30-Jan-20	1,439.96	1,457.28	1,436.40	1,455.84	1,455.84	13,39,400
29-Jan-20	1,458.80	1,465.43	1,446.74	1,458.63	1,458.63	10,77,700
28-Jan-20	1,443.00	1,456.00	1,432.47	1,452.56	1,452.56	15,77,400
27-Jan-20	1,431.00	1,438.07	1,421.20	1,433.90	1,433.90	17,55,200
24-Jan-20	1,493.59	1,495.49	1,465.25	1,466.71	1,466.71	17,84,600
23-Jan-20	1,487.64	1,495.52	1,482.10	1,486.65	1,486.65	13,51,200
22-Jan-20	1,491.00	1,503.21	1,484.93	1,485.95	1,485.95	16,10,800
21-Jan-20	1,479.12	1,491.85	1,471.20	1,484.40	1,484.40	20,36,700
17-Jan-20	1,462.91	1,481.30	1,458.22	1,480.39	1,480.39	23,96,200
16-Jan-20	1,447.44	1,451.99	1,440.92	1,451.70	1,451.70	11,73,700
15-Jan-20	1,430.21	1,441.40	1,430.21	1,439.20	1,439.20	12,82,700
14-Jan-20	1,439.01	1,441.80	1,428.37	1,430.88	1,430.88	15,58,900
13-Jan-20	1,436.13	1,440.52	1,426.02	1,439.23	1,439.23	16,52,300
10-Jan-20	1,427.56	1,434.93	1,418.35	1,429.73	1,429.73	18,20,700
09-Jan-20	1,420.57	1,427.33	1,410.27	1,419.83	1,419.83	15,00,900
08-Jan-20	1,392.08	1,411.58	1,390.84	1,404.32	1,404.32	15,28,000
07-Jan-20	1,397.94	1,402.99	1,390.38	1,393.34	1,393.34	15,02,700
06-Jan-20	1,350.00	1,396.50	1,350.00	1,394.21	1,394.21	17,32,300
03-Jan-20	1,347.86	1,372.50	1,345.54	1,360.66	1,360.66	11,86,400

Figure:- The CSV file where the Training Data is Stored.

Date	Open	High	Low	Close	Adj. close	Volume
30-Mar-20	1,125.04	1,151.63	1,096.48	1,146.82	1,146.82	25,73,400
27-Mar-20	1,125.67	1,150.67	1,105.91	1,110.71	1,110.71	32,08,500
26-Mar-20	1,111.80	1,169.97	1,093.53	1,161.75	1,161.75	35,71,700
25-Mar-20	1,126.47	1,148.90	1,086.01	1,102.49	1,102.49	40,81,500
24-Mar-20	1,103.77	1,135.00	1,090.62	1,134.46	1,134.46	33,44,500
23-Mar-20	1,061.32	1,071.32	1,013.54	1,056.62	1,056.62	40,44,100
20-Mar-20	1,135.72	1,143.99	1,065.49	1,072.32	1,072.32	36,01,800
19-Mar-20	1,093.05	1,157.97	1,060.11	1,115.29	1,115.29	36,51,100
18-Mar-20	1,056.51	1,106.50	1,037.28	1,096.80	1,096.80	42,33,400
17-Mar-20	1,093.11	1,130.86	1,056.01	1,119.80	1,119.80	38,61,500
16-Mar-20	1,096.00	1,152.27	1,074.44	1,084.33	1,084.33	42,52,400
13-Mar-20	1,179.00	1,219.76	1,117.14	1,219.73	1,219.73	37,00,100
12-Mar-20	1,126.00	1,193.87	1,113.30	1,114.91	1,114.91	42,26,700
11-Mar-20	1,249.70	1,260.96	1,196.07	1,215.41	1,215.41	26,08,500
10-Mar-20	1,260.00	1,281.15	1,218.77	1,280.39	1,280.39	26,11,400
09-Mar-20	1,205.30	1,254.76	1,200.00	1,215.56	1,215.56	33,65,400
06-Mar-20	1,277.06	1,306.22	1,261.05	1,298.41	1,298.41	26,60,600
05-Mar-20	1,350.20	1,358.91	1,305.10	1,319.04	1,319.04	25,61,300
04-Mar-20	1,359.23	1,388.09	1,343.11	1,386.52	1,386.52	19,13,300
03-Mar-20	1,399.42	1,410.15	1,332.00	1,341.39	1,341.39	24,02,300
02-Mar-20	1,351.61	1,390.87	1,326.81	1,389.11	1,389.11	24,31,500

*Close price adjusted for splits.**Adjusted close price adjusted for both dividends and splits.

Figure:- The CSV file where the Testing Data is Stored.

We store the data in CSV File in terms of raw data (both training and test data) with 7 columns. There are multiple variables in the data-set – date, open, high, low, last, close, volume. The columns Open and Close represent the starting and final price at which the stock is traded on a particular day. High, Low and Last represent the maximum, minimum, and last price of the share for the day. Volume is the number of shares bought or sold in the day . The data set changes according to the URL given by the user. The data set can contain a maximum of 100 entries. The data set would be user defined to be precise . the dimensions of the data set would

be determined by the way the user wants the predictions to be presented.

B) <u>Classification and Evaluation of the Data obtained :</u>

The classification and evaluation of the data is done through four steps:

1. Read those CSV files, the CSV module implements classes to read and write tabular data in CSV format. It allows users to operate without knowing the precise details of the CSV format used by Excel. Users can also describe the CSV formats understood by other applications or define their own special-purpose CSV formats.

2. Edit those data as per need, if we open a CSV file directly in Excel, it will automatically format and convert our data, but it may not convert it to the correct format. It will set the cells in the spread-sheet to the General data type, which formats the cells based on their content. To avoid this make sure the data type is set to Delimited.

3. Chose the column we need, the user will choose the column according to his/her convenience, the way he/she wants the forecast to be made and the required information.

4. Divide the Training data into x and y part, here the user has to demarcate the data into x and y categories before the evaluation starts.

5. Reshape the values into 2D to 3D, it is the part where values gets reshaped into 2D to 3D .

C) <u>Processing and Estimating the Evaluated Data :</u>

The processing and estimation of the evaluated data is done through four steps:

1. Initializing the RNN, or recurrent neural network is a class of artificial neural networks where connections between nodes form a directed graph along a temporal sequence. This allows it to exhibit temporal dynamic behaviour.

2. Add the LSTM and add different layers of LSTM into it, stacking LSTM hidden layers makes the model deeper, more accurately earning the description as a deep learning technique. It is the depth of neural networks that is generally attributed to the success of the approach on a wide range of challenging prediction problems.

3. Pass the x_train and y_train into LSTM, the x trained data and the y trained data is passed into LSTM in this step.

4. Save the output of the LSTM into predicted stock, LSTM provides an output .We have to save the output into the predicted or foretasted stock.

D) <u>Prediction and Interpretation of the Required Information :</u>

The predication and interpretation of the raw data is done through four steps:

1. Read the testing data, we read the testing data and compare with the obtained training data to get the actual accurate data.

2. Reshape the data into 3D format, we have to reshape the accurate data obtained after comparison with the training data into 3D format.

3. Plot the graph between testing data and predicted data, here we represent the predicted versus actual stock price value of the selected company. The X-axis represents the number of days in the prediction time period. The Y-axis represents the value of the stock price.

4. Show those two values into a table and calculate the percentage of error, in this, we represent the values in a table having 3 columnar values – "Real Stock Price" having the actual stock price for a corresponding date, "Predicted Stock Price" having the predicted stock price for the same corresponding date and "Error" having an approximate error value in calculating the predicted price.

5. Calculate the accuracy of the prediction, we calculate the accuracy of our algorithm and display the result, which is a very important factor in deciding the effectiveness of our project.

RESULT ANALYSIS

The final outcome of our project is represented in two ways, as shown below:

1. **Graphical Format:**

Here we represent the predicted versus actual stock price value of the selected company. The X-axis represents the number of days in the prediction time period. The Y-axis represents the value of the stock price (in USD).

The graph itself shows two tracings, each having a different colour. The red tracing in the graph represents the "Real Stock Price" and the blue tracing represents the "Predicted Stock Price", which we obtain after applying LSTM algorithm.
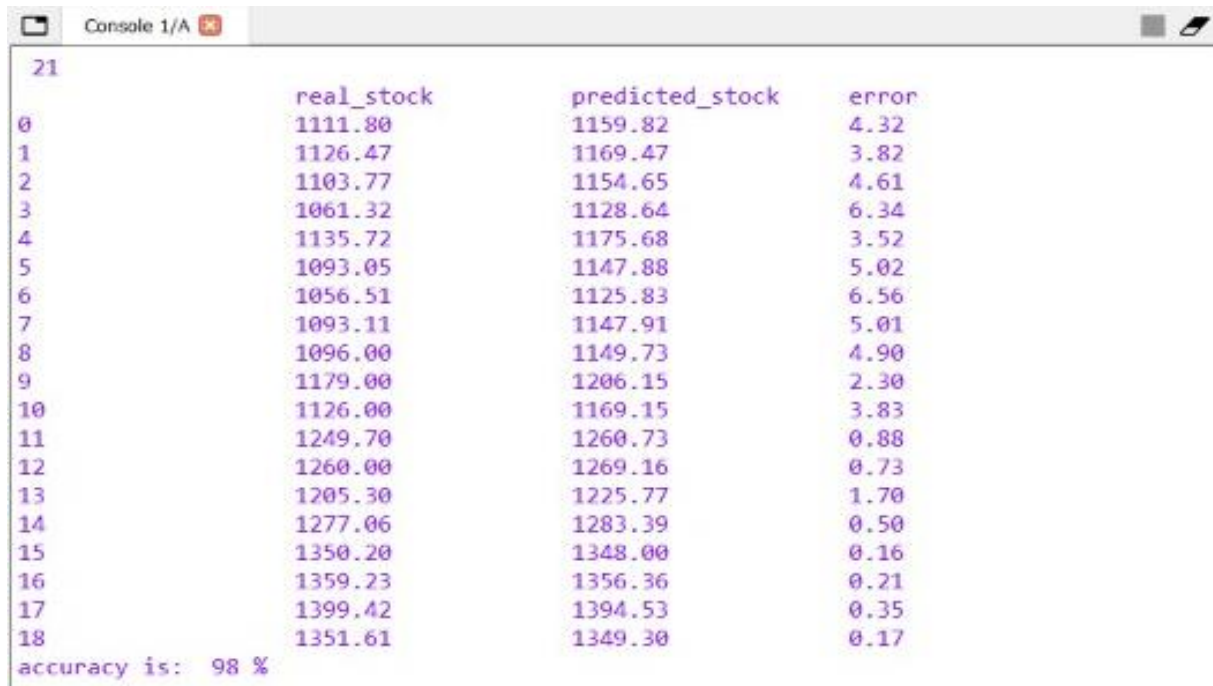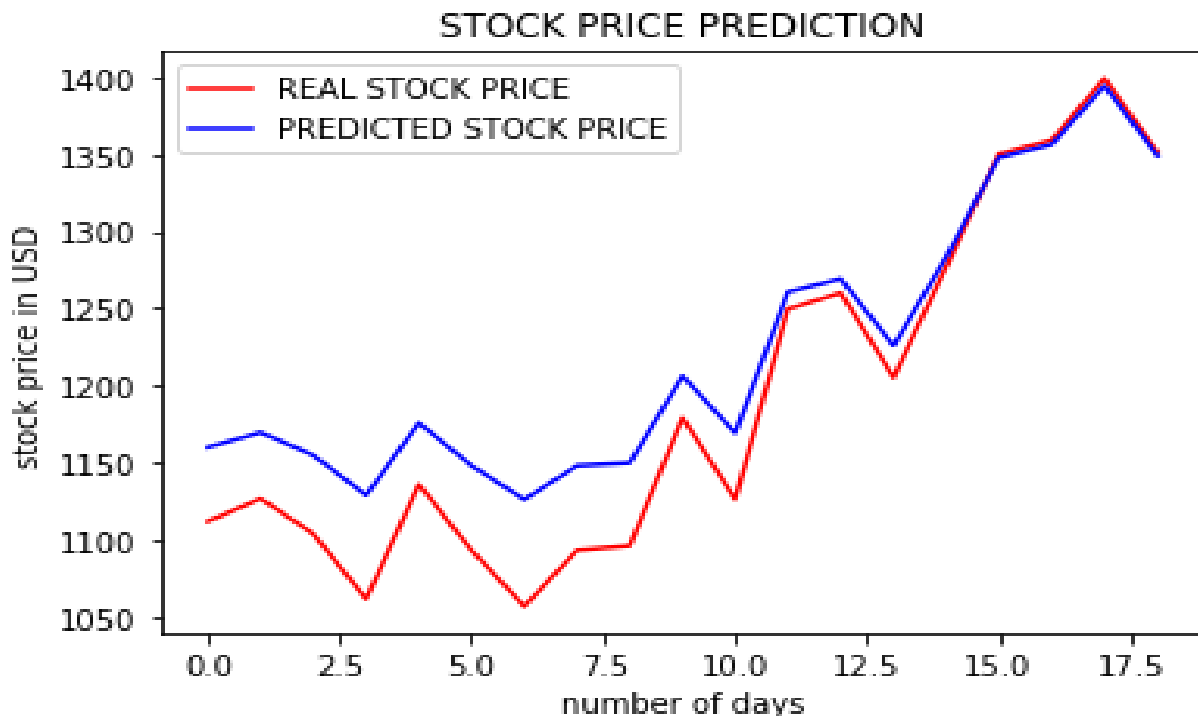

Figure:- The Graph Shows the Predicted Versus Actual Stock Price of the selected company.

2. **Tabular Format:**

In this, we represent the values in a table having 3 columnar values – "Real Stock Price" having the actual stock price for a corresponding date, "Predicted Stock Price" having the predicted stock price for the same corresponding date and "Error" having an approximate error value in calculating the predicted price.

At the end of the table, we calculate the accuracy of our algorithm and display the result, which is a very important factor in deciding the effectiveness of our project. In the numerous times we

11.

have generated an output with varying datasets, the accuracy is **approximately 95%**.

```
Console 1/A
 21
                real_stock        predicted_stock      error
0               1111.80           1159.82              4.32
1               1126.47           1169.47              3.82
2               1103.77           1154.65              4.61
3               1061.32           1128.64              6.34
4               1135.72           1175.68              3.52
5               1093.05           1147.88              5.02
6               1056.51           1125.83              6.56
7               1093.11           1147.91              5.01
8               1096.00           1149.73              4.90
9               1179.00           1206.15              2.30
10              1126.00           1169.15              3.83
11              1249.70           1260.73              0.88
12              1260.00           1269.16              0.73
13              1205.30           1225.77              1.70
14              1277.06           1283.39              0.50
15              1350.20           1348.00              0.16
16              1359.23           1356.36              0.21
17              1399.42           1394.53              0.35
18              1351.61           1349.30              0.17
accuracy is:   98 %
```

Figure:- <u>The Table shows The Real Stock Price, The Predicted Stock Price and The Error Value</u>

12.

DISCUSSION

The procedure of predicting the prices of the stock market is a tough task for lot of researchers, analysts and investors. Factually, Investors are always fascinated in the estimation and analysis and forecasting of stock price. For a productive investment, investors are inclined to know the pattern of current and the future situation of the stock market. Stock market Prediction can be described as a process of understanding he value of stocks and providing the concerned people such as investors, companies and their competitors a detailed knowledge so as to predict the market situations and the prices of the stock. Usually stock market predictions are presented with the help of the quarterly financial ratio using various datasets. Depending on a single dataset might not provide sufficient information which in turn produces faulty results. Thus we come in accordance with machine learning with amalgamation of various data sets and integrate them to predict a pattern of the stock market and values and prices. Predicting the pattern of stock market performance is a hindrance. After a brief search of generic solutions to the above mentioned problem of price prediction in stock market we decided to work on the LSTM neural network to perform stock prediction. LSTM networks are acquainted with identifying, classifying and processing time series data overcoming the problems of lag and unknown interruptions in the duration of important events. At the end of the project, we calculate the accuracy of our algorithm and display the result, which is a very important factor in deciding the effectiveness of our project. In the numerous times we have generated an output with varying datasets, the accuracy is approximately 95%. Thus we can see it is easier to work with LSTM as unlike other neural networks working with feed-forward connections , it works with feedback connection and also LSTM is more correct in terms of forecasting than any other prediction algorithms because it works on real time data and overcomes the lags and disruptions.

FUTURE SCOPE

Complying with the norms of every possible software in this universe, our project, apart from all the essential functionalities, also has some limitations, which are discussed as follows:

- Our program is website specific (i.e., it only works on Yahoo Finance website). A possible update of this project might include some modifications to the project such that it is website independent.
- A small limitation to using Beautiful Soup is that it cannot extract more than 100 records at any given instant of time. An alternative solution to this might include running the same piece of code multiple times and storing the records extracted in a temporary database, before finally collecting and storing it in a CSV file. In regards to keeping our project simple yet efficient, we have overlooked this minor limitation. But this can be further improved in the future updates of this software.

<u>CONCLUSION</u>

The stock market is always on the trend, inspiring research aspirants to locate new methods for the evaluation and estimation of market pattern using new techniques. The forecasting technique used by us deals with real time data, classifies and processes it to help the researchers, investors and any person concerned with the stock market to help evaluate the stock indices. In our project we have worked with one of the most unambiguous and precise prediction technology using Long Short Term Memory unit which is also abbreviated as the LSTM unit which helps Investors, Technical analysts to estimate or invest in the stock market by facilitating them with important information about the past current and future situation of the stock market. It is easier to work with LSTM as unlike other neural networks working with feed-forward connections, it works with feedback connection. LSTM is more correct in terms of forecasting than any other prediction algorithms because it works on real time data and overcomes the lags and disruptions.

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