STOCK MARKET PREDICTION USING MACHINE LEARNING TECHNIQUES

A THESIS

Submitted by

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Under the guidance of

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In partial fulfilment for the award of the degree of

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VIVA-VOCE EXAMINATION

The viva-voce examination of the project work titled **"Stock Market Prediction using Machine Learning Techniques"** submitted by **NIZAMUDEEN K** (RRN: 170282602058) is held on _____

INTERNALEXAMINER **EXTERNAL EXAMINER**

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- NIZAMUDEEN K

ABSTRACT

Stock market values can have a huge or highly impact on country's and people's economy as a whole. Predicting stock uptrends and downtrends in an efficient manner can minimize the risk of loss and maximize the profit. The research on predicting stock prices is going on to get accurate close prices. The aim or target of this work is to be maximizing the company's profit and minimizing the risks for the investors and get efficient and good working model for predicting the stock prices for future.

In this project work proposed an integrated approach by using TATA GLOBAL stock price dataset time stamps and Neural Networks to forecast the future prices of stock market. Machine learning and neural networks helps to predict or forecast the stock values in efficient way.

Using Convolutional Neural Network (CNN) and Long-Short Term Memory (LSTM) Neural Networks model to predict or forecasting the future stock price values and compare the model to each other to know which model is to be best for predicting future stock prices.

The objective of the research is to overcome the stock market challenge and maximize the company's or organization's profit, stock market price data represents time series of financial time series data which becomes more difficult to predict in real time.

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LIST OF ABBREVIATIONS

CNN	-	Convolution Neural Network
LSTM	-	Long-Short Term Memory
NSE	-	National Stock Exchange
ML	-	Machine Learning
DL	-	Deep Learning
NN	-	Neural Network
RMSE	-	Root Mean Square Error
MSE	-	Mean Squared Error
Relu	-	Rectified Linear Units

1. INTRODUCTION

1.1 INTRODUCTION OF STOCK MARKET

Stock market is the one of the important part in the Country's economy. Stock market is used to raise money for a company or organization, and by issue the shares of a company can raise some capital for the business, is considered as part ownership of the company. In another side the stock market is where the investors can buy and sell the stocks or shares of the company, stock market is a collection of markets and exchanges that holds buy and sell activities.

Predicting the future is one of the most difficult tasks ever. Stock market prediction is helps to the investors as well as to the company or organization to know their future is profitable or not, it is very challenging task when predicting the stocks uptrend and downtrend.

For the stock market prediction researchers use different techniques like Artificial intelligence (AI), Machine Learning (ML), Deep Learning (DL), Deep-Q-Network (DQN) etc., and different algorithms like Support Vector Machine (SVM), Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Long Short- Term Memory(LSTM) etc.,

Prediction of the stocks can help to get huge profits for the seller as well as broker, but it is not so easy to predict the stock prices between ups and downs. Machine learning and neural networks helps to predict the stock values [1] with minimum errors and best accuracy. With the help of Traditional and modern approach it is possible to predict the market trends by analysing the patterns of stock movement [2]. Finding the patterns that generally yield a profit not only in a stock market of the single country whose data is used for training our model but also in global stock markets. Artificial intelligence model, which is trained on the data of only a single country, is the first to obtain numerous testing results on global stock markets [3].

In this paper, we attempt to add more accuracy using real time stock market prices to predict the closing price of the stock market prices. The

dataset form NSE (National Stock Exchange) TATA GLOBAL's Stock prices holds more than 10 years of stock details like timestamp, open, high, low, average, close, turnover which are real time data, etc., and the data set has 10 years of real time data with timestamp each and every business days stock price. In the dataset we take a time stamp of 3 months to predict the closing time prices, with this prediction we can able predict the stock price and give accuracy for the shareholders or investors that can able to give huge profit to them.

1.2 EXISTING SYSTEM

For prediction of stock prices there are many websites like Yahoo finance, nseguide.com, moneycontrol.com, damodarans.com etc., these websites are predicting stock values to the investors, but the challenges of the modern time series is predicting the accurate stock values, if the investors think the prediction of stock price will give profit, but the stock price will down like that there is miss predictions over the existing system, since the stock price are time series it is difficult to predict the accurate stock close price value.

1.3 PROPOSED SYSTEM

This work is to predict the real time stock values profit and loss of the company or organization using Machine Learning and Neural Networks.

In this project work using Tata Global organization stock values dataset which is around 10 years of stock values to predict the organizations future or the next day stock value.

The goal is to be give accurate prediction model of stock value for the company or organization.

2. Literature Survey

2.1 BACKGROUND

Ishita Parmar, Navanshu Agarwal and Sheirsh Saxena [1] says, Using machine learning can we able to predict the recent trend on stock market, the prediction based on the prices of current stock market values indices by training on their past prices or values.

Stock market prediction is also based on sentiment analysis Ashish Pathak and Nisha P. Shetty [2] Efficient Market Hypothesis (EMH) states that the market not able to be defeated, so that the prediction of stocks uptrend and downtrend makes very challenging task. By combing both sentiment analysis and machine learning technique, the model provides good accuracy and flexible recommendations.

Jinho lee , Raehyun Kim , Yookyung Koh , and Jaewoo Kang [3] says their model gives profit in the stock market of the country whose values for training their model but also it yields profit not only in that country, the results shows that the future stock prices can be predicted even if the model is trained and tested on data from different countries. The model can be trained on huge liquid flow countries like United States (US) and tested with small countries.

Dharmaraja Selvamuthu* , Vineet Kumar and Abhishek Mishra [4] says, Predicting the financial time series data is most difficult challenges in the stock market to predict the stock prices. Neural networks are the best method technical analysis for predicting in financial markets.

The work proposed by Mehak Usmani, Syed Hasan Adli, Kamrari Raza and Syed Saad Azhar Ali [5] to predict the performance of the market on day closing using different machine learning techniques. The model predicts the market as Positive and Negative using different attributes as input, the old techniques including Simple Moving Average (SMA) and Autoregressive Integrated Moving Average (ARIMA) are also used as input.

Haider Maqsooda, Irfan Mehmoodb, Muazzam Maqsoodc [6] says, Due to high profitability peoples invest in stocks rather than traditional investments. Stock exchange forecasting is most challenging and important aspect of business investment plans. They had explored the effect of different major events occurred in stock market, they use Twitter dataset for sentiment analysis for each of the events. They evaluated the performance of the system using Root Mean Square Error (RMSE) and Mean Absolute Error (MAE).

Rosdyana Mangir Irawan Kusuma, Trang-Thi Ho [7] says, Stock market prediction is very challenging task because there is many factors to analysis the stock market, the factors are effect to the stock market prices such as investor sentiment, social media sentiment, industry performance, company news and performance and economic factors. They proposed the work using Deep Convolutional Network, residual network and visual geometry group network. The effectiveness of their model is evaluated in stock price prediction with a optimize results.

Xingyu Zhou, Zhisong Pan, Guyu Hu , Siqi Tang, and Cheng Zhao [8] says, Stock market prediction is an major issue in the financial world, they proposed a generic framework using Long Short-Term Memory (LSTM) and Convolutional Neural Network (CNN) to forecast high-frequency stock market for adversarial training. Their model takes the publicly available index provided by trading software as input to avoid difficult technical analysis and complex financial theory research. Their proposed approach can effectively improve stock price direction prediction accuracy and minimizing the forecast error.

Forecasting the trend of financial time series remains a high level of challenge. Min Wen, Ping Li, Lingfei Zhang, and Yan Chen [9] introduced a new method to simplify noisy-filled financial temporal series via reconstruction by frequent patterns; the results show the efficiency of their proposed method in feature learning and outperformance with 4%-7% accuracy improvement compared with the traditional signal process methods

and frequency trading patterns modelling approach in stock trend prediction with deep learning.

Guang Llu and Xiaojie Wang [10] proposed a numerical-based attention (NBA) method for dual sources stock market prediction. First they proposed an attention-based method to effectively exploit the complementarity between news and numerical data in predicting stock values. The stock trend was hidden in the news is transformed into the importance distribution of numerical data. They said that their method can effectively filter the noise and make full use of the trend details in news. To evaluate their NBA model, they collect news corpus and numerical data to build three datasets from two sources. The NBA is superior to previous model in dual sources stock price prediction.

2.2 SUMMARY

The objective of research presented in this chapter is to predict the stock prices for a nation or organizations. The concept behind the predictive analysis of stock market is early state are discussed in detailed. Based on the concepts the proposed system has been implemented in this project.

3. ARCHITECTURE OF STOCK PREDICTION MODEL

3.1 ARCHITECTURE OF STOCK PREDICTION MODEL

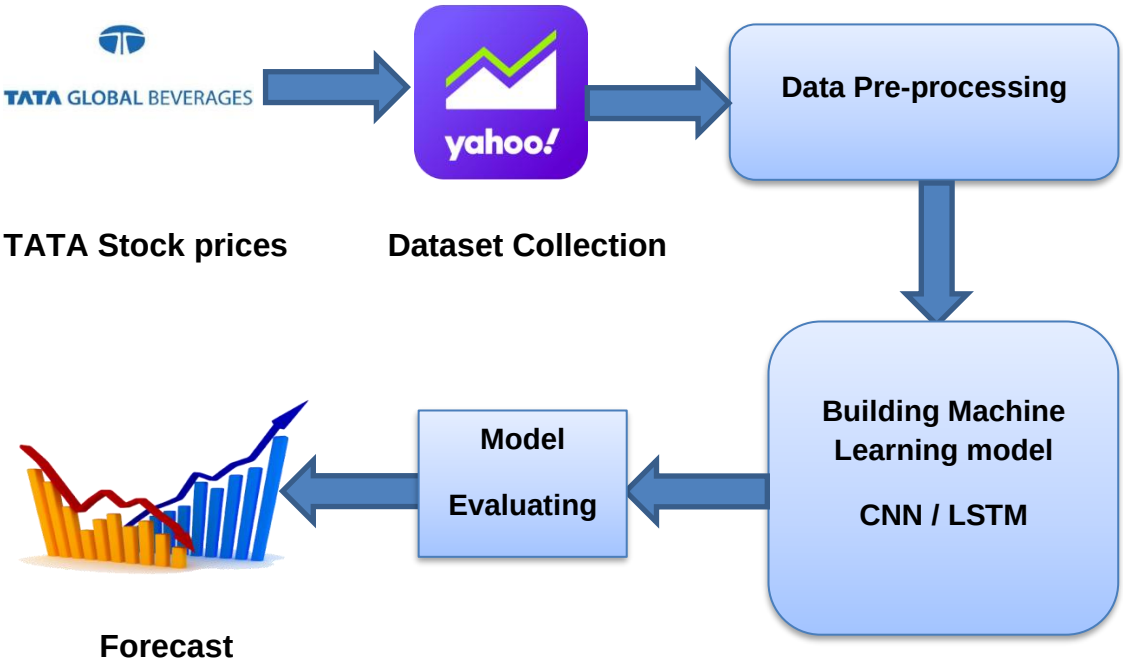

Figure 3.1 ARCHITECTURE OF STOCK PREDICTION MODEL

The Architecture defines the structure of the developed machine learning model. An overall architecture of the model which helps to predict the future stock values of TATA Global organization.

This project work comprises of the following phases:

1. Data collection
2. Data pre-processing
3. Model building
4. Model Evaluating
5. Forecasting stock Values

3.1.1 Data Collection

The first phase of the project work is Data Collection. The dataset form Yahoo finance of NSE (National Stock Exchange) TATA GLOBAL's stock

prices holds more than 10 years of stock details like timestamp, open, high, low, average, close, and turnover of the company.

Example of Stock data:

Table 3.1 TATA Stock Prices 2020-06-19 to 25

Date	High	Low	Open	Close	Volume	Adj Close
2020-06-19	382.00000	373.00000	373.00000	378.45001	133930.0	378.450012
2020-06-22	384.75000	377.250000	380.450012	380.750000	129675.0	380.750000
2020-06-23	391.85006	382.000000	385.000000	390.700012	116540.0	390.700012
2020-06-24	395.00000	379.299988	391.000000	382.850006	117684.0	382.850006
2020-06-25	389.20001	378.100006	381.500000	384.299988	72596.0	384.299988

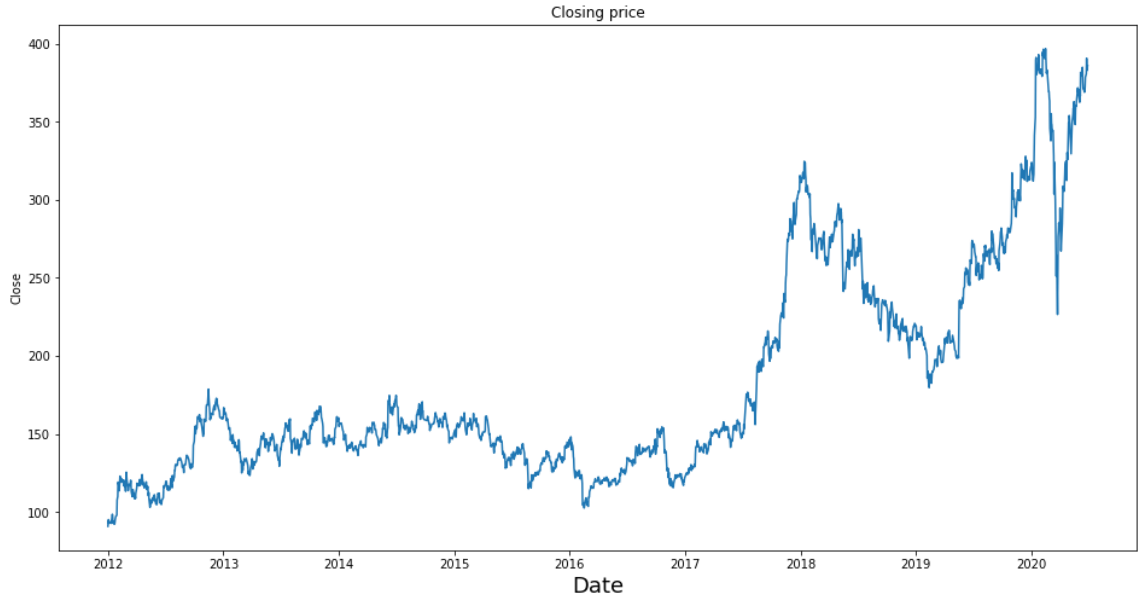

Figure 3.2 Closing Price

3.1.2 Data Pre-processing

The second phase of the project work is Data Pre-processing. Data pre-processing is a step that changes the data into machine readable format, it cleans the Noisy and inconsistent data and handles the missing values. Since this is modern time series and continues value, there is no need to handle or take care of categorical data.

3.1.3 Model Building

The third phase of the project work is Model Building for prediction of stock value. In model building we create a model that finds a pattern of the dataset which in time series and sequential, here we use two Neural Network models to predict the future values.

- Convolution Neural Network (CNN).
- Long-Short Term Memory (LSTM).

3.1.4 Model Evaluating

The fourth phase of the project work is Model Evaluating, in model evaluating we evaluate the models to each other to know which model performs well in the time series prediction.

The performance metrics evaluated the performance of the system using Root Mean Square Error (RMSE) and Mean Absolute Error (MAE).

3.1.4.1 Root Mean Square Error

Root Mean Square Error is the one of the performance metrics in regression problem to predict errors.

RMSE is a measure of how spread out these residuals is, it tells you how concentrated the data is around the line of best fit.

In the project will evaluate by using RMSE.

$$RMSE = \sqrt{\sum_{i=1}^{n} \frac{(\hat{y}_i - y_i)^2}{n}}$$

FIGURE 3.3 Root Mean Square Error Formula

3.1.4.2 Mean Square Error

Mean Square Error (MSE) is the one of the performance metrics in regression problem to predict errors.

Mean squared Error is the average squared difference between the estimated values and the actual value.

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2$$

FIGURE 3.4 Mean Square Error Formula

3.1.5 Forecasting Stock Values

The fifth phase of the project work is Forecasting Stock Values of TATA Global organization. With help of time stamps of last 60 days of business days which is previous 3 months of stock price values of the organization used here to predict the next day's stock value. Once done with evaluation of the model choose the best model for stock price prediction and apply the features to predict the next's day stock price value for TATA GLOBAL.

4. CONVOLUTION NEURAL NETWORK IN STOCK PRICE PREDICTION

4.1 ARCHITECTURE OF CNN

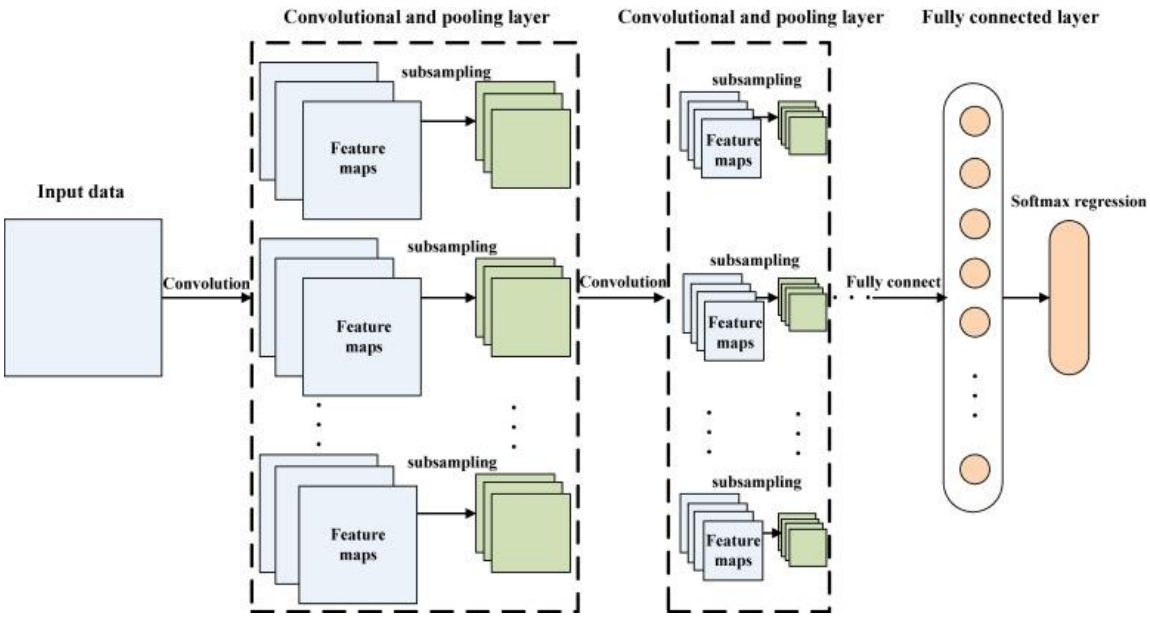

Figure 4.1 Architecture of Convolution Neural Network

Convolution Neural Network (CNN) is a feed forward neural network that I generally used to analyse visual images by processing data with grid like topology.

The layers in CNN

- Convolution Layer
- Relu Layer
- Pooling Layer
- Flattening Layer
- Fully Connected Layer

4.1.1 Convolution Layer

A Convolution Layer has a number of filters that perform convolution operation.

Sliding the filter matrix over the data or image and computing the dot product to detect patterns.

4.1.2 Relu Layer

Once the features of maps are extracted, the next step is to move them to Relu Layer.

It perform element wise operation and sets all the negative pixels to zero, the output is a rectified feature map.

4.1.3 Pooling Layer

The Rectified feature map now goes through a pooling layer. Pooling is a down-sampling operation that reduces the dimensionality of the feature map.

4.1.4 Flattening

Flattening is the process of converting all the resultant 2 dimensional arrays from pooled feature map into a single long continuous linear vector.

4.1.5 Fully Connected layer

The Flattened matrix from the pooling layer is feed as input to the Fully Connected Layer to predict the output.

4.2 CNN IN STOCK VALUE PREDICTION

CNN is known to obtain good performance of the model in numerous tasks and it can be trained much faster than RNN or LSTM [3].

The model constructed here with

STEP 1: Convo1D with 64 filters Layer, 2 kernel size and relu activation.

STEP 2: MaxPooling1D with pool_size 2,

STEP 3: Flatten Layer

STEP 4: Dense Layer with 50 neurons and relu activation

4.2.1 Architecture of CNN Model Building

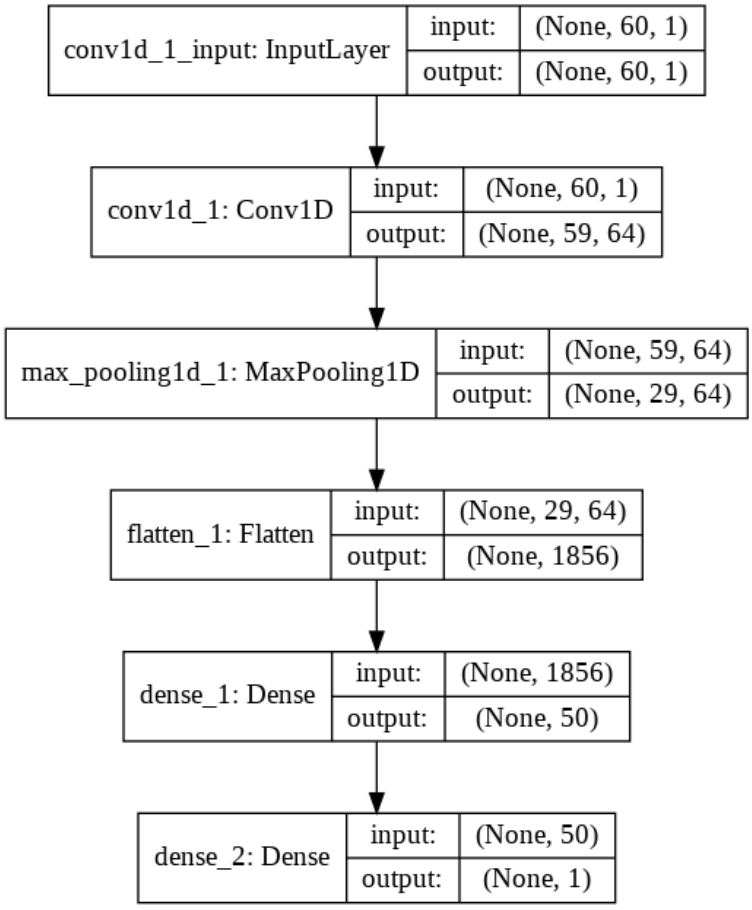

Figure 4.2 Architecture of CNN Model Building

```
cnnmodel.fit(X_train,y_train, batch_size=32, epochs=100)

Epoch 1/100
1608/1608 [==============================] - 1s 843us/step - loss: 0.0049
Epoch 2/100
1608/1608 [==============================] - 0s 145us/step - loss: 0.0014
Epoch 3/100
1608/1608 [==============================] - 0s 154us/step - loss: 0.0010
Epoch 4/100
1608/1608 [==============================] - 0s 156us/step - loss: 7.5742e-04
Epoch 5/100
1608/1608 [==============================] - 0s 145us/step - loss: 7.2744e-04
```

Figure 4.3 CNN Model Fitting

CNN model trained with 80% of training data and 20% of testing data. CNN model trained with 100 epochs with 32 batch size.

4.3 EVALUTION OF CNN IN STOCK VALUE PREDICTION

The model loss evaluated with Root Mean Square Error and the loss is around **9.4892**. The model will get more accurate when minimizing the loss value.

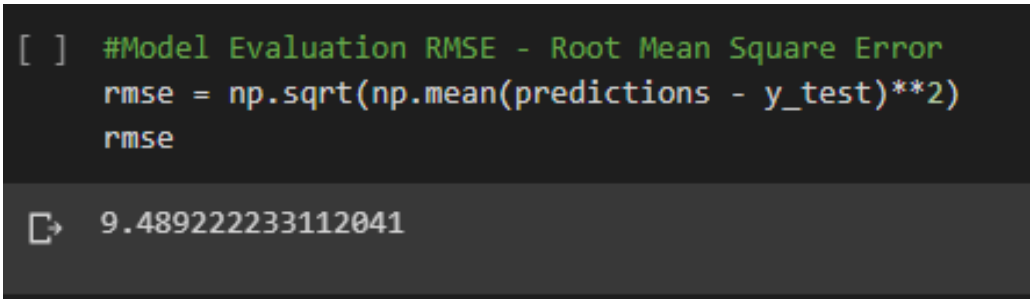

Figure 4.4 Evaluation of CNN Model

5. LONG SHORT TERM MEMORY IN STOCK PRICE PREDICTION

Sequence or Time series problems have been around for a long time. It is considered as one of the major problem to solve in data science industry. Long-Short Term Memory (LSTM) is best to known for solving time series or sequence problems.

5.1 ARCHITECTURE OF LSTM

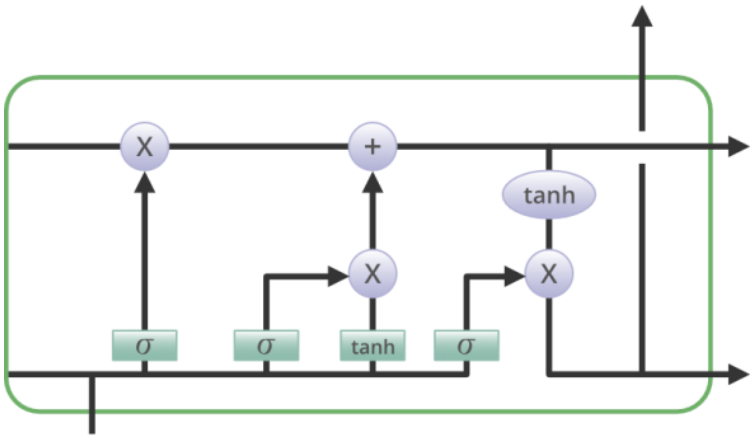

FIGURE 5.1 Architecture of LSTM

5.1.1 Forget Gate

A Forget Gate is responsible for removing information form the cell state. The information that is no longer required for the LSTM to understand things or information that is of less importance is removed via multiplication of a filter. This is required for optimizing the performance of the LSTM network.

5.1.2 Input Gate

The input gate is responsible for the addition of information to the cell state. This addition of information is basically three-step process as seen from the figure 5.1.

5.1.3 Output Gate

This job of selecting useful information from the current cell state and showing it out as an output is done via the output gate. Input and hidden state values and be applied on the cell state vector.

5.2 LSTM IN STOCK VALUE PREDICTION

LSTM is known to obtain good performance of the model in sequence and time series data, but it will be trained slower than others. In our case the model constructed here with,

STEP 1: LSTM with 50 neurons.

STEP 2: Dropout Layer

STEP 3: Dense Layer with 25 neurons.

STEP 4: Constructing 2 more Layers of LSTM

STEP 5: Constructing 2 Layers of Dropout

STEP 6: Constructing final 2 Layers of Dense

5.2.1 Architecture of LSTM in Stock Value Prediction

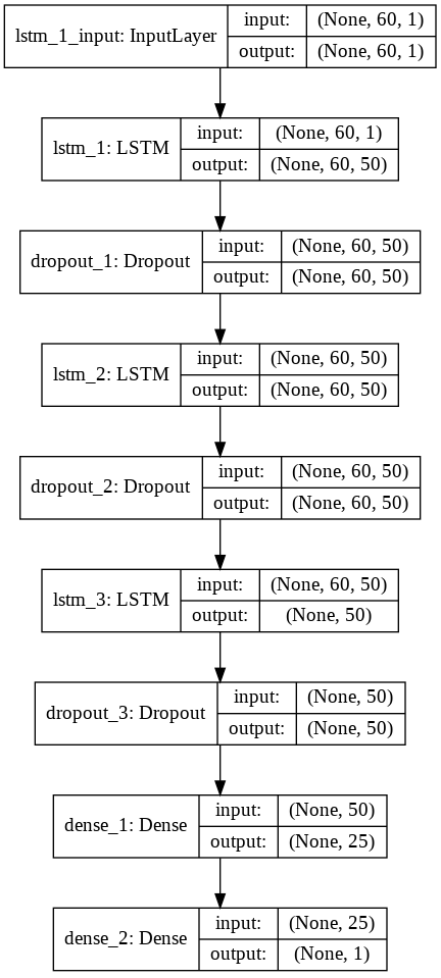

Figure 5.2 Architecture of LSTM Model Building

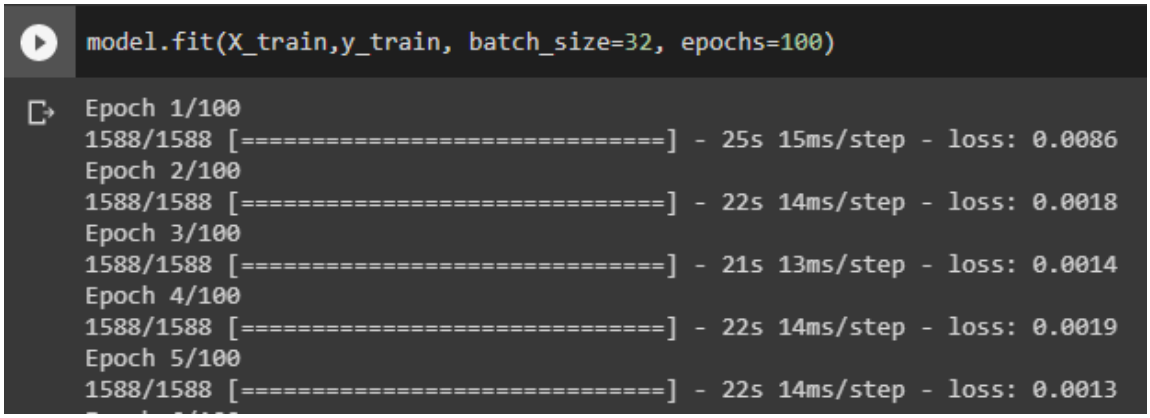

Figure 5.3 LSTM Model Fitting

Long Short Term Memory model trained with 80% of training data and 20% of testing data. LSTM model fitted with 100 epochs with 32 batch size.

5.3 EVALUTION OF LSTM IN STOCK VALUE PREDICTION

The model loss evaluated with Root Mean Square Error and the loss is **4.3128**. The model will get more accurate when minimizing the loss value.

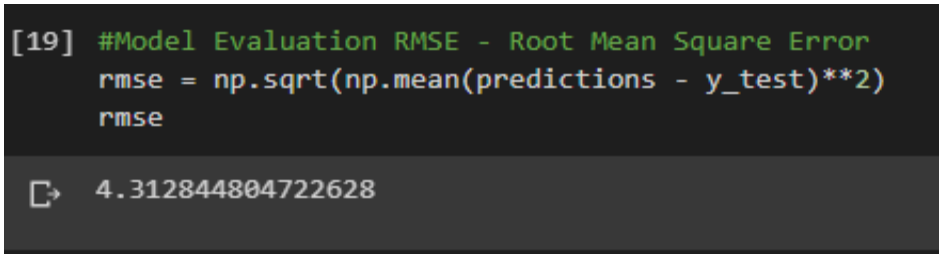

Figure 5.4 Evaluation of LSTM Model

6. DISCUSSION AND ANALYSIS

6.1 PERFORMANCE OF CNN IN STOCK VALUE PREDICTION

6.1.1 Advantages of CNN in Stock Value Prediction

Convolution Neural Network can able to execute faster than Long-Short Term Memory. CNN gives better prediction in Uptrend and Downtrend that will help to find whether the stock value increase or decrease. CNN model prediction value is near to accurate stock value of TATA GLOBAL. CNN has obtained Less Root mean Square Error around 9.

6.1.2 Comparison to Actual Stock values and CNN Predictions

Table 6.1 Sample of Actual values and CNN Predictions

Date	Close	Predictions
2020-06-15	370.149994	361.059998
2020-06-16	368.950012	353.299469
2020-06-17	369.500000	357.309601
2020-06-18	372.200012	356.219788
2020-06-19	378.450012	354.003662
2020-06-22	380.750000	352.510376
2020-06-23	390.700012	353.416992
2020-06-24	382.850006	357.153656
2020-06-25	384.299988	369.507355
2020-06-26	386.000000	354.369629

Table 6.2 shows Actual stock price and predictions TATA GLOBAL.

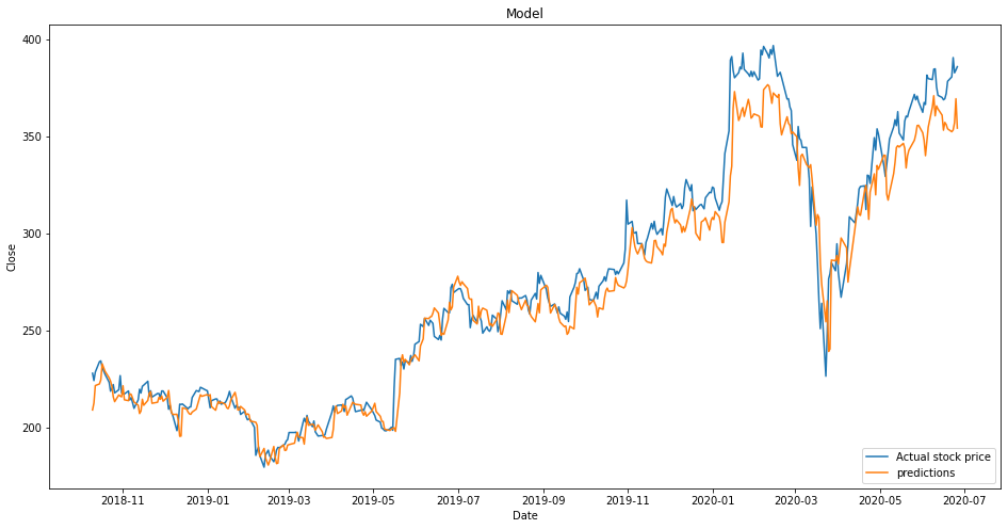

Figure 6.1 Actual Values vs CNN Predictions

Figure 6.1 Shows the visualization of Actual Values and Predicted values which are done by Convolution Neural Network (CNN) model.

6.1.3 Forecasting the Next Day Stock Price for TATAGLOBAL

Forecasting the next day price in the Convolution Neural Network model with Yahoo finance data set, the prediction will done with a help of time stamps of TATA GLOBAL.

- Predicted next day's TATA GLOBAL stock price using last 60 days of timestamp closed price.
- Forecasted TATA GLOBAL stock price of 29th June 2020.
- The Predicted stock price is **351.52** INR.

```
#get the quote
tata = web.DataReader('TATAGLOBAL.BO', data_source='yahoo', start='2012-01-01', end='2020-06-26')
#create new dataframe
new_df = tata.filter(['Close'])
#print(new_df.tail())
#get the last 60 days closing price values and convert the dataframe to an array
last_60_days = new_df[-60:].values
#scaling the data to values between 0 to 1
last_60_days_scaled = scaler.transform(last_60_days)
#create an empty list
X_test = []
#append the past 60 days
X_test.append(last_60_days_scaled)
#convert the X_test data to np array
X_test = np.array(X_test)
#reshape the data
X_test= np.reshape(X_test, (X_test.shape[0],X_test.shape[1],1))
#get the predict value
pred_price = cnnmodel.predict(X_test)
#undo the scaling
pred_price = scaler.inverse_transform(pred_price)
print(pred_price)
```

```
[[351.52625]]
```

Figure 6.2 Forecasting the Next Day Stock Price in CNN

6.2 PERFORMANCE OF LSTM IN STOCK VALUE PREDICTION

6.2.1 Advantages of LSTM in Stock Value Prediction

Long-Short Term Memory is a state of art algorithm in Time Series and Sequence data. LSTM works well in financial time series, in our case LSTM obtained best prediction in uptrend and down trend as well as the

forecasted price is very closed to the actual stock price of TATA GLOBAL and also LSTM is Less is Root Mean Square Error this show the performance of the model is very high compare to any other model.

6.2.2 Comparison to Actual Stock values and LSTM Predictions

Table 6.2 Sample of Actual values and Predictions

Date	Close	Predictions
2020-06-15	370.149994	363.646393
2020-06-16	368.950012	362.678040
2020-06-17	369.500000	361.878113
2020-06-18	372.200012	361.612579
2020-06-19	378.450012	362.835358
2020-06-22	380.750000	366.620697
2020-06-23	390.700012	368.771454
2020-06-24	382.850006	374.842224
2020-06-25	384.299988	372.046326
2020-06-26	386.000000	371.942505

Table 6.2 shows the value of Actual stock close price and predictions of TATA GLOBAL.

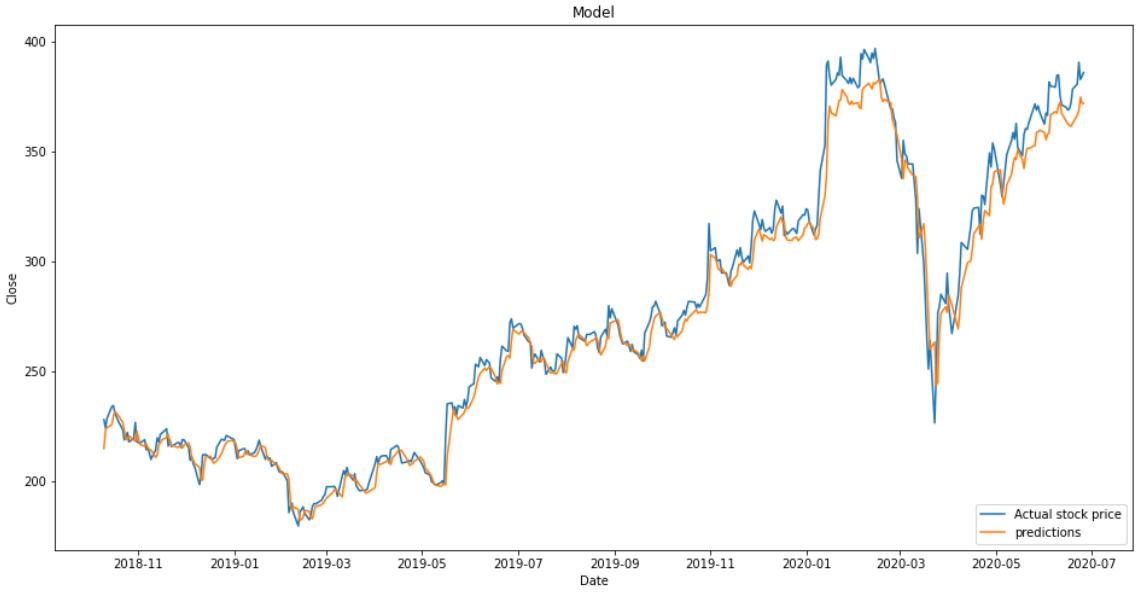

Figure 6.3 Actual Values vs LSTM Predictions

Figure 6.3 Shows the visualization of Actual Values and Predicted values which are done by Long-Short Term Memory (LSTM) model. The graph shows the model gives the prediction of uptrend and downtrend is matches to the actual stock value.

6.2.3 Forecasting the Next Day Stock Price for TATAGLOBAL

Forecasting the next day price in the Long-Short Term Memory model with Yahoo finance data set, the prediction will done with a help of time stamps of TATA GLOBAL.

- Predicted next day's TATA GLOBAL stock price using last 60 days of timestamp closed price.
- Forecasted TATA GLOBAL stock price of 29th June 2020.
- The Predicted stock price is **373.82** INR

```
[22] #get the quote
     tata = web.DataReader('TATAGLOBAL.BO', data_source='yahoo', start='2012-01-01', end='2020-06-26')
     #create new dataframe
     new_df = tata.filter(['Close'])
     # print(new_df.tail())
     #get the last 60 days closing price values and convert the dataframe to an array
     last_60_days = new_df[-60:].values
     #scaling the data to values between 0 to 1
     last_60_days_scaled = scaler.transform(last_60_days)
     #create an empty list
     X_test = []
     #append the past 60 days
     X_test.append(last_60_days_scaled)
     #convert the X_test data to np array
     X_test = np.array(X_test)
     #reshape the data
     X_test= np.reshape(X_test, (X_test.shape[0],X_test.shape[1],1))
     #get the predict value
     pred_price = model.predict(X_test)
     #undo the scaling
     pred_price = scaler.inverse_transform(pred_price)
     print(pred_price)

     [[373.82605]]
```

Figure 6.4 Forecasting the Next Day Stock Price in LSTM

6.3 ACTUAL STOCK PRICE OF TATA GLOBAL

TATA GLOBAL is also known as TATA Consumer Products Ltd. Actual stock price of TATA GLOBAL in 29th June 2020 is shown in Table 6.3 below.

The data extract form Yahoo finance, the open price is 387.05 INR, high price of the day is 392.30 INR, low price of the day is 382.15 INR and close price is 386.50 INR in the day of 29th June and this day fixed for forecast the model the model will predict this day's stock closing price.

Table 6.3 Actual price of TATA GLOBAL

Date	Open	High	Low	Close
2020-06-29	387.05	392.30	382.15	386.50

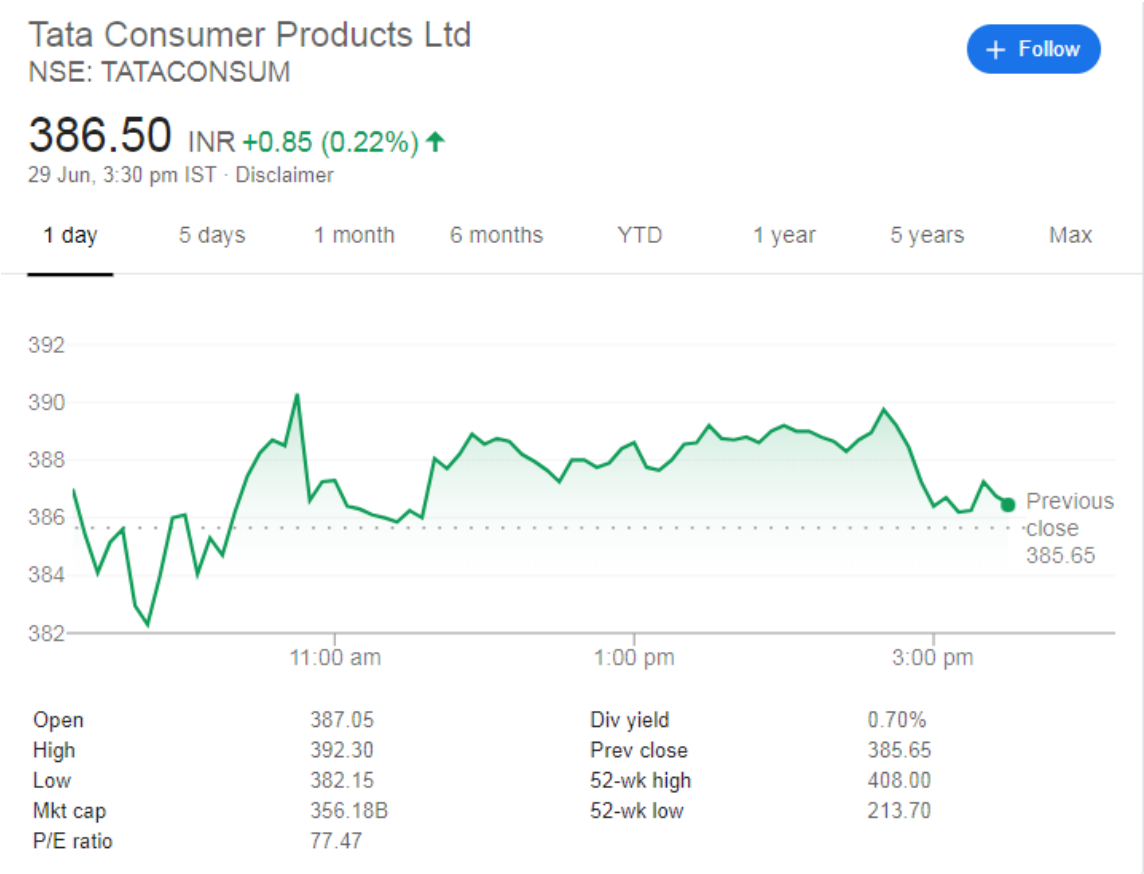

Figure 6.5 Actual price of TATA GLOBAL

Figure 6.5 shows the actual stock price of TATA GLOBAL on 29th June 2020. The actual stock price is 386.50 INR.

6.4 Comparison Score of CNN and LSTM

Table 6.4 Comparison Score of CNN and LSTM

	RMSE	Forecast Price of 29th June 2020
CNN	9.4892	351.52
LSTM	4.3128	373.82

The table 6.4 shows comparison of CNN model and LSTM model with help of Root Mean Square Error and the forecasted price of 29th June 2020 for TATA GLOGAL. The result show Long-Short Memory is obtain good result compare to Convolution Neural Network, LSTM gives good prediction on uptrend and downtrend as well as good prediction in stock closing price respected to forecasted day.

7. CONCLUSION AND FUTURE ENHANCEMENTS

7.1 CONCLUSION

In this project done with financial Time series prediction with Neural Network models like **Convolution Neural Network (CNN)** and **Long-Short Term Memory (LSTM)** and compare to each other, the final approach of this project is to be Predicting the Real time Stock market closing price of the TATA GLOBAL. In our case LSTM gives Good results with less Root Mean Square Error of **4.3128**. Long-Short Term Memory is best model to predict sequence data, time series and financial time series data. The LSTM model is slow while compare to CNN, but LSTM is obtained efficient results than CNN.

7.2 FUTURE ENHANCEMENTS

The stock prediction model will describe Long-Short Term Memory performs well in sequence, time series and financial time series data in this project work. The model predict well on uptrend and downtrend as such, but also the values may differ in actual and prediction values, since the stock prediction values is closed to actual price there is only good prediction in uptrend and downtrend, if future works tune the model with hyper parameter tuning and get the prediction of accurate value.

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TECHNICAL BIOGRAPHY

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