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Stock Market Price Prediction using two-layer LSTM-RNN

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ABSTRACT

Stock market is carrying highly dynamic as well as time-varying characteristics, this field is drawing enormous amount of attention in financial sector. Prediction of stock prices are often challenging as it is involves current socio-economic condition, company profiles and many more. This paper attempts to predict Tesla stock market price using two-layer LSTM model. Close price, high price, low price, and open price are forecasted using this proposed two-layer LSTM model. Experimental results exhibited an accuracy of 86.67%, 86.48%, 89.82%, 88.81% respectively for close, open, high and low prices respectively.

KEYWORDS: Stock Market, Tesla, RNN, LSTM, Price prediction.

I. INTRODUCTION

There are various complicated financial indicators and also the fluctuation of the stock market is highly violent. However as the technology is getting more advanced, the probability of getting gains from stock marketis increasing and also to make more accurate predictions. The predictionof the market value is of great importance to help in maximizing the profitof stock purchases keeping the risk low[1].Over the years, investors and researchers have been interested in developing and testing modelsof stock price behaviour. However analysing the stock market and doing predictions upon it is very challenging because of the markets dynamic, non-linear, noisy nature. The stock markets are affected by many highly interrelated factors that include economic, political, psychological, and company-specific variables. The stock market prediction is a tricky thing. Several theories regarding stock market have been conceptualized over the years. Many new technologies and methods have been proposed over the years to try and predict stock marketvia many avenues[2]. The main focus of our research paper today is to predict the necessary prices related to the stock market using an improved version of the RNN neural networks - Long-short-Term-Memory (LSTM).

Recurrent neural networks (RNN) have proved one of the most powerfulmodels of predictions for sequential data[3]. Long-Short-Term-Memory (LSTM) is an improvement over RNN that is capable to remembering long-term dependencies. We have used Long-Short-Term-Memory (LSTM) for building our model. LSTM introduces the memory cell, a unit of computation that replaces the traditional artificial neurons in the hidden layer of the network[4]. The structure of LSTM cell is shown in Fig. a. This results in a high prediction capacity of the model as the networksare able to associate memories effectively and grasp the structure of data dynamically.

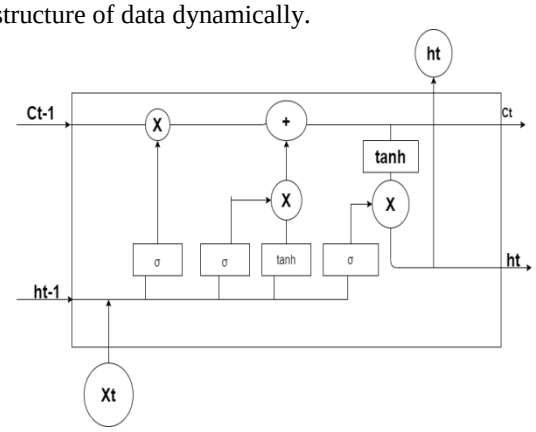

Fig a: The Structure of LSTM cell.

Two layer LSTM model is proposed in this paper that is used to estimate and predict the closing, high, open, low stock price of TSLA Inc. The proposed model is fine-tuned in terms of hyper-parameters for obtaining maximised performance.

II. RELATED WORKS

Kamijo and Tanigawa in [5] established a pattern recognition technique that estimates the stock prices on the Tokyo Stock Exchange. Recurrent neural networks are utilised to recognise stock price based triangle patterns. This method is also applied for extracting temporal contextual

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transition. The objective of this paper is to minimize patterns that mismatch.A comparative analysis between two very promising artificial neural network models between a Long Short-Term Memory recurrent neural network (LSTM-RNN) and a deep neural network (DNN) are drawn in [6]. This will yield forecast results for daily and weekly activities of the Indian BSE Sensex index. The problem of over-fitting is handled in both the cases. Only closing price data are considered for these models.Cheng-Ming Lee et. al. in [7] provide an innovative idea that embeds lifting scheme with ARIMA model to increase short-term forecasting accuracy. The lifting scheme is a four-stage procedure that splits the original data loads into several sub loads at different resolution levels. These sub loads are fitted using several ARIMA models and the forecasting results are obtained. Applying inverse lifting scheme, original forecasting result is retrieved. Experimental results indicate that the proposed scheme outperforms well over back-propagation network (BPN) algorithm and traditional ARIMA models in terms of forecasting accuracy.

III. METHODOLOGY

This section elaborates the working paradigmof our system.Our system consists of the multiple steps which are as discussed as follows-

- Step 1 : Collection of Raw Data :

In this stage, we obtain the data using web-driver from TSLA Inc. and this data is used for the prediction of future stock price.

- Step 2 : Data Pre-processing :

The pre-processing stage involves
Data reduction: Part of the data is reduced but with particular importance
Data Division: Splitting the datainto training and test data respectively.
Data Integration: The integration of the data files.
After this Stage we proceed to the construction of our prediction model

- Step 3 : Feature Extraction :

In this stage, we choose our parameters which are to be fed to the LSTM. Since, we will predict the close stock price of 2020 hence we will take the Closed,Opening, High,Low prices as our parameter.

- Step 4 : Training the model :

In this Stage, the data is fed to the neural network and trained for making predictions. A diagram of LSTM is shown in Fig 1. Our model has a sequential input layer and a dense layer.

- Step 5 : Output Generation :

The obtained output is evaluated on the basis of RMSE[8], MSE[8] and Accuracy[8]. If the MSE and RMSE obtained a small value then we can consider our model to be a perfect one.

Model Description-

In this paper, proposed model is implemented by stacking two layers of LSTM and two dense layers into single platform. The LSTM layers consist of having 50 nodes and the next two dense layers contain 25 and 1 node respectively. This implemented model is trained through 10 epochs with a batch size of 64. These layers are compiled using RMSprop optimizer. The structure of the proposed model is shown in fig. 2.

Layer (type)	Output Shape	Param #
lstm_1 (LSTM)	(None, 60, 50)	10400
lstm_2 (LSTM)	(None, 50)	20200
dense_1 (Dense)	(None, 25)	1275
dense_2 (Dense)	(None, 1)	26

Fig 2: Structure of Proposed two-layer LSTM Model

Experimental Results-

The tesla stock price data has been used for prediction purpose. This data has been collected from Kaggle [9]. The data we obtained ranges from 29.06.2010 to 17.12.2019. For training the model we used RMSprop as the optimizer and normalized each vector of the sequence[10]. For our experiment, we have used Closed, Open, Low, High stock price as our parameters with the help of epochs to measure the RMSE,MSE,and accuracy of our model.We evaluated the prediction results and established the prediction model by the mean square error (MSE), root mean square error (RMSE) and data accuracy. The use of RMSE is highly common and it makes an excellent general purpose error metric for numerical predictions. The smaller the

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MSE and RMSE the closer is the predicted value to the original value.

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

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

After obtaining the necessary prediction model we use the last 60 day stock prices to make our predictions.The predicted Close price for the year 2020 is 362.73508. The predicted Open price for the year 2020 is 353.63153.The predicted high price for the year 2020 is 378.91257.The predicted Low price for the year 2020 is 389.91257. The predictive price and the original price are shown in table 2. Table 1 provides insight about the performance of two-layer LSTM model during forecasting of stock market price. Fig 3 to fig 6 shows the graphical representation of stock market original as well as predicted prices.

Parameters	**RMSE**	**MSE**	**Accuracy**
Close Price	3.12401774	9.75948686	86.67 %
Open Price	4.12401665	17.0075133295	86.48 %
High Price	2.12457332	4.51381179206	89.82 %
Low Price	2.12457332	4.51381179206	88.81 %

Table 1: Performance summary of proposed two-layer LSTM model.

Predicted Items	Original value	Predicted value
Close Price	**390.51124**	**384.44336**
Open Price	**370.78835**	**362.54331**
High Price	**360.67885**	**357. 57994**
Low Price	**380.77882**	**384.67332**

Table 2: Comparison of Predictive Prices with Original prices

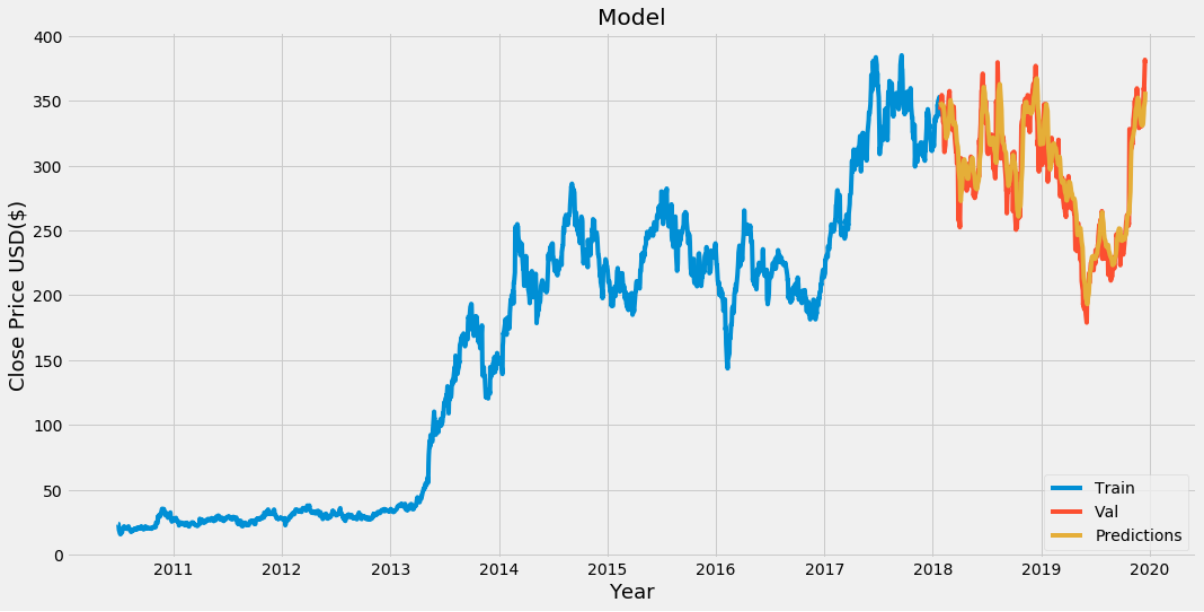

Fig 3: Closing Price Prediction using Proposed Model

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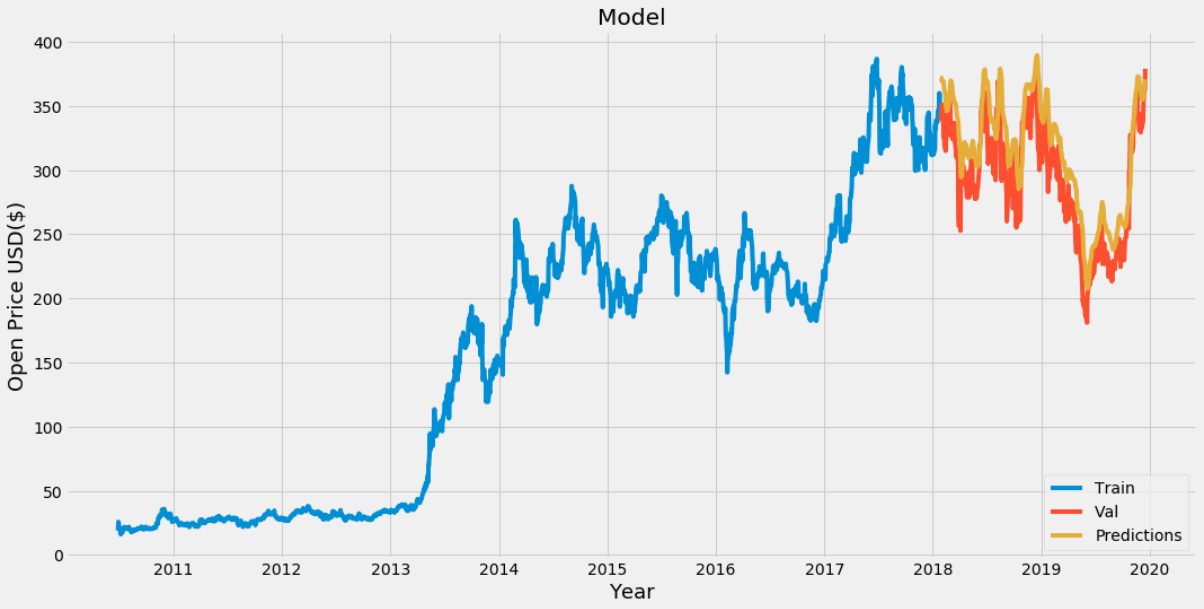

Fig 4: Opening Price Prediction using Proposed Model

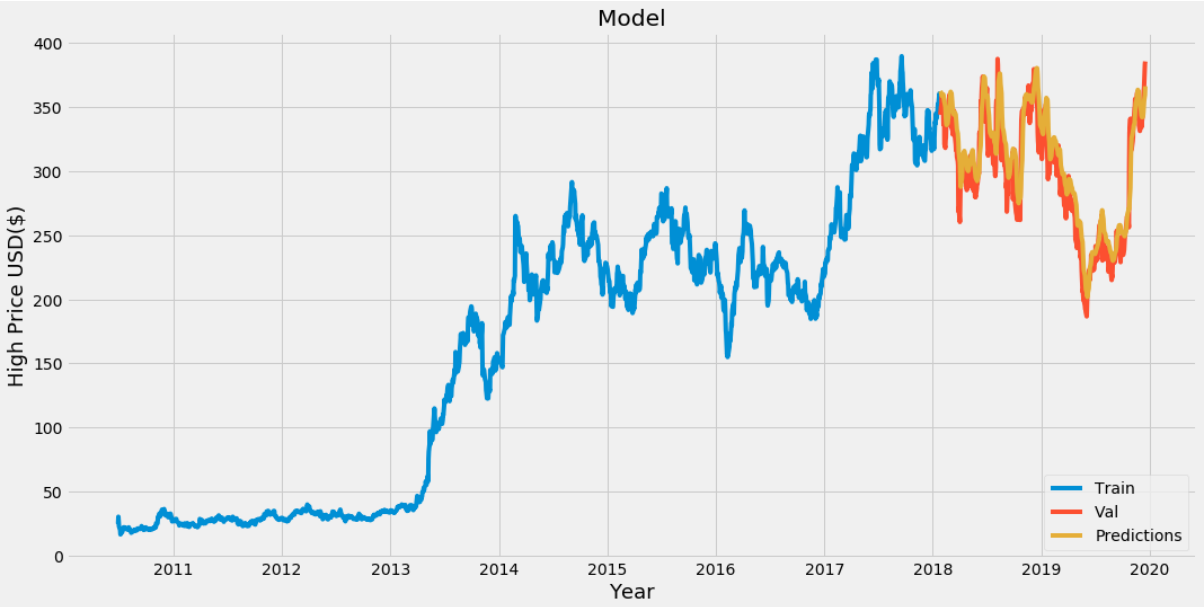

Fig 5: High Price Prediction using Proposed Model

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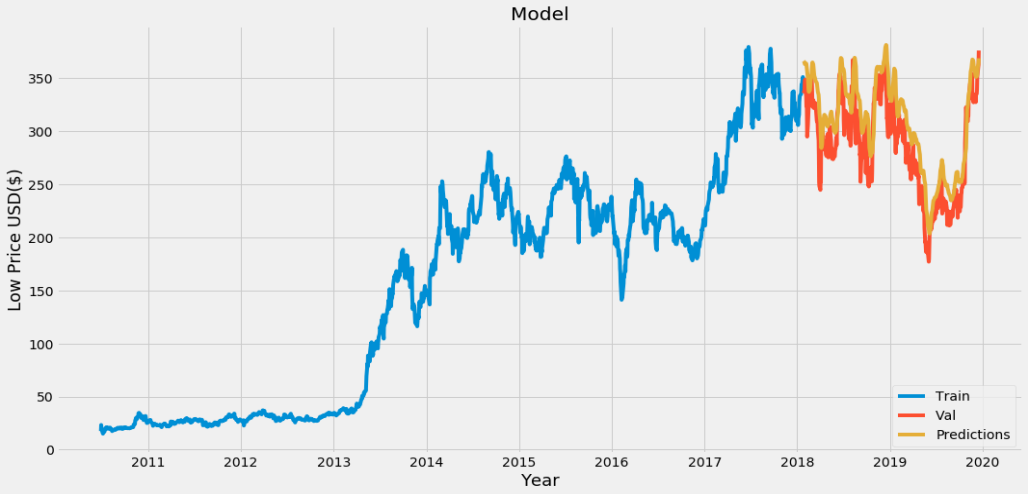

Fig 6: Low Price Prediction using Proposed Model

IV. CONCLUSION

The popularity of the stock market trading is growing rapidly, and thus day by day it is increasing researchers to develop new techniques to make more accurate predictions. This is not only helping researchers but also helps investors or any other person dealing with the stock market.Governments of most countries invest a part of their healthcare,employment,or retirement funds into stock market to achieve better returns for anyone. The financial markets have evolved rapidly into a strong and interconnected global marketplace. These advancements bring forth new opportunities and the data science techniques offer many advantages but along with that they also carry various set of challenges. In order to predict the stock indices, a forecasting model with good accuracy is required to improve the stock market scenario and to tackle the challenges related to it.The proposed two-layer LSTM model is compatible enough for forecasting stock market prices with significantly promising efficiency.

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