



AN INTELLIGENT FORECASTING MODEL FOR TIME SERIES STOCK PRICE PREDICTION LSTM RECURRENT NEURAL NETWORK

¹Saranya.N, ²Sowndarya.P, ³Krishnammal.N and ⁴Sugunamuki.K. R

^{1&3}Assistant Professor, ^{2&4}PG Scholar

Department of Computer Science and Engineering
Sri Shakthi Institute of Engineering and Technology
Coimbatore, Tamil Nadu, India

Abstract

Forecasting of time series stock price is definitely be a great challenge for investors, by the way it would be an important task to make profit out of investing stock market. Since the stock market data is continues numerical and time series data, prediction became much harder, when using simple mathematical statistics. Artificial Intelligence helps to design such an ultimate intelligent model for this dynamic environment. The proposed system focuses on training the model to predict daily closing price of Indian Stock market such as Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) by Open, High, Low and Close price (OHLC) of specific time period. In this model a novel deep learning method been employed for accurate forecasting. Prediction is achieved by Long Short-Term Memory Recurrent Neural Network (LSTM-RNN). The fulfilment of this proposed model is evaluated Mean Absolute Error (MAE) by varying epoch and results of all the epochs were compared.

Keywords:Deep Learning, LSTM, OHLC, Stock Market Analysis, Time Series Forecasting.

1. Introduction

The result of effective forecasting of stock price will gives huge benefit. In general equity market or stock market is the place where any organisation or any individual can invest by means of buying the share or selling share. Analysing stock market is an important piece of work in forecasting, this analysis has two broad categories such as

1. Technical analysis
2. Fundamental analysis

Predicting the trend with the help of statistical data and statistical charts comes under technical analysis. On the other hand, predicting the future by analysing organization’s current business performance is fundamental analysis. The proposed study focuses on **technical analysis** [1]. Based on the supply and request made by the investors and dealers, the stock price may vary every day or even every minute, these trades taking care by any e-marketplace which make trading much easier. In addition to that forecasting of the price on a particular day could leads outstanding profit. This has been employed by a Deep Learning algorithm called RNN LSTM that is Recurrent Neural Network Long Short-Term Memory. Since this financial data is varying at a specific time interval and also follows chronological order this lays under timeseries data. Any financial sequential data which is changing over time and not has fixed value is known as continues data, so this model would be trained by continues time series data.

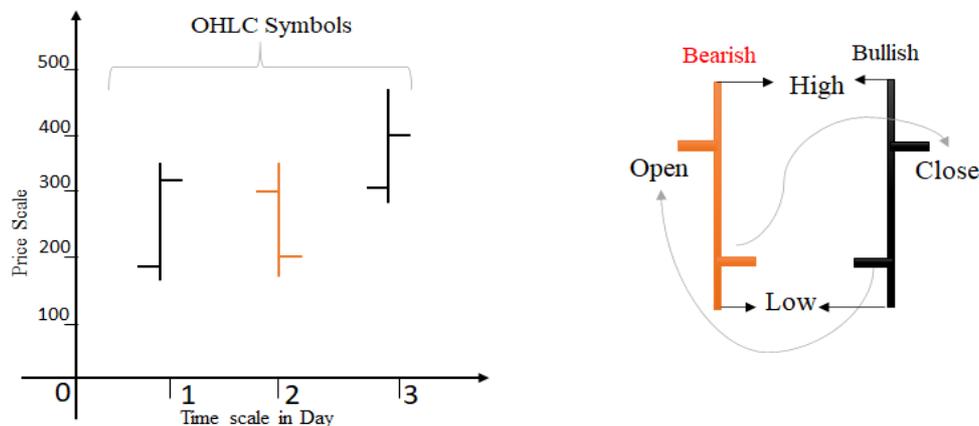


Figure 1. OHLC Chart and Symbol Anatomy



Cover Page

The term OHLC might be defined as Open High Low Close price of a stock on the particular time period. The figure 1 represents the clear picture of OHLC chart and OHLC bar symbol anatomy. This chart is useful for visualizing the stock change during particular time period, this time period might be fit for any time frame, it varies according to the need. The x-axis of the chart represents time period and the y-axis represents price range. When comes to OHLC bar, the vertical height of the bar depends on high and low price during specific time, while the open price is denoted by left marks from the vertical line and the close price is right marks from the vertical line. If the close price is higher than the bar would be black colored and this is called as bullish, if the close price is lower than the bar would be red colored and called as bearish. This color representation is useful to identify whether the market is bullish or bearish on the particular period [2][3][4][5].

2. Related Work on Existing Model

Stock price prediction became a challenging issue because of its characteristics in nature such as non-linearity, continuous, time-series and so on. This literature study consciously done by evaluating the forecasting models of stock indices from the year 2009 to till date. In the early twenty first century a hybrid model was proposed to predict the stock price, but rules of the model haven't described clearly. The combination of Artificial Neural Network (ANN) and Decision Tree (DT) model has proposed by Tsai, C. F and S. P. Wang (2009) [6]. Nair, Binoy B., et al (2011) [7] proposed a fine-tuned system by testing on different stock indices and various performance measures. This model uses the Genetic Algorithm to adapt the time series dynamically changing stock price. Kara., et al (2011) [8] used SVM and ANN as a classification algorithm to predict the stock price. This model has been trained by daily ISE Index that is Istanbul Stock Exchange and it provides higher accuracy for ANN model than baseline SVM model.

The SSVM that is Structural Support Vector Machine algorithm was employed to improve the efficiency early models and that provides the improved accuracy than baseline models and this proposed by Leung., et al (2014) [9]. Performance of the simple ANN model has been accelerated with back propagation algorithm by Masoud and Najeb (2014) [10]. The authors used error calculation methods such as Mean Absolute Percentage Error, R^2 , Root Mean Square Error and Mean Absolute Error to evaluate the performance. Prediction of Indian Stock Exchange is proposed by Patel, Jigar, et al (2015) [11] and they compared the prediction accuracy of various ML models such as Random Forest, SVM, Naive-Bayes model and ANN model. Performance of the models has been evaluated by varying the input parameters. Selvin, et al. 2017 [12] proposed a model to Compare the performance of linear and non-linear algorithms for stock price and index movement forecasting have done. Have used the single company data to train the model. Three type of Deep Learning architectures where used to predict the future values. The dataset used for this model is NSE listed companies daily closing price. Methods used for Linear data is AR, MA, ARIMA. The methods used for Non-linear data is ARCH, GARCH, Neural Network. Performance evaluation for trained model has done by percentage error.

Henrique., et al (2018) [13] proposed a SVR (Support Vector Regression) model using per-minute data and as well daily stock index. This model provides higher accuracy by updating the strategy of the model frequently. In addition to accuracy of prediction a user-friendly GUI (Graphical User Interface) with the sliding – window prediction model was proposed by Chou, Jui-Sheng., et al (2018) [14]. This model aims to provide the better results for non-linear time series forecasting. The above literature survey stated about the how the various Machine Learning techniques been employed in stock price forecasting. Then later the Long Short-Term Memory (LSTM) algorithm has employed in several studies, and thus produces better results as well when compared to other prediction models. The Table 1 has listed the comparative studies which used LSTM with some other algorithms.

3. Proposed System

The Artificial Intelligence based forecasting model for time series stock prediction system with the algorithm LSTM that is Long Short-Term Memory Recurrent Neural Network (LSTM-RNN) is proposed in this paper also the basic work flow of the frame work is represented in the figure 2. The proposed model has four modules as mentioned in the figure such as Data Acquisition Module, Pre-processing Module, Prediction Module, Performance Evaluation Module are explained below. The Evaluation metric Used in this system is Mean Absolute Error (MAE).

Mean Absolute Error defined as mean of sum of absolute value of residuals, and talks about how far the predicted values lies from actual value. Here, when the value of metric increases the performance of the model decreases, MAE defined as follows:

$$MAE = \frac{\sum_{i=1}^N |\hat{x}_i - x_i|}{N} \quad (1)$$

Table 1: Annotations used

\hat{X}_i	= Prediction target value
X_i	= Actual target value
N	= Total number of datapoints
i	= variable

The raw data of stock market is collected from Indian stock exchanges known as NSE and BSE. Those data sets are explored by means of finding missing values, fixing target variable, exploring independent variables, finding outliers and so on, then the pre-processing has done by reducing the column. Further the data has been segregated in to two parts for training and testing purposes, 70% is for training and remaining 30% is for testing. Then the forecasting of stock price is done by LSTM-RNN. Finally, performance evaluation has done by calculation various error terms by changing epoch and batch size.

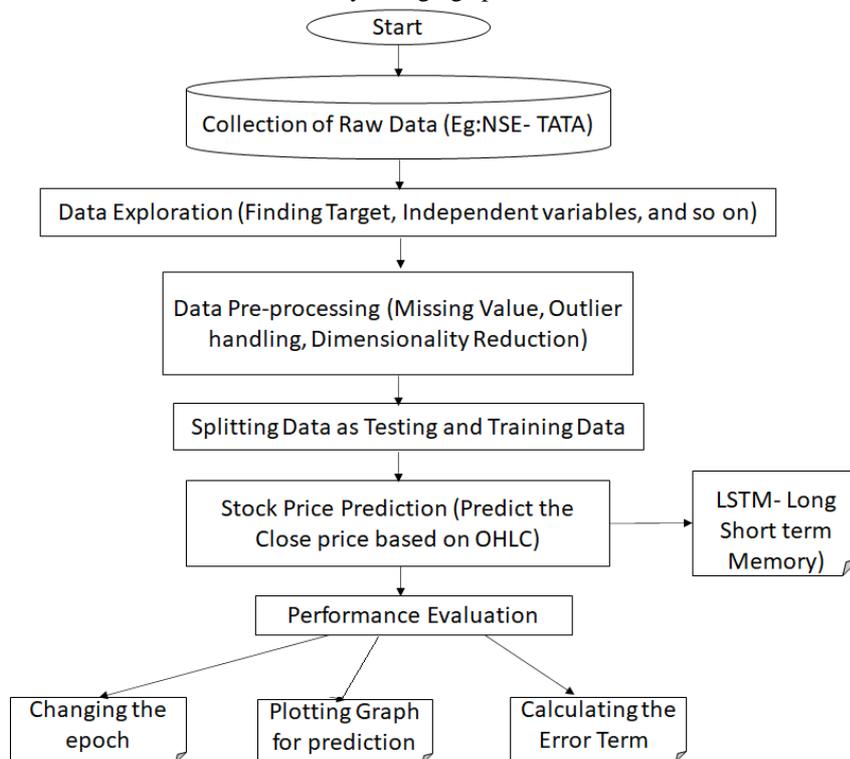


Figure 2: Block diagram of proposed model.

4. Methodologies in Proposed System

Long Short-Term Memory is one of the technics which comes under Recurrent Neural Network to overcome the problem of vanishing gradient. Sequential might get obtain better results by LSTM, which was introduced by Hochreiter and Schmidhuber at 1997. The sharp thought of acquainting self-circles with produce ways where the slope can stream for long lengths is a centre commitment of the underlying LSTM model. LSTM network acknowledges fleeting memory work through switch of the entryway, and can adequately take care of the issue of angle disappearing and blast in repetitive neural organization. The way to LSTM is the presentation of a gating unit framework that stores verifiable data through the inner memory unit cell state unit, utilizing extraordinary "entryways" to allow the organization to learn powerfully, i.e., when to fail to remember authentic data or update cell state with new data. The figure 3 represents the block diagram of LSTM [15][16].



Cover Page

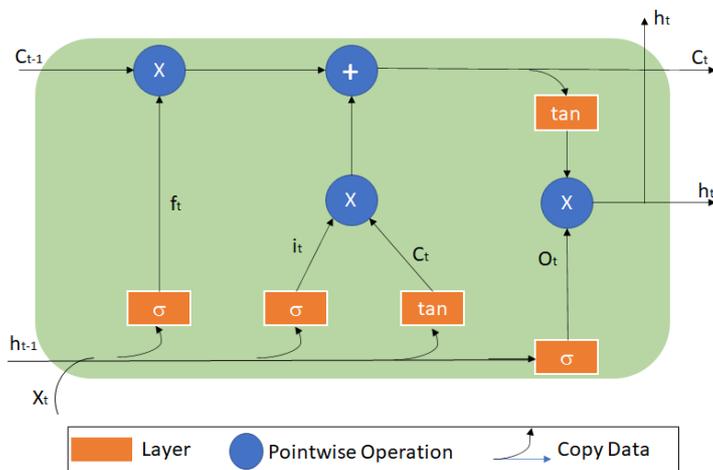


Figure 3: Long Short-Term Memory Block Diagram

5. Obtained Results and Discussion

The obtained results were presented in the form of graphs and tables. Where the difference between the prediction and actual results were clearly shown for NSE-TATA Global beverage limited dataset. Various epoch has changed as 1, 5, 10 and 20 and the actual and model prediction were compared by graph that has been shown from figure 4 to 7. The red line in the graph represents the actual stock prediction and green line represents the predicted stock price. When comparing these results, for epoch 20 the model produces best prediction than lesser number of epochs. Epoch one has very high error value, and if the number of epochs increases the error value has decreased.

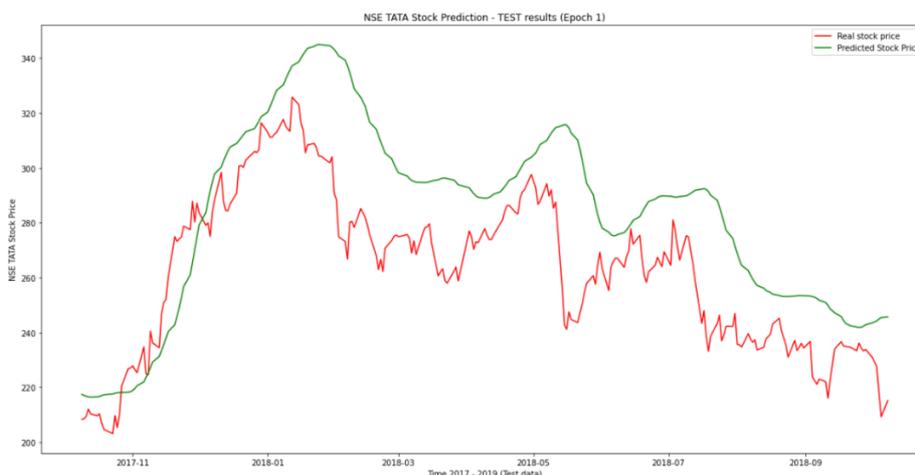


Figure 4. Actual and Prediction plot for NSE TATA stock prediction for Epoch 1



Cover Page

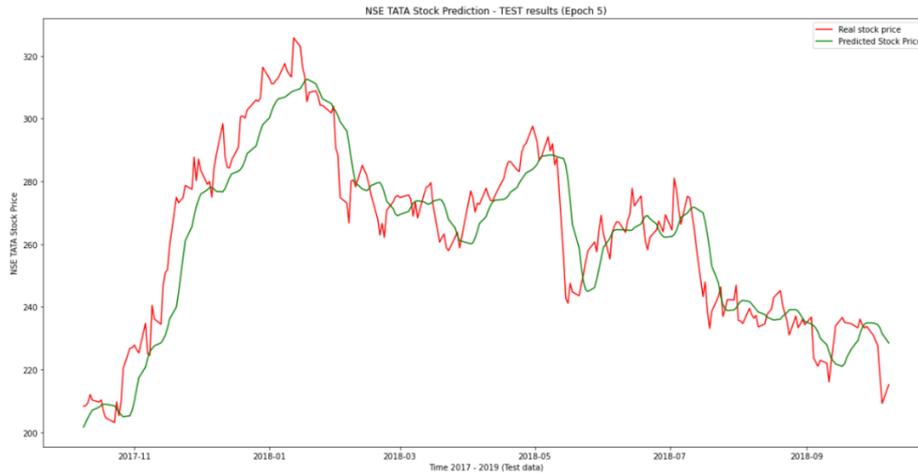


Figure 5. Actual and Prediction plot for NSE TATA stock prediction for Epoch 5



Figure 6. Actual and Prediction plot for NSE TATA stock prediction for Epoch 10



Figure 7. Actual and Prediction plot for NSE TATA stock prediction for Epoch 20



Cover Page



6. Conclusion and Future Work

The financial exchange is developing quickly and prominence also increases due to technology growth. This means that many new technical strategies involved in stock price forecasting also it urging specialists to discover some more. The prediction strategy isn't just helping the analysts yet it moreover helps financial specialists and any individual managing the stock market. To help anticipate the stock records, an anticipating model with great precision is required. The proposed model obtained results with higher accuracy for the epoch 20 with SLTM model.

In future this model might be compared with some other machine learning algorithm including Bidirectional LSTM to evaluate the performance of the model. Improved efficiency might be achieved with the help of testing the model with various approaches such as changing the algorithm, dataset, feature selection and so on[17][18].

Reference

- [1] <https://www.analyticsvidhya.com/blog/2018/10/predicting-stock-price-machine-learningnd-deep-learning-techniques-python/>
- [2] https://datavizcatalogue.com/methods/OHLC_chart.html
- [3] <https://www.investopedia.com/terms/o/ohlcchart.asp>
- [4] <https://www.investopedia.com/articles/stocks/09/indian-stock-market.asp>
- [5] <https://economictimes.indiatimes.com/definition/stock-market>
- [6] Tsai, C. F., and S. P. Wang. "Stock price forecasting by hybrid machine learning techniques." Proceedings of the international multiconference of engineers and computer scientists. Vol. 1. No. 755. 2009.
- [7] Nair, Binoy B., et al. "A GA-artificial neural network hybrid system for financial time series forecasting." International Conference on Advances in Information Technology and Mobile Communication. Springer, Berlin, Heidelberg, 2011.
- [8] Kara, Yakup, Melek Acar Boyacioglu, and Ömer Kaan Baykan. "Predicting direction of stock price index movement using artificial neural networks and support vector machines: The sample of the Istanbul Stock Exchange." Expert systems with Applications 38.5 (2011): 5311-5319.
- [9] Leung, Carson Kai-Sang, Richard Kyle MacKinnon, and Yang Wang. "A machine learning approach for stock price prediction." Proceedings of the 18th International Database Engineering & Applications Symposium. 2014.
- [10] Masoud, Najeb. "Predicting direction of stock prices index movement using artificial neural networks: The case of Libyan financial market." Journal of Economics, Management and Trade (2014): 597-619.
- [11] Patel, Jigar, et al. "Predicting stock and stock price index movement using trend deterministic data preparation and machine learning techniques." Expert systems with applications 42.1 (2015): 259-268.
- [12] Selvin, Sreelekshmy, et al. "Stock price prediction using LSTM, RNN and CNN-sliding window model." 2017 international conference on advances in computing, communications and informatics (icacci). IEEE, 2017.
- [13] Henrique, Bruno Miranda, Vinicius Amorim Sobreiro, and Herbert Kimura. "Stock price prediction using support vector regression on daily and up to the minute prices." The Journal of finance and data science 4.3 (2018): 183-201.
- [14] Chou, Jui-Sheng, and Thi-Kha Nguyen. "Forward forecast of stock price using sliding-window metaheuristic-optimized machine-learning regression." IEEE Transactions on Industrial Informatics 14.7 (2018): 3132-3142.
- [15] Sherstinsky, Alex. "Fundamentals of recurrent neural network (rnn) and long short-term memory (lstm) network." Physica D: Nonlinear Phenomena 404 (2020): 132306.
- [16] Perera, Dilruk, and Roger Zimmermann. "Lstm networks for online cross-network recommendations." arXiv preprint arXiv:2008.10849 (2020).
- [17] Lu, Wenjie, et al. "A CNN-BiLSTM-AM method for stock price prediction." Neural Computing and Applications (2020): 1-13.
- [18] Sunny, Md Arif Istiake, Mirza Mohd Shahriar Maswood, and Abdullah G. Alharbi. "Deep Learning-Based Stock Price Prediction Using LSTM and Bi-Directional LSTM Model." 2020 2nd Novel Intelligent and Leading Emerging Sciences Conference (NILES). IEEE, 2020.

Filename: 18
Directory: C:\Users\DELL\Documents
Template: C:\Users\DELL\AppData\Roaming\Microsoft\Templates\Normal.dotm
Title:
Subject:
Author: Windows User
Keywords:
Comments:
Creation Date: 5/15/2021 12:19:00 PM
Change Number: 11
Last Saved On: 6/2/2021 8:08:00 AM
Last Saved By: Windows User
Total Editing Time: 19 Minutes
Last Printed On: 6/2/2021 8:08:00 AM
As of Last Complete Printing
Number of Pages: 6
Number of Words: 2,229 (approx.)
Number of Characters: 12,708 (approx.)