Stock Price Prediction Using RNN and LSTM

Janki Patel* [1]*, *Prof. Miral Patel* [2]*, **Prof. Mittal Darji**[3]
[1]Information Technology, G. H. Patel collage of engineering, India
[2]Information Technology, G. H. Patel collage of engineering, India
[3]Information Technology, G. H. Patel collage of engineering, India

Abstract

Prediction of stock market has been an attractive topic to the stockbrokers. In stock market the decision on when buying or selling stock is important in order to achieve profit. There are number of techniques that can be used to help investors in order to make a decision for financial gain. In this research work I have propose a prediction algorithm that will give the relation between the dependent factor like price and independent factors like opening price, closing price, high value of stock, low value of stock and volume of stocks bought. In this research, I have explained development of stock price prediction with the use of deep learning algorithm. In this work, I am going to use different deep learning architecture for the price prediction of BSE listed company and compares their performance. Here I had used LSTM and RNN algorithms. I had shown comparative study of this two deep learning algorithm. Study shows that RNN gives better performance than LSTM. Accuracy of LSTM is 87% and accuracy of RNN is 89%.

Keywords: Stock price prediction, Deep Learning, LSTM, RNN

INTRODUCTION

1. BASIC INTRODUCTION OF STOCK MARKET

A stock market is a public market for trading of company stocks. Stock market prediction is the task to find the future price of a company stock. The price of a share depends on the number of people who want to buy or sell it. If there are more buyers, then prices will rise. If the seller has a number of buyers, the price will drop. The agent can often help people to buy/sell shares on the stock market. A broker can also help customers make the right choices in stock [2].
The existing methods for stock price forecasting can be classified as follows [1]

1. Fundamental analysis: This is a type of investment analysis of the shared values, the company estimates that its sales, revenues, profits and other economic factors. This method is the most suitable for long-term forecasts.
2. Technical analysis: This method uses historical prices of stocks, look for the price. This method usually uses a moving average technical analysis. This method is useful for short-term forecasting.
3. Time series data: It includes two basic types of algorithms, which is linear and non-linear model.

Prediction of stock market is an attractive topic to the stoke brokers. In stoke market the making decision when buying or selling the stock is an important in order to achieve profit. As market fluctuating everyday it is difficult to predict the future stock price. There are number techniques which is designed to overcome this uncertainty of market (I.e. clustering, regression, SVM, neural network, deep learning etc. In this research work I had concentrated on deep learning architecture [1].

The deep learning algorithm has a self-learning process that is capable to identify hidden patterns and dynamics. The stock market is non-linear and the resulting data is enormous. To establish this model, this dynamic data, we need a model to analyze the hidden patterns and the fundamental driving force. The deep learning algorithms are able to identify and take advantage of the interactions and patterns that have a data through a self-learning process. Unlike other algorithms, deep learning mode can be an effective model for these types of data, and can provide a good forecast analysis of the interaction and hidden patterns in the data.

2. DEEP LEARNING

The deep learning study is a subfield of machine learning algorithms inspired by the concerns and the structure and function of the brain, this is call artificial neural network. Most of the learning method uses neural network architecture, which is why you want to study deep learning model is commonly referred to as a deep neural network. Here, the term "deep" usually refers to the number of hidden layer of the neural network. In the traditional neural network consists of only 2-3 hidden layers, while the deep neural networks with up to 150 hidden layers. These models are trained in the use of large data sets and neural network architecture and learn about the features directly from the data, without the need for manual feature extraction. In deep learning method, requires a very large amount of data for the purpose of training models and graphics processing unit (GPU), and rapid processing of the data[3][4].

A deep neural networks have multiple non-linear processing layer, it uses a simple elements run in parallel, which is inspired by the biological neurone system. It consists of an input layer, there are a few hidden layer and the output layer. Through the layer of interconnected nodes, or neurones, each hidden layer using the output of the previous level as their input. Each node decides what to send on to the next tier based on its own inputs from the previous tier.

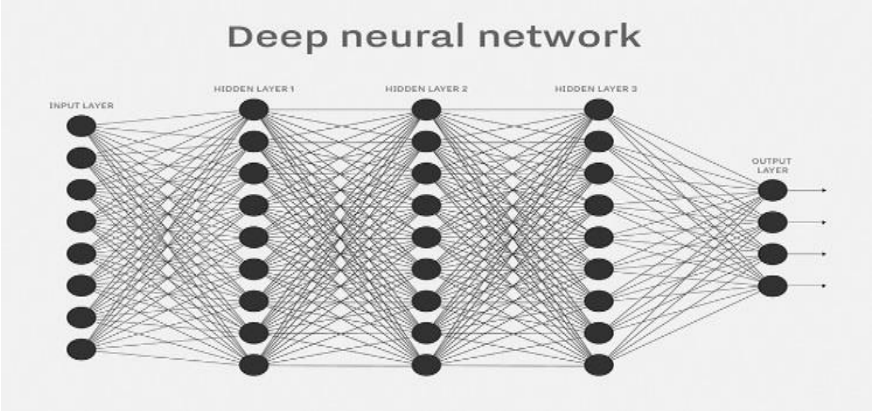


Fig. 1: deep neural network architecture

Deep learning architectures:

1. **Recurrent neural network (RNN):** It is a class of artificial neural network where connections between units form a directed graph along a sequence.
2. **Long short-term memory (LSTM):** Lstms is a RNNS to capture long-term dependency on time series forecasting.

3. RECURRENT NEURAL NETWORK (RNN)

In a traditional neural network, all input and output are independent of each other. But for many tasks, it is not a bad idea. If you want to predict the next word, sentence, you need to know which words come before it. RNNs referred to as often as they perform the same tasks for each element, the output voltage depends on the previous word. RNNs have a “memory” which stores the information about what has been calculated so far. A recurrent neural network (RNN) is a class of artificial neural network where connections between units form a directed graph along a sequence.

There is one problem in RNN which is “Long-Term Dependencies”, and also RNN requires more memory, to solve this problem LSTM is proposed. We just write through the unrolled network integrity sequence. For example, if the order is our concern that a sentence of 5 words, the network will be extracted into a 5-layer neural networks, one for each of the fields.

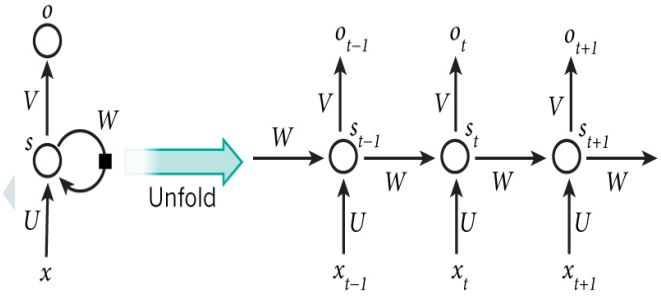


Fig. 2: A RNN diagram of being *unrolled* full network

- x_t Is the input at time step t.
- s_t Is the hidden state at $s_t = f(Ux_t + Ws_{t-1})$ time step$t$. This is a "Memory" of the network. s_t calculation is based on the previously hidden and enter in the current step.
- This is usually a non-linear functions, such as tanh orReLU. s_{-1}, This is to be the first to hide the status, are usually initialized to all zeros.
- o_t Is the output at step$t$.

4. LONG SHORT – TERM MEMORY (LSTM) NEURAL NETWORK

LSTM have cell state which contains additional memory, which is used to store the relevant past information of prediction. Some of the information is in a cell, the status of the modified structure, known as the gate. There are steps to perform such a task. In the initial steps to forget the door to decide whether or not to get rid of any of the available information. After that, tanh layer and enter the door to decide which new information to be stored. The storage of new information, add and delete information in accordance with the previous gate. In the last step, the Activation function is applied to the output data [2].

LSTM is a kind of RNN. In the LSTM architecture, hidden layers will be replaced with a LSTM's cell. The LSTM cell contains a wide range of gate, you can control the input stream. A LSTM cell contains the input gate, the status of the cell, forget gate and output gate. It also includes a ban on the sigmoid layers, tanh layers, and the point-wise multiplication operator.

- Input gate: Input gate consists of the input data.
- Cell State: The Entire Network runs through the cell's state, and it allows you to add or delete information, Gate.
- Forget gate layer: It is used to determine the part of the information is allowed.
- Output gate: It consists of the output generated by the LSTM.
- Sigmoid layer generates numbers between zero and one.
- tanh Layer generates a new vector, which will be added to the state.

The cell's status will be updated based on the output of the gate. We can represent it mathematics and use the given formula:

$$f_t = \sigma(W_f.[h_{t-1}, x_t] + b_f)$$
$$i_t = \sigma(W_i.[h_{t-1}, x_t] + b_i)$$
$$c_t = \tanh(W_c.[h_{t-1}, x_t] + b_c)$$
$$o_t = \sigma(W_o[h_{t-1}, x_t] + b_o)$$
$$h_t = o_t * \tanh(c_t)$$

Where, f_t: forget gate vector, h_t: output vector, x_t: input vector, c_t: cell state vector, i_t: input gate vector, o_t: output gate vector and W, b are the parameter matrix and vector.

LITERATURE SURVEY

In [1], three different deep learning architecture of the RNN, LSTM and CNN used. A sliding window model prices to infer the NSE listed companies and their performance. For forecast future values, a short-term basis, they have applied a sliding window, use the percentage error, this model is quantified. They have been trained in the model data and the ability to predict stock price of Infosys, TCS, cipla. It proves that the proposed system can recognize a number of intergovernmental relations within the scope of the data. Changing trends can be identified by the CNN architecture. The CNN is determined to be the best model, the proposed methodology.

In [2], they discussed with regard to artificial neural networks, feed-forward neural network and recurrent neural network. The study shows that the advance forward multi-layer perceptron performed better than the long-term and short-term memory, in forecasting short-term prices of stocks. The trained model is in the same data and make predictions of stock prices. Here the deep neural networks are used, this is a very powerful algorithm. The performance of the network is dependent on the number of neurons each layer (width), some of the hidden layers (depth) for activation function, the training algorithm, the feature set and enter the data.

In [3], they proposed a novel method to predict the stock market closing prices on the basis of deep belief networks (DBNS) with built-in to plastic. In this work, the S&P 500 is used to check performance. Back propagation algorithm is used for output. The intrinsic plasticity (IP) also apply to the network, the ability to adapt. In this study, who had predicted in the next day's closing price of the stock price using open, high, low, and the closing price of the previous day's profound belief network, there are

intrinsic to plasticy. In this article, they had used four indicators to assess the performance of the Forecasting stock price time series. The first is one of the mean square error (MSE).

In [4], they have developed a LSTM model which includes market information and investor sentiment, in order to predict the value of the CSI 300 Index in China's stock market. First, they have deployed a naive bayes sentiment classification is to assign all posts on the stock market in three categories: positive, negative and neutral, then they have the mood of the time series of follow-up. Finally, they have developed a deep neural network model, which includes a long-term and short-term storage layer (LSTM), the merge layer, a RELU softmax linear layer and layer. Their training, 90 per cent of the data set, and gives the 87.86% forecasting accuracy, the remaining 10% of the test data, more than any other type and the arrangement of the SVM method, at least 6%.

In [5], they used one of the most useful forecasting techniques, the use of recurrent neural network (RNN) and long-term and short-term memory (LSTM) unit to help investors, analysts, or any person who is interested in investing in the stock market, and to provide them with a good knowledge of the future status of the stock market.

In [6], researchers had explore the research and development in stock market prediction applications using regression analysis and artificial neural networks. For this they had taken a 210 days data of a particular stock and 30 days testing data. This system represents two algorithms to analyse the data from stock exchange. First algorithm is regression analysis which is used to predict future stock prices. The other algorithm is artificial neural network.

In [7], they proposed a method to predict the stock price with distributed representations of the reported information, and taking into account the interaction between multiple companies in the same industry. On their way to a regular network forecast changes, time-series fluctuations on the stock price. The experimental results show that distributed the text information is far better digital, data-only methods and the bag of text-based method, LSTM can capture the time series than other types of input data, and the company is effective stock price forecast.

MOTIVATION

As stock market fluctuating every day it is required intensive planning for making profit from stock market. Since the stock market begins, analyst have always face struggle to predict the future stock price because of its complexity and profitability. The most easy and reliable way to forecast the future is to try to understand the present but the amount of available data nowadays is huge.

Data analysis is used to better understand the present scenario of the Stock exchange so as to understand and try to create a better future scope for investment of stock. With Data analysis, we can add a degree of certainty to the unpredictable and volatile nature of stock prices.

This certainty can go a long way to ensure that losses are minimized and profits are maximized. Though the predictions can never be fully accurate even a minute increase in accuracy of prediction can help a lot in terms of profitability.

The motivation behind the use of these two methods LSTM and RNN to determine if there are any long-term dependence on existing in a given data or not. This can be determined from the performance model. The LSTM and RNN architecture to identify long-term dependencies, and they are used to predict the future.

PROPOSED WORK

My object of this research work is to predict the stock price. For that I am going to use deep learning architecture which helps in prediction of future stock price. Here I have taken database from BSE of stock companies from date 1st January 2016 to 1st January 2018.

The proposed method focuses on prediction of stock price of closing price of next day for BSE listed companies. The approach I have taken is recurrent neural network (RNN) and long-short term memory (LSTM). The data set contains day wise data of listed companies.

The data set consist of day wise stock price of TCS Company for the period of 1st January 2016 to 1st January 2018 which have 518 days data. It includes information like opening price, closing price, high price, low price and volume of the stock sold in each day. For this work I have selected two sectors one is IT company and another is financial sector. One company from IT sector and the one company for financial sector. The data for these two companies were taken from the historical data.

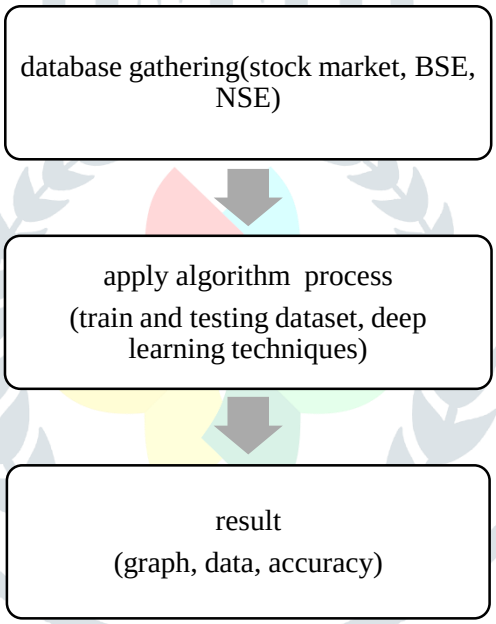


***Fig. 3**:* Proposed Workflow

Steps:

Step 1: Gathering database from BSE, NSE, Yahoo finance, NYSE

Input: Data collected from various companies such as TCS.

Output: pre-processed data which doesn't contain any missing values.

Step 2: Applying Algorithms.

Input: RNN & LSTM

Output: Complete trained model of RNN & LSTM which can predict the future prices.

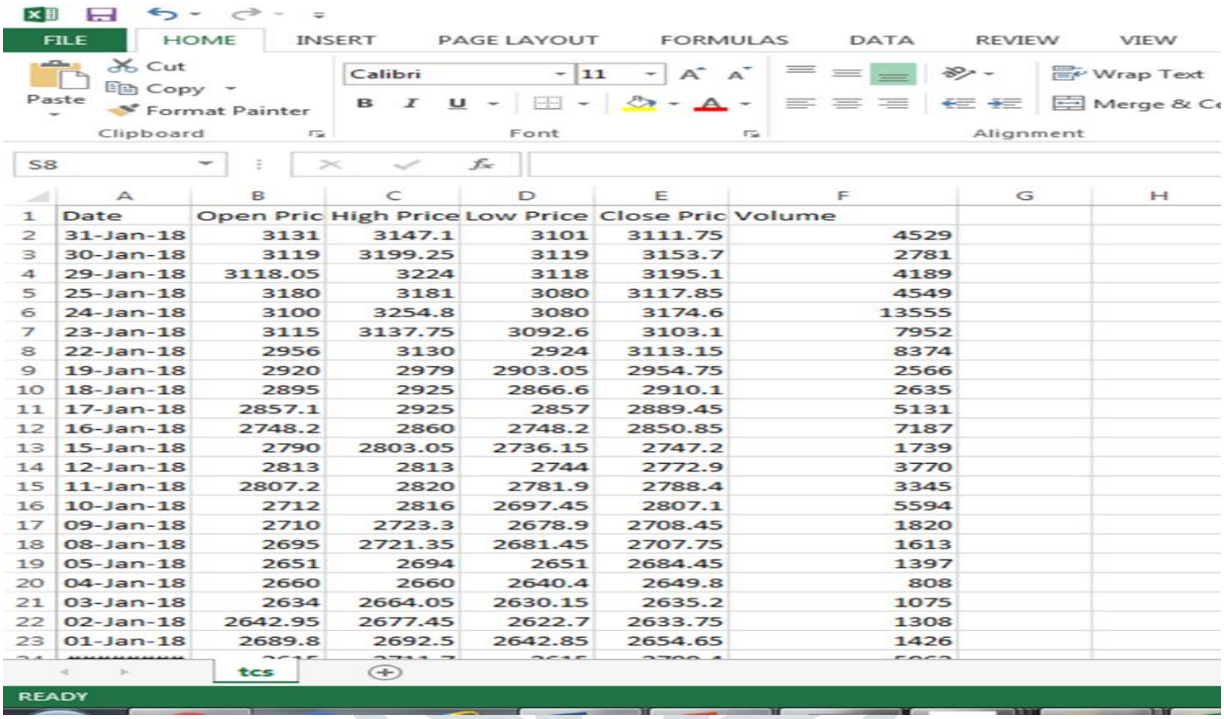
Step 3: prediction of given data.

Input: train model of RNN & LSTM model

Output: Prediction of future price for any given dataset.

IMPLEMENTATION

This section gives the abstract of the tool which I'm going to use for implementation of the previous chapter. For Implementation we have used the Python3.6 programming language along with Anaconda3 Cloud. Python has inbuilt libraries and packages which we can install directly with the use of command prompt. PyPI (Python Package Index) provides numbers of packages which is well-matched with almost many other programming languages. All the experiments are going to perform on Windows 7 Professional operating system running on Intel(R) Pentium(R) CPU B940 @ 2.00 GHz with 4 GB RAM.



	A	B	C	D	E	F
1	Date	Open Pric	High Price	Low Price	Close Pric	Volume
2	31-Jan-18	3131	3147.1	3101	3111.75	4529
3	30-Jan-18	3119	3199.25	3119	3153.7	2781
4	29-Jan-18	3118.05	3224	3118	3195.1	4189
5	25-Jan-18	3180	3181	3080	3117.85	4549
6	24-Jan-18	3100	3254.8	3080	3174.6	13555
7	23-Jan-18	3115	3137.75	3092.6	3103.1	7952
8	22-Jan-18	2956	3130	2924	3113.15	8374
9	19-Jan-18	2920	2979	2903.05	2954.75	2566
10	18-Jan-18	2895	2925	2866.6	2910.1	2635
11	17-Jan-18	2857.1	2925	2857	2889.45	5131
12	16-Jan-18	2748.2	2860	2748.2	2850.85	7187
13	15-Jan-18	2790	2803.05	2736.15	2747.2	1739
14	12-Jan-18	2813	2813	2744	2772.9	3770
15	11-Jan-18	2807.2	2820	2781.9	2788.4	3345
16	10-Jan-18	2712	2816	2697.45	2807.1	5594
17	09-Jan-18	2710	2723.3	2678.9	2708.45	1820
18	08-Jan-18	2695	2721.35	2681.45	2707.75	1613
19	05-Jan-18	2651	2694	2651	2684.45	1397
20	04-Jan-18	2660	2660	2640.4	2649.8	808
21	03-Jan-18	2634	2664.05	2630.15	2635.2	1075
22	02-Jan-18	2642.95	2677.45	2622.7	2633.75	1308
23	01-Jan-18	2689.8	2692.5	2642.85	2654.65	1426

***Fig. 4**:* Dataset

Figure 4 shows the database of TCS. It contains day wise data of this company which have 518 data. Database contains date, Opening price, High Price, Low Price, Close Price and no. of Trades (Volume). These are the main parameters which I had used in prediction.

Prediction Based on RNN algorithm for TCS

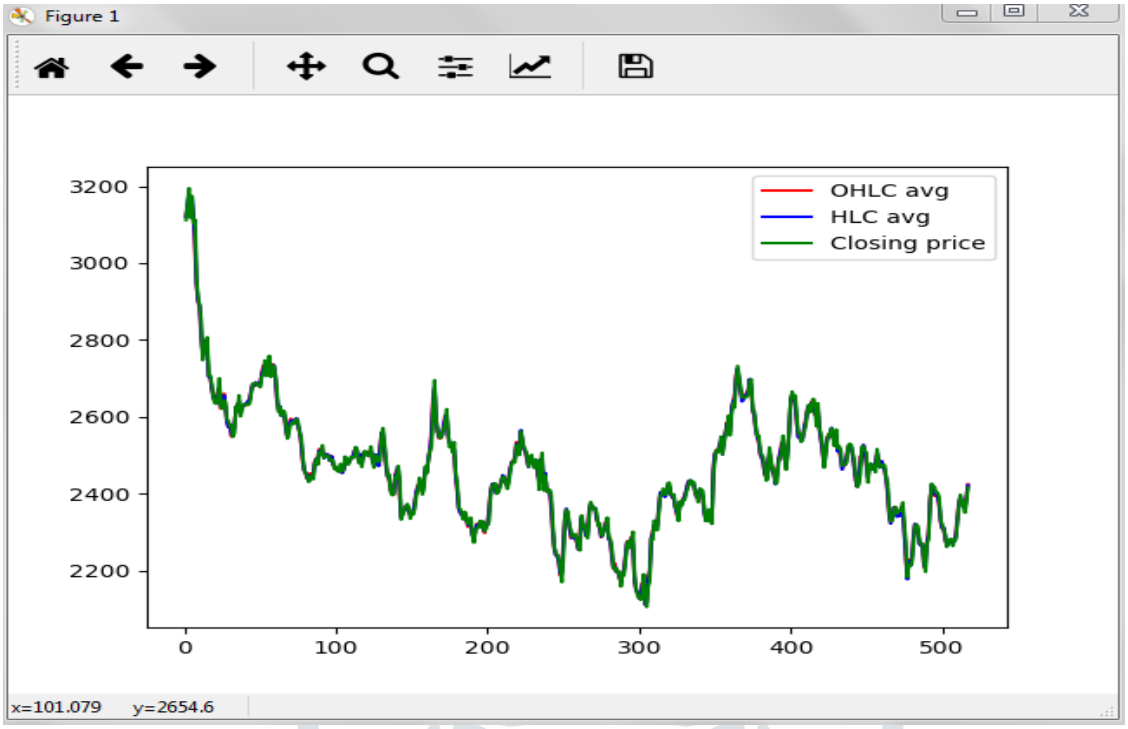


***Fig. 5**:* Average Graph of database

Figure 5 shows the average graph of TCS data. Where Red line shows the average value of open, high, low and close prices. Blue line indicates the average value of high, low and closing price. Green line indicates the average value of Closing price of TCS.

***Fig. 6**:* Predicted Output of RNN for TCS

Figure 6 shows the Predicted Output of RNN for TCS. Here it shows the accuracy of this algorithm which is 89%. And next day's predicted closing price for 5 days.

Comparison of RNN:

Table 1: Results of RNN

Days	Prediction of next day's closing price	Actual Closing Price
1	3049.85	3111.75
2	2848.77	3153.7
3	2934.06	3195.1
4	2683.15	3117.85
5	3086.26	3174.6

Prediction Based on LSTM algorithm for TCS

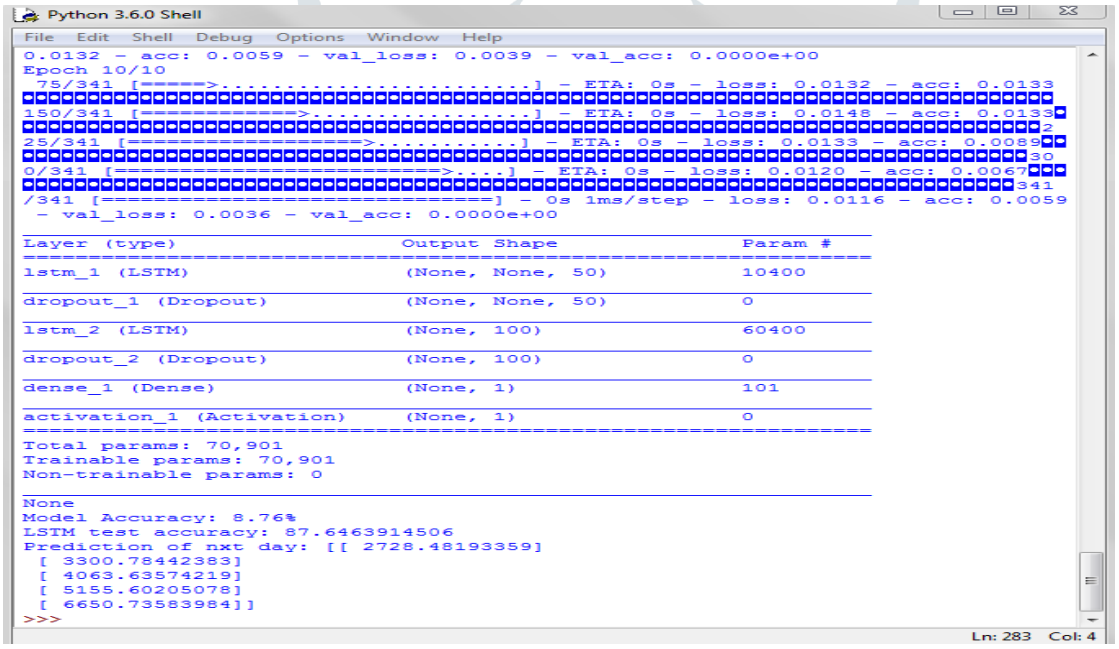


Fig. 7: Predicted Output of LSTM for TCS

Figure 7 shows the Predicted Output of TCS for LSTM algorithm. Here it shows the accuracy of this algorithm which is 87.64%. And next day's predicted closing price for 5 days.

Comparison of LSTM:

Table 2: Result of LSTM

Days	Prediction of next day's closing price	Actual Closing Price
1	2728.48	3111.75
2	3300.78	3153.7

3	4063.63	3195.1
4	5155.60	3117.85
5	6650.73	3174.6

Comparison of Algorithms:

Table 3: Comparison of LSTM and RNN

Days	Algorithm	Accuracy
1	RNN	89.16%
2	LSTM	87.6%

CONCLUSION AND FUTURE WORK

I had apply the LSTM and RNN algorithm in python3.6.0 version. Which give me the predicted value of closing price of next day and accuracy of the model. By the comparison of this two algorithm I can conclude that RNN is more accurate algorithm then LSTM because RNN have 89% of accuracy and LSTM have 87% accuracy.

Future Work Plan:

As part of the future of the stock market is infinite, and require their data analysis will be more and more. Only by changing the training data, the proposed system can be used for any stock market in other countries. There are a few altercations, the system can be used for various purposes, such as forecasting the price of commodities such as gold.

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