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Long-Short Term Memory Techniques based on predicting Stock Prices

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Abstract: ***Stock Market is a source of investment for nearly every person. People invest their complete earnings and savings to make easy money. They are not aware of the spontaneous nature of the market. This nature of the market can lead to people making huge profits or losing everything. This uncertainty in the market may lead to people losing faith while investing their money in stock market. In order to make people aware of the stock market's nature and providing them knowledge on how to invest, this paper proposes a model built on the concept of Long-Short Term Memory. It is a special type of recurrent neural network that can remember the important past sequences of time-series data. The model will predict the future stock prices and will provide a comparative report to determine the model's accuracy and for better analysis, while investing in stocks.***

Keywords: Stock Market, Stock Prices, Prediction, Machine Learning, Long-Short Term Memory, Recurrent Neural Network

1. Introduction

Stock Market has always been an attraction and a source of investment for nearly every individual in India. The stock market is a world of numbers, data, statistics, analyses, graphs, and emotions that is present inside another world, the Actual World. The Stock Market presents itself as a challenge attracting people, to tempt them to put their income, their money in stocks, either to win or lose. The biggest challenge posed by the Market in front of the investors is its volatility, its spontaneity. Market has its own shades of emotions that it expresses through its investors, the shades of excitement, joy, craftiness, remorse, and many more as it experienced. The prediction of stock prices is not an easy path to walk on or as we say "Not a piece of cake". The stock price prediction is based on many factors like the festivities, the sentimental aspect of investors towards particular stocks, holidays, any special message conveyed by the company to its investors over the weekend. A financial theory Monday Effect, prevails in the market which suggests that the stock market returns will follow the prevailing trends from the previous Friday, when it opens on the following Monday. There are quite some factors that rule the uncertainty in the market. The prediction of stock prices for the following trading periods becomes more important when it involves individuals investing their savings and incomes, from which they might gain big or lose everything.

There have been many proposed models for the prediction of stock prices; the one proposed in this paper is the LSTM (Long-Short Term Memory) Model for Stock Price Prediction. LSTM is a Recurrent Neural Network that is widely used for sequence prediction problems. It is able to store the past information that is important and forget the information that is not. It is an unsupervised machine learning method. Stating how this model will function, it will train and analyze on historical stock price data and predict the future stock prices. The research work will give us a comparative report among various stocks on the basis of their prices and helps the investor take decision based on the analytical proofs provided.

2. Related Works

Many organizations, statisticians and research people are exploring the stock market trends and are analyzing the future stock predictions. The idea for predicting the future stock prices has been motivated by Aparna Nayak et al.2. The stock price prediction took place by taking into consideration many factors like news, social media data and historical data. The paper aimed to build two models to predict stock prices, first model predicted price for the very next day and the second model predicted the price for the next month, both based on sentiment analysis from the social media and news data both integrated with historical data and trained under supervised machine learning algorithms. The paper that forms the basis for the research work and the concept has been referred from Adil Moghar et al.1. The paper has aimed to build a model using Recurrent Neural Networks (RNN) and Long-Short Term Memory (LSTM) to predict future stock prices. The main objective of the article lied in the theory that how much the epochs can improve the model and to what precision can the model predict the prices correctly. The paper Pramod B S et al.4 proposed the building of an LSTM model that would train on the historical stock price data, the paper considered several parameters namely open price, day high and day low, close price and many more. The model then preprocessed the data for a particular parameter that is the open price that will train the proposed model. The results were then visualized by plotting a comparative graph between the predicted price and the real price.

The paper Mehar Vijh et al.3 proposed predicting the future closing prices of the stocks by building two models, based on ANN (Artificial Neural Networks) and RF (Random Forest). The paper aimed at a comparative analysis between the Mean Root Squared Error, Mean Absolute Percentage Error and Mean Bias Error graphically. The ANN model was built of three layers namely the input layer, the hidden layer and

the output layer and trained on several parameters like Open Price, Close Price, Day High, Day Low, Total number of volume, total number of trades and many others.

In the paper P. S. Rao et al.5 the author aimed at explaining about stock market and its trends, while putting forth the two analyses or methods which are prevalent in the market and are used to predict stock prices which were namely Fundamental Analysis and Technical Analysis. It stated that the Fundamental Analysis used various parameters like p/e ratio, ROI, book value, earnings etc. It is considered suitable for long-term investment because of its systematic approach. While the paper stated that Technical Analysis made use of historical data and parameters like daily highs and lows, daily price fluctuations. It is said that rules from the data can be extracted, on which investors predict the future trends and make decisions. The paper proposed on various methods to predict future stock prices and present a comparative analysis of the proposed techniques. The methods proposed were Holt-Winters, Artificial Neural Networks, Hidden Markov Model, ARIMA Model, Recurrent Neural Networks and Time Series Linear Model.

In the paper Xuan Ji et al.6 described various stock prediction models and proposed a new model Doc2Vec-W-LSTM, Doc2Vec was adopted to train financial social media documents and to extract text feature vectors. The Stacked-Auto Encoder (SAE) was used to reduce the dimensionality of text feature vectors to reduce the imbalance between it and social media documents. Haar wavelet transform was used to avoid the impact of noise on stock price data and generate a denoised stock price time-series data. The text features and social media features were combined and used the LSTM model to predict the future stock prices. The paper finally compared the proposed model with other baseline models namely ARIMA, RNN and LSTM experimentally. The paper Zhaoxia Wang et al.7 aimed at comparing different training models to find the best one for predicting stock prices. The models were Bayesian regularization backpropagation, Levenberg Marquardt backpropagation, Conjugate gradient backpropagations with Powell-Beales restarts. The proposed model involved studying the sentimental scores and implementing the enhanced Neural network method. The paper took into consideration two scenarios which were firstly, the scenario in which only the stock price time-series data was used for the prediction without considering the influence of news articles sentiments and second, the scenario in which both the stock price time-series data as well as the news article sentiments were considered to study the prediction and the influence of news sentiments. The paper as a result observed that the neural network method trained with the Levenberg Marquardt backpropagation yielded the best results as compared to the other 3 training models.

3. Recurrent Neural Network (RNN) and Long-Short Term Memory (LSTM)

Neural networks are regarded as a set of algorithms that are inspired by the functioning of the human brain. Talking of humans, after opening our eyes what we see around is the data which is processed by the neurons of our brain to let us recognize whatever is around us. This is the principal, neurons work on, they take a large set of data, tend to process it and find any patterns from the data and give as output, what they receive or fetch as result. They are also called as Artificial Neural Networks (ANN) because they are not natural like neurons of the brain. They are composed of intricately connected processing elements called neurons that work in unison to solve specific problems [8].

The ANN comprise of three layers namely [2]:

1. Input Layer
2. Hidden Layer
3. Output Layer

Speaking of the Recurrent Neural Networks, the neural network got its name recurrent as it performs the same task for every element in the sequence. Since the output being depended on the previous computations, they have a “memory” which will capture the information of what has been calculated since the start of the first computation.

The most important reason that recurrent networks are highly preferred and used in computing problems is that they allow us to operate over a sequence of vectors. A recurrent neural network is of following types:

1. One-to-one
2. One-to-many
3. Many-to-one
4. Many-to-many

RNN is not capable enough to analyze the sequential time-series data. Thus, a special kind of RNN’s which is capable of storing past information for longer period of time is the LSTM. It is their default behavior to remember past information that is important, which prioritizes them over RNN. The LSTM, this paper describes is the stacked LSTM. By stacked LSTM, we indicate to the hidden layers present in the model. More the number of layers, higher will the accuracy of the model to analyze the time-series data. This paper presents a 3-layered LSTM model to predict the future stock prices. Describing about the LSTM architecture, every LSTM has 3 modules namely:

1. Forget gate
2. Input gate
3. Output gate.

4. Methodology and Data

4.1 Dataset

The historical data in this paper consists of the date, daily open price, the day high price, day low price, daily close price, number of shares and number of trades of five stocks in the Bombay Stock Exchange (BSE). The stocks include Tata Chemicals, Tata Steel, Cipla, L&T (Larsen & Toubro)

and Reliance Industries, extracted from the BSE itself. The historical data covers the period from 01/01/2016 to 07/10/2021. The dataset consists of 1428 rows of data. The feature or attribute chosen in this paper for prediction of the stock prices is the daily close price of the stocks.

4.2 Proposed methodology

The model used in this paper is based on LSTM RNN, the model will be analyzing the historical data for the prediction of stock prices. So, extracting of the data becomes a mandatory step in analysis. Afterwards the preprocessing of data and feature extraction will take the analysis a step further. The dataset has been divided into training and testing data with 70% of the data as training data covering a period from 01/01/2016 to 20/01/2020 and 30% of the data as testing data covering a period from 21/01/2020 to 07/10/2021. Fig.1 shows the workflow of our proposed model.

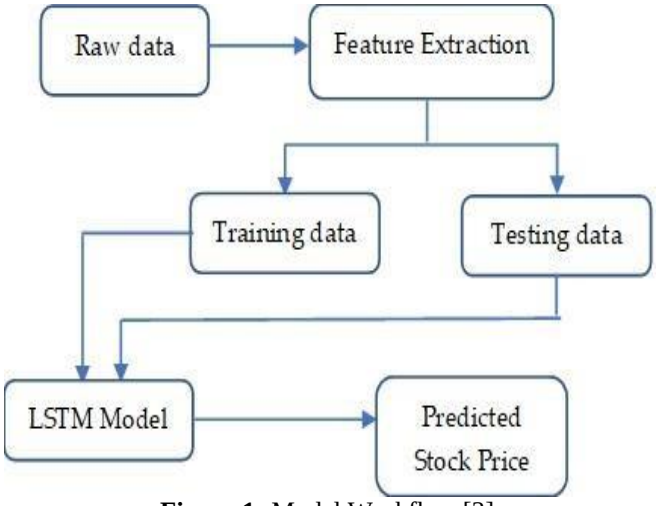


Figure 1: Model Workflow [3]

Table 1 shows us the algorithm followed by our model to predict the stock prices.

Table 1: Algorithm for stock price prediction [4]

Algorithm: Stock price prediction using Long-Short Term Memory model

Input: Historical data

Output: Prediction and visualization of stock price

Step 1: Extracting the historical dataset from the respective source (BSE).

Step 2: Data preprocessing and cleaning of data in case of any null values.

Step 3: Importing the dataset to the data structure and reading it for all the parameters.

Step 4: Extracting the features, Date and Close Price to be read and used for analysis and training our model.

Step 5: Performing normalization on the data to get values ranging between 0 and 1.

Step 6: Building the RNN model for the data and training it using the train dataset.

Step 7: Adding layers to the model for a greater accuracy.

Step 8: Testing the model with the test data.

Step 9: Getting the output and visualizing the predicted stock price, graphically.

Every step and method stated in Table 1 plays an important role to make the model function correctly and yield the desired results. The proposed model is built on the basis of stacked LSTM architecture. For training the model we used mean squared error and adam optimizer to optimize our model. We have used Epochs equal to 25 epochs for training data. By stacked LSTM we indicate to the number of hidden layers present in a particular model. Table 2 shows us the 3-Layered structure of our model.

Table 2: LSTM model structure

Layer (type)	Output Shape	Parameters
lstm (LSTM)	(None, 60, 150)	91200
lstm_1 (LSTM)	(None, 150)	180600
dense (Dense)	(None, 1)	151
Total number of parameters: 271, 951 Trainable parameters: 271, 951 Non-trainable parameters: 0		

5. Results and Observation

The implementation of our proposed model, which predicts the future price for the Tata Chemicals, based on the historical data. Fig.2 depicts the predicted stock price for Tata Chemicals; in a graphical form by applying 150 LSTM units in order to achieve accurate results.

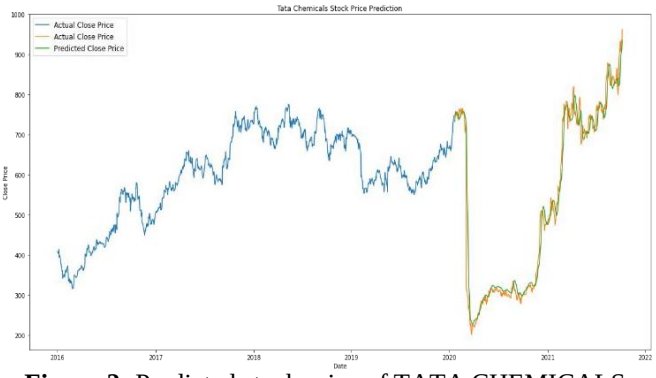


Figure 2: Predicted stock price of TATA CHEMICALS

Fig.2 represents the predicted stock close price (green) and the testing stock close price (orange) along with training stock close price (blue). The graph has been plotted for the complete dataset. It can be seen that the prediction varies slightly from the actual close price, which proves that our model is able to predict the close prices with a minimum loss rate for the given test data.

If we take the last element of the dataset according to the feature date that is 07/10/2021 we can see that the actual close price is 959 rupees (INR) while the predicted close price is 935 rupees (INR). It is proposed that if we increase the batch size and the epochs, our model will become much more efficient in predicting the stock price. The batch size taken for the dataset is 32. Fig.3 shows us the predicted stock price for all the stocks analyzed in this paper.

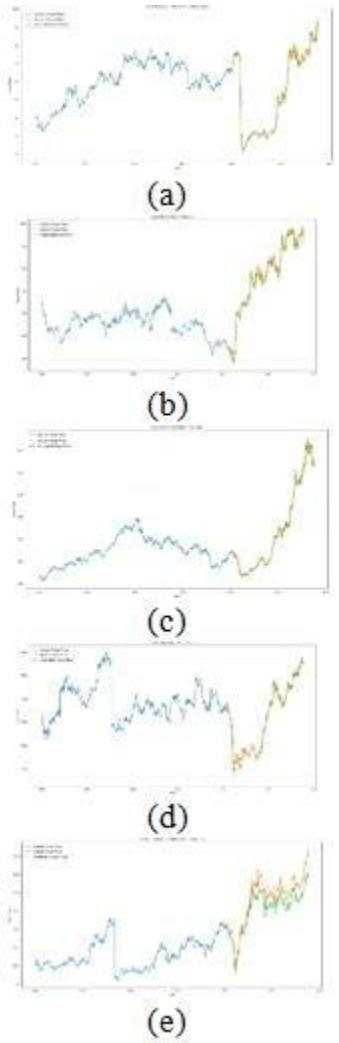
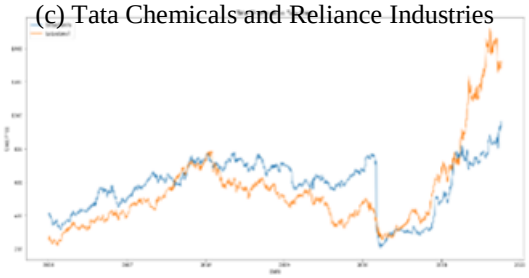


Figure 3: (Clockwise from top-left) Predicted stock price: (a) Tata Chemicals (b) Cipla (c) Tata Steel (d) L&T (e) Reliance Industries.

The paper further compares the given stocks with each other, to provide knowledge on aspects such as performance of stocks in the form of graphical representation. Fig.4 shows us the comparison between all the stocks stated in this paper.

(a) Tata Chemicals and Cipla

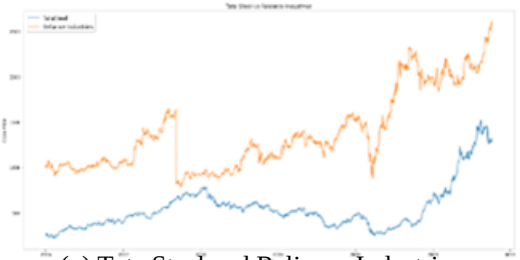
(c) Tata Chemicals and Reliance Industries



(d) Tata Chemicals and Tata Steel

(e) Tata Steel and Cipla

(f) Tata Steel and L&T

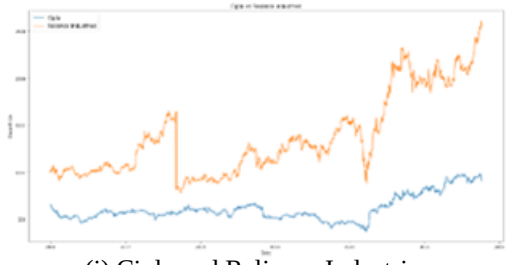


(g) Tata Steel and Reliance Industries

(h) L&T and Cipla

(b) Tata Chemicals and L&T

(i) L&T and Reliance Industries



(j) Cipla and Reliance Industries

Figure 4: (Blue and Orange) Comparison between all the stocks on the basis of actual close price.

The comparative report, will tell us about how accurately did our proposed model predicted the future stock prices of all stocks. Table 3 shows a comparative report for the test data with 428 rows, that states the mean actual close price and the mean predicted close price of the stocks.

Table 3: Comparative report consisting of actual close price mean and predicted close price mean

Stocks	Actual close price (Mean) (In Rupees)	Predicted close price (Mean) (In Rupees)
Tata Chemicals	531.29	532.60
Cipla	755.33	751.53
L&T	1225.80	1241.62
Tata Steel	684.34	675.78
Reliance Industries	1913.58	1782.61

6. Conclusion and Future Scope

People invest in stock market to make money easily. But they are unaware of its security, which might result in people losing all the money invested. Thus, the requirement of a model that predicts the future stock prices, increases as it will make the investors aware of the stock's performance in future by gaining knowledge about how a particular stock has performed in the past. This paper proposed a model built on the concept of LSTM that accurately predicted the close price of the provided stocks. It is very evident from Table 3 how exceptionally all the stocks have performed at the day's end, the time when an investor decides to hold or sell the stock the next trading period. Talking of the improvements that this model can accept is increasing its accuracy by introducing a greater number of layers to it, by increasing the epoch size and by increasing the batch size for a larger dataset. This study can be carried on several other stocks in the present as well as in the future.

Stating the future scope and enhancement of this research work is we can include sentimental analysis data as well, since the social media, news articles convey the emotions of investors towards the stock market and its stocks. The sentimental analysis will help the investors know about how the stock will perform in future based on the emotions expressed by the people towards the particular stock in the present day. Moreover, we can add many aspects of the stock market as well, which are namely issuing of bonus shares by the companies holding the stocks, popularity of a stock, financial theories like the Monday Effect and many more which will enhance scalability as well as the accuracy of the proposed model.

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