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Nifty Fifty Stock Index Value Forecasting using Deep Learning

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Abstract: *In this project a forecasting system is presented which can predict the change in stock market value of Nifty Fifty index using the historical data of various factors influencing the stock value. Traditional stock market prediction models only factor in the trends of the historical data of the targeted stock value which is then fed to a time series algorithm to get a forecast. Since the real-world stock market is constantly being influenced by various factors, it is not possible to take all those factors into account and make the forecast, let alone using the target stock by itself. So, the objective of this project is to analyze and use the trends in the factors that majorly influence Nifty Fifty index like international stock indices and commodities that affect the economy and the stock market into consideration and use a deep learning model, Long Short-Term Memory (LSTM) which is based on Recurrent Neural Networks (RNN) which has the architecture that can retain the past information and use it in the prediction along with the observations at the current time step. This will allow the predictions to be more accurate and make it possible to make a better decision when investing in the Nifty Fifty index.*

Keywords: Deep Learning, Long Short-Term Memory, Recurrent Neural Network, Stock Price Prediction.

I. INTRODUCTION

In the past few years, with the progression of national economy and enhancement of economic services, the financial market has lured the eye of DII, FII and retail investors. Nifty is managed and owned by India Index Services and Products (IISL), which is a wholly owned subsidiary of the NSE Strategic Investment Corporation Limited. Over the years, preparing models and forecasting for financial time series has been possible because of data mining, machine learning and deep learning algorithms. However, because the market is
influenced by the various external factors such as national policies, worldwide and territorial economics, moreover as human sentiments and different factors, the money market predictions tend to be unsuccessful to attain the specified outcomes on a regular basis [1].Predicting the stock market is thought to be a difficult process in the financial market time series forecasting, because the stock market or stock exchange is basically dynamic, nonlinear, complex, nonparametric, and chaotic in nature [2]. Moreover, stock market is littered with several macro-economic factors like RBI decisions, political events, company policies, conditions of economy, expectations of investors, institutional investors' choices, movement of global stock market exchanges, and psychology of investors etc. [3][4].

In literature, there are different varieties of input vectors considered for stock market prediction. Varied input variables have been used for predicting the same dataset on stock market. Researchers over time have focused on inputs from time series as well as heterogeneous market data and macroeconomics variables. Extensive research has been done to make models based on intelligent soft computing techniques made stock market prediction. Over the years, preparing models and forecasting for financial time series has been possible because of data mining, machine learning and deep learning algorithms. Although these techniques play an important role in prediction of time series data, many research work illustrated that Data mining and machine learning techniques have displayed numerous problems due to learning the hidden patterns, tremendous noise, characteristics that are non-stationary and complex dimensionality of data. Therefore, forecasting stock prices becomes difficult [5][6][7].

Support Vector Machine (SVM) is a good alternative bet for forecasting financial time series data. Other variables might affect the ability to alter the prediction performance of such models, like the selection of optimum parameters that still remains a topic of interest for researchers [8].A feed forward neural network that can represent a nonlinear

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relationship made it possible to differentiate between ARIMA and forecasting model of a neural network. A 27 percent and 56 percent lower mean squared error was accomplished by neural network models than ARIMA model. Results proved that the ARIMA model, which was used as a benchmark, was not as accurate as the neural network forecasts.[9]
A stock trading system is proposed for making buy-sell decisions by utilizing genetic algorithms. This model is created using big data platform of Apache Spark. The improved parameters are then sent to a profound MLP neural system for making a buy-sell- hold prediction. Dow 30 stocks are taken into consideration for the sake of model approval. The outcomes demonstrate that streamlining the specialized pointer parameters improves the stock exchanging execution as well as gives a model that may be utilized as a choice to Buy and Hold and other standard specialized examination models [10].
The neural networks have been utilized by analysts in different zones for as long as ten years. Forecast and examination of stock market data have a vital job in the present economy. The different calculations utilized for forecasting can be sorted into linear and non-linear models. The kinds of profound learning models like Recurrent Neural Networks (RNN), Long Short- Term Memory (LSTM), and Convolutional Neural Network (CNN) are used for predicting the prices of a stock market. The stock markets, such as National Stock Exchange (NSE) of India and New York Stock Exchange (NYSE) are considered for forecasting. From the results CNN displays better results than the other models. The network could anticipate for NYSE despite the fact that it was prepared with NSE data. This was conceivable in light of the fact that both the stock markets share some regular internal elements [11].
An optimized ANN or artificial neural network model is used to forecast the value of the Japanese stock market index by applying two types of technical indicators and used genetic algorithms (GA) to modify the trend or accuracy of the stock market index in the upcoming future [12]. A machine learning model such as ANN, SVMs with varied kernels, such as RBF and polynomial, are used for the sake of making predictions on the market trend for KOSPI 200 index and by using machine learning methods. The study projects the instability and variability of market forecasts [13].
The process of making efficient stock trading models and attracting investors by a novel bird model decision support system has been proposed in this work. This model has combined the analysis part with machine learning and deep learning models for effective prediction of stock market decisions. In this paper, the authors displayed the utilization of deep learning strategies together with financial related
examination in trading frameworks headway. The model determines the complex LSTM model based on Recurrent Neural Network. The data has been processed using dropout regularization and compiled with “Adam” and “RMSprop” optimizer and using loss function as mean squared error. By applying optimization algorithms like genetic algorithm, harmony search with the indicators of technical analysis may be considered for improving this model.

II. METHODLOGY

A. Dataset

In our work Historical Dataset is used for training and testing and this has taken from Yahoo finance for the INFOSYS Ltd IT sector stock and NSE NIFTY50 index.
For Training the dataset we used historical data of INFOSYS Ltd from NSE IT sector and NSE NIFTY 50 from Yahoo finance. The training dataset for the INFOSYS Ltd and NIFTY50 is from the period of 11 DEC 2007 TO 2017 DEC 11 and it contains the historical data set such as Date, Open, High, Low, Close. While training the data, the data has been separated into training and test set, so the training data has no acquaintance that test set exists during its training, but once the training is done, the test has been introduced to the RNN, so that it can make prediction for the future stock price.
For feature scaling, the normalization has been applied, so that if there is a sigmoid function as the activation function in the output layer, it can be well accustomed. Therefore, to apply the normalization function:

$$x_{norm} = \frac{x - min(x)}{max(x) - min(x)} \quad (1)$$

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To apply the normalization function, Min-MaxScaler class has been used to import from sklearn library. Now for creating a data structure for different time steps, for example- 60 times Steps, RNN is going to look at 60 stock prices before time t and based on the correlations and trends it is capturing, it will try to predict the next output i.e., the stock price at time t+1. By doing that we are appending the 60 previous stock prices for the current time t.

So in the scope of this Financial Engineering problem, where we try to predict the trends of stock prices, predictors are the indicators, for now we have one indicator that is open Infosys Ltd. Stock price and we take 60 stock prices to predict the next one, that's the only indicator but to predict better results we need to add more indicators to predict the upward and downward trend of the stock market that is by using the reshape function which uses input shape which is the exact function expected by RNN in Keras, it contains the input in the form of 3D array which contains batch size, time steps and third one is corresponding to the indicators, i.e. the predictors.

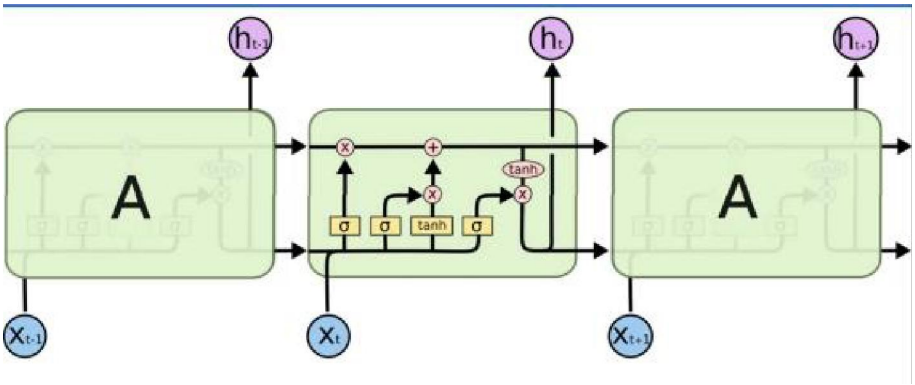

Fig.1 LSTM's Architecture

The Long Short-Term Memory or LSTMs overcome the problem of Vanishing Gradient Descent because in Gradient Descent as we propagate the error through the network, it has to go through unravelled temporal loop and as it does that it Goes through the layers of neurons and are connected to themselves. In LSTM architecture, the memory line is at the top and the lower line represents the output i.e.,ht and xt-1 represents the previous block whereas Xt+1, represents the next block and similarly Xt represents the input.

It is noticeable that output is coming from previous block is also impacting the result. It takes three inputs and has two outputs and all the values are vectors i.e., all the variables contain multiple values rather than the singular value.

The point wise-operation are controlled by layered operations sigma or sigmoid function and based on the output or decision of that, the valves is either closed or open. If it's open the memory flows through it freely. And as the decisions are made, the value which is another layer operation is either added to the memory or not added, so depending on the value that is decided in the point wise-operation. As point wise- operation contains the value either zero or one, the last point wise-operation is the output valve where it decides what part of the memory pipeline is going to be the output. Though there are many variations in the LSTM's architecture, the basic functionalities are same.

For testing, we chose data from NSE NIFTY 50 from Yahoo finance. Here, in the testing dataset we have extracted the daily opening and closing price of every stock and to predict the stock rate for the following year using different time steps and different number of LSTM, the result has been determined. Test datasets were considered from the period of 12 DEC 2017 TO 2018 DEC

12. The epoch size of input stock data was found that it performed error calculation for different epoch size that is the most accurate value that has been observed was using the epoch size of 100.

Mean Absolute Deviation

It is used to measure variability in dataset. The mean absolute deviation is the mean distance between each data point and mean. By calculating how far away the data points are from the mean helps us get the absolute deviation values.

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$$MAD = \frac{\sum_{t=1}^{n} |A_t - F_t|}{n} \quad (2)$$

Mean Squared Error

We measure the squares of the loss or error incurred. It is basically the square of the difference between the actual value and the forecasted value.

$$MSE = \frac{\sum_{t=1}^{n} (A_t - F_t)^2}{n} \quad (3)$$

Mean Absolute Percentage Error

When the loss or error has to be estimated in percentage terms then we use Mean absolute percentage error. It is evaluated is an unsigned percentage error that helps us assess the forecast accuracy.

$$MAPE = \frac{\sum_{t=1}^{n} (A_t - F_t)/A_t}{n} \times 100 \quad (4)$$

B. Deep Learning

When there is humongous amount of data there might be issues with predicting data with simple machine learning models, this is deep learning comes to the rescue. However, it might be a question for a lot of data enthusiasts as to when to we consider data as being big enough. Over a million samples is big enough. However, to test a model one may not require huge set of data and some of the applications of deep learning involve speech recognition, image classification, natural language processing and many more. Ultimately, Deep learning is a part of Machine learning. Deep learning is a subset of machine learning and can use models used in it.

However, with improved accuracies Recurrent Neural Network is a deep architecture of neural networks that learns from sequences, while dealing with sequential data we require a model known as Recurrent Neural Network. The same way as in the CNN processes its grid of values x such as an image,Recurrent Neural Network (RNN) is a neural network that is specialized for processing values x(1) … x(n) .The RNN can process any sequence irrespective of the length .

RNN computation is done in the following three steps:

1) Transformation from input to the hidden state
2) Transformation from the first hidden state to the next hidden state
3) Transformation from the last hidden state to the output state

III. RESULT

A. Figures and Tables

Table-1 depicts the RMSE values obtained after generating the model for Infosys Ltd dataset. The model gives the result for 100 epochs and the results have been given in the figures for NIFTY 50 and Infosys Ltd. which explains the detailed analysis for the data.

TABLE-1 RMSE ERRORS

Method	*Optimizer*	*Time Steps*	*Loss*	*LSTMs*
RNN	Adam	60	0.0014	1

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	RMSprop	60	5.4315e-04	1
			7.2510e-04	4
		20	5.3320e-0.4	1
			6.7978e-04	4

It can be inferred that the best results have been obtained through the use of RMSprop optimizer for 60-time steps and 1 LSTM layer through sensitivity analysis. It gives the minimum loss and influences the output variable obtained. Similarly, the result has been produced for RMSprop optimizer with different time steps and LSTM's values.

Fig. 2, corresponds to graphical output for real vs Predicted Stock price for NIFTY 50, for training and testing data. It displays that the results are not superimposed but provides effectively good results. Here the red line presents the Real Nifty 50 Stock Price whereas the blue line displays the predicted stock price for it. It can be inferred that the the structure used for plotting the network is optimal.

Fig. 3, corresponds to graphical output for real vs Predicted Stock price for Infosys Ltd. The graphs display the results using 60-time steps and 1 LSTM using Adam Optimizer. The error rate given for this structure provides better results from NIFTY50.

Fig. 4, corresponds to graphical output for real vs Predicted Stock price for Infosys Ltd. The graphs display the results using 60-time steps and RmsProp Optimizer where the error rate given for this structure provides superimposed results. After performing senstivity analysis which provides the result whether an input factor influences the output variable, it has been analysed that Fig4 displays the best output result.

Fig5, Fig6, Fig7 provides the graphical result for Infosys Ltd. performed for different time steps and LSTM's. The results have been displayed using real and predicted curves for the stock price in red and blue color for Real and Predicted values respectively. The performance of the RNN algorithm was found to be optimal to predict the results for the Infosys and Nifty 50 stock market results.
After evaluating the Infosys Ltd. and Nifty 50 Dataset, the best accuracy obtained was 0.9764 that counts to 97.64% for Infosys Ltd. using RmsProp Optimizer and 60 time steps. The Mean Square Error value for the same is 0.4761 and the Root Mean Square Value is 0.69 for the training set, whereas Mean Square Error value for the test set is 0.5625 and Root Mean Square Value is 0.74

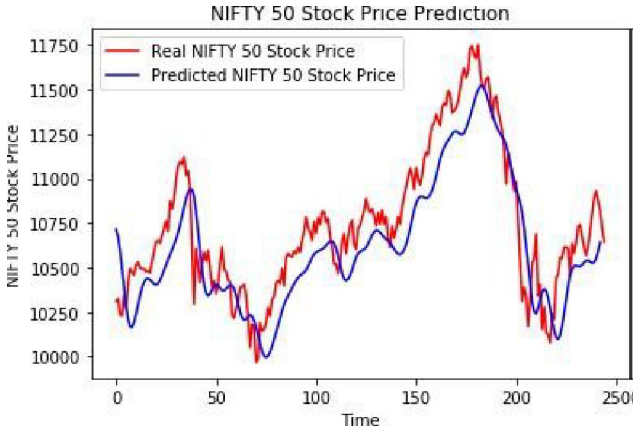

Fig2. Graphical results for Real vs. Predicted Output for NIFTY 50

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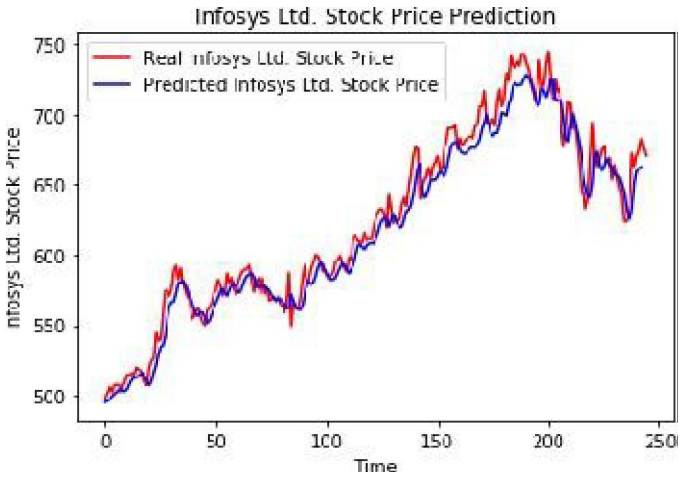

Fig3. Graphical results for Real vs. Predicted Output for Infosys Ltd

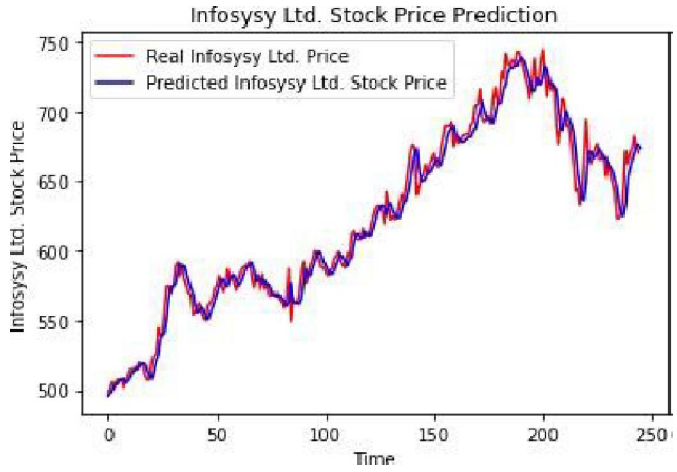

Fig4. Graphical results for Real vs. Predicted Output for Infosys Ltd for 60-time steps

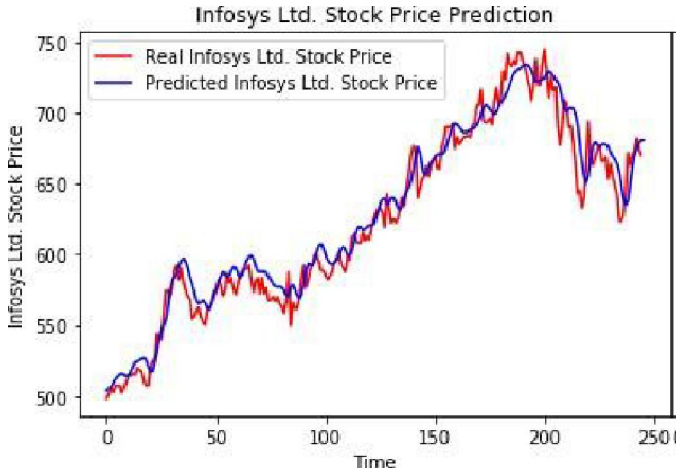

Fig5. Graphical results for Real vs. Predicted Output for Infosys Ltd for 60-time steps and 4LSTM

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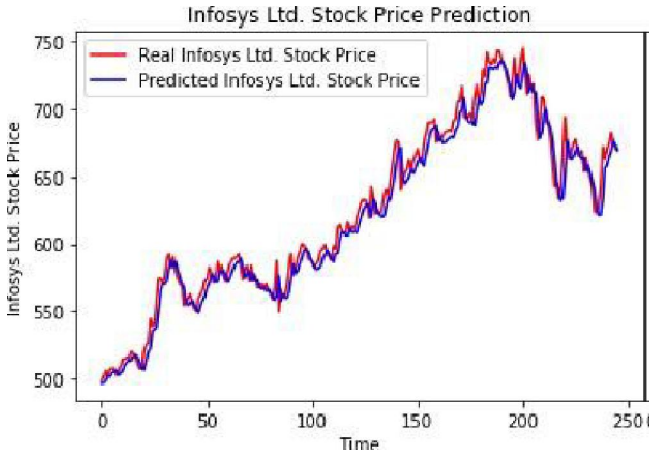

Fig6. Graphical results for Real vs. Predicted Output for Infosys Ltd for 20-time steps and 1LSTM

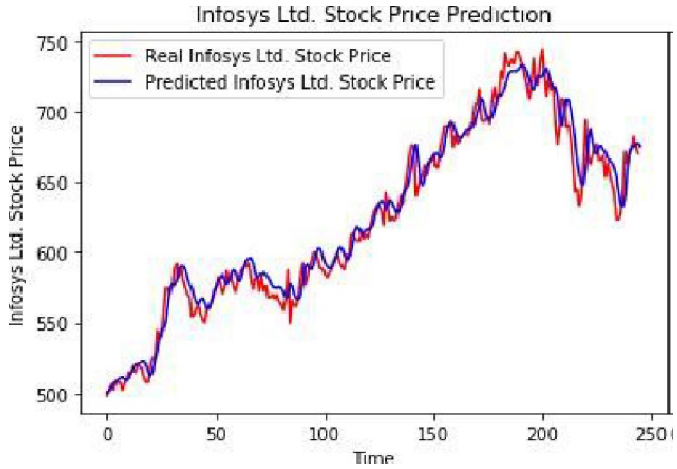

Fig7. Graphical results for Real vs. Predicted Output for Infosys Ltd for 20-time steps and 4LSTM's

IV. CONCLUSIONS AND FUTURE ENHANCEMENT

In this work deep learning method for the stock price and NIFTY50 index forecasting has been performed. Here we trained deep learning – Recurrent Neural Network (RNN) model to forecast M&M from NSE Indian stock exchange and also for predicting the NIFTY50 index. The best accuracy obtained for Infosys Ltd. dataset using 60-time steps and RMSprop as the optimizer was 97.64%. From the results obtained, it is clear evident that the deep learning models are capable of forecasting the NSE stock market. Optimum results were obtained for datasets with small values but failed to provide results for datasets having large values. This work can be extended by identifying new methods and utilizing a hybrid model which merges different techniques to make a model for more accurate prediction.

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