STOCK PRICE PREDICTION USING DEEP NEURAL NETWORKS

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Abstract—The research hotspot in the academic circles and the financial world to work out how financial activities are patterned and to predict their developments and changes. The stock market attracts millions of investors on a daily basis. It is extremely challenging to predict financial data development trends due to their incomplete, complex and fuzzy nature. An effective stock price prediction model can assist managers, investors, and decision makers in making appropriate and effective decisions. There are a number of constantly changing factors that affect financial data fluctuations. Forecasting and analyzing financial data are therefore nonlinear and time-dependent problems. Deep neural networks (DNN) is better choice for solving nonlinear problems than traditional machine learning (ML) algorithms. In this research paper, a DNN-based model on top of long- and short-term memory networks (LSTM) predict stock price with high degree of efficiency. In addition, we propose to do a comparative analysis of the proposed model with the state-of- the-art methods.

Keywords—Deep Neural Networks, Long- and Short-term Memory, Machine Learning

I.INTRODUCTION

Investments in the stocks have the advantage of fulfilling various investment desires and needs, expanding investment options, expanding investment channels and enabling investors to obtain income corresponding to their investment goals. Stocks also offer some flexibility and liquidity to investors [1]. Stocks possess three major characteristics: (1) Non-returnability: once sold, a stock may not be returned to the company or refunded. Instead, it can only be sold to a third party through the secondary market. (2) Unpredictable: in order to earn a profit or lose a loss on the stock market, investors must take greater risks (3) Speculative: It is risky to speculate on the stock market because its price fluctuates frequently. There are high risks associated with stock markets because prices are inherently unstable and speculative [2- 4]. In the recent years, number of financial activities has grown rapidly with rapid economic development. Research in academic and financial circles is focused on understanding financial patterns and predicting their development. A method or set of methods that provide an approximate prediction of financial data can be used to analyze the development and changes of the financial market at the macro level and allows investors to make trading decisions and plan trades at the microscopic level, they can maximize profits. Because it is extremely difficult to predict the development trend of financial data due to their incomplete, ambiguous, and complex nature. Using historical stock trading data, news, and investor sentiment, more researchers working on stock trend prediction system that allows investors to reduce or avoid risky investments by recommending stocks and predicting market trends. Both ML and DL techniques are used in health-care, financial, defence sectors and etc, [5-7].There are a number of ML algorithms that have been employed with good results in stock price forecasting, such as logistic regression, genetic algorithms, and support vector machines [8-9]. Researchers have begun to take DNN into account in order to portray stock prices and predict stock movement patterns as a result of the rise of neural network (NN) algorithm. Stock trend prediction has received numerous improvements over the years in terms of algorithms and optimizations, all of which have been successfully utilized in practice [10-12]. The use of NN is to predict time series, that has been widely used in the analysis of inaccurate and noisy data. With the newly emerging DL algorithms, large volumes of nonlinear data can be trained to create DNN with many hidden layers capable of capturing abstract nonlinear relationships. In this research paper, we propose LSTM based DNN model for the stock prices prediction. LSTM based Recurrent Neural Networks (RNN) models are effective and expandable when used to solve various problems dealing with series data [13]. In the areas of handwriting recognition, concise natural language translation, and audio frequency analysis, these models have achieved exceptional results and are applicable in general use. Additionally, a DNN based models also developed, and the trained prediction model is

uploaded to the stock prediction module. After development and testing, the whole stock trend prediction system is completed by analyzing the requirements of the system and developing each of its functional modules. With the help of this system, investors can make stock selections and investments.

II. RELATED WORKS

In normalization, features are rescaled in the range from 0 to 1, which is a form of min-max scaling. In order to normalize the data, the features can be scaled using the min-max method. Min-max scaler is better normalization technique for time- series applications. The use of normalization is necessary when the data must be within bounded intervals [14]. Divide the maximum value encountered by the range between the maximum and minimum or subtract the minimum value and divide the range by the maximum and minimum.

LSTM is an application of RNN techniques to get prediction of stock price of a company. A company's historical data is analyzed using the LSTM based approach, which applies prediction on a specific attribute. In addition to Opening price, day high, day low, prior day's price, close price, and date of trading, shares also exhibit Previous Day's Price. To predict a share price over a specified period of time, it explains the time series analysis [15]. The modern society's economic operations are largely determined by the stock market. The analysis of stock price can be performed based on data obtained from a legitimate source [16]. The said methodology, makes it possible for multiple sources to be utilized when evaluating the stock value. Based on historical data, a lot of analysis is required of the stock market's volatile nature. Historical time series stock data is used in traditional stock trend forecast algorithms, and statistical data analysis is used in traditional technical forecasting procedures. Additionally, it has implemented, how AI and ML continue to advance in the field of predicting stock prices. There is no universal formula which can be applied to all cases, hence historic data for predicting stock prices should be taken into account [17].

A significant problem with basic ANN for stock forecasting is the phenomenon of explosive flashover, in which the loads of a hugely large system become either extremely large (either too massive) or too minimum (either), drastically easing their union back to the ideal level of value. There are two principal causes regarding this: loads are established self-assuredly, while the loads progress towards the end of the system and in addition gradually change into considerably more than those at the beginning [18]. LSTM supports the introduction of a memory cell in the secret layer; a device that replaces conventional artificial neurons. By utilizing these memory cells, networks can effectively link memory and remote input over time, enabling it to capture dynamic data structures with a high predictive limit which shows how stock predictions can be made with the NIFTY50 shares [19].

Fundamental Analysis focuses on interest rates, various ratios of prices (such as the price to earnings ratio), economic parameters, while Technical Analysis focuses on past prices, historical data, volume traded over a particular period and various moving averages. A sliding-window approach train the NN model based on the values of Open, High, Low, and Close prices[20]. Stocks meet different investment desires and investment needs, expand the range of investment options, expand investment channels, to some extent meet the possi- bility of investors to obtain the corresponding income, and to some extent enhance the flexibility and liquidity of capital. By using motifs (frequent patterns) in sequence reconstruction, a new method eliminates the noise of financial time series, and then used convolutional neural networks (CNN) to extract the spatial structure. Compared to the traditional signal processing approaches and the frequency trading approach with DL in stock trend prediction, it shows high efficiency in feature learning and out-performance with 4% to 7% improvement in accuracy [21].

III. PROPOSED MODEL

Figure 1 shows the block Diagram of stock price prediction using LSTM-DNN method, that works well for prediction. To predict stock market values, we use APPLE's dataset. The APPLE's stock price had examined in this research paper using the 41 years (1980 to 2021) of data. The dataset has parameters like High, low, open, close, volume. It is given to data pre- processing, LSTM-DNN model for prediction.

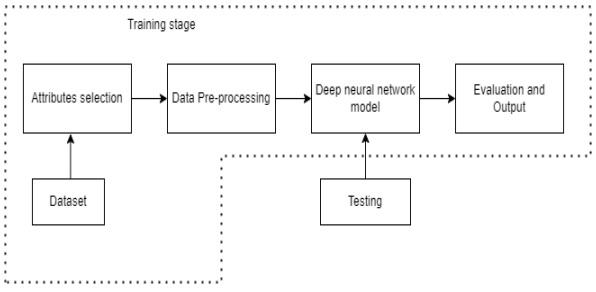
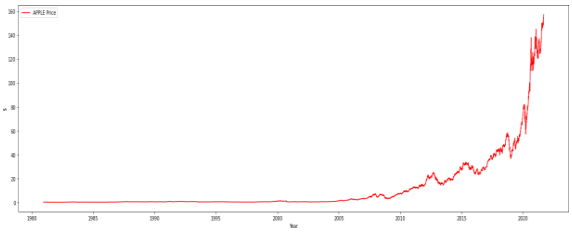


Figure 1: Block diagram of proposed model

A. Data Pre-processing

The normalization of the data is important to



facilitate the convergence of the algorithm. Here we can see what the maximum and minimum values of the data are, and how we can normalize them based on those values. In the preparation for the model, the min-max normalizer are used to re-scale the data in the range from 0 to 1. Because some features may have a greater impact than others, scaling may be necessary to improve prediction performance. For instance, The high, low, open, close and volume feature values in the data set are used. The volume feature has a value between 0 and Millions. High and low are expressed in decimals. The DNN algorithm tries and finds optimized values to handle large value and it results poor performance. In order to enable the DL algorithms to behave better, the value of features must be transformed in a similar range as all other features.

B. Deep Neural Network Model

RNN produce explicit time models through their self- connection between hidden layers and improve their nodes to store long-term information. In terms of natural language processing and audio frequency analysis, RNN have shown positive results. Traditional RNN contain hidden layers that are connected between the nodes. These traditional models are able to memorize because of these recurrent feedback links. Consequently, it can train a model for time-varying information. Depending on the timeliness of data transfer, the model depth will be determined. The problem with earlier RNN is that, they cannot handle large time span of information and can cause vanishing gradients for large time span models.

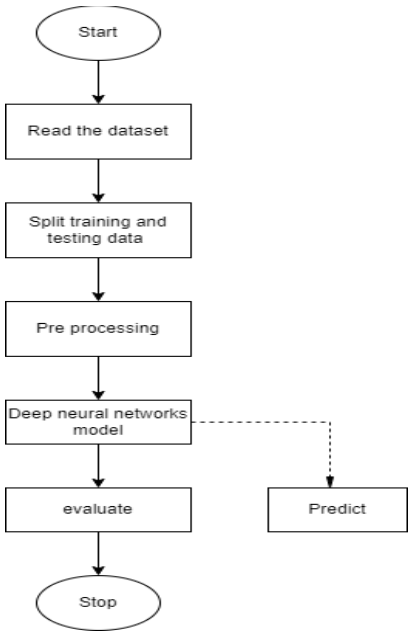
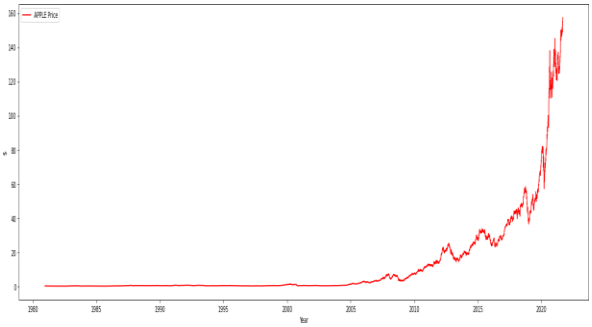


Figure 2: Flowchart of proposed model

In RNN, LSTM are used to prevent the output of a NN from either decaying or exploding as it goes through feedback loops. RNN are better at recognizing patterns due to feedback loops. LSTM alleviate a phenomenon known as vanishing gradients, provide better performance and reduce the requirement of past input memory for solving sequence learning tasks. The Figure 2 illustrates flow chart of the proposed methodology.

IV. IMPLEMENTATION

The APPLE dataset features are considered for data process- ing except Adj-close feature and the



remaining features are feed into pre-processing techniques. We use Date, open, high, low, close, volume parameters to train a model. The Figure 3 illustrates historical price of the APPLE stock. The entire dataset is split into training data and testing data in the ratio of 80:20. Our total data set consists of 10272 rows in which we are using 80% i.e., 8217

rows of our dataset as traing set and remaining 20% i.e., 2055 rows as testing set. By using time window parameter we combine data of 60 days. We are using 60 days price for predicting the next day price. Then we predict the data for next 30 days using the proposed model. The model has implemented with Keras library and google's colab notebook. Table 1 shows the layer structure of proposed LSTM model.

Fig. 3. Dataset

TABLE I LSTM-DNN LAYER STRUCTURE

Layer	Output Shape
lstm(LSTM)	(None, 60, 50)
dropout (Dropout)	(None, 60, 50)
lstm 1(LSTM)	(None, 60, 30)
dropout 1 (Dropout)	(None, 60, 30)
lstm 2(LSTM)	(None, 60, 10)
dropout 2 (Dropout)	(None, 60, 10)
lstm 3(LSTM)	(None, 1)

Our aim is to predict the stock price from the trained model with the greatest reliability. The selected data set has divided into training and testing sets. We have used the same model for validating the data set. In ML, it is often necessary to monitor the training progress of networks. By plotting different metrics during a training session, to visualize the training process. A number of indicators can be used to measure loss, such as how fast the network improves and whether it has over-fit model. Look at the results after the training has been completed to see whether the final validation was accurate and why the training was terminated.

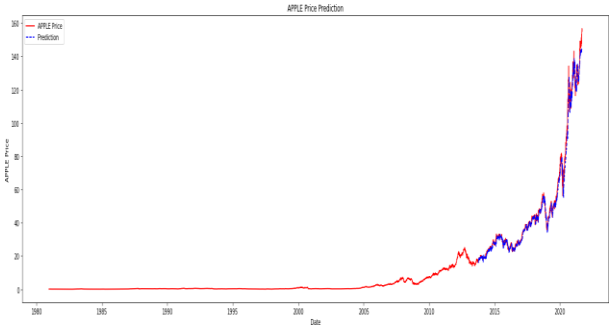


Fig4. Loss during training stage

A network contains batch normalization often uses different verification metrics during validation as well as training. The training stage has stopped after 50 epochs and it has two different batch sizes for training 64 and 128.

V. RESULTS AND DISCUSSION

LSTM model based on historical data is implemented using Python to predict future share prices based on historical data. In this illustration, we visualize the prediction of the APPLE dataset. A computational algorithm is presented in our paper for predicting the stock price of APPLE for a given time period. The Figure 4 depicts loss during training stage based on proposed methodology. It is based on 128 LSTM units applied to our algorithm to achieve efficiency.

The Figure 5 shows the prediction for a period of 2055 days with very minimal loss. We noticed a slight difference between the predicted price (blue) and actual price (red) between the graph plotted with the algorithm, which indicates that the algorithm was able to predict the price successfully with a loss rate of 0.0002. We have shown that the proposed algorithm is very accurate at predicting share prices with very low loss and error rates, and that training will be more efficient with larger batch sizes. The Figure 6 illustrates the result, which is drawn from the original dataset, and compares it with the trained model created by the algorithm and price of next 30 days. It shows the data for a period of 10302 days.

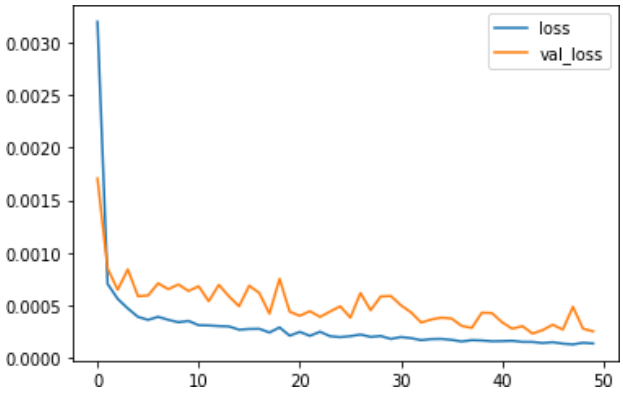


Fig. 5. Prediction of 20% data

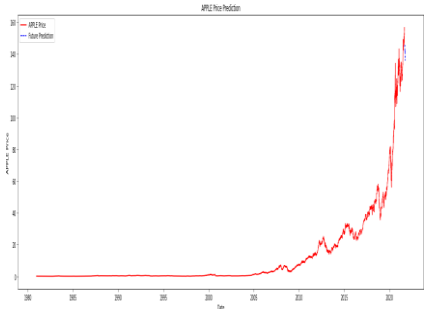


Fig. 6. Prediction for next 30 days

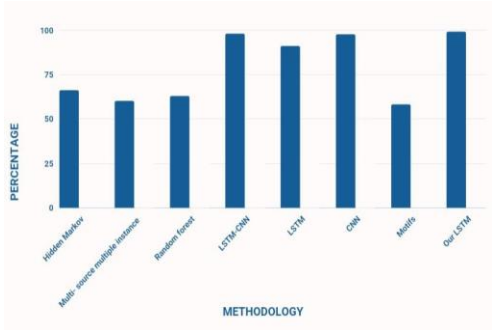


Fig. 7. Comparison between proposed methodology and existing methods

The Figure 7 shows the comparison between the proposed methodology and existing literatures. The Hidden markov model based model predicts the stock price with 66.034% [15], the Multi-source Multiple Instance (M-MI) model achieved accuracy as 60.1% [16], the Random forest model gives accuracy as 62.90% [17], the LSTM-CNN achieved accuracy as 98% [18], the LSTM model achieved accuracy as 91% [19], the RNN gives accuracy as 96.1%, the LSTM model achieved accuracy as 95.83 and the CNN model achieved accuracy as 97.64% for Infosys stock [20], high-order structures, i.e., motifs achieved accuracy as 58.06% for APPLE stock [21] whereas our proposed model achieves accuracy as 99% for APPLE stock which is very accurate compared to other existing models.

VI CONCLUSION

This research paper proposes a formalization of stock price prediction based on low budget computational DNN. The DNN architectures may be able to generate predictions and capture hidden dynamics. We trained the model and were able to predict its stock price using APPLE's stock price data. It is observed that the proposed system identifies some inter- relationships within the data. LSTM architecture is also capa- ble of detecting trend changes from its results, which is evident from the results. LSTM is the most appropriate model for the proposed methodology. The proposed methodology has less training parameters 22.6K compared to existing literatures. It tracks and predicts the stock market with high reliability. The results are accurate, so investors and stock analysts will be able to make better decisions. The method provides a novel solution for predicting prices in financial time series and sheds light on the discovery of macroscopic patterns.

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