STOCK PRICE PREDICTION USING LSTM AND MARKETS SENTIMENT ANALYSIS

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***Abstract* - One of the most important challenges in the world of computation is predicting the stock price. Rational and irrational behavior, the sentiment of investors, market rumors, physical, physiological, and other factors all play a role in the forecast. Many of these factors contribute to making stock markets very unpredictable and impossible to forecast accurately. We investigate data analysis as a game changer in this domain. According to efficient market theory, as all knowledge about a company and stock market practices is automatically available to all stakeholders/market participants, the ramifications of those developments are now rooted in the stock price. As a consequence, it is believed that only the previous spot price accurately represents all other market practices and can be used to predict potential movement. As a result, we use Machine Learning (ML) techniques on historical stock market data to infer future patterns, taking the past stock price as the final manifestation of all impacting variables. Deep learning for forecasting stock market prices and patterns has been much more common than ever in the age of big data. In this paper, we introduced a system that predicts the stock prices using LSTM (Long Short-Term Memory) neural network and sentiment analysis using twitter's data. Then, through an in-depth study on how to predict the stock price by the LSTM neural network optimized by ADAM optimizer, the feasibility of the method and the applicability of the model are analyzed, and finally, the conclusion is drawn.**

Keywords: **Machine Learning, Artificial Intelligence, Long Short Term Memory, Adam Optimizer, Deep Learning, Neural Network, Prediction of stock price, Sentiment Analysis.**

I. INTRODUCTION

The stock exchange is where securities are exchanged, sold, and distributed. On the one hand, stock issuance offers a lawful and fair outlet for capital flow, allowing for the accumulation of vast amounts of idle capital in the stock market. Such efficient capital investment will increase the organic composition of enterprise capital and significantly aid economic growth. On the other hand, stock circulation allows capital to be effectively accumulated and capital investment to be effectively encouraged.

As a result, scholars from all walks of life view the stock market as an intuitive indicator of a country's or region's economic growth over a given time frame. One of the key factors is that stock market share rates will critically represent supply and demand relationships in the stock market. Furthermore, the stock exchange is often used as a gauge of stock values and quantities. The stock price development process, on the other hand, exhibits instability and unpredictability due to the stock market's complexity, fluctuations, and uncertainty. Stock prices are determined by a variety of variables, including political, fiscal, market, technological, and investor behaviour, as well as individual factors. These factors combine to cause fluctuations in stock prices, and the presence of various unpredictable factors adds to the uncertainty of stock price changes. Constant fluctuations in equity markets offer fertile ground for betting in the financial market and raise the stock market's risk.[1]

Individual investors and analysts are "irrational," based on personal knowledge and instincts to make decisions and decide there is a certain constraint, namely, experience and intuition to predict the stock market is not reliable, this is not accuracy under the guidance of similar actions induced greater risks, and may result in economic losses to investors. As a result, knowing how to correctly interpret, evaluate, and forecast stock markets is crucial for investors to make informed decisions.

Deep learning focused on neural networks has gotten a lot of recognition from deep learning researchers. Since a neural network is a complex nonlinear dynamic system, it is the only method that can deal with the low efficiency of complex and nonlinear systems. This method is characterised by handling mechanisms that can run in parallel, topological structure performance that is very flexible, operation ability that is extremely powerful, and nonlinear operation that is faster and stronger. In the area of analysis, this approach has gotten a lot of recognition.

II. LITERATURE REVIEW

Over the past two decades, the financial market environment has undergone several dramatic changes. The development of reliable networking and trading infrastructure has expanded the variety of options open to investors. Forecasting stock returns is a significant financial topic that has piqued the interest of academics for many years. It is based on the assumption that fundamental information made public in the past has some predictive relationships to future stock returns. Data mining techniques are modern techniques that can be used to retrieve information from data in order to extract certain relationships from the available data. As a result, some scholars have concentrated on technical study and the application of advanced math and science.

Artificial intelligence and data mining methods have received a lot of coverage. Any models have been proposed and applied using the above strategies. The authors Tsang, P.M., Kwok, P., Choy, S.O., Kwan, R., Ng, S.C., Mak, J., Tsang, J., Koong, K., and Wong, T. conducted an observational analysis on developing a stock buying/selling alarm method using backpropagation neural networks (BPNN), their NN was codenamed NN5. The machine was educated and checked using historical price data from Hong Kong and Shanghai Banking Corporation Holdings from January 2004 to December 2005. The empirical results revealed that the implemented system was capable of predicting short-term price movement directions with an accuracy of approximately 74%. [1]

Wu, M.C., Lin, S.Y., and Lin, C.H. used the decision tree method to expand on Lin's work. Lin attempted to change the filtering rule to buy when the stock price rises k percent above its previous local low and sell when it falls k percent below its previous local peak. The suggested filter rule change included integrating three decision variables consistent with fundamental research.

Lin's approach outperformed the filter law in an observational evaluation using stocks of Taiwanese electronics firms. According to Wu, M.C., S.Y., and C.H. Lin, the criterion for clustering trading points in Lin's work included only past information; potential information was not considered at all. Wu, M.C., Lin, S.Y., and Lin, C.H. conducted an analysis to develop the filter rule and Lin's study by taking into account all previous and future knowledge while clustering trading points. To conduct observational experiments, the researchers used data from the Taiwan stock exchange and the NASDAQ. The suggested solution outperformed both Lin's method and the filter law in the two capital markets, according to the findings of the tests.[2]

The Wang, J.L., and Chan, S.H. (2006) model, "Stock market trading law discovery using two-layer bias decision tree," used serial topology to construct a new decision structure, the two-layer bias decision tree, for stock price prediction. The methodology developed by the authors differs from other studies in two respects.[3]

To begin, the decision model was changed to a bias decision model in order to reduce the classification error. Second, to increase buying accuracy, a two-layer bias decision tree is used. The empirical findings showed that the presented decision model provided excellent buying accuracy, outperforming random purchases by a considerable margin.[4]

Hajizadeh et al. gave a description of how data mining methods including decision trees, neural networks, association laws, and factor analysis are used in the stock market. One of the most difficult problems for the AI group has been predicting asset prices or capital markets. With differing outcomes, various technical, basic, and statistical metrics have been suggested and used. Soni reviewed some recent literature in the field of stock market prediction using machine learning and artificial intelligence. In the field of stock market prediction, Artificial Neural Networks (ANNs) have been described as the leading machine learning technique.[5]

II. SYSTEM DEVELOPMENT

1. Architecture

Fig-1 depicts architecture for the system, it gives a short idea about the basic working and the technical flow of the system.

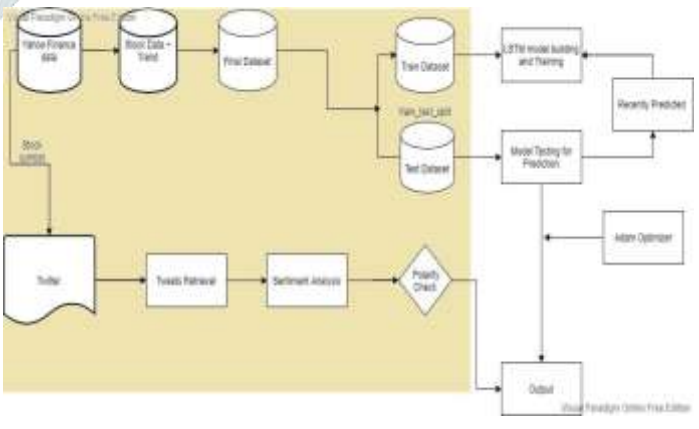

Fig-1:System Architecture

2. StoxWiz(Web App)

StoxWiz is a machine learning based web application. We have used the Django framework for the development of this website. Using this website, the users (investors / traders / shareholder) will interact with our system, where users will be able to perform various operations related to stock trend analysis like viewing indexes, apply technical indicators, can go through companies' profile, predict stock price using historical data, etc. Also, users for their own good can know the peoples sentiment on a particular stock/equity as well, users will be able to analyze technical charts such as candlestick, line charts, etc. In short, this website will give ample confidence in technical analysis to the users for better trading or investing.

3. Yahoo Finance (Yfinance) & Twitter API

The historical data used for predicting the stock prices is collected from Yfinance which is an API provided by Yahoo Finance. The stocks/equities on which the prediction can be applied can be of three stock exchanges namely BSE(Bombay Stock Exchange), NSE(National Stock Exchange) and NASDAQ(National Association of Securities Dealers Automated Quotations). The sentiment analysis of people about a particular stock is done by collecting tweets of different users those have tweeted about that stock using the Twitter's API for developers.

4. Long Short Term Memory (LSTM)

The LSTM algorithm is a recurrent neural network (RNN) that remembers values at random times. Provided time lags of uncertain length, LSTM is well-suited to characterise, process, and forecast time series.[1]

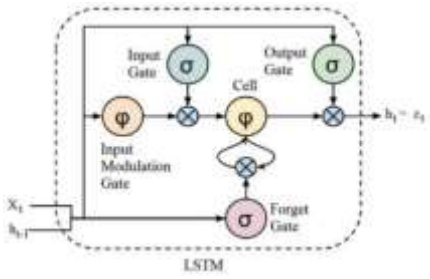

Fig-2: LSTM CELL

The cell state is the term used to describe long-term memory. The recursive nature of the cell is shown by the looping arrows. This allows for the storage of data from previous periods in the LSTM cell.[4] The forget gate, which is located underneath the cell state, modifies it, and the input modulation gate adjusts it. According to equation, the previous cell state is forgotten by multiplying with the forget gate and new information is added via the input gates' production.

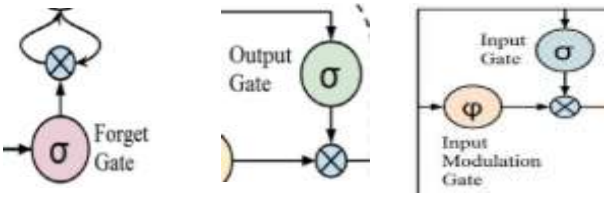

Fig-3:Forget, Output and Input Gate

The remember vector is also known as the forget gate. By multiplying 0 to a spot in the matrix, the forget gate's output informs the cell state which details to forget. Cell state stores information if output is

1.Using the equation, the sigmoid function is generalised to the weighted input/ observation and the previous hidden condition. The input gate is the name given to the save vector. These gates decide which data can be stored in the long-term memory of the cell. The activation functions for each gate are the most critical ones.

The input gate has a range of [0,1] and is a sigmoid function. The output gate is the name given to the focus vector. Which of the potential values from the matrix can be used to advance to the next secret state?

III. Proposed System

In this project, We used the LSTM algorithm with Adam optimization to forecast future stock prices. LSTM forecasts the stock price using historical price pattern data from the previous two years, as well as core data such as open, high,low, close, and volume. There are two steps to making a prediction. The first move is to figure out how the model has been trained. The data is then used to measure the precision of the data in the second process. For stock price prediction, the proposed study employs an LSTM recurrent neural network. The RMSE procedure is used to quantify the error. The data in this paper were derived from the regular closing prices of stocks on the NSE and BSE, which were obtained using Yahoo Finance, and the data series spans two years from the current year. We will use the LSTM RNN to build our model, which will use 80% of the data for training and 20% for research. To refine our model, we use mean squared error for training. Our model will be organised as follows: We used various Epochs for training data (12 epochs, 25 epochs, 50 epochs, and 100 epochs).[11]

IV. Results

Following the training of our model, the findings of our research revealed that the number of epochs as well as the duration of the data had a substantial effect on the testing outcome.

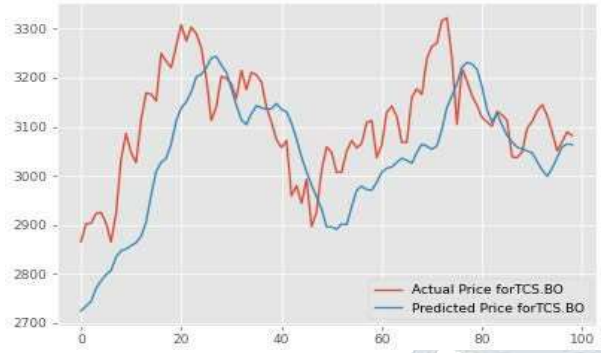

Fig-4.1:TCS price with epoch 12 and batch size 96

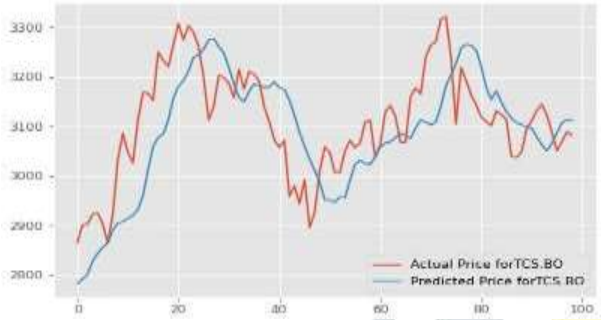

Fig-4.2:TCS price with epoch 25 and batch size 96

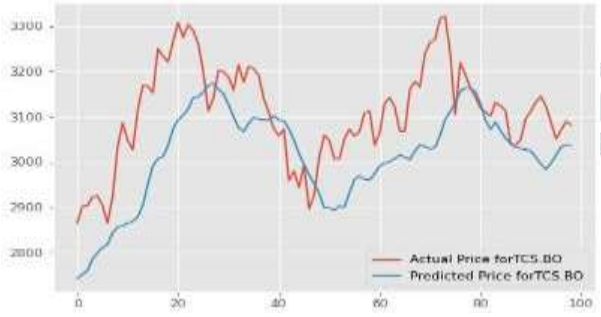

Fig-4.3:TCS price with epoch 50 and batch size 96

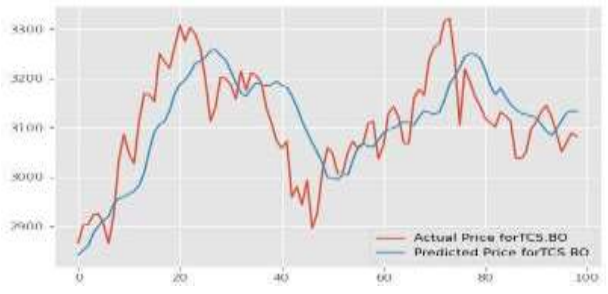

Fig-4.4:TCS price with epoch 100 and batch size 96

Following the training of our model, the findings of our research revealed that the number of epochs as well as the duration of the data had a substantial effect on the testing outcome.

We can see that training with fewer data and more epochs improves our research results while still allowing us to have better forecasting and prediction values for different data sets. For TCS asset prices, the above figures displays the accuracy of our training and research for all epochs.

For **sentiment analysis** the tweets of the users about a particular stock is collected using Twitter's API. TextBlob is a Natural Language Processing (NLP) Python library. Natural Language ToolKit (NLTK) is used extensively by TextBlob to complete its activities. NLTK is a library that helps users to deal with categorization, grouping, and a variety of other activities while providing convenient access to a large number of lexical tools. TextBlob is a basic library that allows for complex textual data processing and operations. TextBlob returns polarity and subjectivity of a sentence. The range of polarity is [-1,1], with -1 indicating a negative sentiment and 1 indicating a positive sentiment. Negation words are used to change the polarity of a sentence. Semantic marks in TextBlob aid in fine-grained analysis. For example - Emoticons, exclamation marks, emojis, etc. Between [0,1] is subjectivity. The amount of personal experience and truthful knowledge in a document is measured by subjectivity. Because of the text's higher subjectivity, it incorporates personal judgement rather than objective facts.

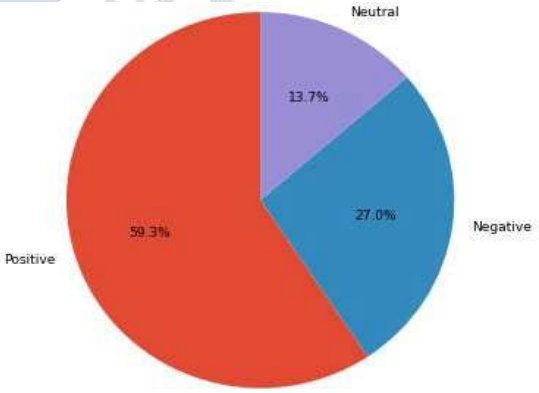

Fig-4.5: Polarity of a stock

V. Limitations of existing methods

The proposed methodology demonstrated by Dou Wei implements Mini-batch gradient descent to optimize the accuracy of the prediction model. Though it is a decent approach but can be improved using another optimizer such as Adam. Mini-batch gradient descent may or may not produce satisfactory results. It all depends on how much data is taken up in the mini batch. The convergence rate would be sluggish if the learning rate is reduced. The loss function will oscillate and deviate at the minimum value if the learning rate is too high. noise, and RMSprop providing proper learning rate updation without the drawbacks of Adagrad.

For each parameter, Adaptive Moment Estimation (Adam) computes adaptive learning speeds. Like Adadelta and RMSprop, it remembers and stores an exponentially decaying average of past squared gradients. In the same way as momentum holds an exponentially decaying average of past gradients, Adam keeps an exponentially decaying average of past gradients. Adam is a hybrid of Momentum and RMSprop, with Momentum providing a smoothing effect and reducing noise, and RMSprop providing proper learning rate updation without the drawbacks of Adagrad.

VI. CONCLUSION

In this paper, The feasibility study of BSE and NSE stocks was carried out for stock pattern prediction approach based on LSTM deep learning model, and the efficacy of the proposed algorithm was checked. The innovation of this article point can be summarized as the following three aspects:

(1) This paper proposes a kind of LSTM stock pattern prediction algorithm with the depth of the neural network, the length of the memory model, and the closing price of the stock as input variables of the model, the hidden layer predicts the next trading day's closing price of stock.

(2) Instead of using the mini batch gradient descent algorithm, the adam algorithm was used to refine the model in the LSTM algorithm training, allowing the model to be approximated faster and with less error.

(3) TextBlob library is used to perform sentiment analysis of a stock using tweets from Twitter's API that gives users an idea about markets sentiment.

VII. REFERENCES

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