Stock Market Forecasting Using Metaheuristic LSTM Approach with Sentiment Analysis

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Abstract

Machine learning, which differs from conventional algorithms and models in that it applies computer algorithms and statistical models in a systematic and all-encompassing manner, is utilized extensively in a variety of fields. Machine learning is mostly utilized in the realm of finance to analyze the trajectory of capital market prices. In this study, we employed conventional models and machine learning models for predicting linear and non-linear issues, respectively, to predict the time-series data of stocks with less risk. The LSTM (long short-term memory) neural network model is used to train and forecast stock price and stock price sub-correlation, and the proposed time series-based metaheuristic model is utilized to construct a prediction with risk assessment. The experiment findings demonstrate that: (1) Stock price and stock price correlation are accurately predicted by the MLSTM model; and (2) compared with the existing model for performance checking. Finally, we analyze the proposed model using a number of indicators.

As a result, our suggested solution offers less complicated assistance and method for risk analysis.

Keywords: Stock market, LSTM, MLSTM, Performance.

1. Introduction

In general, the word "stock market" refers to a group of markets where equity, bond, and other types of securities are issued and traded via various over-the-counter (OTC) markets, physical exchanges, and electronic exchanges. One of the most crucial elements of a market economy is the stock market because it gives businesses access to capital by enabling investors to purchase shares of firm ownership. The stock market's environment is continually changing as a result of process improvements. Given the daily differences it delivers, investors must carefully prepare their strategies in order to succeed [1]. When predicting stock market data, it is assumed that current publicly available data has some predictive correlations to future stock returns. The very complex world of the stock market makes stock trend forecasting one of the most challenging undertakings in the financial sector. By predicting stock movements and reducing investment risk, stock market investors are constantly looking for a strategy that may ensure simple earnings. This encourages forecasting model developers to create new forecasting techniques [2]. Stock prices can be thought of as a discrete-time series model, which is based on a set of clearly defined numerical data items acquired at subsequent points at regular intervals of time. Stock prices are not numbers that are generated at random; rather, they can be handled as such. Since it is crucial to find a model to analyze stock price movements with sufficient data for decision-making [3], it is advised that using CNN to convert the time series is a better algorithmic method than directly forecasting because it produces more accurate

results. Prior to processing, the MCNN Model transforms non-stationary data into stationary data. It is one of the most widely used models for predicting data from linear time series. A programming language and environment for statistical and graphical processing, Python. Data analysts typically use the Python programming language for statistical programming and data analysis [4].

1.1 Motivation and Background

The exchange of the venture's stocks or shares will take place on the stock market. People who exchange shares must register with a company called the Security and Exchange Board of India, which is a collaboration with a controlling body (SEBI). The SEBI is given the mandate to support the growth of Indian stock exchanges. It protects the interests of small-time investors in the same way as the legal system, market regulation, and the activities of financial intermediaries do, assisting when it is challenging to predict the stock market. Organizations typically take a very unstable stance when estimating future stock costs. The strategy of anticipating stock costs makes future predictions of stock costs based on historical data [5]. The stock exchange regularly displays stock costs based on the production and consumption of goods. When there is interest in the organization's stock costs, the stock costs will increase, however when there is less interest due to risk at the organization's stock costs, the stock costs will decline. Financial experts who may have invested in particular organizations need to increase their revenues. This should be possible by promptly exchanging their offer [6].

The prediction of future stock exchanges is one of the most difficult tasks when we consider the market as a whole. This is useful because it gives us a clear understanding of how to separate the assets and how to foresee future expenses, which enables us to think about the future. Financial experts also hope to effectively identify risks so that rewards from speculating can be significantly more prominent. Economic expectations will aid in ensuring that the interaction between producers and consumers is protected [7].

We have largely concentrated on the degree of accuracy of forecasting stock values with less risk for various sectors in this work, which will help new investors to understand the market and make a sensible decision to invest in the stock market.

The following are this paper's main contributions:

(1) A new deep learning technique (MCNN) is suggested to predict the stock price with risk analysis by studying the correlation and time series of stock price data. CNN is utilized in this method to forecast data as well as extract the time feature of the data [8]. It can fully utilize the stock price data's time sequence to produce more accurate forecasts with lower risk.

(2) It is demonstrated that MLSTM has high forecasting accuracy and is better suitable for stock price forecasting with a lower risk factor by comparing the evaluation indices of CNN with multilayer perceptron (MLP), CNN, RNN, LSTM, and CNN-RNN.

2. Related work

The stock price can be projected using either the traditional analysis method or the machine learning method at the moment because the financial market is a noisy, nonparametric dynamic system. The analysis of complicated, high-dimensional, and noisy financial series data is not appropriate for using typical econometric approaches or equations with parameters. Because it can extract data features from a huge number of

high-frequency raw data without relying on prior information, neural networks have recently been a popular research area in the field of stock forecasting. White utilized a neural network to forecast IBM stock in 1988, but the experiment's outcomes weren't promising. Zhang projected equities in 2003 using a neural network and an ARIMA (autoregressive integrated moving average model). The experimental findings demonstrate clear advantages of neural networks in nonlinear data forecasting, but accuracy still needs to be increased. A time series forecasting technique based on a neural network was put forth by Sun et al. in 2005. The optimum partition algorithm (OPA) and radial basis function (RBF) neural network are combined in this approach. Adhikari et al. suggested a method in 2014 to predict four financial time series data using a combination of random walk (RW) and artificial neural network (ANN), and the results showed a certain improvement in forecasting accuracy [9]. The network structure of stock price forecasting based on the LM-BP neural network was proposed by Zhang et al. in 2018, which addressed the limitations of the classic BP neural network training technique, including its sluggish training speed and low precision. A convolutional neural network can predict time series in 2018, according to Hu et alexperimental .'s findings, although deep learning is more suited to handling the problem of time series. The forecasting accuracy of CNN alone is, however, only moderate because it is more frequently used to address picture identification and feature extraction problems.

Kamalov used MLP, CNN, and LSTM to predict the stock prices of four significant US public firms for the year 2020. These three strategies outperformed comparable research that predicted the direction of price change, according to experimental findings [10].

A high-precision short-term forecasting model for financial market time series was developed by Xue et al. in 2020 and compared to the BP neural network, the conventional RNN, and the enhanced LSTM deep neural network. The outcomes demonstrated that the LSTM deep neural network has good forecasting accuracy and is capable of accurately predicting stock market time series [12].

Zhang et al. (2019) build a model to forecast gas concentration using LSTM multi-dimensional time-series data in this research study. The author has used the LSTM model, which uses time series data from the gas concentration data set, to improve the accuracy of the forecast of the gas concentration. The batch size and the number of layers are the variables that are employed in the gas prediction model. This improved model is used to forecast the gas concentration for upcoming time periods after fitting the LSTM model. The training set is altered in this case to meet the range between 0 and 1. The Sklearn preprocessing package's Minmax scaler method, which has been imported, is used for this transformation.

2.1 Deep Learning Techniques Used in Stock Price Prediction

The LSTM model was used in this study by Fischer and Krauss (Fischer and Krauss; 2018), who saw it as a cutting-edge model suitable for sequence learning. The author claims that while LSTM models are better appropriate for this type of data, they are rarely used to financial time series data. For the purpose of predicting stock market data between the years 1992 and 2015, the author deployed the LSTM model. The LSTM models have outperformed memory-free classification models like Random Forest, Deep Neural Networks, and Logistic Regression. They have developed a trading strategy based on forecasts that are consistent with current literature with the use of the LSTM model. The

outcomes are more trustworthy when they use volume-weighted average pricing (VWAP) as opposed to closing prices [13].

As it is crucial to assess the viability of the position of an investment and the associated risks, (Guo; 2020) has developed a method to anticipate volatility on the basis of environmental, governmental, and social news flow. These environmental, governmental, and social data are structured, and the ESG data can be incorporated and further fed into the model. The output of this model is useful for developing professional investment advice for ESG. The textual financial ESG data, according to the author, are the data that are fed into the model. To forecast the news that is connected to ESG, they have employed a natural language processing model, which is a deep learning technique. To convert the data from text to numerical, they employed a language model that is based on transformers.

Mehtab and Sen (2019) used the NIFTY 50 dataset from the National Stock Exchange of India in this research work. They have used the NIFTY 50 data's closing value. The data set includes information from 2015 to 2017. They have made predictions for the data from 2018 to 2019. They have used a variety of classification techniques to forecast the movement of the stock price. To forecast the closing stock price value, they have used a variety of regression models. To predict the closing value of the stock price, they have used a variety of machine learning algorithms, including multivariate regression, bagging, boosting, Random Forest, decision trees, and support vector machines. However, to predict the close value of the stock price, they have used LSTM, a deep learning network [14].

In order to anticipate the stock price of future dates, this research article (Moghar and Hamiche; 2020) uses Recurrent Neural Networks (RNN), particularly Long Short-Term Memory (LSTM). The author is interested in learning how accurately the LSTM predicts the future stock price. They also want to know how many epochs are employed to achieve the best possible stock price forecast outcomes. The Network Stock Exchange provided the data that they needed for the analysis (NYSE). The remaining 20% of the data was taken into account for testing, and the remaining 80% was used for training. To enhance the model's performance, they used mean squared error during the training process. To evaluate the model's performance, they took into account various epochs in ascending order. The author has noted that more epochs and less training data are needed to provide effective forecasting results.

Deep learning approaches were used in this study work by Saud and Shakya (2020) because they are more effective at anticipating stock prices. RNN models were used by the author to assess the look-back period parameter. Vanilla RNN, GRU, and LSTM are the deep learning models that the author employed for the analysis. The data set they selected for the analysis includes stock price data for the banks on the Nepal Stock Exchange's list (NEPSE). The data was preprocessed by the author, who used the next day's close price column for the analysis. For scaling the data, they used Z score normalization. In a ratio of nine to one, the data are divided into training data and testing data. The three models are then fitted, and a comparison is done in light of the outcomes. The findings indicate that, when compared to other deep learning models, the GRU model performs better [13].

Here, in this research work, the data from the most recent transaction were used to extract the pertinent information by (Wen et al.; 2019). Forecasting future or immediate ups and downs uses the information that has been gathered. The machine learning models are capable of accurately identifying the nonlinear dependencies in the stock price. They have selected the S & P 500 data set for the analysis. The stock price time series data will be

exceedingly erratic and non-stationary. Therefore, it will be challenging to predict future stock market statistics. The author has created a system that will recreate the sequences that will be influenced by these sequenced patterns in order to stop these common patterns from occurring [10]. Later, they used a convolutional neural network to extrapolate the time series data' future stock price.

3. METHODOLOGY

3.1. MCNN Model

Because LSTM focuses on the most glaring features in the line of sight, it is frequently utilized in feature engineering. LSTM, which is frequently employed in time series, has the property of growing in accordance with the passage of time. A stock forecasting model built on LSTM is constructed in accordance with its properties. The figure displays the model's structure. The major component is an LSTM, which is also present in the input layer, one-dimensional convolution layer, pooling layer, LSTM hidden layer, and complete connection layer.

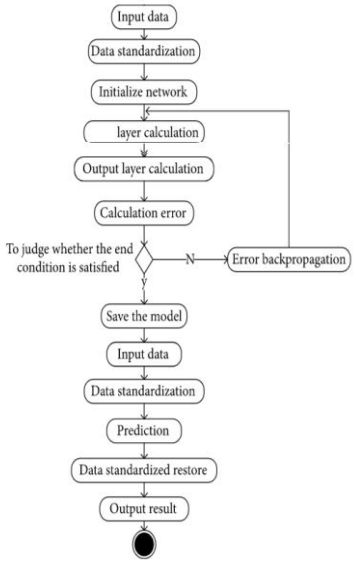

Figure 01: Work Flow for Predicting the Stock market prediction with risk analysis

The preprocessing step for categorizing sentiment analysis from reviews has been done in the suggested technique.

Sentiment classification, score generation, preprocessing, train/validation/test splitting, and dataset collection

4. Experiments

Using the same training set and test set data in the same operating environment, we compared MCNN with MLP, CNN, RNN, LSTM, and CNN-RNN to demonstrate its efficacy. Windows 10 and a running environment are used for all studies. Risk analysis is anticipated based on the influencing elements, such as the opening price, maximum price, lowest price, closing price, volume, turnover, ups and downs, and change.

4.1. Data

The Shanghai Composite Index (000001) is chosen as the experimental data in this experiment. The wind database is used to get the daily trading data. For risk analysis and accurate stock prediction, each piece of data has several components, including the opening price, maximum price, lowest price, closing price, volume, turnover, ups and downs, and change. Consider some sample trading day data as the training set and some sample trading day data as the test set. After testing and training the dataset under consideration, certain companies' predictions with risk analysis are shown in the following figure.

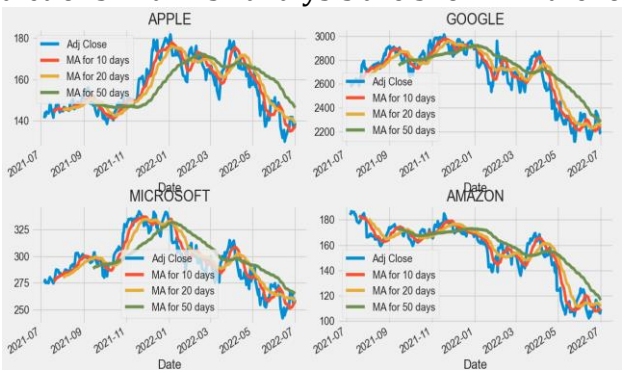

Figure 03: Using MLSTM, a comparison between the closing price of some company and the closing value as predicted.

After training MLP, CNN, RNN, and LSTM with the training set data that has been processed The model developed during training are utilized to forecast the test set data for CNN-RNN and MLSTM, respectively, and the real value is compared with the predicted value as shown in the accompanying Figures.

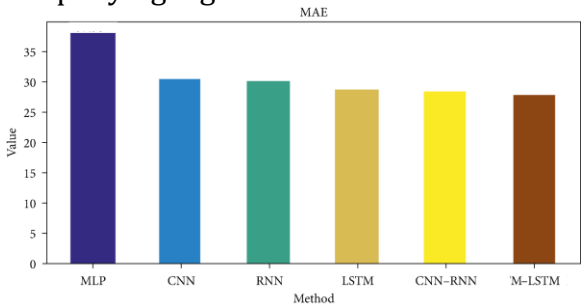

Figure 04: The outcome of comparing mean absolute errors (MAE) across several techniques.

5. Conclusion and Future Work

In this study, we conducted a critical analysis of the machine learning and deep learning models used to predict stock prices. We used the proposed technique to identify the company names in order to forecast the stock prices of various companies. The extraction, transformation, and loading of the stock price data have all been successfully completed since the postgres database has been utilized to store the dimension and stock price data of the companies. Exploratory data analysis has been effectively completed with minimal risk in order to obtain the inside details of the stock price prediction. The stock price data has been analyzed using deep learning models like LSTM as well as machine learning models like ANN and SVM. These models have each undergone a comparative time series analysis including risk analysis. In comparison to currently used methods, the Prediction value we have gotten for the Proposed model is lower. As a result, we were able

to apply, assess, and contrast the proposed approach's outcomes with those of existing models. This study can be applied on a broad scale with other performance parameters in the future if the data set includes more companies and their corresponding stock values.

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