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Design Analysis and Implementation of Stock Market Forecasting System using Improved Soft Computing Technique

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Abstract

In this paper, a stock market prediction model was created utilizing artificial neural networks. Many people nowadays are attempting to predict future trends in bonds, currencies, equities, and stock markets. It is quite challenging for a capitalist and an industry to forecast changes in stock market prices. Due to the numerous economic, political, and psychological aspects at play, forecasting future value changes on the stock markets is quite challenging. In addition, stock market forecasting is a difficult endeavor because it relies on a wide range of known and unknown variables. Many approaches, including technical analysis, fundamental analysis, time series analysis, and statistical analysis are used to attempt to predict the share price; however, none of these methods has been demonstrated to be a consistently effective prediction tool. Artificial neural networks (ANNs), a subfield of artificial intelligence, are one of the most modern and promising methods for resolving financial issues, such as categorizing corporate bonds and anticipating stock market indexes and bankruptcy (AI). Artificial neural networks (ANN) are a prominent technology used to forecast the future of the stock market. In order to understand financial time series, it is often essential to extract relevant information from enormous data sets using artificial neural networks. An outcome prediction neural network with three layers is trained using the back propagation method. Analysis shows that ANN outperforms every other prediction technique now available to academics in terms of stock market price predictions. It is concluded that ANN is a useful technique for predicting stock market movements globally.

Keywords: ANN, CNN, AI, Machine Learning, Stock Market

1. INTRODUCTION

Stock market or equity market is a place where stock (share) of listed companies is traded at agreed price. It is an area where people buy and sell financial instruments, be it equity or debt. In other words it is a mechanism to facilitate the exchange of financial assets. The share price is based on order/delivery basis. The price of the share will go high if it's more demanded in the market.

In the United States, the largest stock exchanges are: NASDAQ (National Association of Securities Dealers Automated Quotations) and New York Stock Exchange (NYSE), in Canada largest one is Toronto Stock Exchange. In the Asian biggest stock exchanges as: Tokyo Stock Exchange, Singapore Exchange, the Hong Kong Stock Exchange, the Shanghai Stock Exchange, the Bombay Stock Exchange. India's stock exchanges: - NSE (National Stock Exchange) and BSE (Bombay Stock Exchange).

Predicting the Stock Market

According to Wikipedia, Stock market prediction is the act of trying to determine the future value of a company stock or other financial instrument traded on an exchange. Accurate prediction of price index movement of stock market may yield huge profits.

In order to forecast future value of the prices, investors should be familiar with the recent cost of investment they possess, schemes to acquire and its potential selling value in future. Regardless of this, shareholders always keep watch on the historical prices of shares to make their forthcoming opinions on investment. Many investors do not want to buy share those are rising very rapidly, as these are supposed to be change

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very soon while some investors stay away from decreasing shares as they panic about that these share will go to decay.

There is no doubt that the forecasting of the stock market is an out of the ordinary task. So there are a number of techniques those are useful to achieve this task as follows:

- Technical Analysis Methods
- Fundamental Analysis Methods
- Traditional Time Series Prediction Methods
- Machine Learning Methods

2. OBJECTIVE

In The applications of ANN in different prediction problems have been a hot research topic for many years and continuously growing. Though, in India not so much of works have done in this field if we compare it with other countries. Therefore, the objective of this work is:

- To develop artificial neural network (ANN) models for stock market prediction.
- To observe and to examine that the neural network can be the applied as an effective tool for the prediction of stock market future price index.
- To perform evaluation of the formulated models for daily closing price movements of NSE Nifty 50 Index of India.
- To perform evaluation of the formulated models for daily closing price movements of NSE Nifty 50 Index of India.

3. LITERATURE REVIEW

(Mehar Vijh 2020) Making precise estimates of market returns is a very challenging task since the stock markets are so unpredictable and non-linear. Programmable techniques of prediction are now more accurate in predicting stock prices because to developments in artificial intelligence and computational power. In this study, artificial neural networks and random forest techniques were used to forecast the closing prices of five enterprises from distinct industry sectors. The open, high, low, and close prices of the stock are utilized to generate new variables that are inputs into the model. The models are assessed using two popular strategic metrics, RMSE and MAPE. The low levels of these two indicators are proof that the models are successful in forecasting stock closing price. [1]

(Milad Shahvaroughi Farahani, Seyed Hossein Razavi Hajiagha, 2021) The stock market of today fulfills an important function and may be used to assess one's financial status. People have the opportunity to make a big return by putting their money in the stock market. But it is challenging since there are so many considerations. There are therefore many methods for predicting share price change. The main goal of this paper is to anticipate stock price indices using an artificial neural network (ANN) trained with novel metaheuristic algorithms as the social spider optimization (SSO) and bat algorithm (BA). We made use of various technical indicators as input variables. Then, we employed evolutionary algorithms as a heuristic method for feature selection and choosing the best and most relevant indicators (GA). We used a variety of loss functions, such as mean absolute error, as a standard for evaluating errors (MAE). On the other hand, using time series models like ARMA and ARIMA, we predicted stock price. Finally, we compared the results obtained utilizing ANN-Metaheuristic approaches and time series models. [2]

(Mehtabhorn Obthong, G. Wills, and N. Tantisantiwong, 2020). Stock traders need fast information at their disposal in order to make informed judgments. A stock market trades a range of stocks, therefore several factors might affect the decision-making process. Additionally uncertain and difficult to predict is the behavior of stock prices. These elements make stock price forecasting both an important and challenging process. As a result, research efforts are concentrated on identifying the prediction model that has the lowest mistake rate and best forecast accuracy. This article analyzes research on machine learning techniques and algorithms that improve the accuracy of stock price forecasts. [3]

(Zhongbao Zhou, Helu Xiao, and M. Gao, 2020) We employ a number of heterogeneous data sources, such as historical transaction data, technical indicators, stock postings, news, and Baidu index, to predict the movements of stock prices. With an emphasis on the unique prediction patterns of active and inactive stocks, we assess the support vector machine's (SVM) capacity to forecast in various degrees of activity for a single stock. We construct a total of 14 data source combinations in accordance with the aforementioned 5 heterogeneous data sources and choose three forecasting horizons, namely 1 day, 2 days, and 3 days, in order to investigate the forecast effects of stock price movements in the China A-share market under various data source combinations and forecasting horizons. It is shown that the best data source combinations for active and inactive stocks differ from one another. Active stocks obtain the most accuracy when integrating many non-traditional data sources, whereas inactive stocks earn the highest accuracy when fusing traditional data sources with non-traditional data sources. After further classifying each stock into inactive,

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active, and extremely active phases, the expected impacts of the same securities at various points in time are compared. We find that for most data source combinations, the more active the stock is, the more accuracy we are able to achieve, demonstrating that our technique is more effective in forecasting stock price movements during active and highly busy times. [4]

(U. Singh, G. Kumar, and Sanjeev Jain, 2020) The social and economic foundation of a country depends on the stock market. Stock market forecasting is one of the most challenging challenges for investors, professional analysts, and researchers in the financial sector because to the extremely noisy, nonparametric, volatile, convoluted, non-linear, dynamic, and chaotic character of stock price time series. Given the increased risk involved in participating in the stock market, stock market forecasting is a crucial responsibility and a well-known study area in the financial sector. However, the majority of the risk may be minimized with the advancement of very powerful computational technology. This in-depth investigation focuses on the application of computationally intelligent stock market forecasting approaches, such as artificial neural networks, fuzzy logic, genetic algorithms, and other evolutionary methods. This paper reviews the current research on computationally intelligent stock market forecasting methods. The chosen papers are organized and discussed in this article from the standpoints of six main areas: (1) the stock market under investigation and the related dataset, (2) the type of input variables investigated, (3) the pre-processing techniques used, (4) the feature selection techniques to select effective variables, (5) the forecasting models to address the stock price forecasting problem, and (6) performance metrics used to evaluate the models. This work's major contribution is to provide academics and financial professionals with a systematic methodology to develop intelligent stock market forecasting algorithms. This study also describes upcoming work that will increase the efficiency of the techniques now in use. [5]

4. PROPOSED METHODOLOGY

The objective of this work is to forecast the stock market using ANN. Neural networks acquire knowledge through repeated iterations of input data (called training period). Although there is a lot of noise in the training set, ANNs are capable of carrying hidden and non-linear interdependencies. Without making strict assumptions about the distribution of samples, the ANN model also displays complicated and non-linear relationships (Bishop, 1995; Breiman, 1984) and can recognize new samples even if they haven't been in the training set. The usage of neural networks as a preferred method over other conventional models of prediction is promoted by a number of distinguishing characteristics. Therefore, neural networks are more accurate at predicting stock market returns than other models . Consequently, the following are the main reasons to use ANN in stock market prediction:

•Since stock market data are very difficult to represent and extremely complicated, a non-linear model is necessary.

•A large number of connected input nodes are frequently required to describe a specific stock, which is ideal for ANN. The stock market not only has acknowledged input and output, but it is also affected by outside knowledge that creates ambiguity.

The ANN approach aims to predict the hidden connections between input and output, reducing the possibility of unpredictability and enhancing profit generation. Information of the sort called noise does not fall within this category. Figures 4.1 and 4.2, respectively, provide illustrations of the stock market prototype and the use of ANN for the stock market.

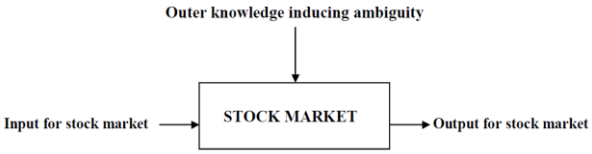

Figure 4.1 Depiction of Stock Market

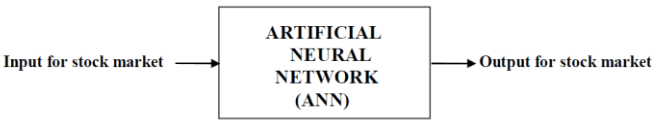

Figure 4.2 Using ANN, Representation of Stock Market Model

Research Methodology

Research Methodology is a technique by which one can discover the solution of a specified problem called research problem.

Our research problem can be partitioned in two portions, as:

1. Data accrue and analysis
2. Neural Networks toolbox of MATLAB software is used for training purpose

Material and Methods

The research data set encompassed in this study is the daily closing prices movement in NSE (National Stock Exchange) Nifty 50 Index. The whole data set includes

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the periods from 4th January, 2010 to 31st March, 2016. The entire cases are 1538 trading days.

The stock market data used in this research was obtained from World Wide Web. The data obtained from historical data offered on the website of National Stock Market. We got the initial original data in the form of soft copy .csv format.

We have finally made a file that included all the daily closing prices of index in that particular time period, which is showing selected data fields. The performance of the neural network is directly affected by ANN models. So to model a neural network a number of critical issues like: recognition of input-output variables, selection of parameters, network structural designing and statistics for performance evaluation are measured carefully.

Four technical indicators are applied as input and output variables for each case and we categorized them as ***independent variables*** and ***dependent variable*** in models development process. Followings are shows that dependent and three independent variables.

Dependent Variable:

Daily closing: Daily closing data of Nifty 50 index

Independent Variable:

FII inflow: Foreign Institutional Investors gross purchase
FII outflow: Foreign Institutional Investors gross sales
Exchange rate: USD to IN

The data of independent variables (FII inflow, FII outflow and Exchange rate) and dependent variable collected from the websites respectively and processed in required format. The independent variables are very important because the closing price values greatly depend on these factors. All fields hold numeric values as training algorithm needed only numeric values. So, we converted the values of dependent variable (Daily closing) in whole numbers using 'roundup' function offered by MS Excel 2007/CSV because if we express this field in decimal values then algorithms are not capable to understand the pattern correctly as we desire. It demonstrates selected data with understandable identification of dependent and independent variables.

Artificial Neural Network Model Development

ANN may be defined as an enormous parallel disseminated connection which consists of neurons that storing knowledge. ANN has the capability to procure meaning from indefinite or complex data that can be worked to infer patterns and identify trends those are excessively intricate to observe by any computer approaches or human beings. To forecast the price index fluctuation of stock market we used three layered feedforward neural network model where input layer linked to the hidden layer and hidden layer further joined to an output layer. Three neurons of the input layer represent the input for the network as FII inflow, FII outflow and Exchange rate. A single neuron indicates the output which shows the way of movement. The output is either 0 or 1. Based on the heuristic, the quantity of neurons in the hidden layer was decided. Figure 4.3 reveals the structural design of three layered feedforward ANN model.

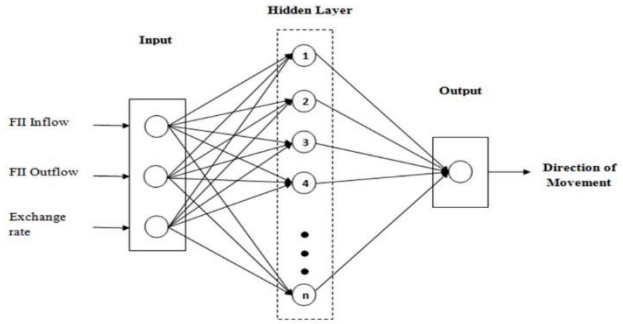

Figure 4.3 Structural Design of Three Layered Feedforward ANN

Partitioning Strategies Used

Training and testing data set are two groups in which the whole historical data set is divided. To build the ANN model for training purpose we used training data set and then applied testing data set to assess how well the ANN models act upon prediction by new data set (This data set not used in training of network). After recognition of input variables we created three partitioning strategies to train and to test ANN models.

Ist Strategy (70%, 30%) symbolized as ***a***. In which 70% cases are applied in training process while remaining 30% cases in testing process from total of 1538 cases.

IInd Strategy (75%, 25%) symbolized as ***b***. In which 75% cases are applied in training process while remaining 25% cases in testing process from total of 1538 cases.

IIIrd Strategy (80%, 20%) symbolized as ***c***. In which 80% cases are applied in training process while remaining 20% cases in testing process from total of 1538 cases.

Network Training/Learning

Training is very crucial part for any prediction model. In neural network, training is a repetitive progression of discontinuous upsurge of bias and network weights. To train neural network models, a text file created in which training

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(input) data set and corresponding testing (output) data set organized using above stated strategies. In the training process two sets of variables of training data are used as training or input variable ('q') and target variable ('r'). By a space the values of variable are separated while semicolon (;) are used at the end for separation of each input data.In whole training process cycle input data set [q1, q2, q3, q4…….] is provided to input node and accordingly the values of target data set is provided to output node. An error signal is generated when network output is compared with target/ desire output. A control system is trigged by error signal which implements a sequence of corrective modification for neurons weights and biases in each step of repetitive training process. Neural network has been trained after several iterations and the weights are saved. Now in trained neural network, we provided the testing data set for checking the network behavior. After modification in the network weights, the result is used to inspect the network capability for prediction of output.

Performance Evaluation Criteria

For neural network model, prediction accuracy is evaluated using Root mean square error (RMSE).

RMSE (Root mean square error) RMSE provides the residual error in accordance with MSE (mean square error). It is used to assess the performance of developed model.

5. RESULT ANALYSIS

The dataset was downloaded in csv format from yahoo finance and kaggle and contains information on stock performance over the last five years. The goal of this statistical research was to see if there was a link between multiple price indicators and the share's closing price. For this, a neural network model was used. The opening price, high price, and low price are all good predictors of the closing price, according to a lot of evidence. It's striking that volume has no statistical importance in determining the closing price. Obtaining a Daily stock preparation set of data model fitting and cross-validation Visualization The model's evaluation The end result is Predicted Price Visualization.

Step 1. *Loading Data*
Step 2. *Obtaining Daily Price Data*
Step 3. *Fitting Model and Valuation*
Step 4. *Visualization of Results*
Step 5. *Parameter Evaluation*
Step 6. *Output: Predicted Price Visualization*

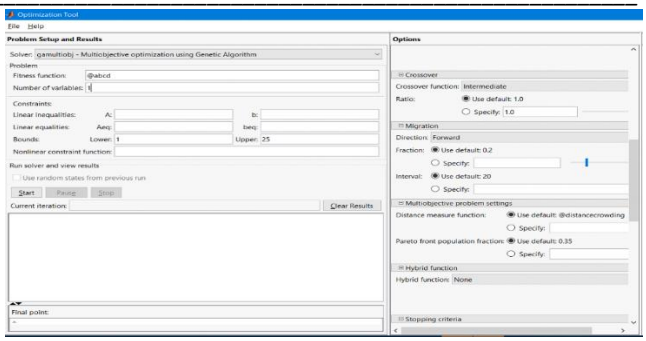

Figure 5.1 Design of Training Algorithm

Figure 5.1 indicates the design of neural network architecture and learning model for the proposed system the network has been designed using gradient descent learning along with momentum. The network has been trained with training, testing and validation to assess the accuracy of the proposed system. Figure 5.2 indicates the design of layers of neural network model for the proposed system the network has been designed using feed forward architecture with custom layers. There are seven features which are considered as input layer for the proposed system. Similarly there is one hidden layer and one output layer which has been used to assess the forecasted value. The network has feed forward architecture.

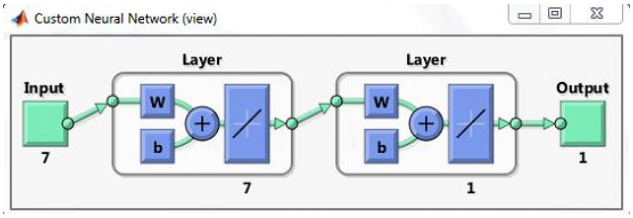

Figure 5.2 Layers of Neural Network

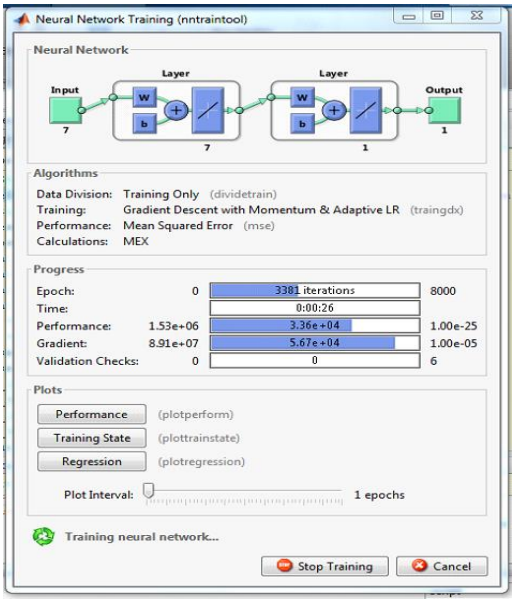

Figure 5.3 Design of Training Phase of Neural Network

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The data was downloaded in csv format from yahoo finance and kaggle, and it includes stock performance data for the previous five years. The purpose of this statistical study was to examine if there was any correlation between numerous price indicators and the closing price of the stock.

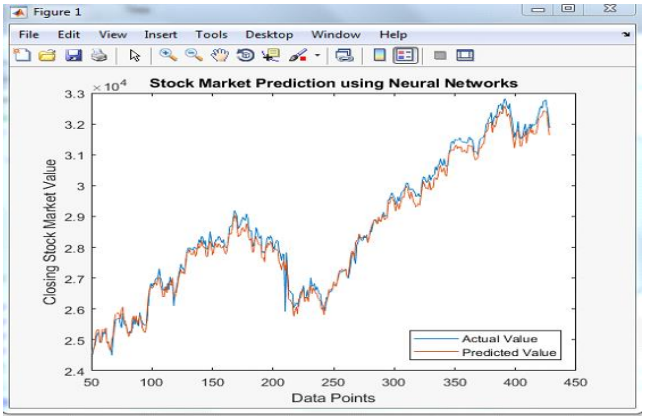

Figure 5.4 Correlation of Actual Value and Predicted Value

Figure 5.3 indicates the phase of training of neural network architecture it is evident that the network has been designed using rigorous training testing and validation of proposed system. The network has shown better performance the further accuracy analysis has been done on the parameters of matching of forecasted data and historical data of the stock closing price over the data point.

The dataset has been analysed for testing and validation for various data points there is clear indication that the predicted value is in line with the actual value which is evident form figure 5.5, figure 5.6 and figure 5.7.

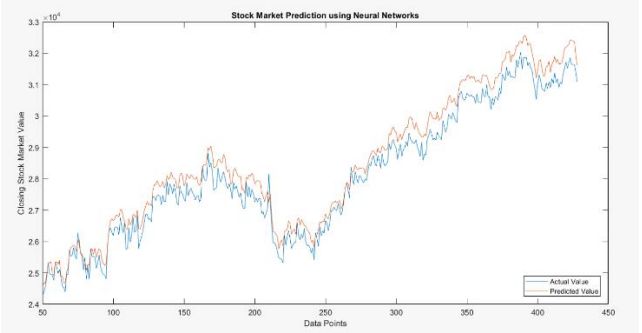

Figure 5.5 Correlation Between Actual and Predicted Value Phase-1

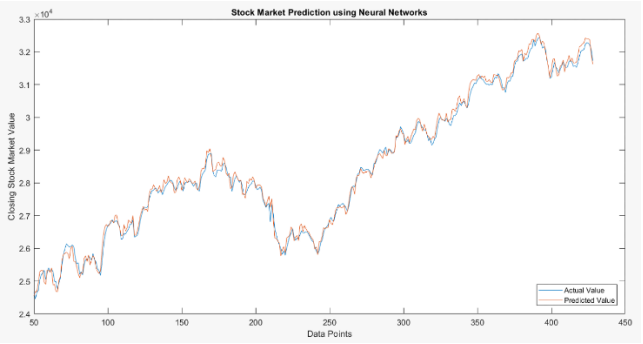

Figure 5.6 Correlation Between Actual and Predicted Value for Improved Network

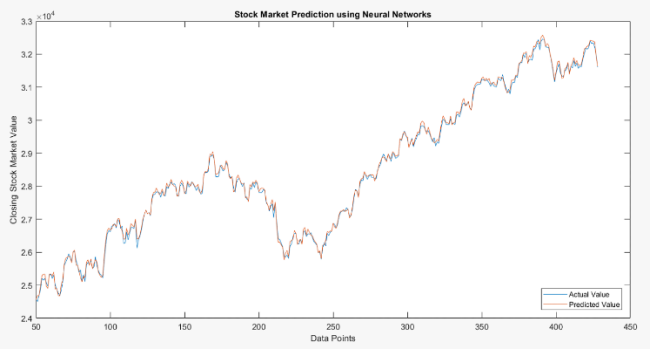

Figure 5.7 Analysis of Accuracy with Multiple Iterations

The goal of this work was to use artificial neural networks to predict the stock market (ANN). Stock market index prediction is a difficult assignment, but ANN has the potential to do so. It has been demonstrated that ANN is a realistic, universal approach for pattern recognition, categorization, grouping, and, in particular, for very accurate time series prediction. In this work, we tried to find the best structural design for an ANN that could accurately predict the daily closing prices movement in the NSE Nifty 50 Index of India. It is clear from the trials that if we offer appropriate data to train the neural network, it can correctly forecast market prices. ANN models were tested in MATLAB with multiple divisions of training patterns and different ANN parameter combinations. The performance is measured using the Root Mean Square Error.

6. CONCLUSION AND FUTURE SCOPE

Conclusion

The success of the stock market is a major factor in organizational growth, and this development has a significant direct impact on the nation's financial system. This study used artificial neural networks to try to forecast the stock market (ANN). The task of forecasting the stock market index is extremely difficult, yet ANN is capable of doing it. It has

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been demonstrated that ANN is an effective, all-encompassing method for pattern recognition, classification, clustering, and notably for time series prediction with a high degree of accuracy. In this paper, we made an effort to achieve an optimum structural design for ANN to predict the daily closing prices movement in NSE Nifty 50 Index of India with high degree of accuracy. It is obvious from the experiments that the stock prices can be correctly predicted by neural network if we provide appropriate data to train the network. ANN models have been experimented using various partitions of training patterns and different ANN parameters combinations using MATLAB. The daily data from 2 to April, 2021 have been used as the data set that included a total number of 1600 Aprox trading days. Root Mean Square Error is used to evaluate the performance. The three layered feedforward neural network model trained by backpropagation algorithm shows the prediction accuracy of 89.46% when rearmost 20% cases of data set deployed as test data with learning function "trainoss" of MATLAB. Therefore, it is observed that the ANN is an effective tool for the prediction of stock market. So it can be successfully applied to the forecasting of Nifty 50 daily closing price, as a result of which both investors as well as regulators can get attractive benefits.

Future Scope

As future work, in our study we selected three independent variables for the stock market prediction but other international financial factors like CPI (Consumer Price Index), WPI (wholesale Price Index), IIP (Index of Industrial Production) and interest rates etc. may also be included as inputs for the model to enhance the accuracy. The current study can be further extended by using genetic algorithm or fuzzy logic to improve the outcomes. We can also go through deep learning algorithm processes. One may explore the possibility of redefining training patterns, by applying n hidden layers in the architecture for better performance. The intended model may also be applied in mutual funds, exchange rates, interest rates, petrol prices and other financial market forecasting. The preeminent model can be further programmed and fabricated in a micro-controller and can be used as small Android application.

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