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Trading in Indian Stock Market Using ANN: A Decision Review

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Abstract

A stock market is a public market for trading the company's stock. Prediction provides knowledgeable information regarding the current status of the stock price movement. Hence, it can be utilized in decision making for customers in finalizing whether to buy or sell the particular shares of a given stock. Stock market forecasters focus on developing a successful approach for forecast or predict index values of stock prices. Since in stock market, data are highly time variant and are normally in a nonlinear pattern, pre predicting the future price of a stock is highly challenging. From the evolution of machine learning, researchers from this area are busy to solve this problem effectively. Many different techniques are used to build predicting system. Here we describe the different state of the art techniques used for stock forecasting and compare them with respect to their pros and cons. Many methods like technical analysis, fundamental analysis, time-series analysis etc are used to predict the price but none of these are proved as a consistently acceptable. Neural Network is the best technique till time to predict stock prices especially when some de-noising schemes are applied to a neural network. Artificial Neural Network (ANN), a field of Artificial Intelligence (AI), is a popular way to identify unknown and hidden patterns in data which is suitable for share market prediction. The past data of the selected stock will be used for building and training the models. The results from the model will be used for comparison with the real data to ascertain the accuracy of the model. In this approach, we use back propagation algorithm for training phase and multilayer feed forward network as a network model for predicting the price of a share.

Key words

Artificial neural networks**,** Multi-layer feed forward neural network, back propagation, the stock market.

1. Introduction

Stock market prediction is the act of trying to determine the future value of a company stock traded on an exchange. Share is the control of the company, divided into small parts and each part is called as Share or Stock. A stock exchange is a firm or mutual union which provides "trading" services for traders and stock brokers, to trade stocks and other securities. The stock market prediction has been an area of intense interest due to the potential of obtaining a very high return on the invested money in a very short time. It is possible to predict the future stock prices or indices with results that are better than random. Different modeling techniques have been used to try and model the stock market index prices. These techniques have been focused on two areas of forecasting, namely technical analysis, and fundamental analysis. The technical analysis considers that market activity reveals significant new information and understanding of the psychological factors influencing the stock price in an attempt to forecast future prices and trends. It has been used since a very long time but has had limited success. Recently, soft computing techniques are being increasingly employed. Artificial neural networks (ANNs) have been widely used in prediction of financial time series. This paper represents the idea how to predict share market price using Artificial Neural Network with a given input parameters of share market. Artificial Neural Network receives data of any number of years and it can predict the future price, based on the past data. Here we use Back propagation with feed forward architecture for prediction. The network was trained using more than five years of data. It shows a good performance for market prediction. The network selected though was not able to predict the exact value of a stock but it succeeded in prediction the trends of the stock market.

2. Prediction method analysis

Share Trading is basically an intuition. There are several methods used for predicting the stock market prices. As investing and trading grew with respect to time, people searched for advance tools and methods to increase their gain while minimizing their risk. Many methods like fundamental analysis, technical analysis and Time series analysis method have been used to attempt predictions of share prices but none of these methods have been proven as a consistently applicable prediction tool.

2.1 Fundamental analysis

Fundamental Analysis finds an intrinsic value of a stock and generates a buy signal if the current value of stocks is below intrinsic value. Here the market is defined 90% by logical and 10% by physiological factors but this analysis is not suitable for our study because the data it uses to determine the intrinsic value of an asset does not change on a daily basis and therefore is not suitable for a short-term basis. However, this analysis is suitable for predicting the share market only on a long-term basis.

2.2 Technical analysis

Technical analysis uses past market data, mainly price and volume information to make a prediction of future market movements. A technician used past price and volume data displayed in graphical form to make a decision about when the financial market will move in the future. All information related to the stock is reflected in the price. But the problem of these analyses is that the extraction of trading rules from the study of charts is highly subjective, as a result different analysts extract different trading rules studying the same charts. These analyses can be used to predict the market price on a daily basis but criticized due to its highly subjective nature.

2.3 Time series analysis

Time-series forecasting is a popular quantitative forecasting technique, in which data is gathered over a period of time to identify the future trends. These methods are one of the simplest methods to deploy and can be quite accurate, particularly over the short term. It is costly because the forecasts are based on the historical data patterns that are used to predict the future market behavior.

3. Literature review

R.K. Dase and Pawar D.D. in [1] tried to predict the stock rate because it is a challenging and daunting task to find out which is more effective and accurate method so that a buy or sell signal can be generated for a given stocks. Predicting stock index with traditional time series analysis proved to be difficult. An artificial neural network may be suitable for this task. Neural network has the ability to extract useful information from large set of data. In this paper the author also presented a literature review on application of artificial neural network in stock market Index prediction.

Halbert white in [2] provided some results of an on-going project using neural network modeling and learning techniques to search and decode nonlinear regularities in asset price

movements. He focused on IBM common stock daily returns. To deal with the salient features of economic data highlights, statistical inference played a vital role and requires modifications to standard learning techniques that may improve the prediction of trading.

Jing Tao Yao and chew Lim tan in [3] used Artificial Neural Networks for classification, prediction and recognition. Neural network training is an art of trading based on neural network outputs or trading strategy. Authors discussed a seven-step neural network prediction model building approach in this article. Pre and post data processing/analysis skills, data sampling, training criteria and model recommendation also covered in this article.

Tiffany Hui-Kuang and Kun-Huang Huarng in [4] used Neural Network because of their capabilities in handling nonlinear relationship and also implement a new fuzzy time series model to improve forecasting. The fuzzy relationship is used to forecast the Taiwan stock index. In the neural network fuzzy time series model input sample observations are used for training and out sample observations are used for forecasting. The drawback of taking all the degree of membership for training and forecasting may affect the performance of the neural network. To avoid this, they took the difference between the observations and thus reduced the range of the universe of discourse.

Akinwale adio T, Arogundade O.T and Adekoya Adebayo F in [5] examined the use of error in back propagation and regression analysis to predict the untranslated and translated Nigeria Stock Market Price (NSMP). The author used 5-j-1 network topology to adopt the five input variables. The number of hidden neurons determined the j variables during the network selection. Both the untranslated and translated statements were analyzed and compared. The Performance of translated NSMP using regression analysis gives better result than that of untranslated NSMP. The result was showed on untranslated NSMP ranged for 11.3% while 2.7% for NSMP.

David Enke and Suraphan Thawornwong in [6] used machine learning for data mining to evaluate the predictive relationship of numerous financial and economic variables. Neural network model used for estimation and classification are examined for forecasting the future price of the trade. A cross-validation technique was used to improve the generalization ability of several models. The trading strategies of classification models gives higher profits than the buy-and-hold strategy and guided by the level-estimation based on forecast of the neural network and regression models. The author decides to deploy the forecast of the stock dividends, transaction costs and individual-tax brackets to replicate the realistic investment practices.

Yi-Fan Wang, Shihmin Cheng and Mei-Hua Hsu in [7] used Markov chain concepts into fuzzy stochastic prediction of stock indexes to achieve better accuracy and confidence. In this paper they examined that in comparison to ANN, Hidden Markov model has major advantages. It

generates high accuracy result and requires only one input of data. The first hour's stock index data was used as the input and it lead the prediction of the probable index at any given hour. This approach did not require the standard deviation of the prediction. This approach provided not only improved profit performance but also used to determine the losses with greater confidence.

Md. Rafiul Hassan and Baikunthu Nath in [8] used Hidden Markov Models (HMM) approach to forecast the stock price for interrelated markets. HMM was used for pattern recognition and classification problems because of its suitability for modeling dynamic system. The author summarized the advantage of the HMM, which has strong statistical foundation. It's able to handle new data robustly and computationally efficient to develop and evaluate similar patterns. The author decides to develop hybrid system using Artificial Intelligence paradigms with HMM to improve the accuracy and efficiency of forecasting the stock market.

4. ANN model in time series forecasting

In Stock Market, prediction of share trading is a chaos system. There are many variables that could affect the share market directly or indirectly. For this kind of chaotic system, the Neural Network approach is suitable because we do not have to understand the solution. The main characteristics of ANN is not only learning by means of examples but also generalizing from learned information. This is a major advantage of Neural Network approach. An Artificial Neural Network is a set of interconnected links that have weights associated with them. The concept of Artificial Neural Network was derived from biological Neural Network. Neural Network opens up a new foray into the field of making an efficient and usable prediction in order to optimize profits. ANN is a set of interconnected units broadly categorized into three layers. These three layers are the input layer, the hidden layer, and the output layer. Inputs are fed into the input layers, and its weighted outputs are passed onto the hidden layer. The neurons in the hidden layer are essentially concealed from view [Fig-1]. The artificial neuron operates in the following manner.

i. Signals are submitted to the inputs of the network,

ii. Each signal is multiplied by its respective synaptic weights,

iii. A sum between the weighted input signals and the neuron threshold value is calculated,

iv.This information is processed by the neuron activation function, producing an output.

Fig1: Mathematical model of ANN.

Using additional levels of hidden neurons provides increased flexibility and more accurate processing. It costs more if the hidden layer neurons get increased. The cost of extra complexity

in the training algorithm provides more flexibility. Increasing the number of hidden neurons is unnecessary, as less number of neurons would serve our purpose. On the other hand, less hidden neurons than required would cause reduced robustness of the system, and defeat its purpose.

For our system, there is a training phase where the weights are found from this section and Back-propagation algorithm is used to train the network. These weights are used in prediction phase using same equations which are used in the training phase [9]. This is the basic architecture of our system and this approach is known as Feed Forward Network. There are a lot of inputs in share market. But all the inputs are not used in our system because their impacts are not significant in share market price. We collect the stock price for Reliance Capital from NSE, India from January,2010 to December, 2014. We need five inputs for the system. Those are Open, Close, Low, High and Volume.

5. Back propagation with feed forward neural network

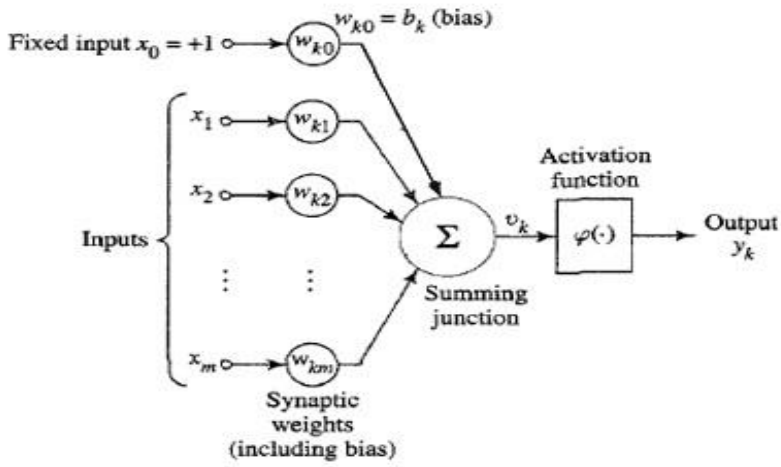

Fig.1. Back Propagation with Feed Forward Neural Network

Back propagation is a form of supervised learning for multi-layer networks. In this paper, we apply Back propagation feed forward NN to the stock market in order to search the trend of the price. It aims to predict the future trend of the stock market and the fluctuation of price. This makes use of Back Propagation Neural Network algorithm to predict the stock market by establishing a three-tier structure of the neural network, namely input layer, hidden layer, and an output layer. Back-propagation algorithm is basically the process of back-propagating the errors from the output layers towards the input layer during training sessions. Back-propagation is necessary because the hidden units have no target values which can be used, so these units must be trained based on errors from the previous layers.

The output layer has a target value which is used to compare with the calculated value. As the errors are back propagated through the nodes, the connection weights are continuously updated. Training will continue until the errors in the weights are adequately small to be accepted [10]. On the other hand, the computational complexity of Back propagation Algorithm is only O(n). These features of the algorithm are the main criteria for predicting share prices accurately. The main steps using the Backpropagation algorithm as follows:

Step 1: Feed the normalized input data sample, compute the corresponding output.

Step 2: Compute the error between the output(s) and the actual target(s).

Step 3: The connection weights and membership functions are adjusted.

Step 4: IF Error > Tolerance THEN goes to Step 1 ELSE stop.

6. Neural Network Application Development

The development process for an ANN application has eight steps.

Step 1: (Data collection) The data to be used for the training and testing of the network are Collected for "Reliance Capital" from NSE, India for Sixty months.

Step 2: (Training and testing data separation) The available data are divided into training and testing data sets. More than four years of data has been taken as Training and Testing data and six months data has been chosen as validation of the purposed network. For a moderately sized data set, 70% of the data are selected for training, 15% for testing, and 15% secondary testing (validating).

Step 3: (Network architecture) Multilayer feed forward artificial neural network architecture and a learning method is selected. There are four numbers of perceptrons and ten numbers of hidden layers are used.

Step 4: (Parameter tuning and weight initialization) The parameters are set for tuning the network to the desired learning performance level i.e learning by minimum Mean Square Error. Part of this step is the initialization of the network weights and parameters, followed by modification of the parameters as training performance and corresponding feedback is received. The initial values are determining the effectiveness and length of training.

Step 5: (Data transformation):- The collected data samples are normalized first. Then transforms the normalized data into the type and format required by the ANN.

In the propagation phase, the input data is normalized for feeding the network into the input nodes using the formula:

$V'' = \text{Normalized} \quad \text{Input}$

$V = Actual \quad \text{Input}$

$V'' = [(V - A_{min})/(A_{max} - A_{min})](New\_A_{max} - New\_A_{min}) + New\_A_{min}$ Where,

$A_{min}, A_{max} = Boundary$ Values of the old data range.

$New\_A_{min}, New\_A_{max} = Boundary$ Values of the new data range. In this case, it is -1 and 1 because the back propagation can only handle data between –1 to +1.

Step 6: (Training) Training is conducted iteratively by providing the input and the desired or known output data to the ANN. The ANN computes the outputs and adjusts the weights until the computed outputs are within an acceptable tolerance of the known outputs for the input cases. For this purpose, we use Back Propagation Algorithm to adjust the weights and continue this until minimize the Mean Square Error. Here we use the Sigmoid Activation function to compute the desired output.

*Step 7: (Testing) O*nce the training has been completed, it is necessary to test the network. The testing examines the performance of the network using the derived weights by measuring the ability of the network to classify the testing data correctly.

Step 8: (Implementation) Now a stable set of weights are obtained. Using the validation data inputs the network can reproduce the desired output. The network is ready to use as a stand-alone system where new input data will be presented to it and its output will be a recommended decision.

7. Results and Discussion

This article is a part of a project which studies a decision support system using ANN for stock trading. The literature review presents numerous previous works concerning Neural Network based in decision making process. Therefore, in future we hope to be able to enhance it in fuzzy if-then rule or SVM with GA by using more input variables in order to make it more efficient and precise. It would be a good effort if we have to develop a functional system by using this fuzzy rule. We used MLP neural network with back propagation algorithm to predict future stock price.

For different combinations of input values, the model varies. Now it gives a ‘performance curve’, ‘error curve’ and ‘output graph’. For different combinations of data and parameters, this performance curve varies. Training of the model stops either it reaches to the mentioned number of epochs or when Mean Squared Error (MSE) is almost never improving after certain epochs [fig.2].

After 7 epochs we get the best validation performance curve with no further improvement of the MSE.

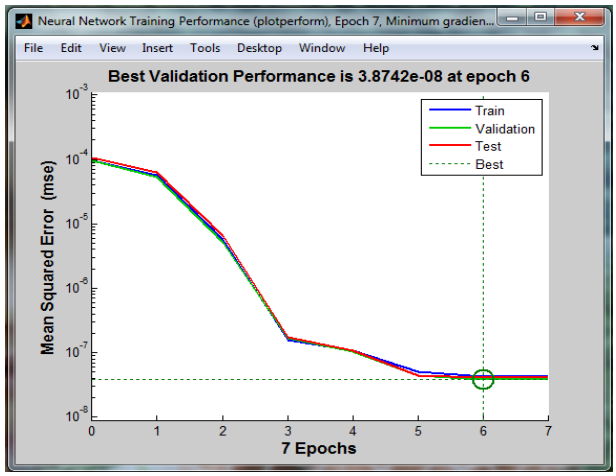

Fig.2. Validation Performance with MSE

The circle in the performance curve shows the best validation performance. Also, we got the best regression value 0.996. but while we use the data sets without normalization in the same network, we got the regression value in around 0.866.

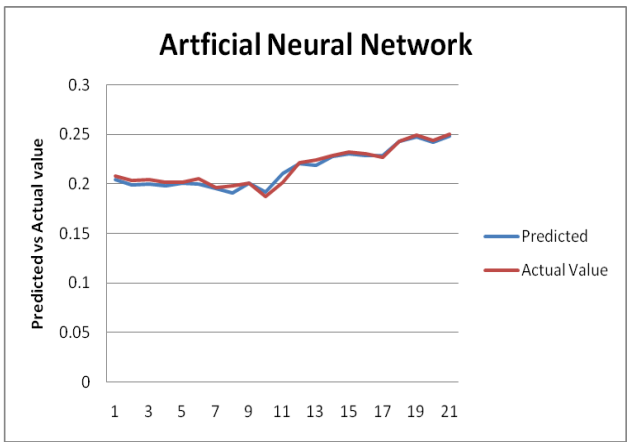

Fig.3. Best Results from Actual and Predicted Value.

While comparing the actual value with the predicted value, we find both the curves are almost touching each other which indicates that the prediction is mostly accurate.

Conclusions

ANNs are efficiency methods in the area of stock market predictions, and in this paper, we tried to sum up the application of Artificial Neural Networks (ANN) for predicting the stock market. We described the theory behind ANNs and our Neural Network model and its salient features. Back propagation algorithm is the best algorithm to be used in Feed forward neural network because it reduces an error between the actual output and the desired output in a gradient

descent manner. Thus, we can see that Neural Networks are an effective tool for stock market prediction and can be used on real world datasets. ANN have shown to be an effective, general purpose approach for pattern recognition, classification, clustering and especially time series prediction with a great degree of accuracy.

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