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Applications of Artificial Neural Network in Forecasting of Stock Market Index

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Abstract: **Prediction in any field is a challenging and unnerving process. Stock market is a promising financial investment that can generate great wealth. However, under the impact of Globalization Stock Market Prediction (SMP) accuracy has become more challenging and rewarding for the researchers and participants in the stock market. Artificial Neural Networks (ANN) have been found to be an efficient tool in modeling stock prices and quite a large number of studies have been done on it. ANN modeling of stock prices of selected stocks under NSE is attempted to predict the next day's price. The network developed consists of one input layer, hidden layer and output layer with four, nine and one nodes respectively. The input being the closing price of the previous four days and output being the price for the next day. In the first section the adaptability of neural networks in stock market prediction is discussed, in the second section we discuss the traditional methods that were being used earlier for stock market prediction, in the third section we discuss the justification for using neural networks and how it is better over traditional methods, in the fourth section we discuss the basics of neural networks, section five gives an overview of data and methodology being used, in section six we have discussed the various forecasting errors methods to calculate the error, in section seven we have presented our results. The aim of this paper is to provide an overview of the application of artificial neural network in stock market prediction.**

Keywords: **Artificial Neural Networks, Back propagation, Feed Forward Network, Stock Index, Stock Market Prediction, and Stock Price.**

I. INTRODUCTION

Stock market is a public market in which companies list their stock and gather financial resources by trading their stock with an agreed price. In return, the stockholder receives yearly dividend or portion of the company's profit. Trade in stock market means the transfer of money of a stock from a seller to a buyer. This requires these two parties to agree on a price. Stock market participants includes small individual investors to large stock traders investors, who can be based anywhere in the world and these may include banks, insurance companies or pension funds. A stock exchange trader may execute buy or sell orders on behalf of the company.

Some of the popular stock markets where the investors can invest include New York Stock Exchange (NYSE), NASDAQ, Bombay Stock Exchange (BSE), London Stock Exchange, Philippines Stock Exchange, Toronto Stock Exchange and many others.

There are two kinds of stocks that are traded. Shares and stocks. Both Shares and stocks documents issued by a company. Share is directly issued by a company through an act called Initial Public Offering (IPO) or it can be purchased through the stock market. A person can earn a portion of the company's profit called the dividend, by owning a share of that company. Trading facilities are provided for stock brokers and traders to trade stocks and other securities by a mutual organization called Stock Exchange. Thus, providing a marketplace.

An index is a statistical composite measurement of the overall movement in the industry. The performance of a group of companies over a time period is measured using a parameter called Indexes. Stock market indices are the price indices that capture the movement of the prices in a market.

In this paper we are using the companies listed under the NIFTY-50. Nifty is Index of NATIONAL STOCK EXCHANGE (NSE) of India, which comprises top 50 listed companies of 23 different Sectors. NSE is the leading stock exchange of India, located in Mumbai. Established in 1992, NSE was the first demutualized electronic exchange in the country. Also, NSE was the first exchange in the country to provide a trading system which was modern and fully automatic screen based trading system which offered easy trading facility to the investors spread across country. Some of the companies under NIFTY-50 include Bharti Airtel, Coal India, Maruti Suzuki, Tata Motors, HDFC Bank, Ambuja cement etc.

II. TRADITIONAL STOCK MARKET PREDICTION TECHNIQUES

Many Traditional methods have been devised and applied to predict the moving price and closing price of the Stock Market. Efficient Market Hypothesis (EMH) and Random Walk theory are the two most important conventional theories used in traditional stock market prediction.

1. ***Efficient market Hypothesis:*** The EMH was introduced by Fama in 1964. According to EMH the future price of the stock is unpredictable based on historical data. The unbalanced stock is immediately discovered and quickly eliminated by the change in price, as new data enters the system. The EMH exists in three forms which depends of the information used to predict the stock price:

i. ***Strong EMH-*** All the data including historical, public and private info about the stock is used to predict the future price of that stock.

ii. ***Semi-Strong EMH-*** All the current public info about the stock is used besides the historical data.

iii. *Weak EMH-* Historical data is used to predict the stock price. The 'weak' form of EMH states that the previous historical data cannot be used to predict the future price.

2. ***Random walk Theory:*** The random walk theory states that stock prices do not depend on the previous stock. Trading companies, now with the advent of new and powerful computer hardware and infrastructure are trying to build algorithmic trading system which can determine the underlying price patterns efficiently. With huge data sets machine learning techniques can outrun the EMH.

Technical Analysis or technical trading rule and Fundamental Analysis are the two conventional approaches to stock market prediction.

i. ***Technical Analysis*****:** The technical analysis which uses charts as primary tools, is a time series approach to predict the stock price. This approach tries to use data mining technique to mine information from the historical data in order to recognize the pattern which it has discovered. Sometimes, referred as mining of financial time series. Many methods have been devised and research is still going on the grounds of these conventional rules. Technical analysis is based on the hypothesis which states that 'all reaction to all the news is contained in the price of the stock'. Thus, it ignores the news. The main concern of this conventional technique is to identify the existing trends of the stock and predict the future trend from the chart of that stock. The charts contains only the vents and not the cause of why it happened. Technicians use the historical data to study the trend of ac stock in order to predict the trend in the future.

ii. ***Fundamental analysis*****:** It is the study of factors which affect supply and demand. It states that gathering of information and interpretation is the main process involved in predicting the stock price. This conventional technique utilizes the time gap between the occurrence of an event and the response of the market to that event. The important data used in this technique is the economic data of companies, balance sheets, auditor's reports, income statements etc. News also plays an important role as news also effects the demand and supply. This technique is concerned more about the company rather than the stock. In this technique the price of a stock can predicted through the basics of financial numbers. These numbers are derived from the company itself or the overall economy of that company. When applying the data mining and machine learning technique, we are concerned in doing a technical analysis to check if our algorithmic approach can accurately learn the pattern that underlie in the stock market time series. This being said, machine learning can play a major role in evaluation and prediction of performance of a company.

Due to the advent of powerful computer hardware and infrastructure, there has been a massive increase in the computational power of computer systems which can now compute larger data more accurately and within a short time, these conventional techniques are now becoming inferior. However, these conventional techniques still serve as the base of new artificial intelligent approaches. Some of the most successful and powerful automated stock market prediction systems use hybrid analysis model which involves both, fundamental and technical analysis.

III. JUSTIFICATION OF USING ARTIFICIAL NEURAL NETWORKS IN FORECASTING STOCK PRICES

The stock market behaves differently at different times depending on the trend and other factors (like political events, scandals, hype, supply and demand, natural calamities and disasters which affect the stock market. Such factors are undeterminable.). Sometimes, the market may seem to react irrationally to financial news even if that news has no fundamental effect on the stock market. The nature of the stock market is non-linear and volatile. Many researchers claim that stock market is a chaos system. Irregular fluctuations make chaos system a non-linear deterministic system which appears random. These systems are highly sensitive to initial conditions of the system. Since, Neural networks make a very few assumptions about the functional form of the underlying the underlying dynamic dependencies and their initial conditions. Thus, are effective in learning such non-linear chaotic systems.

Trading shares is big business in many economies. Based on the information given on their websites, most of the stockbrokers doesn't seem to have any king of intelligent tool which can help them to advice their clients what stock to buy or sell and at what price. These websites provide information that uses fundamental, technical and time series analysis method. These methods show a trend on future movement and not on the likely price of any stock in the future. It is therefore desirable to have a tool that just does not provide a direction of the price movement, but also provides most likely price of the stock itself.

Since ANNs have the ability to deal with fuzzy and uncertain data fluctuating in small interval of time, they have proved to be very efficient method used in prediction of stock market. Neural Networks have a built in capability through which they can adapt from the network parameters to the changes that occur in the studied system. Moreover, the neural network can change its network parameters in real time when the system under study is non stationary and dynamic in nature. An ANN model can be used to develop such predictive tool.

The application of ANNs in prediction problems is very promising due to some of their characteristics:

1. Even if the relationship between the input and output might be very complicated, ANNs can find the relationship between them because they are general function approximations. There may exist problems in which extracting the relationships among data is really difficult. Artificial neural networks are well applied to such problems.

2. ANNs have generalization ability which means that once trained, they can recognize the new patterns even if they haven't been in the training set. Since, predicting future events (unseen data) is based on previous data (training set) in most of the pattern recognition problem. In such problems the application of artificial neural networks can prove to be very beneficial.

ANNs have claimed to be general function approximations. It is proved that an MLP neural network can approximate any complex continuous function that enables us to learn any complicated relationship between the input and the output of the system.

IV. ARTIFICIAL NEURAL NETWORKS

'Neural' is an adjective for neuron and 'Network' is a structure similar to a graph. Artificial neural networks, an important aspect of cognitive design and machine learning is based on the biological neural networks. The main processing unit of the human brain is a neuron. The neuron consists of dendrites. Dendrites are responsible for receiving signals from the Axon of another cell and axons are the part which carries out the signal from one cell to another. A neuron collects signals from the dendrites. When the strength of the signal exceeds some threshold value, the neuron sends an impulse called an action. Fig. 1 is a representation of a biological neuron.

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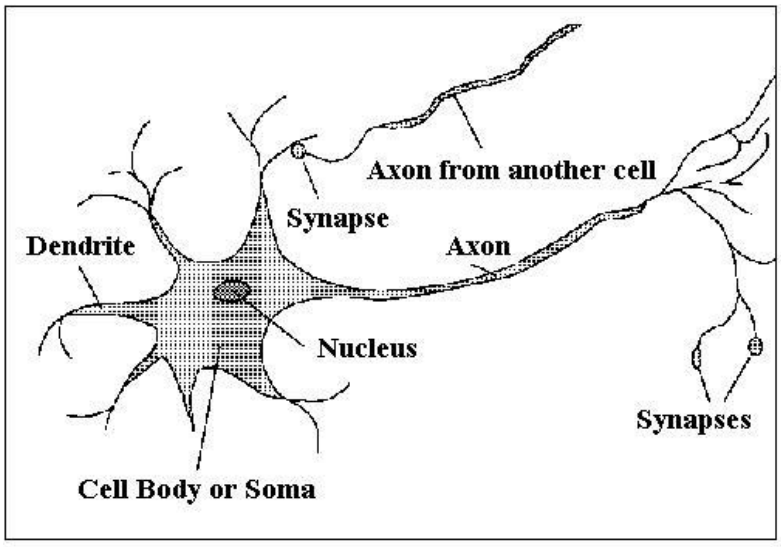

Figure 1. Biological Neurons

NN is actually an information processing system. It consists of a graph representing the processing system as well as various algorithms that access that graph. ANNs are also referred as 'Neural Nets'. Artificial neural networks works in the same way as the biological neuron. They receive an input and sends an output. However, they do not model their biological counterparts. Artificial neurons receive their inputs from other neurons and sends the signal when particular condition is met. Biological neurons have a memory bank in which they store the information. However, the case of artificial neural networks is different. The information is distributed throughout the network and then it is stored in the form of weighted interconnections. Fig. 2 shows the representation of an artificial neural network. The nodes are like individual neurons while arcs are their interconnections. Each of these processing elements functions independently from the other and uses only local data to direct its processing.

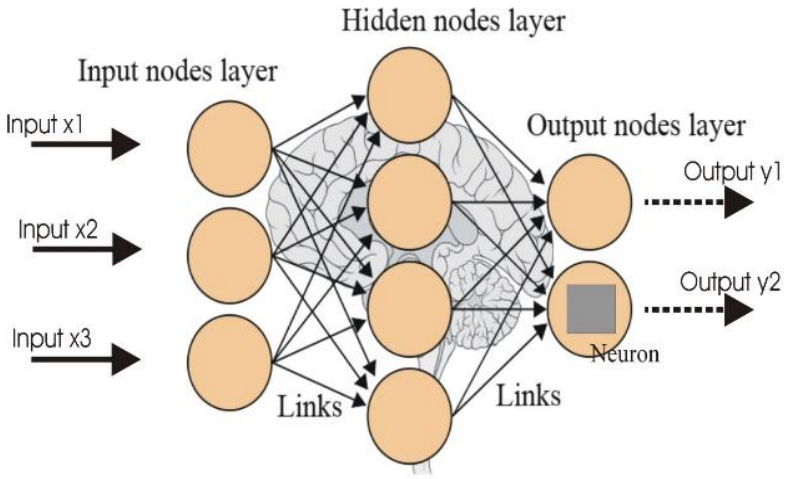

Figure 2. Artificial neural network

The NN approach, like the decision tree requires that a graphical structure to be built to represent the model and then that the structure be applied to that data. NN can be viewed as directed which is distinguished in three hierarchical layers, namely:

i. ***Input layer*****:** There occurs no processing of data at this layer. The input layer takes the input and passes it to the next layer.

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ii. Hidden layer: An artificial neural network can contain more than one hidden layer. The hidden layer or middle layer is the layer where all the complexity of the ANN resides. The computations are carried out in this layer. The number of layers increases the complexity of the ANN.

iii. Output layer: This is the layer which receives the input from the middle layer after all the computations have been done.

To perform the data mining task, a tuple is input through the input nodes and what the prediction is, is determined by the output nodes. Unlike decision trees, which have only one input node, the NN has one input node for each attribute value to be examined to solve the data mining function. Unlike decision trees, after a tuple is processed, the NN may be changed to improve the future performance. In addition to solving complex problems. NNs can "learn" from prior applications. That is, if a poor solution to the problem is made, the network is modified to produce a better solution to this problem the next time.

The interconnections between the neurons are called weights. Fig. 3 shows a simplified neuron.

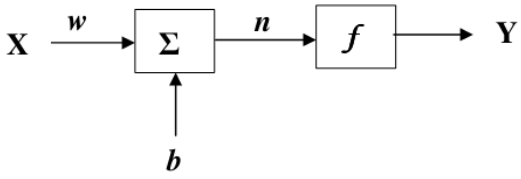

Figure 3. A simplified Neuron

A Neuron consists of a set of input variables: {Xi}. i=1, 2, 3….n. and a set of one or more output variables: {Yj}. j=1, 2, 3….m. The overall input to the neuron is calculated by:

$$n= \sum_{i=0}^{n} w_i X_i$$

Where Xi represents input to the neuron and wi represents the weight to the neuron and b is the threshold value.

An activation is sometimes called a processing element function or a squashing function. The function is applied to the set of inputs coming in on the input arcs. An activation function may also be called a firing rule, relating it back to the workings of the human brain. When the input to a neuron is large enough, it fires, sending an electric signal out on its axon. Likewise, in an ANN the output may be generated only if the input is above a certain level. The input is mapped to the output variables by using some special functions known as activation or threshold functions. An activation function f_i, is applied to the input values $\{x_{1i} \ldots . x_{ki}\}$ and weights $\{w_{1i}, \ldots \ldots, w_{ki}\}$. these inputs are usually combined in a sum of products form:

$S = (\sum_{h=1}^{k}(w_{hi}x_{hi}))$

If a bias input exists, this function formula becomes

$S = w_{0i} + (\sum_{h=1}^{k}(w_{hi}x_{hi}))$

Following are the activation functions:

i. *Linear:* A linear activation function produces a linear output value based on the input. The following is the typical activation function:

$f_i(S)=cS$

ii. *Threshold or step*: The output value is either 1 or 0, depending on the sum of the products of the input values and their associated weights. Fig (a) represents the threshold activation function. Values above threshold, T will be 1 or 0:

$$f_i(S)=f(x) = \begin{cases} 1, & if\ S > T \\ 0 & otherwise \end{cases}$$

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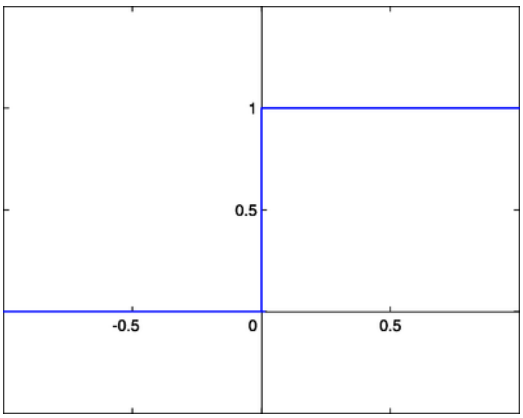

Figure (a). Threshold function

iii. *Sigmoid:* As seen in fig. (b), this is an 'S' shaped curve with output values between -1 and 0 (or 0 and 1). Although there are several types of sigmoidal functions, they all have this characteristic "S" shape. A common sigmoid functions is:

$f_i(S)=\frac{1}{1+e^{-cS}}$

Here c is a constant value that changes the slope of the function.

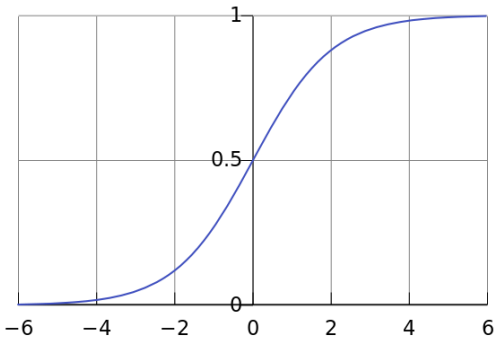

Figure (b).

iv. *Hyperbolic tangent function:* A variation of the sigmoid function is the hyperbolic tangent function. It is represented as:

$f_i(S)=\frac{1-e^{-S}}{1+e^{-cS}}$

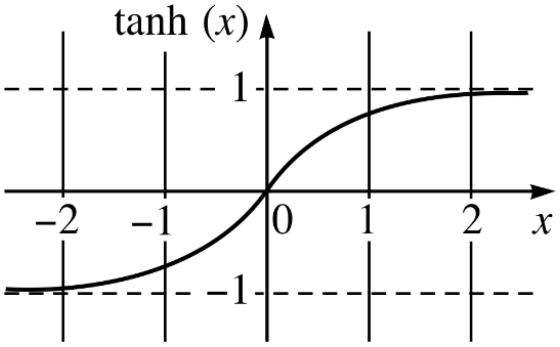

Figure (c).

v. *Gaussian:* The Gaussian function fig. (d), is a bell shaped curve with output values in the range [0, 1]. A typical Gaussian function is:

$f_i(S)=e^{\frac{-s^2}{v}}$

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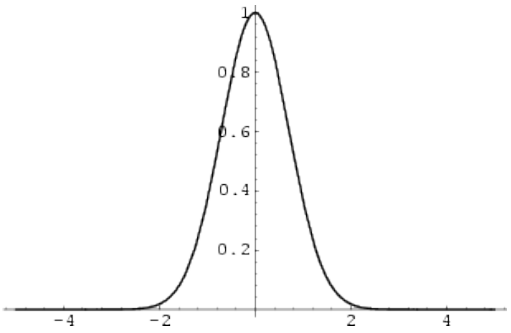

Figure (d).

V. DATA AND METHODOLOGY

The data that has been employed in this study consists of daily closing price of S&P Nifty 50 index. The data set encompassed the days from 1st January 2006 to 31st March 2016. The data is collected from Yahoo Finance.

In this paper Feed forward Network has been used as the network model and Back propagation Algorithm is used for learning. The activation function used is the sigmoidal function:

$$f_i(S)=\frac{1}{1+e^{-cS}}$$

a. ***Feed Forward Network*****:** There exist many combinations of neurons that can creates different types of neural networks. However, the most simple and widely used type of neural network is the feed forward neural network. Which consists of three parts. A layer of input nodes, a layer of input neurons and a layer of output nodes. In this type of network there is a neuron for each input variable which is then propagated to the hidden layer neurons. Fig. 4 shows a simple feed forward network.

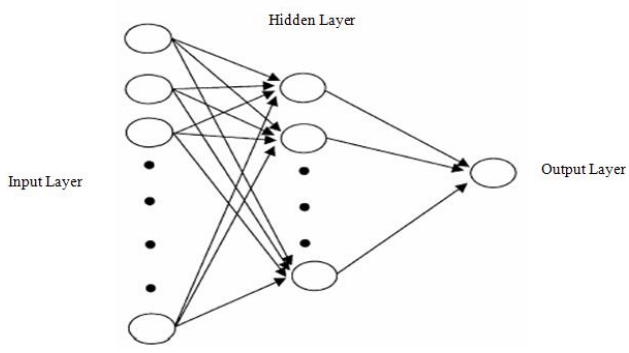

Figure 4. Feed forward network

The input layer nodes takes the input from the software's interface. Values from the input are fed left to right through hidden layers. The output values are obtain from the output nodes. Each neuron in the hidden layer is multiplied by weight of the interconnection between nodes and then it is summed up. After this the value is passed to the activation function (sigmoid function in this case) and then each neuron in the hidden layer passes the output to the nodes in the output layer.

b. ***Training:*** Training is the process through which the weights (free parameters) of the network get their optimal values. Fig. 5 shows the way a network is trained. MLP and GFF type of networks use supervised learning techniques. In such models input signals are distributed among the network by the input units. Each sample consists of two parts. Input and the target (Learning system or algorithm). The weights of network are assigned with random values initially. These random values assigned to the weight are within [-1, 1]. A first set of input is presented to the neural network and computations are performed. After the computation the output is obtained. The output generated is compared with the target value and the weights are adjusted in such a way that the error between the target value and the obtained value is minimum.

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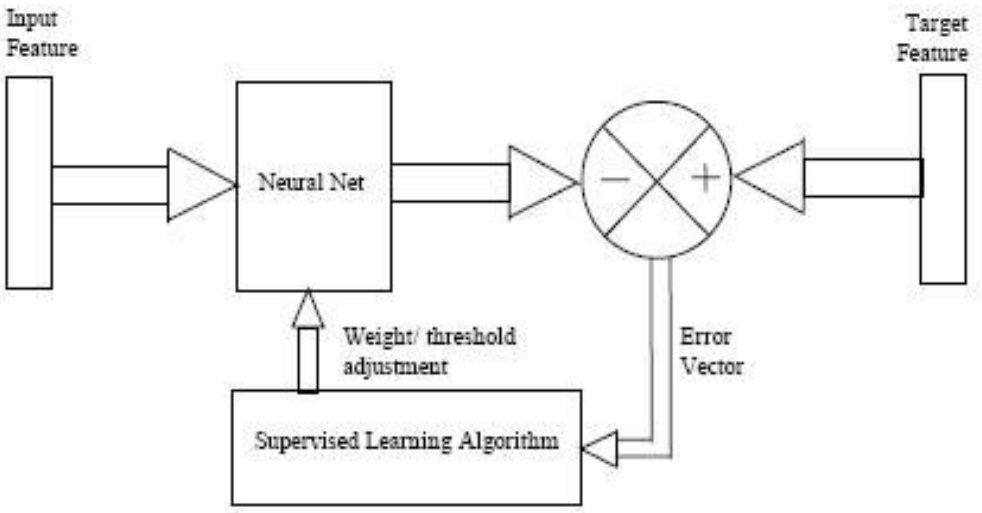
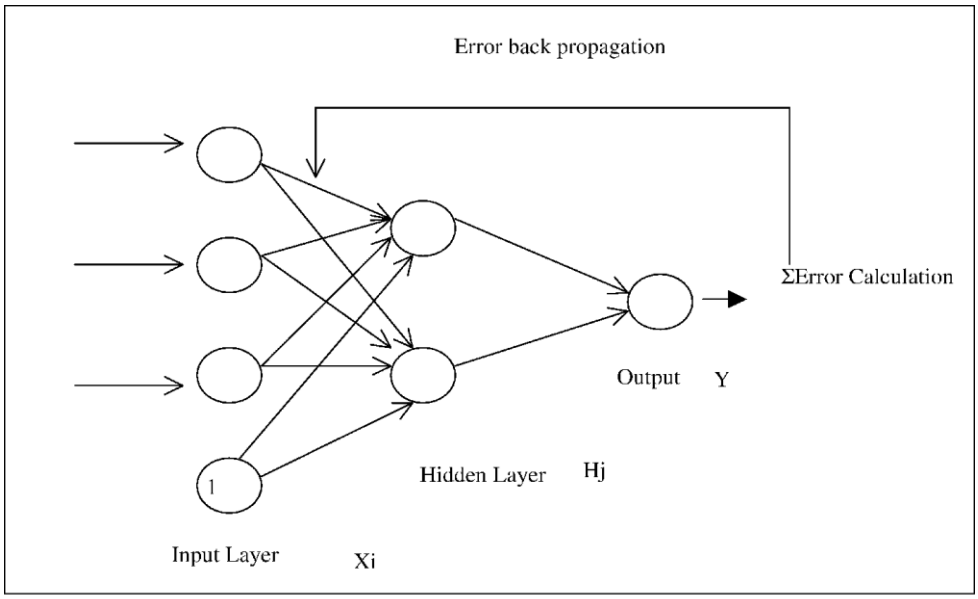


Figure 5. Training process of neural network

Supervised learning in an NN is the process of adjusting the arc weights based on its performance with a tuple from the training set. The behavior of the training data is known a priori and thus can be used to fine tune the network for better behavior in the future. Thus, the training set can be used as a 'teacher' during the training process. The output from the network is compared to this known desired behavior of the network. The supervised learning algorithm used in this paper is the back propagation algorithm.

There are two major categories of network training. Namely, Batch training and Incremental Training. In the former one, the weights of the network are adjusted each time that each one of the input samples are presented to the network. However in the later one, the weights are adjusted only when all the training samples have been presented to the network. The number of times that the training set will be fed to the network is called number of ***epochs.***

c. ***Back Propagation algorithm:*** Fig. 6 depicts the back propagation algorithm. Back propagation is a learning technique that adjust the weights in the NN by propagating weight changes backward from the output nodes to the input nodes. Back propagation is the most well-known form of leaning because it is easy to understand and is generally applicable.



Notes: The weight connecting node *i* in the input layer to node *j* in the hidden layer is denoted by *Wji*, and the weight connecting node *j* to the output node is represented by *Vj*

Figure. 6 Back Propagation

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Algorithm for Back Propagation is as follows:

1. Accept the input.
2. Perform its weighted summation.
3. Apply it to the input layer neurons.
4. Process all the inputs at each neuron by using the transfer function.
5. Repeat steps 1-4 and forward the output from the input layer as the input to the hidden layer neurons.
6. Forward the output from the hidden layer to all the output layer nodes as input.
7. Calculate the output.
8. Calculate the error between the output value and the target value.
9. Check if the error value is greater than the minimum value (tolerance).
10. If the error is greater than the tolerance, then adjust the weights on the arcs. So as to minimize the error in the next output. Repeat steps 1 to 10. Else go to step 11.
11. Stop.

For how many ***epochs*** (an epoch is completed when all training patterns have been read in exactly one) should a network be trained? Mainly two prototypes exist, late and early stopping. Late stopping means the network is trained until a minimum error on the training set is reached which means network is over fitted. The training set is split into two parts which are- a new training set and a validation set, in early stopping. Gradient descent is applied to the new training set. The network is evaluated on the validation set after each sweep through the new training set. This technique is a simple but efficient hack to deal with the problem of over fitting.

VI. EVALUATION OF FORECASTING ERROR

The neural networks built in this study are designed to provide the closing price for the stock for the next five days. The data set being used in this study are the stocks from the National Stock Exchange (NSE). The stocks being studied are Tata Consultancy Services, Hero Motocorp Ltd., Dr Reddy's Laboratories, HDFC Bank and Maruti Suzuki. The data being used is dated from 1st January 2006 to 31st March 2016. The network utilizes the dynamic back propagation model and implements a logistics sigmoid function as the activation function.

The network consists of four input neurons, $2n + 1$ hidden neurons which are eleven hidden neurons and one output neurons in the three respective layers which are namely input, hidden and output layers.

To measure the performance of the neural network model used, Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Root Mean Squared Error (RMSE) were calculated. Suppose that (p1, p2, p3….pn) are the predicted values and (a1, a2, a3….an) and are the predicted values. Then, MAPE, MAD and RMSE are calculated as:

$$\text{RMSE}=\sqrt{mean(a_i - p_i)^2}$$

$$\text{MAPE}=100*\frac{1}{n}\sum\left|\frac{a_i - p_i}{a_i}\right|$$

$$\text{MAD}=\frac{\sum|a_i - p_i|}{n}$$

VII. RESULT

Using the developed neural network system to predict the future stock values with MLP an analysis is done to measure the performance of the dynamic back propagation algorithm. By using the past stock prices of select companies under NSE Nifty-50 we tried to predict the future price of the stock for the next five days. Table I displays the comparison between the actual value and the predicted value and the forecasting error between the actual value and the predicted value.

TABLE –I ACTUAL VALUES VS PREDICTED VALUES OF STOCK PRICE

Company Name	Date	Actual Value	Predicted Value	Forecasting Error
Tata Consultancy Services ltd.	23-Apr-2016	2417	2433	0.661%
	02-Nov-2015	2517	2497	0.794%
	29-May-2015	2610	2580	1.149%
	25-Dec-2014	2479	2481	0.0806%
	23-Jul-2014	2582	2529	2.323%
Maruti Suzuki Ltd.	23-Apr-2016	3816	3829	0.340%
	02-Nov-2015	4482	4509	0.602%
	29-May-2015	3882	3896	0.360%
	25-Dec-2014	3333	3335	0.060%
	23-Jul-2014	2498	2453	1.801%
Dr Reddy's Laboratories Ltd.	23-Apr-2016	3141	3145	0.127%
	02-Nov-2015	4335	4281	1.245%
	29-May-2015	3538	3528	0.282%
	25-Dec-2014	3143	3147	0.127%
	23-Jul-2014	2704	2739	1.294%
Hero Motocorp Ltd.	23-Apr-2016	2997	2976	0.7007%
	02-Nov-2015	2582	2557	0.968%
	29-May-2015	2701	2678	0.851%
	25-Dec-2014	2096	2082	0.667%
	23-Jul-2014	2538	2519	0.748%
HDFC Bank Ltd.	23-Apr-2016	1092	1076	1.373%
	02-Nov-2015	1084	1069	1.383%
	29-May-2015	1036	1048	1.158%
	25-Dec-2014	948	959	1.160%
	23-Jul-2014	842	852	1.187%

VIII. CONCLUSION

In our study ANN technique has been implemented to forecast the stock prices for selected sectors under National Stock Exchange (NSE). The input used is the closing price for the previous four days. The predicted results demonstrate that artificial neural network has been able to predict stock prices with better accuracy if we increase the number of input data. It is conclusive that neural network models have outperformed the traditional methods of prediction. Various techniques can be used for pre-processing of data. Also, algorithms can be combined with neural networks to improve the accuracy. Yet the result is not 100% accurate but lot of improvement has been done.

REFERENCES

[1] Sneha Soni, Applications of ANNs in Stock Market Prediction: A Survey, *International Journal of Computer Science & Engineering Technology (IJCSET), 2014.*

[2] J. G. Agrawal, Dr. V. S. Chourasia, Dr. A. K. Mittra, State-of-the-Art in Stock Prediction Techniques, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 2, Issue 4, April 2013.*

[3] A. Victor. Devadoss, T. Antony Alphonnse Ligori. Head and Associate Professor, Department of Mathematics,Loyola College, Chennai, India. Ph. D Research Scholar, Department of Mathematics,Loyola College, Chennai, India. Stock Prediction Using Artificial Neural Networks, *International Journal of Data Mining Techniques and Applications Vol:02, December 2013, Pages: 283-291.*

[4] Debashish Das and Mohammad Shorif Uddin, Data Mining and Neural Network Techniques in Stock Market Prediction: A Methodological Review, *International Journal of Artificial Intelligence & Applications (IJAIA), Vol.4, No.1, January 2013.*

[5] Adebiyi Ayodele A., Ayo Charles K., Adebiyi Marion O., and Otokiti Sunday O, Stock Price Prediction using Neural Network with Hybridized Market Indicators, *Journal of Emerging Trends in Computing and Information Sciences, VOL. 3, NO. 1, January 2012.*

[6] Selvan Simon and Arun Raoot, ACCURACY DRIVEN ARTIFICIAL NEURAL NETWORKS IN STOCK MARKET PREDICTION, *International Journal on Soft Computing (IJSC) Vol.3, No.2, May 2012.*

[7] Zabir Haider Khan, Tasnim, Md. Akter Hussain, "Price Prediction of Share Market using Artificial Neural Network (ANN)", *International Journal of Computer Applications (0975 – 8887) Vol.22 No.2, 2011.*

[8] Aghababaeyan R., and N. TamannaSiddiqui. Forecasting the Tehran Stock Market by Artificial Neural Network. *International Journal of Advanced Computer Science and Applications, Special Issue on Artificial Intelligence, 2011.*

[9] Gomes, G. S., T. B. Ludermir, and L. M. Lima. Comparison of New Activation Functions in Neural Network for Forecasting Financial Time Series. *Neural Computing and Applications 20(3):417-439, 2011*.

[10] Dase R.K. and Pawar D.D., "Application of Artificial Neural Network for stock market predictions: A review of literature" *International Journal of Machine Intelligence, ISSN: 0975–2927, Volume 2, Issue 2, 2010, pp-14-17.*

[11] Phaisarn Sutheebanjard and Wichian Premchaiswadi, "Stock Exchange of Thailand Index predictionusing Back Propagation Neural Networks", Second *International Conference on Computer and Network Technology, 2010, pp: 377-380, IEEE.*

[12] Atsalakis, G. S., Valavanis, K. P., "Surveying stock market forecasting techniques – Part II: Soft computing methods", Expert Systems with Applications, Vol. 36, pp. 5932-5941, 2009.

[13] Butler M., and A. Daniyal. Multi-objective Optimization with an Evolutionary Artificial Neural Network for Financial Forecasting. *Proceedings of the 11th Annual conference on Genetic and evolutionary computation 1451-1457, 2009.*

[14] M.T. Philip, K. Paul, S.O. Choy, K. Reggie, S.C. Ng, J. Mak, T. Jonathan, K. Kai, and W. Tak-Lam, "Design and Implementation of NN5 for Hong Stock Price Forecasting", *Journal of Engineering Applications of Artificial Intelligence, vol. 20, 2007,pp. 453-461*.

[15] C. D. Tilakaratne, S. A. Morris, M. A. Mammadov, and C. P. Hurst, "Predicting stock market index trading signals using neural networks," in *Proceedings of the 14th Annual Global Finance Conference(GFC '07)*, pp. 171–179, Melbourne, Australia, September 2007.

[16] M. Thenmozhi, "Prediction stock index returns using artificial neural networks", *Delhi Business Review X Vol. 7, No. 2, July - December 2006*.

[17] Q. Yang, and X. Wu, "10 Challenge Problems in Data Mining Research", *International Journal of Information Technology & Decision Making*, vol. 5, No. 4, 2006, pp. 1-8.

[18] H. Pan, C. Tilakaratne, and J. Yearwood, "Predicting Australian stock market index using neural networks exploiting dynamical swings and intermarket influences," *Journal of Research and Practice in Information Technology*, vol. 37, no. 1, pp. 43–54, 2005.

[19] B. Egeli, M. Ozturan, and B. Badur, "Stock market prediction using artificial neural networks," in *Proceedings of the 3rd Hawaii International Conference on Business*, pp. 1–8, Honolulu, Hawaii, USA, June 2003.

[20] M. Safer, "A comparison of two data mining techniques to predict abnormal stock market returns," *Intelligent Data Analysis*, vol. 7, no. 1, pp. 3–13, 2003.

[21] R. E. Uhrig, "Introduction to artificial neural networks," *Proceedings of the 1995 IEEE IECON 21st International Conference on, vol. 1, pp.33-37 vol. 1, 1995.*