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# Performance Analysis of Stock Price Prediction using Artificial Neural Network

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*GJCST Classification:* *I.2.6*


*Strictly as per the compliance and regulations of:*

# Performance Analysis of Stock Price Prediction using Artificial Neural Network

K.K.Sureshkumar [α], Dr.N.M.Elango [Ω]

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## I. Introduction

Stock price prediction is a heated topic in prediction study of financial area. The use of ANN in business environments has been increasing over the last few years. Excellent algorithm has been applied to predict stock price or index. Interest in neural networks has led to a considerable surge in research activities in the past decade. Artificial neural network models are based on the neural structure of the brain. The brain learns from experience and so do artificial neural networks. As a useful analytical tool, ANN is widely applied in analyzing the business data stored in database or data warehouse. Identifying customer behavior patterns and predicting stock price are emerging areas of neural network research and its application. Most of the companies have created new methods of evaluating financial data and investment decisions. Artificial Neural Networks are being used by most companies for improved forecasting capabilities in analysis of stock market. So, artificial neural network suits better than other models in predicting the stock market.

To predict stock prices there are so many conventional techniques can be used, in which fundamental and technical analysis one among them (Atiya, A. F, El-Shoura et al, 1999). Fundamental analysis involves various macro-economic factors, results of the company, financial conditions and other related attributes are used to measure the value of the company with reflect to stock price changes. Technical analysis, on the other hand, involves analyzing statistics generated by market activity, such as past prices and volume (Kai Keng Ang and Chai Quek, 2006). Recent development in soft computing has set a new dimension in the field of financial forecasting. Tools based on ANN have gained more popularity due to their inherent capabilities to approximate any non linear function to a high degree of accuracy.

The idea of forecasting using neural network is to find an approximation of mapping between the input and output data through training. The trained neural network is then used to predict the values for the future (Abhyankar, A. et al, 1997). This research work presents the use of artificial neural network as a forecasting tool for predicting the stock market price.

The remainder of the paper is organized as follows. Section II reviews the background study of the stock market prediction by Artificial Neural Network. Section III focuses on the objectives of the study. Section IV discusses about the basic of Artificial Neural Network; benefits and limitations of ANN were presented. Section V discusses about the Indian Stock market. Section VI explains about data and methodology of using NeuralWorks Predict to predict the stock prices and calculating result performance. Section VII concludes the research.

## II. Background Study

In the last two decades lot of research has been done on models based on intelligent soft computing. In general, the approaches to predict stock market could be classified into two classes, fundamental analysis and technical analysis (Kai Keng Ang and Chai Quek, 2006). Fundamental analysis is based on macroeconomic data and the basic financial status of companies like money supply, interest rate, inflationary rates, dividend yields, earnings yield, cash flow yield, book to market ratio, price-earnings ratio, lagged returns (Fama and French, 1988; Lakonishok, 1994). Technical analysis is based on the rationale that history will repeat itself and that and the correlation between price and volume reveals market behavior. Prediction is made by exploiting implications

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hidden in past trading activities and by analyzing patterns and trends shown in price and volume charts (Smirlock and Starks, 1985; Brush 1986).

According to (Refenes, Zapranis and Franchis, 1994) "neural networks are capable of making better prediction in capturing the structural relationship between a stock's performance and its determinant factors more accurately than MLR models". (Kryzanowski, Galler and Wright, 1993) using Boltzmann machine trained an artificial neural network with 149 test cases of positive (rise in the stock price) and negative (fall in the stock price) returns for the years 1987-1989 and compared this to training the network with positive, neutral (unchanged stock price), and negative returns for the same 149 test cases for the years 1987-1989. The network predicted 72% correct results with positive and negative returns. However the network predicted only 46% correct results with positive, neutral, and negative returns.

Using neural networks to predict financial markets has been an active research area in both fundamental and technical analysis, since the late 1980s (White, 1988; Fishman, Barr and Loick, 1991; Shih, 1991; Utans and Moody, 1991; Katz, 1992; Kean, 1992; Swales and Yoon, 1992; Wong, 1992; Azoff,1994; Rogers and Vemuri, 1994; Ruggerio, 1994; Baestaens, Van Den Breg and Vaudrey, 1995; Ward and Sherald, 1995; Gately, 1996; Refenes Abu-Mostafa and Moody, 1996; Murphy, 1999; Qi, 1999; Virili and Reisleben, 2000; Yao and Tan, 2001; Pan, 2003a; Pan 2003b).

Fujitsu a Japanese technology company and Nikko Securities - an investment company joined together to develop a stock market prediction system for TOPIX (Tokyo based stock index). The emergence of artificial intelligence techniques has seen their enormous application to financial forecasting, such as expert systems (Tsaih Yenshan Hsu, and Charles Lai, 1998), fuzzy logic (Hiemstra, 1994), and neural networks (Kryzanowski, Galler and Wright, 1993). Among them, neural networks are the most popular and successful tools. There is extensive literature about the application of neural networks in financial forecasting (Azoff, 1994; Goonatilake and Treleaven, 1995; Wong and Selvi, 1998). One of the most popular Journals published on the application of neural networks in finance is the Journal of Computational Intelligence in Finance (Bhagirathi Nayak, et al, 2011).

Also, all of the researches using neural network applications in prediction of stock market trend are mainly based on the assumption that the basic laws in a certain stock market is consistent through the time of experiment data.

## III. Objectives of the Study

The main objective of this study is to use NeuralWorks Predict tool to obtain more accurate stock prediction price and to evaluate them with some performance measures. This study can be used to reduce the error proportion in predicting the future stock prices. It increases the chances for the investors to predict the prices more accurately by reducing error percentage and thus gain benefits in share markets.

## IV. Artificial Neural Network

Artificial Neural Network (ANN) is an information processing system where the elements called neurons, process the information. The signals are transmitted by means of connection links. The links possess an associated weight, which is multiplied along with the incoming signal (net input) for any typical neural network. The output signal is obtained by applying activations to the net input. The network consists of a set of sensory units that constitute the input layer and one or more hidden layer of computation modes. The input signal passes through the network in the forward direction. This type of network is called as multilayer perceptron (MLP) (Sivanandam, S.N. et al, 2006). The multilayer perceptron are used with supervised learning and have to lead the successful back propagation algorithm where logistic sigmoid function is widely used. The MLP network has hidden neurons and this will make the network more active for complex tasks. The layers of network are connected by synaptic weights and have a high computational efficiency.

### *a) Benefits of Using Artificial Neural Network*

Neural networks often lead to significant results, e.g. in weather forecasting, a rule of weather change is less probable than a steady weather pattern. According to (Schoneburg, 1990), this is also true for stock prices.

A key aspect to successful forecasting lies in the ability to merge data available in diverse formats (Steven H. Kim and Se Hak Chun, 1998). The data analysis performed by neural networks tolerates a considerable amount of imprecise and incomplete input data due to the distributed mode of information processing. Neural network lie in their ability to predict accurately even in situations with uncertain data, and the possible combinations with other methods. Despite the benefits of artificial neural networks, there are still some limitations to neural networks that are discussed below.

### *b) Limitations of Artificial Neural Network*

Some methods are executed with insufficient reliability tests, data design and with inability to identify the optimal topology for a specific problem domain.

There is no known method of designing an optimal neural network, but the best network is highly dependent on the data and application (Carlos Cinca. 1996).

Some of the limitations are mentioned below:

1. NN require very large number of previous data.
2. The best NN architecture topology is still unknown.
3. For complex networks the result and accuracy may

decrease.
4. Statistical relevance of the result is needed.
5. More careful data design is needed and systematically analyzed.

In order to improve the NN applications, there are some other limitations, concerning the problems of evaluation and implementation of NN that should be discussed. Large number of research is done and implemented by companies that are not published in scientific indexes.

## V. Indian Stock Market

Investors are mostly preferred the stock market investments because it has the opportunity of highest return over other schemes. For companies, stock market is one of the key sources to raise money through initial public offer (IPO). This allows businesses to be publicly traded, or raise additional capital for expansion by selling shares of ownership of the company in a public market. Indian stock market is mainly consists of two major stock indices, Bombay Stock Exchange (BSE) and National Stock Exchange (NSE). The benchmark for these two exchanges are Sensex (30 Stocks) and Nifty (50 Stocks).

BSE was the first stock exchange in the country and approved under the Securities Contract Regulation Act, 1956. Sensex is an index of 30 stocks with 12 major sectors. In the year 1993, National Stock Exchange of India has been the frontier of Indian securities market. NSE is located at Mumbai, India referred as Nifty. Nifty is a well diversified index consisting of 50 major stocks from 21 sectors of the economy (Refer NSE, 2010). It is the largest stock exchange in India in terms of daily turnover and number of trades, for both equities and derivative trading. Trading on both exchanges is carried out in dematerialized form.

Securities and Exchange Board of India (SEBI) is the regulatory authority and have the rights to monitor all the stock markets in India established by Government of India in the year 1988. The main goal of the board is to protect the investors in securities and regulate the stock market. There are 23 stock exchanges in India, out of that only 18 stock exchanges are currently in the operative mode. Among 18 exchanges BSE and NSE are considered to be the primary exchanges of India.

## VI. Data And Methodology

The actual problem discussed in this paper is to forecast the stock price of National Stock Exchange in India. For this purpose we have used available daily stock data of TCS (i.e., bhavcopy) from the National Stock Exchange beginning from 01-November-2009 to 12-December-2011 (Refer NSE, 2011).

For this study, we select 508 day's NSE stock data of TCS Company. The data field used in this research consists of previous close, open price, high price, low price and close price. In order to predict the stock price, past data is necessary and it has been collected for the trading days from 01-November-2009 to 12-December-2011. The historical data set is available on the National Stock Exchange website.

The main task is to predict the stock price of TCS will be up or down for tomorrow by using the historical values of the company stock. In this research, NeuralWorks Predict version 3.24 packages are applied to predict the future stock price of TCS The historic data of previous close, open price, high price, low price and closing price data is used. NeuralWorks Predict 3.24 tool is used throughout the process, this research choose 5 important attributes including previous close, open price, high price, low price and closing price. The performance of the neural network largely depends on the architecture of the neural network. Issues critical to the neural network modeling like selection of input variables, data pre-processing technique, network architecture design and performance measuring statistics should be considered carefully.

### *a) Methodology of Building a Predict Model*

General steps of building and predicting the value by using Multi Layer Perceptron model in the NeuralWorks Predict.

1. Building a Predict Model: To make predictions from data if target outputs can be any value in a continuous range of numeric values or a discrete ordered range of numeric values.
2. Selection of model: Multi Layer Perceptron (MLP) model is selected to predict the stock value.
3. MLP Input training data
4. MLP Output training data
5. MLP Training data characteristics
6. MLP Network parameters
7. Reviewing parameters and training the model
8. Saving the model
9. Training statistics
10. Testing a predict model
11. Specifying data sets for testing
12. Interpreting test results
13. Running a MLP predict model

### *b) Results and Performance Statistics*

Performance statistics that are computed for prediction model train and test sets are shown in Table1.

| Close Price | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Accuracy (20%) | Conf. Interval (95%) | Records |
|---|---|---|---|---|---|---|---|---|
| All | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 1 | 24.72697 | 508 |
| Train | 0.997092 | 0.995172 | 9.816971 | 49.1059 | 12.68724 | 1 | 24.76381 | 355 |
| Test | 0.99713 | 0.995504 | 10.0007 | 37.47821 | 12.67708 | 1 | 24.87982 | 153 |

*Table.1 :* Train and Test Results of TCS

In Table 1, R Correlation (R) is the linear correlation between predicted outputs and target

outputs, in problem domain units. Average Absolute Error (Avg Abs) denotes the average absolute difference between predicted output values and target output values. Maximum Absolute Error (Max Abs) is the maximum absolute difference between a predicted output value and a target output value. The Root Mean Square Error (RMS) is the error between the predicted outputs and the target outputs. Accuracy is the percent of predicted output values that lie within 20% of their corresponding target output values. Confidence Intervals (Conf Interval) 95% of the model predictions lie within the range around target output values bounded by the confidence intervals and number of records processed. Finally, records indicate the number of records processed during training or testing.

The close correlation between the market value predicted by the neural network and the true value suggests that such networks may indeed become very powerful tools in financial applications. In this study, a real world output range is calculated whose limits are the minimum and maximum of all real world targets and real world model outputs. This range is used in several of the analysis results as shown in the Table 2.

| Close Price | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Accuracy (20%) | Conf. Interval (95%) | Records |
|---|---|---|---|---|---|---|---|---|
| All | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 1 | 24.72697 | 508 |
| Primary | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 1 | 24.72697 | 508 |
| Secondary | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 1 | 24.72697 | 508 |
| Train | 0.997092 | 0.995172 | 9.816971 | 49.1059 | 12.68724 | 1 | 24.76381 | 355 |
| Test | 0.99713 | 0.995504 | 10.0007 | 37.47821 | 12.67708 | 1 | 24.87982 | 153 |
| Valid | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 1 | 24.72697 | 508 |

*Table.2 :* Results Interpretation and Performance Statistics

*c) Output Summary*

The result of the predicted value has been shown in the Fig. 1. In Fig. 1, the actual close price of TCS have compared with the predicted price. Here, days refer to 508 values for each day starting from (19-November-2008 to 14-December-2010).

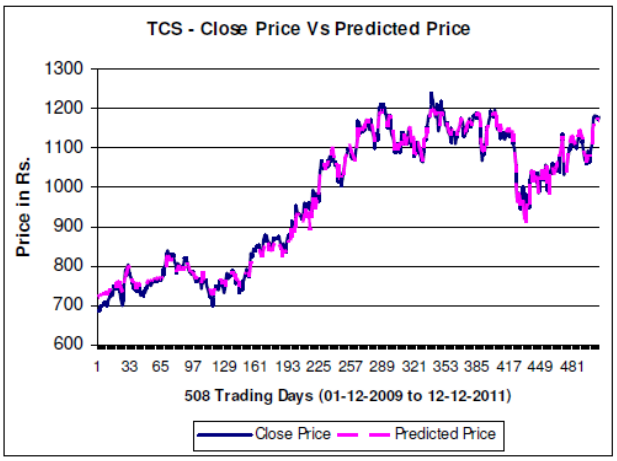


*Fig.1 :* Comparison of Actual Vs Predicted Price

The error percentage rate of the actual close price and predicted price of TCS as shown in Fig. 2.

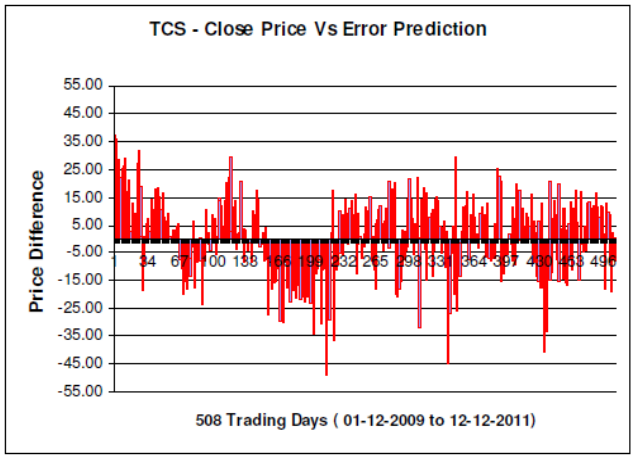


*Fig.2 :* Error Percentage rate of Actual Close Price Vs Predicted Price

There are many different methods to measure performance of systems. In order to evaluate the net performance of the stock value some of the following indicators have to be considered.

The indicators are R, Net-R, Average Absolute, RMS, Accuracy measures and Confidence limits. Net-R measure is the linear correlation between the real world target output and the raw neural net output. RMSE is a basic measure is used to find out the difference between values predicted by a model and the value actually observed.

We have used NeuralWorks Predict package tool for training, testing and predicting the stock prices. It is found that the percentage of correct prediction has been made and the result of this analysis is shown in the Table 2.

The train and test data sets are selected from the primary and secondary working sets, which will preliminary, trim the data sets. The following are the outcomes of all test and train set data.

| All | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Conf. Interval (95%) |
|---|---|---|---|---|---|---|
| 1 | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 24.72697 |
| 2 | 0.93295 | 0.933051 | 20.20458 | 37.47821 | 21.68696 | 43.78338 |
| 3 | 0.920938 | 0.920919 | 5.275382 | 18.66345 | 6.604043 | 13.04181 |
| 4 | 0.932548 | 0.932497 | 10.21521 | 27.56531 | 11.92409 | 24.05034 |
| 5 | 0.839133 | 0.839492 | 16.69528 | 30.37744 | 17.85807 | 36.75226 |
| 6 | 0.788178 | 0.787327 | 13.77196 | 49.1059 | 17.27659 | 35.55556 |
| 7 | 0.805987 | 0.808338 | 11.81858 | 40.94519 | 15.69253 | 32.45215 |
| 8 | 0.851505 | 0.853173 | 9.347101 | 33.25348 | 11.24513 | 22.4312 |
| 9 | 0.904238 | 0.904655 | 9.318429 | 25.60205 | 11.07237 | 21.91745 |
| 10 | 0.85448 | 0.859078 | 6.983322 | 31.7677 | 9.281714 | 18.3149 |
| 11 | 0.613367 | 0.615451 | 11.67487 | 44.85999 | 15.94526 | 32.97479 |

*Table.3 :* Test and Train of all Working Set Data

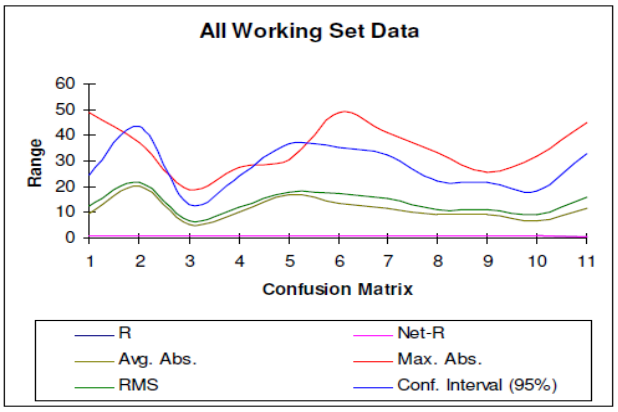


*Fig.3 :* Graph of all Working set Data

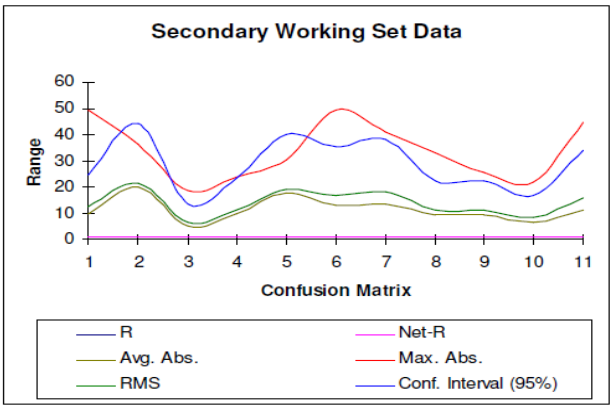


*Fig.5 :* Graph of Secondary Working Set Data

| Primary | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Conf. Interval (95%) |
|---|---|---|---|---|---|---|
| 1 | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 24.72697 |
| 2 | 0.93295 | 0.933051 | 20.20458 | 37.47821 | 21.68696 | 43.78338 |
| 3 | 0.920938 | 0.920919 | 5.275382 | 18.66345 | 6.604043 | 13.04181 |
| 4 | 0.932548 | 0.932497 | 10.21521 | 27.56531 | 11.92409 | 24.05034 |
| 5 | 0.839133 | 0.839492 | 16.69528 | 30.37744 | 17.85807 | 36.75226 |
| 6 | 0.788178 | 0.787327 | 13.77196 | 49.1059 | 17.27659 | 35.55556 |
| 7 | 0.805987 | 0.808338 | 11.81858 | 40.94519 | 15.69253 | 32.45215 |
| 8 | 0.851505 | 0.853173 | 9.347101 | 33.25348 | 11.24513 | 22.4312 |
| 9 | 0.904238 | 0.904655 | 9.318429 | 25.60205 | 11.07237 | 21.91745 |
| 10 | 0.85448 | 0.859078 | 6.983322 | 31.7677 | 9.281714 | 18.3149 |
| 11 | 0.613367 | 0.615451 | 11.67487 | 44.85999 | 15.94526 | 32.97479 |

*Table.4 :* Interpretation of Primary Working Set Data

| Train | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Conf. Interval (95%) |
|---|---|---|---|---|---|---|
| 1 | 0.997092 | 0.995172 | 9.816971 | 49.1059 | 12.68724 | 24.76381 |
| 2 | 0.921331 | 0.921463 | 20.32742 | 37.47821 | 22.11164 | 48.79345 |
| 3 | 0.932825 | 0.932779 | 5.257592 | 13.69232 | 6.361141 | 13.03735 |
| 4 | 0.898039 | 0.897986 | 11.16954 | 27.56531 | 13.33025 | 29.41568 |
| 5 | 0.909343 | 0.909957 | 14.00878 | 23.06158 | 14.95047 | 35.41038 |
| 6 | 0.752458 | 0.749573 | 15.87678 | 34.11078 | 18.31965 | 44.84638 |
| 7 | 0.935137 | 0.936032 | 8.616142 | 13.91046 | 9.812246 | 23.24043 |
| 8 | 0.762268 | 0.761667 | 9.967763 | 22.94531 | 11.82026 | 25.09368 |
| 9 | 0.91631 | 0.917143 | 9.142303 | 20.4364 | 11.00127 | 22.75063 |
| 10 | 0.821826 | 0.828276 | 7.697107 | 31.7677 | 10.76402 | 21.98249 |
| 11 | 0.437907 | 0.440396 | 13.28768 | 26.85999 | 16.00216 | 39.1732 |

*Table.6 :* Interpretation of Training Set Data

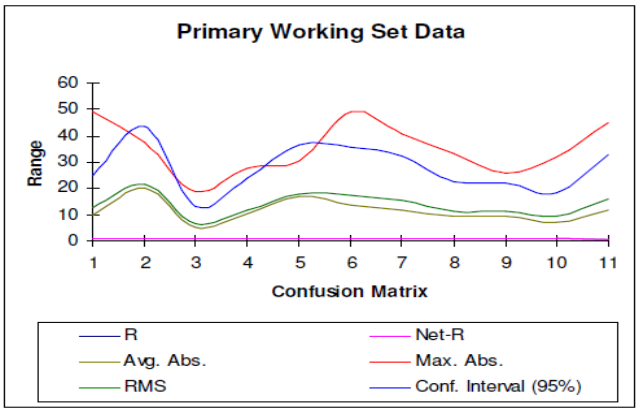


*Fig.4 :* Graph of Primary Working Set Data

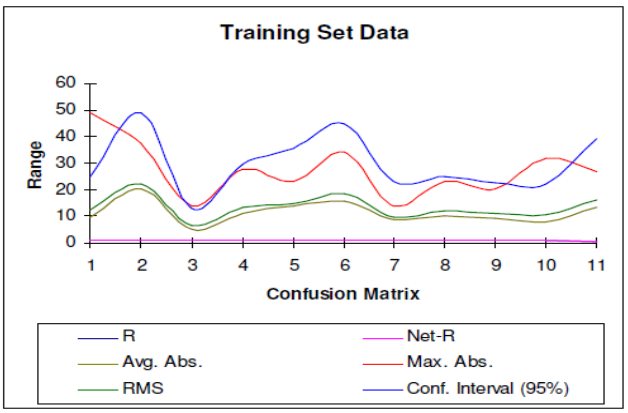


*Fig.6 :* Graph Training Set Data

| Secondary | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Conf. Interval (95%) |
|---|---|---|---|---|---|---|
| 1 | 0.9971 | 0.995268 | 9.872307 | 49.1059 | 12.68418 | 24.72697 |
| 2 | 0.939141 | 0.93923 | 20.14999 | 36.18195 | 21.49552 | 44.14341 |
| 3 | 0.916674 | 0.91667 | 5.283045 | 18.66345 | 6.705967 | 13.33403 |
| 4 | 0.947125 | 0.947079 | 9.806209 | 23.55493 | 11.26785 | 23.0938 |
| 5 | 0.818945 | 0.819175 | 17.88929 | 30.37744 | 19.00811 | 40.15015 |
| 6 | 0.808768 | 0.809089 | 12.9965 | 49.1059 | 16.87607 | 35.487 |
| 7 | 0.780828 | 0.783043 | 13.4198 | 40.94519 | 17.92326 | 38.2675 |
| 8 | 0.883901 | 0.886189 | 9.083319 | 33.25348 | 10.99159 | 22.16953 |
| 9 | 0.899728 | 0.89992 | 9.392587 | 25.60205 | 11.10217 | 22.14604 |
| 10 | 0.874985 | 0.878135 | 6.668418 | 21.67969 | 8.546409 | 16.97648 |
| 11 | 0.730967 | 0.732311 | 11.01076 | 44.85999 | 15.92176 | 33.80093 |

*Table.5 :* Interpretation of Secondary Working Set Data

| Test | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Conf. Interval (95%) |
|---|---|---|---|---|---|---|
| 1 | 0.99713 | 0.995504 | 10.0007 | 37.47821 | 12.67708 | 24.87982 |
| 2 | 0.93295 | 0.933051 | 20.20458 | 37.47821 | 21.68696 | 43.78338 |
| 3 | 0.920938 | 0.920919 | 5.275382 | 18.66345 | 6.604043 | 13.04181 |
| 4 | 0.932548 | 0.932497 | 10.21521 | 27.56531 | 11.92409 | 24.05034 |
| 5 | 0.839133 | 0.839492 | 16.69528 | 30.37744 | 17.85807 | 36.75226 |
| 6 | 0.788178 | 0.787327 | 13.77196 | 49.1059 | 17.27659 | 35.55556 |
| 7 | 0.805987 | 0.808338 | 11.81858 | 40.94519 | 15.69253 | 32.45215 |
| 8 | 0.851505 | 0.853173 | 9.347101 | 33.25348 | 11.24513 | 22.4312 |
| 9 | 0.904238 | 0.904655 | 9.318429 | 25.60205 | 11.07237 | 21.91745 |
| 10 | 0.85448 | 0.859078 | 6.983322 | 31.7677 | 9.281714 | 18.3149 |
| 11 | 0.613367 | 0.615451 | 11.67487 | 44.85999 | 15.94526 | 32.97479 |

*Table.7 :* Interpretation of Test Set Data

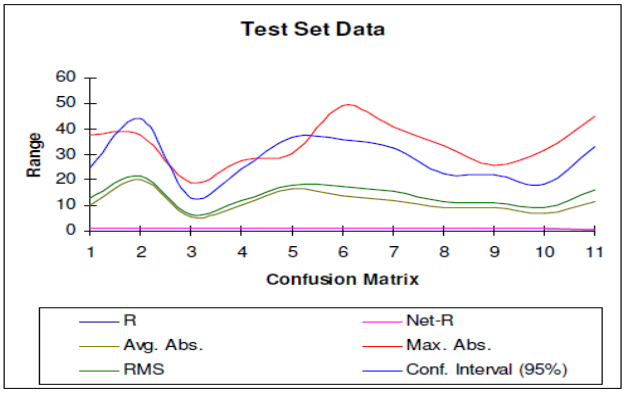


*Fig.7 :* Graph of Test Set Data

| Close Price | R | Net-R | Avg. Abs. | Max. Abs. | RMS | Conf. Interval (95%) |
|---|---|---|---|---|---|---|
| 1 | 0.93295 | 0.933051 | 20.20458 | 37.47821 | 21.68696 | 43.78338 |
| 2 | 0.920938 | 0.920919 | 5.275382 | 18.66345 | 6.604043 | 13.04181 |
| 3 | 0.932548 | 0.932497 | 10.21521 | 27.56531 | 11.92409 | 24.05034 |
| 4 | 0.839133 | 0.839492 | 16.69528 | 30.37744 | 17.85807 | 36.75226 |
| 5 | 0.788178 | 0.787327 | 13.77196 | 49.1059 | 17.27659 | 35.55556 |
| 6 | 0.805987 | 0.808338 | 11.81858 | 40.94519 | 15.69253 | 32.45215 |
| 7 | 0.851505 | 0.853173 | 9.347101 | 33.25348 | 11.24513 | 22.4312 |
| 8 | 0.904238 | 0.904655 | 9.318429 | 25.60205 | 11.07237 | 21.91745 |
| 9 | 0.85448 | 0.859078 | 6.983322 | 31.7677 | 9.281714 | 18.3149 |
| 10 | 0.613367 | 0.615451 | 11.67487 | 44.85999 | 15.94526 | 32.97479 |

*Table.8 :* Interpretation of Predicted Price

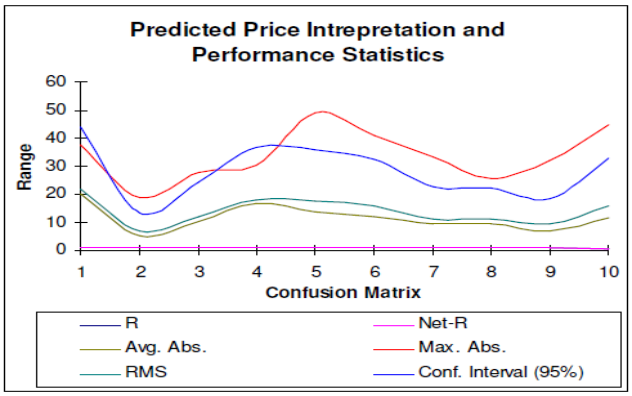


*Fig.8 :* Interpretation of Predicted Price and Performance Statistics

## VIII. Conclusion

In this research, we examined and applied multilayer perceptron model by using the NeuralWorks Predict tool. The results from analysis shows that NeuralWorks Predict offer the ability to predict the stock prices more accurately than the other existing tools and techniques. The accuracy of the predicted output values that lie within 20% of their corresponding target output value. By using this tool one can have the ability to forecast the stock price of NSE more accurately. This analysis can be used to reduce the error percentage in predicting the future stock prices. It increases the chances for the investors to predict the prices more accurately by reducing the error percentage and hence increase their profit in share markets. Utilizing neural network models together with other forecasting tools and techniques can be considered yet another valuable advancement in the age of technology.

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