Multi Layer Feed Forward Neural Network Knowledge Base to Future Stock Market Prediction

G.Sundar, K.Satyanarayana

Abstract: Stock price prediction is always a most challenging task. Artificial Neural Network prediction clears the stock price prediction challenge by forming the training set. By using the past information as the network input, one can predict the expected output of the network. In order to predict the expected result as the accurate we add multi-layer perceptron to the knowledge set we formed from the past historical data available in the nifty NSE and Sensex BSE. This paper proves that proposing the learning knowledge set using multilayer neural network will predict the accurate closing price of future stock in stock market.

Keywords: Artificial Neural Network (ANN), Knowledge set, Multilayer neural perceptron network, stock market.

1. INTRODUCTION

In stock market, the identification of expected loss and profit is used for buying or selling a stock. Always the person in the stock market tries to make preventive measure with the help of the parameter feature related to the stock price. Historical data like open price, high price and low-price are used to identify the behavior of stock. The usage of these historical details creates high degree of accuracy in the prediction in stock market. In this paper we will work with these historical features of stock price by using multilayer neural perceptron network to predict the closing price of the stock.

A. Stock market

Stock market offers the investors to a public sale to buy or sell the stocks. Stock market is also known as the exchanges of regular activities including insurance of shares. Stock market, stock trading and stock exchange are some of the terms used interchangeably. Investors need low rick in stock investment. The investors mostly use diversified investment which has lower risk. To get huge financial capital

companies are used to sell the stocks. Individuals are also use the stock market to gain returns and outpace of their investments. The investment occurs in stock market only if the investors believe that the economy is growing. If the investors think that the economy is unmoving or frozen then they are not invest in stock. Nowadays any one can possibly purchase the stock in online.

Stock market is acts as primary market as well as secondary markets. The company which offers their share for first time for selling or buying is known as primary market. The regular buying and selling of the listed shares of the company in the stock exchange is known as secondary market. Both the primary and secondary stock market performs the trading execution at a fair price to the mutual buyers and sellers. There are two free-float market weighted stock index known as NIFTY 50 and BSE SENSEX.

The NIFTY 50 index is National Stock Exchange of India's benchmark based stock market index for the Indian equality market. Full form the NIFTY is National Stock Exchange Fifty. It represents the weighted average of 50 Indian company stocks in 13 sectors. It is one of the two main stock indices used in India. The BSE SENSEX is the S&P Bombay Stock Exchange Sensitive Index or simply the SENSEX. It includes 30 company stocks in 13 sectors. Some of the sectors are shipping, banking, automobile, financial services, telecommunication, oil & gas, pharmaceuticals, metals, consumer goods, cement, information technology, metals, chemicals and media & entertainment.

B. Artificial Neural Network

ANN has been applied in many different domains with success. ANN follows generalization ability on a learned base of examples. Several methods of ANN have been designed to explicit their knowledge in a symbolic form. ANN is used to form the basis of empirical learning. ANN has been proven to be equal or superior to empirical learning systems over a wide range of domains. Empirical learning means generalize specific theoretical knowledge about the problem domain.

ANN used to make the assumptions about the functional dependencies between the input and output. ANN is a method of finding the relevant weights with the number of thresholds required for computation. The training of neural network is done by the investigation of the historical data. The training data selection is a critical task.

II. STANDARD STOCK KNOWLEDGE SYSTEM

Knowledge is a communication progression between the learner and the surroundings. The learner receives information from the surroundings, and processes the information to form knowledge. The learner uses this learned knowledge to help in making decisions and in solving problems. The performance of problem solving will feed back to the learner. This process occurs iteratively and continues until the knowledge gained. The surroundings serves as a stimulus to the learner, and the level and quality of information affect the strategy of learning. Generally, there are three main learning paradigms: supervised, semi-supervised, and unsupervised learning. The goal of the learning is to generate the regularities from the training set of input patterns. Among these three learning paradigms, although the level and quality of information from the environment vary, they share with one common learning strategy that learning comes passively from the environment.
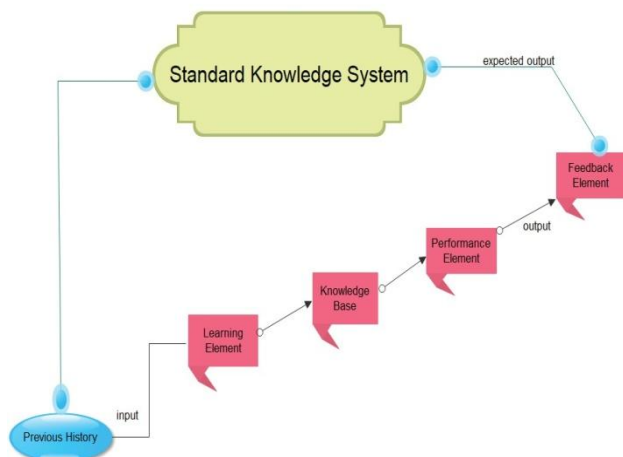

Diagram 1 Typical Standard Stock Knowledge System model

The above Diagram 1 shows a typical knowledge set model. The typical system model of standard stock knowledge consists of the five necessary elements. All these elements are used to form the expected output from the historical data. The standard stock knowledge elements are

- Learning element
- Knowledge Base
- Performance neuron element
- Feedback elements

- Standard knowledge system

B. Learning Element

It receives and processes the input obtained from past history. Learning technique is a process which is used for the making of learning element. It is also necessary for building the blocks of all Artificial Neural Network model based solution. It receives and processes the input obtained from past historical data. Learning method is used to form a new patterns or approaches which is entirely different from the existing methods. Using learning technique observations are formed from the past details of the system. This learning improves the knowledge defined by ANN technique. This is best in multi-layer perceptron class problems. The understanding of the problem is done by using this multi-layer function. Usually stock market problems are divided by fundamental analysis problems and technical analysis problems. Analysing of company's future profitability with the help of its business environment and financial performance is known as fundamental analysis. Identifying the trends of stock market with the help of understanding the statistical charts is known as technical analysis problems. The learning element in this paper includes the analysis of the historical data which focus on the technical analysis. The learning elements of stock market prediction are date, open, high, low, and close.

Multilayer neural networks are made up of three or more layers. This network has more than one hidden layer between the input nodes and output nodes. The structure is shown in the below diagram 2.

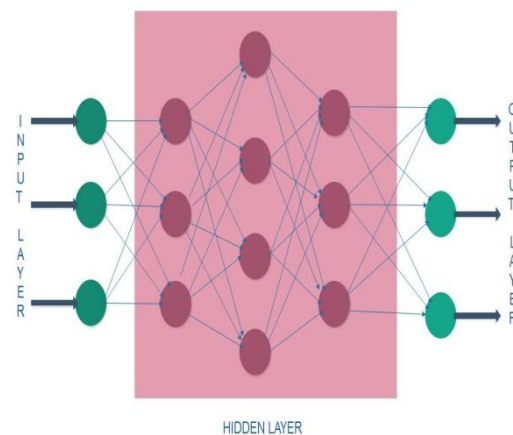Diagram 2 Multi-layer neural networks

In MLNN signals are travelled in both directions. This network introduces loops. This method is also known as interactive network. This network also has 3 major groups of layers. Input layers hidden layers and output layers. Input layers are used to represent the data, which is to be fed into the network. The one hidden layer needs to represent the weights on

the connections between input and weights and hidden layers. These may be more the one hidden layer depending upon the network. The final layer is output layer which is used to represent the output unit depend on weights given between hidden layers.

C. Knowledge base

This is similar to data base. It may contain some basic initial knowledge. It receives more knowledge which may be new and so be added as it or it may replace the existing knowledge. Knowledge is a set mainly used for forming a statement about the future prediction. In scientific work observations and evidences are used to form a quantitative statement about the knowledge set. In this paper knowledge base of stock market is obtained by using artificial neural network technique. Knowledge base is formed for grouping the label from raw historical data. This is also used to identify the patterns in the data like numeric, string, or vector. Neural network is used identify these grouping label to identify the input layers for prediction. These labeled data are used to form training data set. This knowledge base is used to maps the inputs to outputs. The knowledge base is formed by using multi-layer perceptron. The layers are made of various nodes. These nodes are used to combines the data with a set of coefficients known as input layers. All these input layers are used to form the activation function to determine the progress of the network to form the outcome known as knowledge base of classification. This is passed as the signals to neuron in order to activate the function used in the network. The depth of the multi-layer perceptron neural network defines the node layers through which the data pass in to the pattern identification process. Hierarchical structure is formed to abstract the increasing complexity to handle the high-dimensional data set passed through the activation function. Artificial neural network has multi-layer perceptron which is best for discovering the hidden structures within the historical data. Knowledge base is formed using pattern learning in stock historical data to extract necessary features like date, open price, close price, high price, low price and volume. By using neural networks one learns and recognizes the relation between certain necessary features and optimal outcome. Diagram 3 describes the basis for prediction used from the knowledge base set.
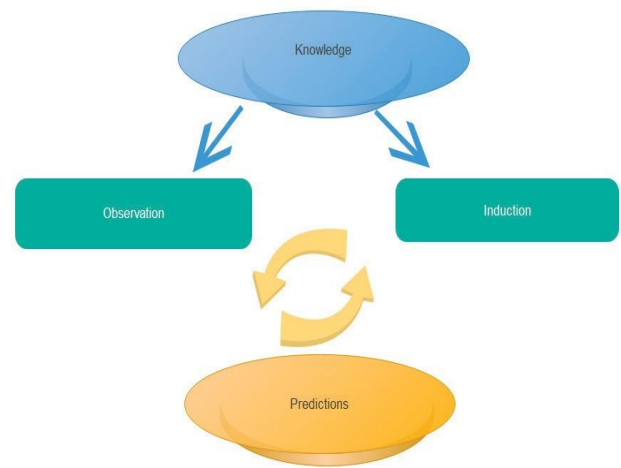

Diagram 3 General structure of Knowledge base

The knowledge base is formed by using the independent learning elements with the corresponding related weights.

(1)

Here is the knowledge base of the neural network formed. ,,… are the independent learning elements and … are the weights related to the elements. In this stock prediction problem we have date as the independent learning elements.

D. Performance element

It uses the updated knowledge base to perform some tasks or solves some problems and produces the corresponding output. The performance element in our study is stock market. All patterns are depends on labeled datasets. Artificial neural network is used to learn the patterns between the labels and the data. The label which is used to generate the output of the data is used to train the neural network. The performance element is found by grouping of label in the data by detecting relationships between them. The predictive analysis is done to evaluate the performance element. The performance element of the future stock prediction is done by determining the closing price of a stock for the day. The closing price is also known as the target variable.

Generally the performance element is formed by generating neuron. The neuron generation is the beginning of the artificial neural network. It is the basic building block of brain. It is a simplified form of numerical processing unit. All neurons are inter-connected and operating in parallel. Each neuron takes input value from other neurons and transfers it as the function and sends it on to the next layer like cascading till it reach the output. ANN is developed to attempt to simulate human brain. The major key point of ANN is information processing. Neuron is helped to inter-connect the working of ANN. ANN is used to form pattern learning. ANN
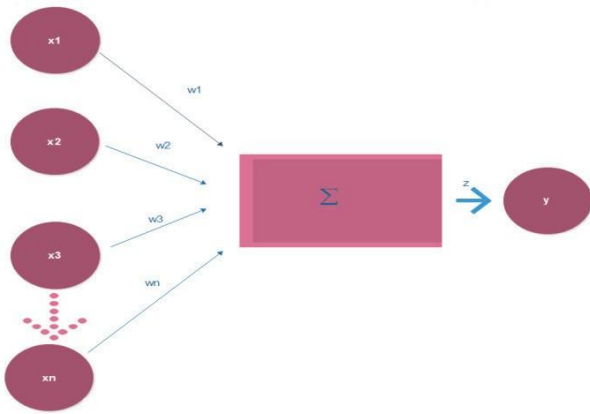
performance is described using the Diagram 4.

Diagram 4 Performance element of neural network

The closing price is predicted by using the moving average formula of multi-layer perceptron which uses the latest prediction of each data set. The data set is fragmented into train and validated set. In this paper we use last year data into fragmentation. Heuristics technique is used for processing the learning element. In the paper we form the learning element for the stock market prediction. The evaluation function for creating learning element for stock using heuristic function is denoted as "Y". The performance element from the learning element is formed using the formula

$$Y = \qquad (2)$$

Where network are weights and are input attributes used in the function.Heuristic function is used for selecting best form the available set.

E. Feedback element

It has two inputs one from the learning system and another from standard system. The feedback system is used to determine what should be done in order to produce the correct output. In this paper a neural net is used to arrive with least error. The weights are collected and the start or end states are attempts to model data's relationship. Neural networks are always accepting the ignorance. The weights and biases are not known clearly in neural network. It is always starts with the presumption and makes the better presumptions in sequential manner as it learns from mistakes.

The feedback element assumption with the network input and weight is defined as

assumption = input * weight

F. Standard Knowledge System

It is a trained person or a computer program that is able to produce the correct output. In order to check whether the system has learned well, the same input is given to the standard system. The outputs of the standard knowledge system and the performance element are given as input to the feedback element to form idealized system.

The sequence of the operation is repeated until the system gets desired perfection. The knowledge system is formed by using the activation function. The activation function determines the output node by fixing the inputs. The activation function is set at all the layer levels. Generally logistic regression function is used in the multi-layer perceptron neural network model knowledge system. This neural network includes many layers like input layers, hidden layers and output layers. Each of the output neural network nodes produces two possible outcomes in binary form known as 0 or 1. The logistic regression function is used to the conversion of the continuous parameter value into the binary output.

III. BUILDING THE MULTI-LAYER NEURAL NETWORK MODEL

First import the data from the historical data to CSV (comma-separated value) file. The construction of stock prediction model using multi-layer neural network has inputs like, date, open price, high price and low price. The linear regression is used in the single-layer network formation. The simplest form of the linear regression is expressed as,

$$\qquad (3)$$

Where 'Y' is the estimated output, X is the input, m is the slope and b is the intercept of the vertical axis. This is extended up to multiple linear regressions, which has many input variables to produce one output. The output form is expressed as,

$$\qquad (4)$$

The above equation is used to form the multiple linear regressions at every node of the multi-layer neural network. In this network the previous layer is again pooled with the input from every other node.

In general the multi-layer neural network is represented as using the neurons in a hidden layer in feature detectors. This is used to detect feature in historical input data. It is used to combine all input to the output. The common rule is

$$Y = \sum (\text{weight} * \text{input}) + \text{bias} \qquad (5)$$

This hybrid proportion with respect to the subsequent layer combinations are used to the error. The training set is used to form feature related to prediction. This is used to specify of modify weights between nodes. There is no specific way or method to choose bias value. It is randomly or chosen by the designer. Training set is formed by historical dataset available

about stock. Then the network is given as input and processed to produce resultant output. In training set a detailed study of past data performance value are loaded as pattern to form general behavior pattern. The future value is drawn by screening the data references in loaded past pattern. The accuracy of prediction is depend on the analytical method used to predict. Data for the month of January for 7 years are taken as training set.

The training is done by using pattern learning method. The data of previous 7 years are used as inputs. The daily price value is given to the network. The network made used to predict the next value in order.

$$MSE = 1/n^n \sum_{1=1} (y_1 - \tilde{y}_i)^2 \qquad (6)$$

IV. IMPLEMENTATION OF MULTI-LAYER FEED FORWARD NEURAL NETWORK

We construct the model which has four inputs (date, open price, high price, low price) and one output neuron (closing price) and 30 hidden layers of neurons for each. The hidden layer uses the tanH activation function.

(7)

The multi-layer networks are formed using the tanH sigmoid function defined in the equation (7). The network described by the knowledge base equation set is shown in the diagram

This diagram explains multi-layer network with three input layers, 30 hidden layers and one output layers.
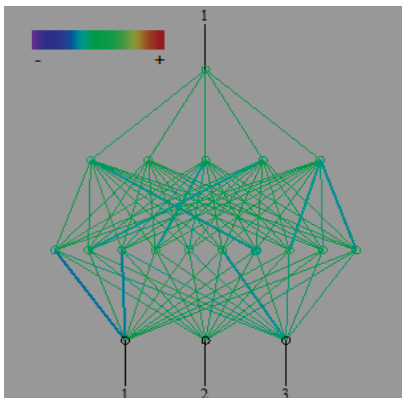
Diagram 5 Multi-layer feed forward network for stock market prediction

Regression line is formed to check the optimality of the network using linear function. This is described in the Diagram 5. The diagram shows the performance plot of the actual and predicted results of the BSE from 2015 to 2018.
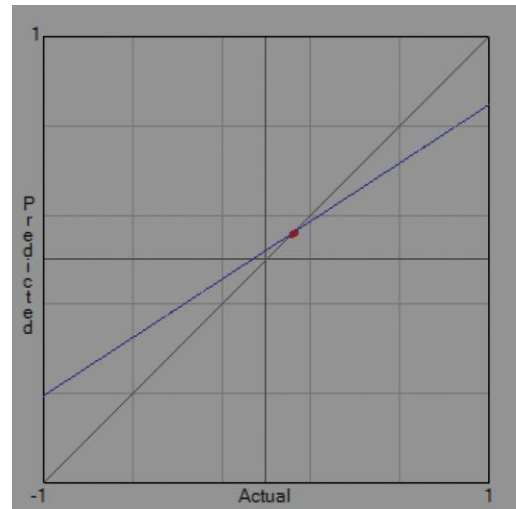
Diagram 6 Performance plot of Multi-layer feed forward stock prediction

V. OUTPUT

This section explains the details about the training set and the training set taken from the BSE stock exchange. The training set is taken from the BSE stock exchange from date 2-nov-2015 to 19-Apr-16.Totally 136 data is chosen for testing data.

Table 1 Training data for stock prediction using Multi-layer feed forward network

S.no.	Date	Open	High	Low	Close	Volume
1	19-Apr-16	111.1	112.45	109.16	112.29	30147644
2	18-Apr-16	109.74	110.81	109.2	110.45	21092654
3	15-Apr-16	110.79	110.97	109.2	109.64	20763396
4	14-Apr-16	110.62	112.04	110.26	110.84	28430914
5	13-Apr-16	112.23	112.65	106.52	110.51	88113011
6	12-Apr-16	109.34	111.16	108.99	110.61	26175943
7	11-Apr-16	110.7	110.91	108.77	108.99	39563863
8	8-Apr-16	114.25	114.33	109.9	110.63	48424776
9	7-Apr-16	113.79	114.89	113.07	113.64	20324759
10	6-Apr-16	112.47	113.81	112.42	113.71	20522412

11	5-Apr-16	112.11	113.32	111.9	112.22	22752484	38	25-Feb-16	107.11	108.07	105.61	108.07	29796180
12	4-Apr-16	114.07	114.55	111.61	112.55	48382180	39	24-Feb-16	104.21	106.95	102.74	106.88	34239396
13	1-Apr-16	113.75	116.17	113.35	116.06	24725954	40	23-Feb-16	106.85	107.47	105.12	105.46	25204873
14	31-Mar-17	114.7	115.01	113.77	114.1	21138743	41	22-Feb-16	105.49	108.25	105.34	107.16	35630883
15	30-Mar-16	116.73	116.99	114.36	114.7	33180317	42	19-Feb-16	102.55	105.02	102.06	104.57	32337444
16	29-Mar-16	113.83	116.32	113.64	116.14	29765753	43	18-Feb-16	105.8	106	103.03	103.47	29374587
17	28-Mar-16	113.32	114.59	112.95	113.69	21312750	44	17-Feb-16	101.94	105.72	100.4	105.2	43852623
18	24-Mar-16	112.13	113.09	111.68	113.05	17063766	45	16-Feb-16	103.8	103.93	100.24	101.61	45438324
19	23-Mar-16	112.01	113.19	112	112.54	18468742	46	12-Feb-16	103.74	104.24	101.09	102.01	36038104
20	22-Mar-16	111.36	112.88	111.17	112.25	18957831	47	11-Feb-16	99.6	105.11	98.88	101.91	43493102
21	21-Mar-16	111.66	112.37	111.03	111.85	18394520	48	10-Feb-16	101.55	103.25	100.24	101	44943948
22	18-Mar-16	111.56	112.42	110.27	111.45	36216958	49	9-Feb-16	97.14	102.4	96.82	99.54	62580050
23	17-Mar-16	112.15	112.69	110.73	111.02	24204773	50	8-Feb-16	100.41	102.68	97.46	99.75	71016537
24	16-Mar-16	110.49	112.5	110.1	112.18	24619730	51	5-Feb-16	109.51	109.58	103.18	104.07	76522716
25	15-Mar-16	109.11	110.83	108.84	110.67	17618460	52	4-Feb-16	111.8	111.94	109.25	110.49	38648485
26	14-Mar-16	109.28	110.33	108.77	109.89	17236054	53	3-Feb-16	115.27	115.34	109.75	112.69	56848084
27	11-Mar-16	108.48	109.42	107.92	109.41	20581320	54	2-Feb-16	114.8	117.59	113.2	114.61	59644925
28	10-Mar-16	107.91	108.66	105.77	107.32	24780710	55	1-Feb-16	112.27	115.72	112.01	115.09	45840867
29	9-Mar-16	106.7	107.51	105.49	107.51	20449881	56	29-Jan-17	108.99	112.84	108.84	112.21	62357459
30	8-Mar-16	104.78	107.37	104.4	105.93	25493546	57	28-Jan-16	107.2	110.34	104.81	109.11	1.07E+08
31	7-Mar-16	108.07	108.07	104.72	105.73	31436401	58	27-Jan-16	97.79	97.85	94.23	94.45	48311872
32	4-Mar-16	110.05	110.05	107.93	108.39	24872895	59	26-Jan-16	97.76	97.88	95.66	97.34	26637412
33	3-Mar-16	110.25	110.3	108.54	109.58	21333496	60	25-Jan-16	98.72	99.48	96.93	97.01	32319141
34	2-Mar-16	109.68	110.55	108.77	109.95	25641627	61	22-Jan-16	96.41	98.07	95.49	97.94	30331442
35	1-Mar-16	107.83	109.82	107.6	109.82	26694696	62	21-Jan-16	94.91	95.99	92.62	94.16	30468830
36	2/29/2017	107.6	108.91	106.75	106.92	32243645	63	20-Jan-16	92.83	95	89.37	94.35	58982367
37	26-Feb-16	108.7	109.45	107.16	107.92	26578891							

64	19-Jan-16	96.53	97.42	93.92	95.26	30620565
65	15-Jan-16	93.98	96.38	93.54	94.97	45935550
66	14-Jan-16	95.85	98.87	92.45	98.37	48488509
67	13-Jan-16	100.58	100.58	95.21	95.44	33091576
68	12-Jan-16	99	99.96	97.55	99.37	28395390
69	11-Jan-16	97.91	98.6	95.39	97.51	29932385
70	8-Jan-16	99.88	100.5	97.03	97.33	35402298
71	7-Jan-16	100.5	101.43	97.3	97.92	45172906
72	6-Jan-16	101.13	103.77	100.9	102.97	25096183
73	5-Jan-16	102.89	103.71	101.66	102.73	23258238
74	4-Jan-16	101.95	102.24	99.75	102.22	37717312
75	31-Dec-17	106	106.17	104.62	104.66	18391064
76	30-Dec-15	107	107.25	106.06	106.22	13115007
77	29-Dec-15	106.42	107.74	106.25	107.26	17179901
78	28-Dec-16	105.02	105.98	104.53	105.93	13069733
79	24-Dec-15	104.74	105.32	104.5	105.02	6512134
80	23-Dec-15	105.89	106.11	103.86	104.63	19599673
81	22-Dec-15	105.22	105.66	104.81	105.51	14597122
82	21-Dec-15	104.91	105.15	103.6	104.77	16138786
83	18-Dec-15	106.08	106.59	103.97	104.04	35994199
84	17-Dec-15	107.49	107.75	106.13	106.22	21675686
85	16-Dec-15	105.37	107.09	104.19	106.79	22680547
86	15-Dec-15	105.3	105.8	104.28	104.55	21764331
87	14-Dec-15	102.28	104.74	101.46	104.66	24648093
88	11-Dec-15	104.15	104.34	101.91	102.12	26427727
89	10-Dec-15	105.05	106.4	104.41	105.42	17454312
90	9-Dec-15	106.18	106.44	103.55	104.6	23517268
91	8-Dec-15	104	106.91	103.95	106.49	20401791
92	7-Dec-15	106.48	106.83	104.66	105.61	15474890
93	4-Dec-15	104.75	107.73	104.11	106.18	21224721
94	3-Dec-15	103.95	106.85	103.35	104.38	23236485
95	2-Dec-15	107	107.92	105.79	106.07	24295162
96	1-Dec-15	104.83	107.15	104.5	107.12	22715616
97	30-Nov-15	105.84	106.1	103.75	104.24	20008996
98	27-Nov-15	105.78	105.96	104.86	105.45	5912671
99	25-Nov-15	106.33	106.6	105.1	105.41	15150785
100	24-Nov-15	106	106.49	104.39	105.74	23462829
101	23-Nov-15	107.19	107.47	106.08	106.95	19733283
102	20-Nov-15	106.84	107.87	106.62	107.32	22085405
103	19-Nov-15	107.36	107.73	105.95	106.26	25477683
104	18-Nov-15	105.8	107.88	105.39	107.77	23679764
105	17-Nov-15	104.62	106.2	104.14	105.13	26649223
106	16-Nov-15	103.32	104.17	100.47	104.04	49140589
107	13-Nov-15	107.71	108.25	103.83	103.95	29438853
108	12-Nov-15	108.48	109.39	108	108.02	20763843
109	11-Nov-15	108.27	109.87	107.11	109.01	25003046
110	10-Nov-15	106.17	108.15	105.24	107.91	24409940
111	9-Nov-15	107	108.25	105.86	106.49	26326885
112	6-Nov-15	108.04	108.74	105.91	107.1	34898019
113	5-Nov-15	108.8	110.65	107.95	108.76	63013501
114	4-Nov-15	103.19	104.14	102.48	103.94	38606400
115	3-Nov-15	103.22	103.65	102.4	102.58	21096752
116	2-Nov-15	101.72	103.47	101.18	103.31	23876266

The testing set is taken from date 28-oct-2018 to 20-apr-2
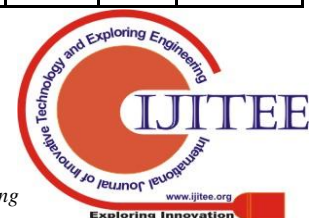
016. This testing set is defined in Table2. Totally 135 data with open, high, low, close and volumes are taken from the historical data. The R statistical tool is used to find the predicted value for the closing price and the corresponding error are measured using equation (6). The actual value, predicted value and the errors are displayed in the Table 3. The various stock predictions input historical data from BSE stock exchange with their corresponding plots are described in the following charts from diagram 7 to diagram 11. The plots are describing the values of open, high, low, close and volume. The diagram 12 shows the whole historical data with respect to the corresponding date.
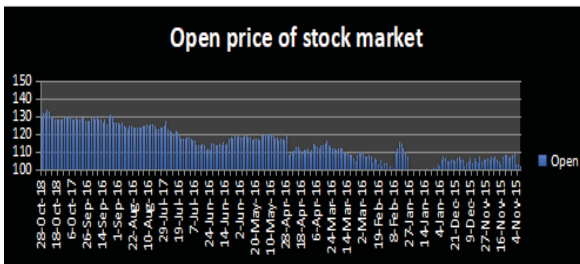
Diagram 7 Open price of stock market
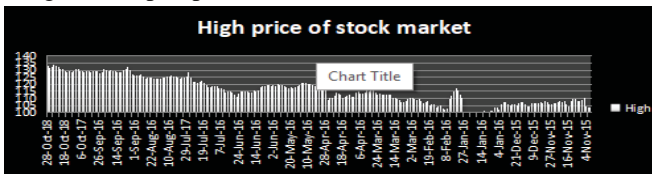
Diagram 8 High price of stock market

Diagram 9 Low price of stock market
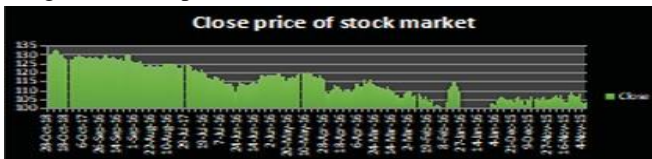
Diagram 10 Close price of stock market
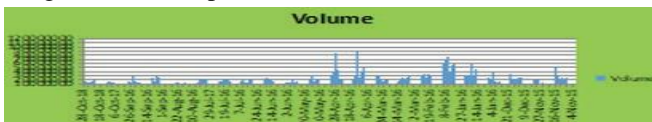
Diagram 11 Volume of stock market

The stock market input layers like open, high and low with the output layer closing price is described by the following performance chart.
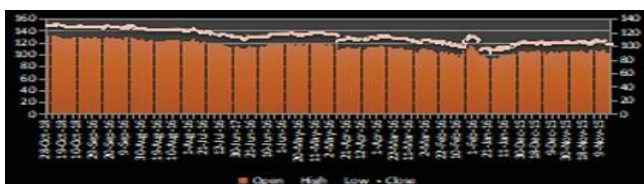
Diagram 12 Volume of stock market

Table 2: Testing data for stock prediction using Multi-layer feed forward network

S.no.	Date	Open	High	Low	Close	Volume
1	28-Oct-18	130.5	132.97	129.93	131.29	24545547
2	27-Oct-18	131.74	131.8	129.27	129.69	16741393
3	26-Oct-18	131.64t	132.26	130.94	131.04	13084731
4	25-Oct-18	133.5	133.5	132.22	132.29	13336787
5	24-Oct-18	132.72	133.4	132.15	133.28	17470227
6	21-Oct-18	129.78	132.13	129.7	132.07	19088794
7	20-Oct-18	130.07	130.66	129.5	130	13167503
8	19-Oct-18	128.74	130.47	128.6	130.11	16752321
9	18-Oct-18	128.68	129.39	128.01	128.57	13503967
10	17-Oct-18	128.2	128.47	127.32	127.54	11351681
11	14-Oct-18	128.49	128.95	127.58	127.88	13345292
12	13-Oct-18	128.21	128.25	126.75	127.82	17139306
13	12-Oct-18	129.01	129.66	128.46	129.05	11072991
14	11-Oct-18	130.23	130.64	128.23	128.88	17537928
15	10-Oct-18	129.68	130.7	129.2	130.24	15138720
16	7-Oct-17	129.04	129.25	128.33	128.99	12804420
17	6-Oct-17	128.43	129.06	128.08	128.74	11682729

18	5-Oct-17	128.25	128.8	127.83	128.47	12386753	38	7-Sep-16	130.04	131.98	129.95	131.05	27990796
19	4-Oct-17	129.17	129.28	127.55	128.19	14307548	39	6-Sep-16	126.67	129.94	126.47	129.73	26278407
20	3-Oct-17	128.38	129.09	127.8	128.77	13156943	40	2-Sep-16	126.85	126.86	126	126.51	12118773
21	30-Sep-17	128.03	128.59	127.45	128.27	18402945	41	1-Sep-16	126.38	126.63	125.6	126.17	13536125
22	29-Sep-16	129.18	129.29	127.55	128.09	14532241	42	31-Aug-17	125.6	126.22	125.1	126.12	14200636
23	28-Sep-16	129.21	129.47	128.4	129.23	12047636	43	30-Aug-16	126.6	126.6	125.15	125.84	17804286
24	27-Sep-16	127.61	129.01	127.43	128.69	15637111	44	29-Aug-16	124.35	126.73	124.35	126.54	15925900
25	26-Sep-16	127.37	128.16	126.8	127.31	15064940	45	26-Aug-16	124.05	125.19	123.91	124.96	17504825
26	23-Sep-16	127.56	128.6	127.3	127.96	28326266	46	25-Aug-16	123.12	124.37	123.1	123.89	10730811
27	22-Sep-16	130.5	130.73	129.56	130.08	15538307	47	24-Aug-16	124.47	124.69	123.09	123.48	12243719
28	21-Sep-16	129.13	130	128.39	129.94	14068336	48	23-Aug-16	124.51	125.09	124.25	124.37	13309452
29	20-Sep-16	128.65	129.17	128.03	128.64	11083808	49	22-Aug-16	123.33	124.83	123.11	124.15	14386361
30	19-Sep-16	129.91	129.94	128.26	128.65	14958794	50	19-Aug-16	123.6	124.16	123.28	123.56	11688265
31	16-Sep-16	128.2	129.18	128.2	129.07	24119174	51	18-Aug-16	124.01	124.26	123.64	123.91	12400816
32	15-Sep-16	127.98	129.1	127.67	128.35	15111838	52	17-Aug-16	123.66	124.38	122.85	124.37	13794179
33	14-Sep-16	126.89	128.8	126.89	127.77	15720388	53	16-Aug-16	123.5	123.92	122.78	123.3	14222410
34	13-Sep-16	128.03	128.35	126.66	127.21	18016152	54	15-Aug-16	124.91	124.92	123.7	123.9	19295130
35	12-Sep-16	125.96	128.76	125.75	128.69	21252752	55	12-Aug-16	124.7	125	124.18	124.88	12158955
36	9-Sep-16	129.71	129.95	127.1	127.1	27100679	56	11-Aug-16	125.2	125.38	124.75	124.9	11729519
37	8-Sep-16	130.92	131.08	129.81	130.27	15676595							

57	10-Aug-16	125.07	125.48	124.54	124.88	10670148
58	9-Aug-16	125.34	126.09	124.53	125.06	19620967
59	8-Aug-16	125.25	125.45	124.55	125.26	15233929
60	5-Aug-16	124.98	125.84	124.62	125.15	20184035
61	4-Aug-16	122.94	124.79	122.51	124.36	21065974
62	3-Aug-16	123.09	123.92	122.31	122.51	18525332
63	2-Aug-16	124.06	124.8	122.07	123.09	23968414
64	1-Aug-16	123.85	124.58	122.86	124.31	25006850
65	29-Jul-17	124.65	125.84	123.71	123.94	35058803
66	28-Jul-16	127.52	128.33	123.63	125	78955758
67	27-Jul-16	122.42	125	121.51	123.34	52654239
68	26-Jul-16	122	122.07	120.75	121.22	17611964
69	25-Jul-16	121.39	121.85	117.78	121.63	18487449
70	22-Jul-16	119.9	121.01	119.31	121	18422410
71	21-Jul-16	121.92	122.1	120.25	120.61	17801663
72	20-Jul-16	121.25	122.2	120.56	121.92	20046452
73	19-Jul-16	118.99	120.85	118.66	120.61	21541292
74	18-Jul-16	117.32	119.61	116.89	119.37	20868367
75	15-Jul-16	117.74	118.28	116.58	116.86	16645964

	6					
76	14-Jul-16	117.5	117.64	116.7	117.29	14579736
77	13-Jul-16	118.39	118.4	116.68	116.78	16207662
78	12-Jul-16	118.63	118.72	117.57	117.93	15217700
79	11-Jul-16	117.71	118.7	117.5	117.87	17711570
80	8-Jul-16	116.43	117.5	115.85	117.24	18142597
81	7-Jul-16	116.63	116.97	115.36	115.85	16630201
82	6-Jul-16	113.36	116.79	112.97	116.7	24337586
83	5-Jul-16	113.94	114.11	112.97	114	14207037
84	1-Jul-16	114.2	115.13	113.81	114.19	14980023
85	30-Jun-17	114.67	115.18	113.67	114.28	23192716
86	29-Jun-16	113.37	114.25	113.04	114.16	20968273
87	28-Jun-16	110.63	112.75	110.55	112.7	26813842
88	27-Jun-16	111.57	111.57	108.23	108.97	36409606
89	24-Jun-16	111.01	113.68	111	112.08	40643130
90	23-Jun-16	114.37	115.09	113.54	115.08	16176895
91	22-Jun-16	114.65	114.74	113.61	113.91	14846329
92	21-Jun-16	114.12	115.21	113.97	114.38	19166269
93	20-Jun-16	113.77	114.72	112.75	113.37	20785390

94	17-Jun-16	114.42	114.43	112.56	113.02	24644308
95	16-Jun-16	113.87	114.5	112.94	114.39	192362557
98	13-Jun-16	115	115.48	113.31	113.95	31718239
99	10-Jun-16	117.54	118.11	116.26	116.62	18510826
100	9-Jun-16	118.13	118.68	117.71	118.56	13859240
101	8-Jun-16	117.76	118.6	117.27	118.39	14505596
102	7-Jun-16	119.24	119.3	117.67	117.76	17103023
103	6-Jun-16	118.62	119.43	118.36	118.79	12744676
104	3-Jun-16	118.98	118.98	117.86	118.47	14135114
105	2-Jun-16	118.69	119.44	118.22	118.93	13228310
106	1-Jun-16	118.5	119.08	117.82	118.78	15029494
107	31-May-17	119.46	120.1	118.12	118.81	23547597
108	27-May-16	119.56	119.85	119.01	119.38	13464434
109	26-May-16	118.24	119.76	117.92	119.47	18191472
110	25-May-16	118.13	118.66	117.38	117.89	20019778
111	24-May-16	116.24	117.73	116.12	117.7	20074093
112	23-May-16	117.42	117.6	115.94	115.97	20367390
113	20-May-16	116.96	117.99	116.95	117.35	18870608
114	19-May-16	117.05	117.49	115.88	116.81	20485379
115	18-May-16	116.8	118.27	116.73	117.65	21571824
116	17-May-16	118.82	119.01	117.2	117.35	21269720
117	16-May-16	119.38	119.61	117.35	118.67	31178289
118	13-May-16	120.38	120.64	119.68	119.81	18047101
119	12-May-16	119.98	120.84	118.9	120.28	21636556
120	11-May-16	120.41	121.08	119.42	119.52	21927392
121	10-May-16	119.62	120.5	119	120.5	22803690
122	9-May-16	119.54	120.28	118.9	119.24	21077084
123	6-May-16	117.16	119.64	117.11	119.49	26216236
124	5-May-16	118.04	118.98	117.25	117.81	21999237
125	4-May-16	116.61	118.3	116.57	118.06	23380209
126	3-May-16	117.52	118.16	117.02	117.43	23746203
127	2-May-16	117.83	118.73	116.57	118.57	27769280
128	29-Apr-17	116.82	117.84	115.84	117.58	37031156
129	28-Apr-16	119.58	120.79	116.23	116.73	86746016
130	27-Apr-16	107.94	108.94	106.31	108.89	44036820
131	26-Apr-16	110.49	110.5	108.15	108.76	22189916
132	25-Apr-16	109.87	110.67	109.07	110.1	20979671
133	22-Apr-16	111.21	111.75	109.01	110.56	38330597

134	21-Apr-16	112.55	114.04	112.31	113.44	20409388
135	20-Apr-16	112.43	113.27	111.56	112.42	20998319

The following Table 3 shows the actual and predicted closing price of the stock with error values. All these values are calculated by using equations (2) to (6). The results are listed in the table 3. The performance chart plots of the actual and predicted values are shown in the following diagrams

Table 3 Performance report of actual and predicted closing price by multi-layer feed forward neural network

no.s	date	three input layers			output layer with error rate			
		open price	high price	low price	actual closing price	predicted closing price	error rate	error rate %
1	28-Oct-18	0.10916	0.1144171	0.1144171	112.29	114.4171	2.1271	0.021271
2	27-Oct-18	0.1092	0.1139759	0.1139759	110.45	113.9759	3.5259	0.035259
3	26-Oct-18	0.1092	0.1143268	0.1143268	109.64	114.3268	4.6868	0.046868
4	25-Oct-18	0.11026	0.1146218	0.1146218	110.84	114.6218	3.7818	0.037818
5	24-Oct-18	0.10652	0.1139179	0.1139179	110.51	113.9179	3.4079	0.034079
6	21-Oct-18	0.10899	0.1137725	0.1137725	110.61	113.7725	3.1625	0.031625
7	20-Oct-18	0.10877	0.114154	0.114154	108.99	114.154	5.164	0.05164
8	19-Oct-18	0.1099	0.1157142	0.1157142	110.63	115.7142	5.0842	0.050842
9	18-Oct-18	0.11307	0.1166116	0.1166116	113.64	116.6116	2.9716	0.029716
10	17-Oct-18	0.11242	0.1159558	0.1159558	113.71	115.9558	2.2458	0.022458
11	14-Oct-18	0.1119	0.1156632	0.1156632	112.22	115.6632	3.4432	0.034432
12	13-Oct-18	0.11161	0.1162211	0.1162211	112.55	116.2211	3.6711	0.036711
13	12-Oct-18	0.11335	0.116691	0.116691	116.06	116.691	0.631	0.00631
14	11-Oct-18	0.11377	0.1171469	0.1171469	114.1	117.1469	3.0469	0.030469
15	10-Oct-18	0.11436	0.1180187	0.1180187	114.7	118.0187	3.3187	0.033187
16	7-Oct-17	0.11364	0.1168137	0.1168137	116.14	116.8137	0.6737	0.006737
17	6-Oct-17	0.11295	0.116415	0.116415	113.69	116.415	2.725	0.02725
18	5-Oct-17	0.11168	0.115597	0.115597	113.05	115.597	2.547	0.02547
19	4-Oct-17	0.112	0.115663	0.115663	112.54	115.663	3.123	0.03123
20	3-Oct-17	0.11117	0.1151708	0.1151708	112.25	115.1708	2.9208	0.029208
21	30-Sep-17	0.11103	0.1152245	0.1152245	111.85	115.2245	3.3745	0.033745
22	29-Sep-16	0.11027	0.114939	0.114939	111.45	114.939	3.489	0.03489
23	28-Sep-16	0.11073	0.1152886	0.1152886	111.02	115.2886	4.2686	0.042686
24	27-Sep-16	0.1101	0.1145252	0.1145252	112.18	114.5252	2.3452	0.023452
25	26-Sep-16	0.10884	0.1136458	0.1136458	110.67	113.6458	2.9758	0.029758
26	23-Sep-16	0.10877	0.1136794	0.1136794	109.89	113.6794	3.7894	0.037894
27	22-Sep-16	0.10792	0.1131296	0.1131296	109.41	113.1296	3.7196	0.037196
28	21-Sep-16	0.10577	0.1122245	0.1122245	107.32	112.2245	4.9045	0.049045
29	20-Sep-16	0.10549	0.1117264	0.1117264	107.51	111.7264	4.2164	0.042164
30	19-Sep-16	0.1044	0.1107209	0.1107209	105.93	110.7209	4.7909	0.04790.
31	16-Sep-16	0.10472	0.1119289	0.1119289	105.73	111.9289	6.1989	0.061989
32	15-Sep-16	0.10793	0.1136578	0.1136578	108.39	113.6578	5.2678	0.052678
33	14-Sep-16	0.10854	0.1139273	0.1139273	109.58	113.9273	4.3473	0.043473
34	13-Sep-16	0.10877	0.1138131	0.1138131	109.95	113.8131	3.8631	0.038631
35	12-Sep-16	0.1076	0.1128059	0.1128059	109.82	112.8059	2.9859	0.029859
36	9-Sep-16	0.10675	0.1124465	0.1124465	106.92	112.4465	5.5265	0.055265
37	8-Sep-16	0.10716	0.1129507	0.1129507	107.92	112.9507	5.0307	0.050307
38	7-Sep-16	0.10561	0.1119036	0.1119036	108.07	111.9036	3.8336	0.038336
39	6-Sep-16	0.10274	0.1099774	0.1099774	106.88	109.9774	3.0974	0.030974
40	2-Sep-16	0.10512	0.1116536	0.1116536	105.46	111.6536	6.1936	0.061936
41	1-Sep-16	0.10534	0.1112714	0.1112714	107.16	111.2714	4.1114	0.041114
42	31-Aug-17	0.10206	0.1091944	0.1091944	104.57	109.1944	4.6244	0.046244
43	30-Aug-16	0.10303	0.1106067	0.1106067	103.47	110.6067	7.1367	0.071367

44	29-Aug-16	0.1004	0.1084367	0.1084367	105.2	108.4367	3.2367	0.032367
45	26-Aug-16	0.10024	0.1090073	0.1090073	101.61	109.0073	7.3973	0.073973
46	25-Aug-16	0.10109	0.1092704	0.1092704	102.01	109.2704	7.2604	0.072604
47	24-Aug-16	0.09888	0.1071445	0.1071445	101.91	107.1445	5.2345	0.052345
48	23-Aug-16	0.10024	0.1082525	0.1082525	101	108.2525	7.2525	0.072525
49	22-Aug-16	0.09682	0.1056305	0.1056305	99.54	105.6305	6.0905	0.060905
50	19-Aug-16	0.09746	0.1069429	0.1069429	99.75	106.9429	7.1929	0.071929
51	18-Aug-16	0.10318	0.1118985	0.1118985	104.07	111.8985	7.8285	0.078285
52	17-Aug-16	0.10925	0.1146808	0.1146808	110.49	114.6808	4.1908	0.041908
53	16-Aug-16	0.10975	0.1160046	0.1160046	112.69	116.0046	3.3146	0.033146
54	15-Aug-16	0.1132	0.1169914	0.1169914	114.61	116.9914	2.3814	0.023814
55	12-Aug-16	0.11201	0.1157531	0.1157531	115.09	115.7531	0.6631	0.006631
56	11-Aug-16	0.10884	0.1136057	0.1136057	112.21	113.6057	1.3957	0.013957
57	10-Aug-16	0.10481	0.1116677	0.1116677	109.11	111.6677	2.5577	0.025577
58	9-Aug-16	0.09423	0.1049844	0.1049844	94.45	104.9844	10.5344	0.105344
59	8-Aug-16	0.09566	0.1054518	0.1054518	97.34	105.4518	8.1118	0.081118
60	5-Aug-16	0.09693	0.1061983	0.1061983	97.01	106.1983	9.1883	0.091883
61	4-Aug-16	0.09549	0.1049411	0.1049411	97.94	104.9411	7.0011	0.070011
62	3-Aug-16	0.09262	0.1034776	0.1034776	94.16	103.4776	9.3176	0.093176
63	2-Aug-16	0.08937	0.1016904	0.1016904	94.35	101.6904	7.3404	0.073404
64	1-Aug-16	0.09392	0.1044571	0.1044571	95.26	104.4571	9.1971	0.091971
65	29-Jul-17	0.09354	0.103472	0.103472	94.97	103.472	8.502	0.08502
66	28-Jul-16	0.09245	0.1037371	0.1037371	98.37	103.7371	5.3671	0.053671
67	27-Jul-16	0.09521	0.1062492	0.1062492	95.44	106.2492	10.80925	0.108092
68	26-Jul-16	0.09755	0.1064993	0.1064993	99.37	106.4993	7.1293	0.071293
69	25-Jul-16	0.09539	0.1054121	0.1054121	97.51	105.4121	7.9021	0.079021

	6							
70	22-Jul-16	0.09703	0.1066214	0.1066214	97.33	106.6214	9.2914	0.092914
71	21-Jul-16	0.0973	0.1069197	0.1069197	97.92	106.9197	8.9997	0.089997
72	20-Jul-16	0.1009	0.1083315	0.1083315	102.97	108.3315	5.3615	0.053615
73	19-Jul-16	0.10166	0.1091752	0.1091752	102.73	109.1752	6.4452	0.064452
74	18-Jul-16	0.09975	0.1082235	0.1082235	102.22	108.2235	6.0035	0.060035
75	15-Jul-16	0.10462	0.1112027	0.1112027	104.66	111.2027	6.5427	0.065427
76	14-Jul-16	0.10606	0.1120164	0.1120164	106.22	112.0164	5.7964	0.057964
77	13-Jul-16	0.10625	0.1118854	0.1118854	107.26	111.8854	4.6254	0.046254
78	12-Jul-16	0.10453	0.1108445	0.1108445	105.93	110.8445	4.9145	0.049145
79	11-Jul-16	0.1045	0.1107407	0.1107407	105.02	110.7407	5.7207	0.057207
80	8-Jul-16	0.10386	0.110913	0.110913	104.63	110.913	6.283	0.06283
81	7-Jul-16	0.10481	0.1110046	0.1110046	105.51	111.0046	5.4946	0.054946
82	6-Jul-16	0.1036	0.1104982	0.1104982	104.77	110.4982	5.7282	0.057282
83	5-Jul-16	0.10397	0.1110133	0.1110133	104.04	111.0133	6.9733	0.069733
84	1-Jul-16	0.10613	0.1122036	0.1122036	106.22	112.2036	5.9836	0.059836
85	30-Jun-17	0.10419	0.1108487	0.1108487	106.79	110.8487	4.0587	0.040587
86	29-Jun-16	0.10428	0.1108551	0.1108551	104.55	110.8551	6.3051	0.063051
87	28-Jun-16	0.10146	0.108904	0.108904	104.66	108.904	4.244	0.04244
88	27-Jun-16	0.10191	0.1096809	0.1096809	102.12	109.6809	7.5609	0.075609
89	24-Jun-16	0.10441	0.1108146	0.1108146	105.42	110.8146	5.3946	0.053946
90	23-Jun-16	0.10355	0.110907	0.110907	104.6	110.907	6.307	0.06307
91	22-Jun-16	0.10395	0.1103097	0.1103097	106.49	110.3097	3.8197	0.038197
92	21-Jun-16	0.10466	0.1113768	0.1113768	105.61	111.3768	5.7668	0.057668
93	20-Jun-16	0.10411	0.1106143	0.1106143	106.18	110.6143	4.4343	0.044343
94	17-Jun-16	0.10335	0.1100933	0.1100933	104.38	110.0933	5.7133	0.057133

95	16-Jun-16	0.10579	0.1119266	0.1119266	106.07	111.9266	5.8566	0.058566
96	15-Jun-16	0.1045	0.1107709	0.1107709	107.12	110.7709	3.6509	0.036509
97	14-Jun-16	0.10375	0.1108597	0.1108597	104.24	110.8597	6.6197	0.066197
98	13-Jun-16	0.10486	0.1112089	0.1112089	105.45	111.2089	5.7589	0.057589
99	10-Jun-16	0.1051	0.1114729	0.1114729	105.41	111.4729	6.0629	0.060629
100	9-Jun-16	0.10439	0.1111262	0.1111262	105.74	111.1262	5.3862	0.053862
101	8-Jun-16	0.10608	0.1120866	0.1120866	106.95	112.0866	5.1366	0.051366
102	7-Jun-16	0.10662	0.1121489	0.1121489	107.32	112.1489	4.8289	0.048289
103	6-Jun-16	0.10595	0.1121003	0.1121003	106.26	112.1003	5.8403	0.058403
104	3-Jun-16	0.10539	0.1113918	0.1113918	107.77	111.3918	3.6218	0.036218
105	2-Jun-16	0.10414	0.1105807	0.1105807	105.13	110.5807	5.4507	0.054507
106	1-Jun-16	0.10047	0.108923	0.108923	104.04	108.923	4.883	0.04883
107	31-May-17	0.10383	0.1115124	0.1115124	103.95	111.5124	7.5624	0.075624
108	27-May-16	0.108	0.1131562	0.1131562	108.02	113.1562	5.1362	0.051362
109	26-May-16	0.10711	0.1127903	0.1127903	109.01	112.7903	3.7803	0.037803
110	25-May-16	0.10524	0.1114658	0.1114658	107.91	111.4658	3.5558	0.035558
111	24-May-16	0.10586	0.1119499	0.1119499	106.49	111.9499	5.4599	0.054599
112	23-May-16	0.10591	0.1123145	0.1123145	107.1	112.3145	5.2145	0.052145
113	20-May-16	0.10795	0.1132466	0.1132466	108.76	113.2466	4.4866	0.044866
114	19-May-16	0.10248	0.1095489	0.1095489	103.94	109.5489	5.6089	0.056089
115	18-May-16	0.1024	0.1095323	0.1095323	102.58	109.5323	6.9523	0.069523
116	17-May-16	0.10118	0.1086228	0.1086228	103.31	108.6228	5.3128	0.053128

The performance plot using the multi-layer feed forward neural network with linear actual and predicted results are plotted in the following diagram 13.
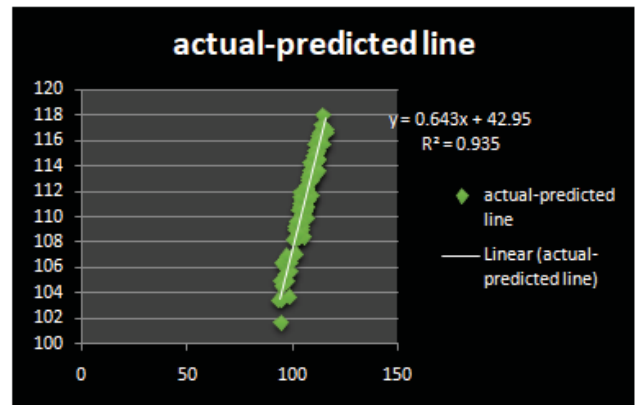

Diagram 13: A performance plot of actual and predicted closing stock market price

The performance analysis of the predicted and error rate is described in the diagram 14. The lerning method used here is the linear line classifier.
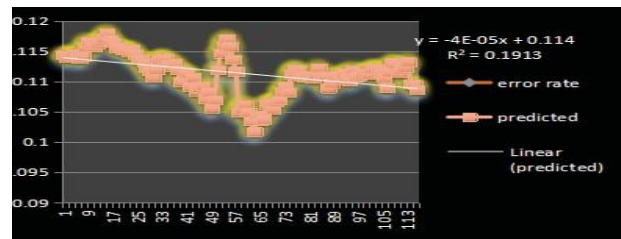

Diagram 14: A performance plot of predicted and error rate of closing price stock market

IV. RESULT AND CONCLUSION

Future stock prediction is necessary for the gaining profit using the stocks. In this paper the output layer closing price is calculated by using input layer like open price, high price and low price. The mean absolute error value is calculated as the performance measure. The prediction was based on by considering the BSE stock market exchange. The actual and predicted values for the closing price are listed in the table 4. This table describes the error rates which show only minimum change with the actual and predicted results. The performance measures are plotted in the graph by using tanH activation function and linear classifier. This paper results that multi-layer feed forward neural network method results significances change in future stock prediction.

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