Volume 5, Issue 11, November 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Stock Price Forecasting: Comparison among Different Types of Neural Network Models

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Abstract— This study presents artificial neural network (ANN) based computational approach for predicting the stock market trend and one day ahead closing prices of companies from five different sectors such as:- IT Sector (Infosys, Wipro, TCS), Banking Sector (SBI,ICICI,HDFC), Consumer Goods Sector (Tata Motors, Maruti Udyog Limited), Industrial Goods Sector (BHEL) and Basic Material Sector (ONGC). This study illustrates the forecasting performance of the developed ANN models on five different companies(like TCS, Wipro, Maruti, ICICI Bank and HDFC Bank) and compares the result of developed ANN models. Developed forecasting models were obtained using hybrid parameter technique.

Keywords: artificial neural network, backpropagtion algorithm, hybrid parameter method.

I. INTRODUCTION

The main aim of this research work is to forecast stock prices of companies from five different sectors by developing efficient neural network models. Efficiency and optimized performance of forecasting models were evaluated by proposing new approach of hybrid parameter methods using derived parameters.

Stock market prediction is the act of trying to determine the future value of a company stock or other financial instrument traded on a financial exchange. The successful prediction of a stock's future price could yield significant profit.

The most common form of ANN in use for stock market prediction is the feed forward network utilizing the backward propagation of errors algorithm to update the network weights. These networks are commonly referred to as backpropagation networks. Since NNs require training and have a large parameter space, it is useful to modify the network structure for optimal predictive ability.

II. METHODOLOGY

This section describes the steps of processing done in this study.

Step1: Data Collection: 10 years of data (stock prices) of ten well known companies from five different sectors are collected from [3], as shown in Table I

Table I Data Collection

S.No.	Company	Sector	Data set
1.	Infosys Ltd.	IT	January 2003-December 2012 (10 years)
2.	Wipro Ltd.		
3.	Tata Consultancy Services (TCS)		
4.	State Bank of India.	Banking	
5.	HDFC Bank		
6.	ICICI Bank		
7.	Tata Motors	Consumer Goods	
8.	Maruti Udyog Limited.(Maruti)		
9.	Bharat Heavy Electrical Limited (BHEL)	Industrial Goods	
10.	Oil and Natural Gas Cooperation (ONGC)	Basic Materials	

Step 2: Data Preprocessing: Data is prepared for training by applying data preprocessing methods (like data cleaning and data transformation).

Step 3: Backpropagation training algorithm is used to train multi layer neural network. Training stops when any of these conditions occurs:

- The maximum number of epochs (repetitions) is reached, which is set to be 2000.
- Performance is minimized to the goal, goal value is set to be 0.05.

Step 4: This study has used two layer neural network architecture (network with one hidden layer and one output layer), with different network parameters used for training.
Step 5: By making various combinations of network parameters shown in Table II, 21 neural network architectures, shown in Table II, were designed and trained with Gradient descent with adaptive learning rate backpropagation **(GDA)**, BFGS quasi-Newton backpropagation **(BFG)**, Resilient backpropagation **(RP)** training algorithms.

Table II Neural Network Architecture

Architecture #	**No. of neurons at input layer of ANN**	**Transfer Function at hidden layer**	**Transfer Function at output layer**	**No. of neurons at hidden layer of ANN**
1.	10	Tan-sigmoid	Pure linear	5
2.	50	Tan-sigmoid	Pure linear	5
3.	90	Tan-sigmoid	Pure linear	5
4.	130	Tan-sigmoid	Pure linear	5
5.	170	Tan-sigmoid	Pure linear	5
6.	210	Tan-sigmoid	Pure linear	5
7.	250	Tan-sigmoid	Pure linear	5
8.	10	Tan-sigmoid	Tan-sigmoid	5
9.	50	Tan-sigmoid	Tan-sigmoid	5
10.	90	Tan-sigmoid	Tan-sigmoid	5
11.	130	Tan-sigmoid	Tan-sigmoid	5
12.	170	Tan-sigmoid	Tan-sigmoid	5
13.	210	Tan-sigmoid	Tan-sigmoid	5
14.	250	Tan-sigmoid	Tan-sigmoid	5
15.	10	log-sigmoid	Pure linear	5
16.	50	log-sigmoid	Pure linear	5
17.	90	log-sigmoid	Pure linear	5
18.	130	log-sigmoid	Pure linear	5
19.	170	log-sigmoid	Pure linear	5
20.	210	log-sigmoid	Pure linear	5
21.	250	log-sigmoid	Pure linear	5

Step 6: Total 63 training models were developed using training data corresponding to each sector.
Step 7: Performance of 63 training models were tested using testing data corresponding to each sector.
Step 8: To measure forecasting performance of training models , three parameters were used:

1. Average Forecasting Accuracy (AVG.F_ACC)
2. Average Standard Deviation (AVG. SD) and
3. Coefficient of determination (COEFFD)

Step 9: To calculate average accuracy in (%), the following using formula were used:

Error F_Error = abs(AP-PP)

Average Accuracy F_ACC = (100 – F_Error)/AP*100

Here AP: Actual Price and PP : Predicted Price

Step 10: To find the best model, two derived parameters (MADD and MRDD) were computed and compared for the purpose of reliability:

where

MADD=AVG. F_ACC/AVG. SD and

MRDD = COEFFD/AVG. SD

Step 11: To find out suitable conclusions and research findings from experimental results, two hybrid parameter methods were developed. These methods were used to obtain optimum network parameters and best forecasting model corresponding to all sectors. The hybrid parameter methods are:

1. Hybrid Parameter Averaging Method using Derived Parameters (HPAMDP)
2. Hybrid Parameter Weighted Method using Derived Parameters (HPWMDP)

III. RESULTS

Table III: Comparison of Maximum Optimum Value for All Sectors Using Hpamdp Method

	Maximum optimum value corresponding to network parameters						
ANN Model	**Sector**	**OV**	**NNIL**	**OV**	**Training Algorithm**	**OV**	**Transfer Function**
1	IT	47.18	10	53.42	BFG	53.42	{tansig,purelin}
2	Banking	47.17	10	50.95	BFG	55.75	{tansig,purelin}
3	Consumer Goods	52.72	50	60.32	BFG	65.07	{tansig,purelin}
4	Industrial Goods	36.07	50, 90	34.47	BFG	41.62	{tansig,purelin}
5	Basic Materials	97.12	130	100.9	BFG	41.62	{tansig,purelin}

Table IV Comparison of Maximum Optimum Value for All Sectors Using Hpwmdp Method

	Maximum optimum value corresponding to network parameters						
ANN Model Number	**Sector**	**OV**	**NNIL**	**OV**	**Training Algorithm**	**OV**	**Transfer Function**
1	IT	1.443	10	1.568	BFG	1.568	{tansig,purelin}
2	Banking	1.443	10	1.518	BFG	1.61	{tansig,purelin}
3	Consumer Goods	1.554	50	1.705	BFG	1.8	{tansig,purelin}
4	Industrial Goods	1.221	50,90	1.189	BFG	1.332	{tansig,purelin}
5	Basic Materials	2.442	130	2.51	BFG	1.33	{tansig,purelin}

On the basis of the above results, this study has obtained five best forecasting models corresponding to all five sectors. Results of the Tables V, VI and VII shows the forecasting performance of developed ANN models on five different companies.

Table V Forecasting Performance of Ann Models

Name of Company	**ANN FORECASTING MODELS**									
	Model-1		**Model-2**		**Model-3**		**Model-4**		**Model-5**	
	ACC.	**STD.**	**ACC.**	**STD.**	**ACC.**	**STD.**	**ACC.**	**STD.**	**ACC.**	**STD.**
Wipro	98.12	1.82	99.21	0.725	99.22	0.598	98.64	1.07	99.01	0.773
TCS	98.77	1.75	99.47	0.568	99.54	0.388	99.29	0.705	99.32	0.511
HDFC Bank	97.99	2.01	99.66	0.28	99.47	0.450	99.26	0.638	99.29	0.596
ICICI Bank	97.94	1.93	99.40	0.502	99.30	0.550	99.01	0.833	99.07	0.862
Maruti Suzuki	97.45	2.05	99.39	0.627	99.29	0.53	98.94	0.937	99.09	0.698

Here : ACC: is Average Accuracy in (%) and STD. : is Standard Deviation

Table VI Forecasting Performance of Ann Models

Name of Testing companies	**ANN FORECASTING MODELS**									
	Model-1		**Model-2**		**Model-3**		**Model-4**		**Model-5**	
	COE	**STD.**	**COE**	**STD**	**COE**	**STD**	**COE**	**STD**	**COE**	**STD**
Wipro	0.982	0.0276	0.996	0.00725	0.996	0.00598	0.990	0.0107	0.995	0.00596
TCS	0.967	0.0175	0.985	0.00568	0.989	0.00388	0.974	0.00705	0.980	0.00511
HDFC Bank	0.973	0.0201	0.998	0.0028	0.996	0.00450	0.994	0.00636	0.993	0.00596
ICICI Bank	0.975	0.0193	0.995	0.00502	0.993	0.00550	0.987	0.00833	0.988	0.00862
Maruti Suzuki	0.973	0.0205	0.994	0.00627	0.994	0.0053	0.986	0.00937	0.989	0.00698

Here: COE: Coefficient of Determination and STD.: Standard Deviation

Table VII Forecasting Performance of Ann Models Using Derived Parameters

Name of Testing companies	**ANN FORECASTING MODELS**									
	Model-1		**Model-2**		**Model-3**		**Model-4**		**Model-5**	
	MADD	**MRDD**	**MADD**	**MRDD**	**MADD**	**MRDD**	**MADD**	**MRDD**	**MADD**	**MRDD**
Wipro	34.35	35.57	136.84	137.37	165.91	166.55	92.18	92.52	128.08	128.71
TCS	56.44	55.25	175.12	168.08	256.54	254.89	140.83	138.15	194.36	191.58
HDFC Bank	48.75	48.40	355.92	356.42	221.04	221.33	156.06	156.28	166.98	166.61
ICICI Bank	50.44	50.51	198.0	198.20	180.54	180.54	118.85	118.48	114.93	114.61
Maruti Suzuki	47.53	47.46	158.51	158.53	187.33	187.54	105.59	105.22	143.81	141.69

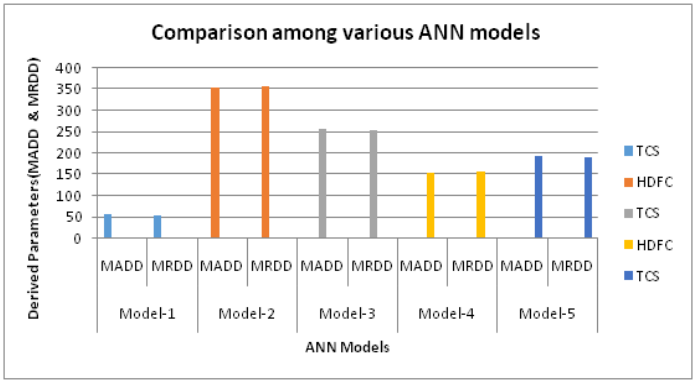

Fig. 1: Comparison of various ANN models using Derived Parameters

IV. CONCLUSION

Forecasting performance of the developed ANN models were tested, using the data from five different companies. Results were shown in Tables V, VI ,VII and Fig. 1

Following conclusions can be drawn from the results shown in Table V, VI and VII and the graph shown in Fig. 1

- Model-1 founds to be most appropriate model for TCS company, which generates more than 98% accuracy.
- Model-2 founds to be most appropriate model for HDFC bank , which generates more than 99% accuracy.
- Model-3 founds to be most appropriate model for TCS company, which generates more than 99% accuracy.
- Model-4 founds to be most appropriate model for HDFC bank, which generates more than 98% accuracy.
- Model-5 founds to be most appropriate model for HDFC bank, which generates more than 99% accuracy.
- For Wipro company Model-3 founds to be best as compared to other models.
- For ICICI bank Model-2 generates best results as compared to other models.
- For Maruti Suzuki company, Model-3 gives highest accuracy as compared to other models.
- Finally, from the above results, it can be concluded that , Model-2 and Model-3 gives best performance as compared to other models.
- From the graph shown in Fig. 1, it is observed that best performance is obtained for HDFC bank and TCS company.

Finally, this study has obtained five best forecasting models corresponding to five different sectors like ANN Model-1, ANN Model-2, ANN Model-3, ANN Model-4 and ANN Model-5, as shown in the Tables III and IV.

Forecasting Results of ANN Model -1

Graphs shown in figure 2, 3, 4, 5 and 6 shows the forecasting performance of ANN Model-1 for various companies:

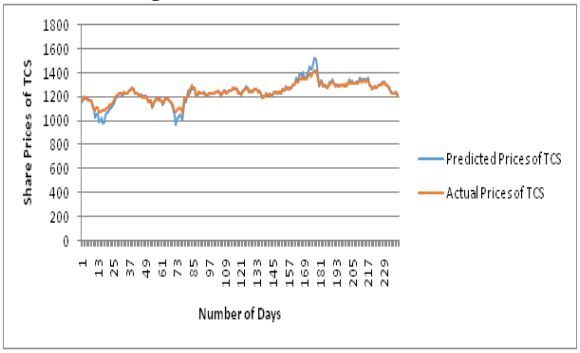

Fig.2: Predicted Share Prices of TCS using ANN Model-1

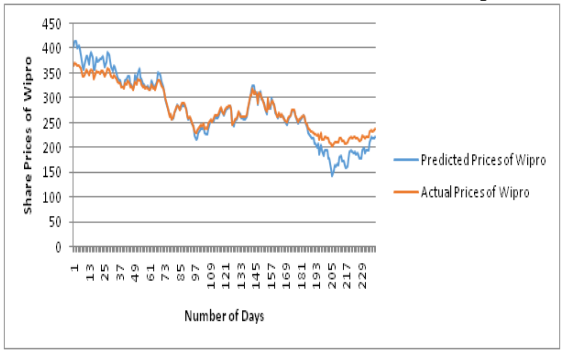

Fig.3: Predicted Share Prices of Wipro using ANN Model-1

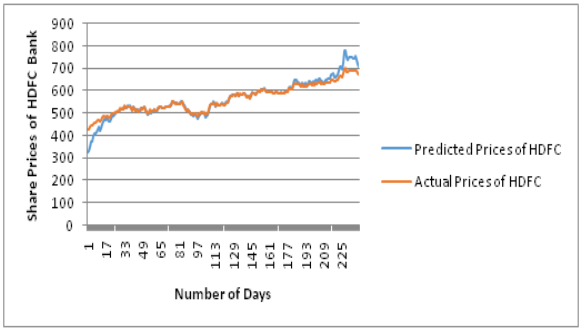

Fig.4: Predicted Share Prices of HDFC Bank using ANN Model-1

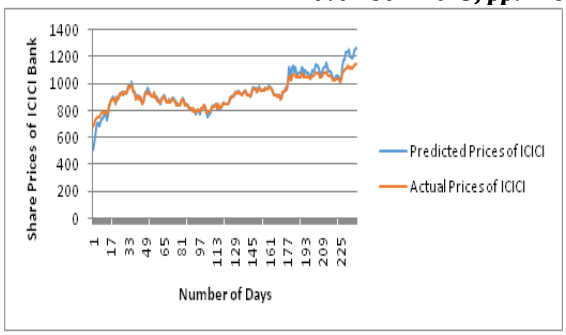

Fig.5: Predicted Share Prices of ICICI Bank using ANN Model-1

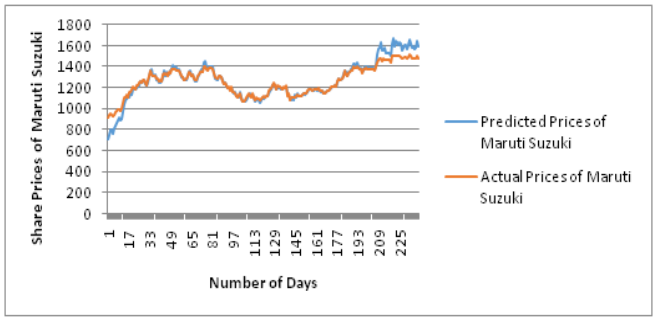

Fig. 6: Predicted Share Prices of Maruti using ANN Model-1

Forecasting Results of ANN Model -2

Graphs shown in figure 7, 8, 9, 10 and 11 shows the forecasting performance of ANN Model-2 for various companies:

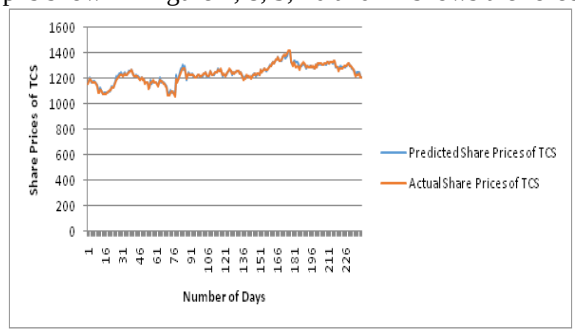

Fig.7: Predicted Share Prices of TCS using ANN Model-2

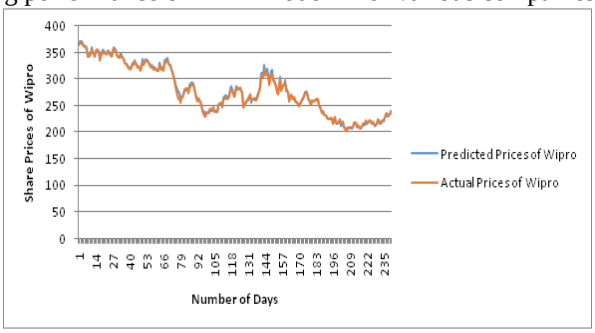

Fig..8: Predicted Share Prices of Wipro using ANN Model-2

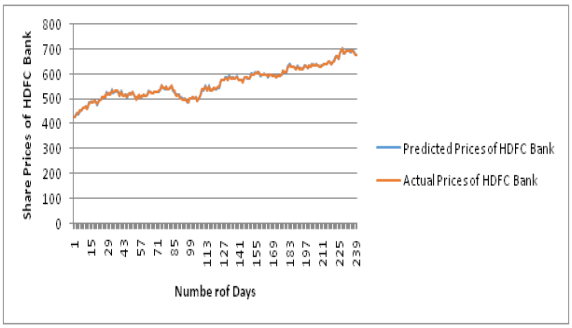

Fig.9: Predicted Share Prices of HDFC Bank using ANN Model-2

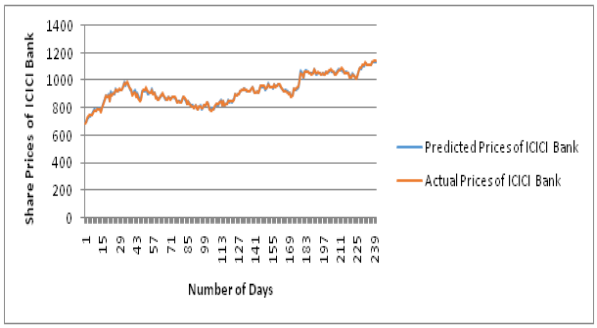

Fig.10: Predicted Share Prices of ICICI Bank using ANN Model-2

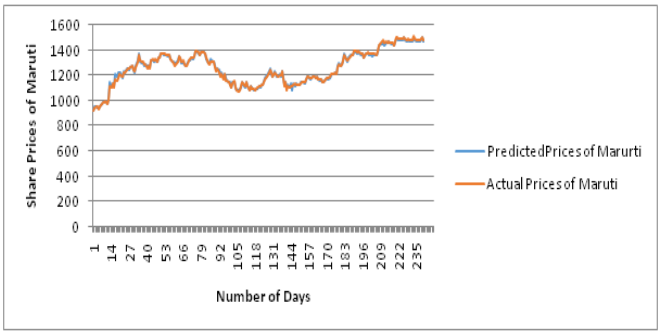

Fig. 11: Predicted Share Prices of Maruti using ANN Model-2

Forecasting Results of ANN Model -3

Graphs shown in figure 12, 13, 14, 15 and 16 shows the forecasting performance of ANN Model-3 for various companies:

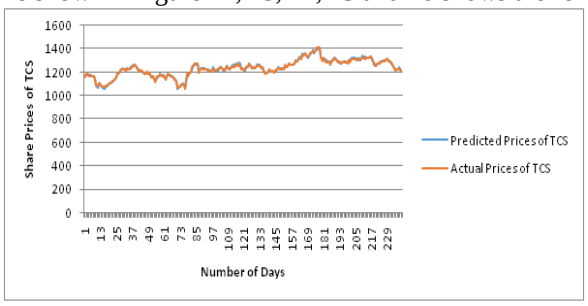

Fig. 12: Predicted Share Prices of TCS using ANN Model-3

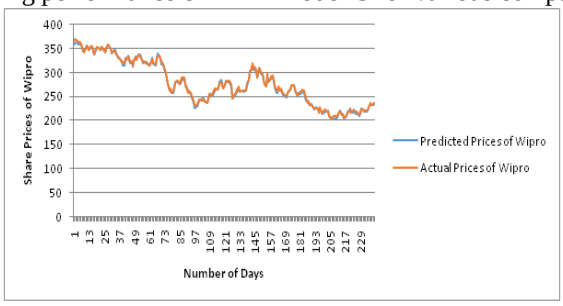

Fig. 13: Predicted Share Prices of Wipro using ANN Model-3

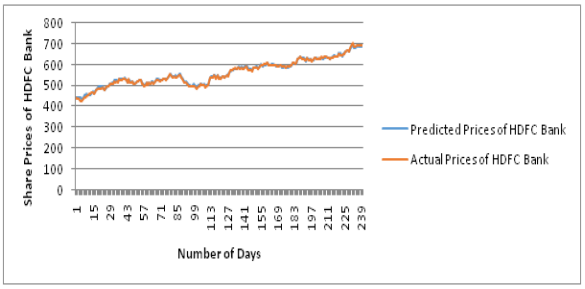

Fig. 14: Predicted Share Prices of HDFC Bank using ANN Model-3

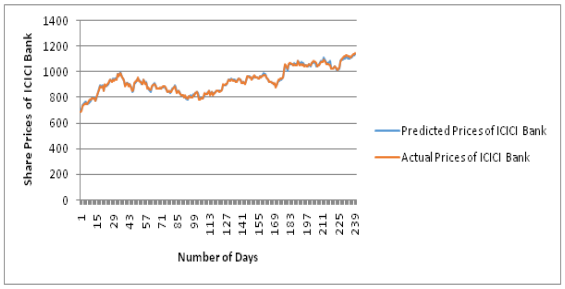

Fig..15: Predicted Share Prices of ICICI Bank using ANN Model-3

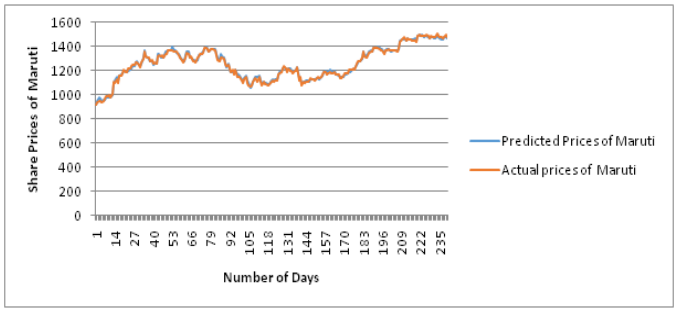

Fig. 16: Predicted Share Prices of Maruti using ANN Model-3

Forecasting Results of ANN Model -4

Graphs shown in figure 17, 18, 19, 20 and 21 shows the forecasting performance of ANN Model-4 for various companies:

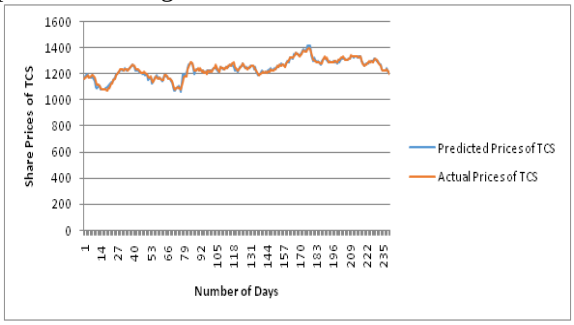

Fig. 17: Predicted Share Prices of TCS using ANN Model-4

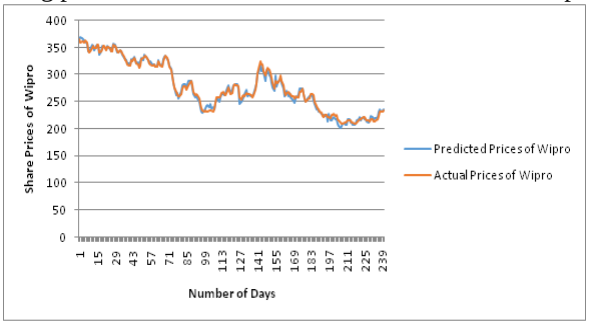

Fig..18: Predicted Share Prices of Wipro using ANN Model-4

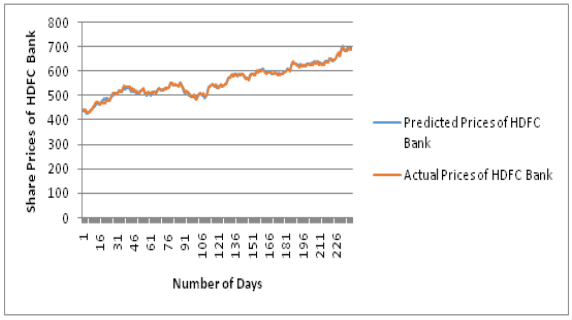

Fig.19: Predicted Share Prices of HDFC Bank using ANN Model-4

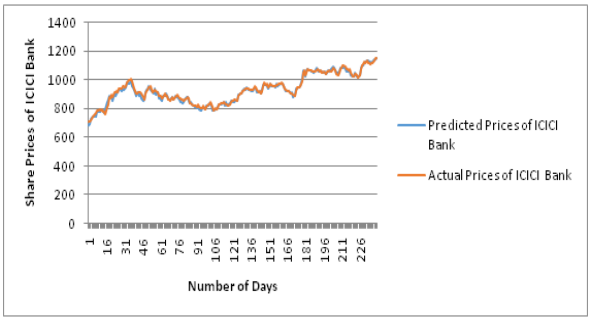

Fig.20: Predicted Share Prices of ICICI Bank using ANN Model-4

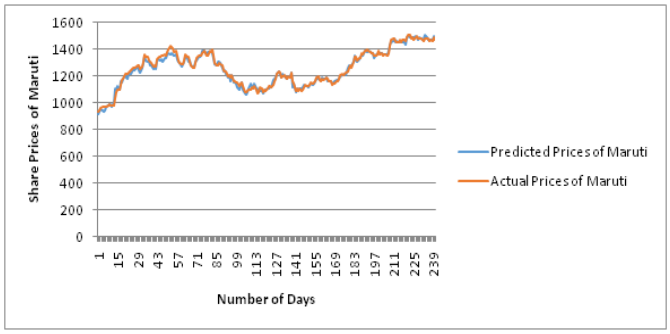

Fig. 21: Predicted Share Prices of Maruti using ANN Model-4

Forecasting Results of ANN Model -5

Graphs shown in figure 22, 23, 24, 25 and 26 shows the forecasting performance of ANN Model-5 for various companies:

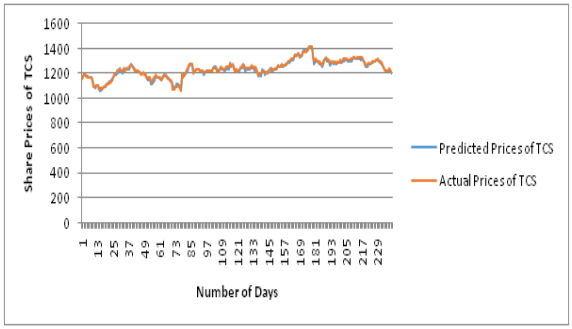

Fig.22: Predicted Share Prices of TCS using ANN Model-

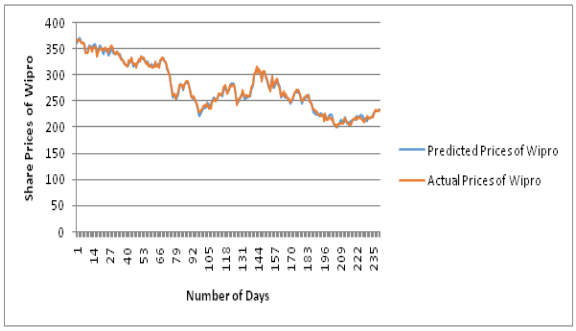

Fig.23: Predicted Share Prices of Wipro using ANN Model-5

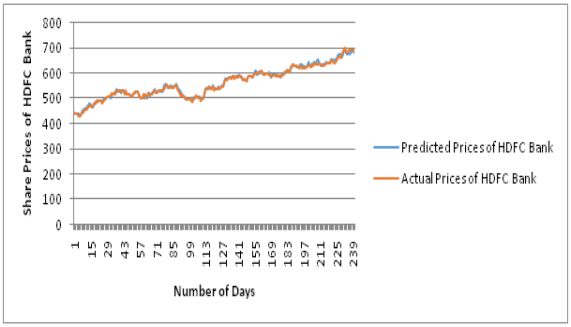

Fig.24: Predicted Share Prices of HDFC Bank using ANN Model-5

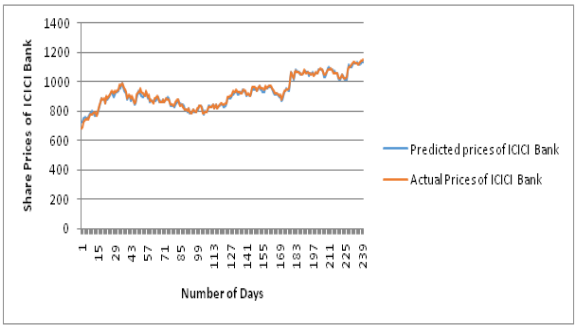

Fig.25: Predicted Share Prices of ICICI Bank using ANN Model-5

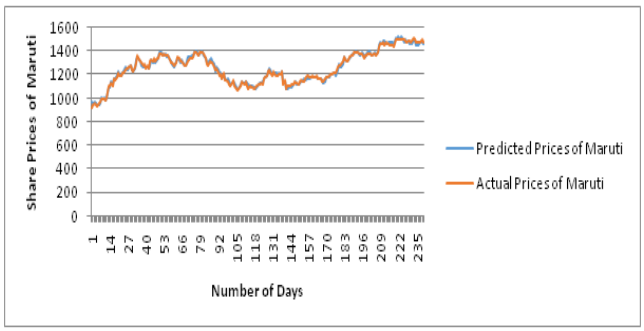

Fig. 26: Predicted Share Prices of Maruti using ANN Model-5

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