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## A fuzzy logic model to forecast momentum in stock markets

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**Abstract:** Trend identification is a visual process where we can draw and see the trend line, then suggest the trend. But to make the system understand this trend is very tough. Using fuzzy logic first we try to make the system understand the actual trend and verify with what we can see and then we go on for forecasting the future trend. Fuzzy membership functions are the key elements while creating any fuzzy system. For generating these membership functions, usually two sources are used, i.e., expert knowledge and real time data. Expert knowledge may not be available all the time, but the probability of getting real time data is more. Here we have tried to develop a method by which fuzzification of real time data can be done and then identification of the trend can be done using those fuzzy values after which forecasting of the short term trend can be done. The type of real time data used here is the daily values of NIFTY 50 index used in National Stock Exchange of India for stock futures trading.

**Keywords:** forecasting; fuzzy-logic; NIFTY 50; stock market.

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**Biographical notes:** G.P. Pandey is an Associate Professor in Bhilai Institute of Technology, Durg (India). He received his MSc in Mathematics and currently he is a PhD scholar in Chhattisgarh Swami Vivekanand University, Bhilai, India. He has published four international research papers in fuzzy metric space.

Sanjay Sharma received his MSc, PhD, MBA in Marketing and HRA. He served Bhilai Institute of Technology (BIT), Durg, for 21 years. He has published 90 research papers in various international and national journals and conferences. At present, five PhD research scholars are working under him and two research scholars awarded the PhD degree. His research areas include fuzzy clustering, signal processing, digital image processing, artificial neural network, fuzzy logic, fuzzy metrics space, fuzzy graphs and fixed point theory. He is a member and fellow of many national and international organisations. Currently, he is working as a Professor in the Department of Applied Mathematics at BIT Durg, Chhattisgarh, India. He is a member of ISCA, IMS.

## 1 Introduction

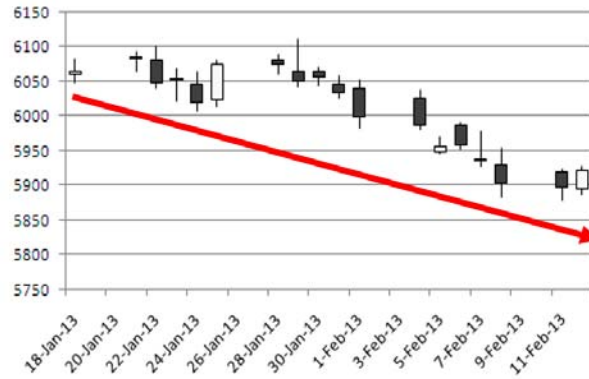
Fuzzy sets theory was introduced by Zadeh (1965). It is different from the traditional Set Theory by using membership function to deal with the questions that cannot be solved by two-valued logic of traditional set theory. After 1965, fuzzy sets have been applied to many fields such as decision analysis, system theory, artificial intelligence, economics and control theory.

Fuzzy sets work as a way to capture uncertainty and vagueness in several systems such as fuzzy database systems. In these systems, impreciseness is generally expressed using fuzzy linguistic terms which are usually defined as fuzzy sets. Each fuzzy set is characterised by its membership function; therefore, these functions must be carefully defined. However, few studies have applied fuzzy set theories to solve some special dynamic process; especially the observations are presented in linguistic values, although this kind of dynamic process plays an important role in daily life. Song and Chissom (1993, 1994) (S-C for short below) proposed a fuzzy time series model which provides an alternative approach for this kind of process. Traditional time series methods such as autocorrelation regressive integrated moving average (ARIMA) model can predict seasonal problem, but fail to forecast the problem with linguistic historical data. Further in principal, traditional time series method needs at least 50 data to stand a better forecasting result. However normally we do not have enough data in all-time series model, and above all, we often use linguistic expression to record some daily observations. To treat such linguistic problems, forecasting methods such as fuzzy time series and fuzzy regression were thus developed.

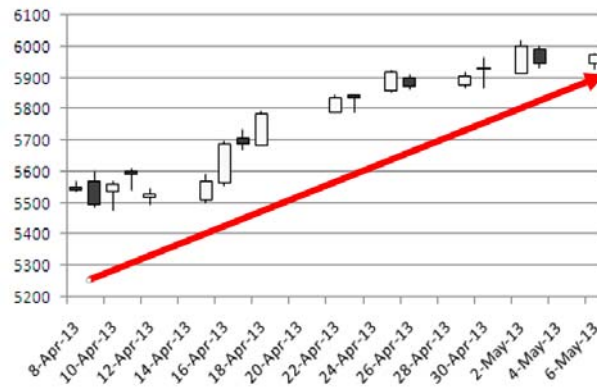
Fuzzy time series models provide us more flexibility in dealing with forecasting problems, but yet the existing models still have certain failings. Most previous attempts on derivation of membership functions require expert knowledge of the application area. However, these methods suffer from the problem of knowledge acquisition and subjectivity. There are usually three types of trends found in the stock market: the bearish trend, bullish trend and neutral trend. The bullish trend indicates that next few sessions might show an up trend and values may move up. The bearish trend indicates that next few sessions might show down trend and values may move down. The neutral trend indicates that next few sessions might show values that would be in a range bounded around few points above and below the mid distance between highest and lowest values. This information is very useful to the short term traders who purchase and sell with in a time span of one week or so. For our experiments we use NIFTY 50 index used in National Stock Exchange of India for stock futures trading. The real time data is collected from the websites of National Stock Exchange of India, Bombay Stock Exchange and Yahoo Finance India.

The main intention of this paper is to induce new ideas in the field of fuzzy logic and its use as an effective tool for forecasting. Also it is intended that researchers find the proposed model useful in their research ventures so that it can be used not only for forecasting purpose but also in modelling more complex human cognition and artificial intelligence.

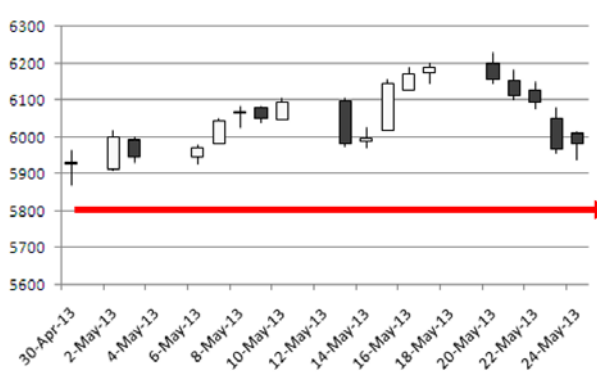
**Figure 1** Bearish trend (see online version for colours)



**Figure 2** Bullish trend (see online version for colours)



**Figure 3** Neutral trend (see online version for colours)



## 2 Literature review

Zadeh (1965) suggested a fuzzy set as  $A[x]$  over a universe of discourse  $X$  is a set of pairs:

$$A = \{(x, \mu_A(x))\} \text{ such that } x \in X, \mu_A(x) \in [0, 1]$$

where  $\mu_A(x)$  is called the membership degree of the element  $x$  to the fuzzy set  $A$ . This degree ranges between the extremes 0 and 1:

- $\mu_A(x) = 0$  indicates that  $x$  in no way belongs to the fuzzy set  $A$ .
- $\mu_A(x) = 1$  indicates that  $x$  completely belongs to the fuzzy set  $A$ .

The Standard and Poor's CRISIL NSE Index 50 or S&P CNX Nifty nicknamed Nifty 50 or simply Nifty, is the leading index for large companies on the National Stock Exchange of India. The Nifty is a well diversified 50 stock index accounting for 23 sectors of the economy. It is used for a variety of purposes such as benchmarking fund portfolios, index-based derivatives and index funds. Nifty is owned and managed by India Index Services and Products Ltd. (IISL), which is a joint venture between NSE and CRISIL. IISL is India's first specialised company focused upon the index as a core product. IISL has a marketing and licensing agreement with Standard and Poor's.

The S&P CNX Nifty covers 23 sectors of the Indian economy and offers investment managers exposure to the Indian market in one portfolio. The S&P CNX Nifty stocks represent about 60% of the total market capitalisation of the National Stock Exchange (NSE).

The index is a free float market capitalisation weighted index. From inception, the index used full market capitalisation as weight assigned to different constituents. From 26 June 2009, the index is computed based on free float methodology. As of November 2010, top four scrips in the index (Reliance Industries, Infosys Technologies, ICICI Bank and Larsen and Toubro) account for about one third of the weight in the index whereas the top eight scrips account for about half the weightage in the index.

The base period for the S&P CNX Nifty index is 3 November 1995, which marked the completion of one year of operations of NSE's capital market segment. The base value of the index has been set at 1,000, and a base capital of Rs 2.06 trillion. The S&P CNX Nifty Index was developed by Ajay Shah and Susan Thomas.

The attractive feature of the stock market is that every investor has the image to make millions in return from buying and selling stocks (cash and futures). Unfortunately, the reality of the nature of the market poses a less optimistic picture. Although, researchers have proposed many methods to somehow predict the market movements and also it is observed that the best market players have been the investors who use their professional knowledge of the markets to predict the next trend of the stock price. Here the need of an automated trustworthy forecasting tool is extremely desired, so that the investors do not have to rely on some one else to do forecasting for them. And also, the more accurately the forecasting tool performs, the more profitable it would be for the investor. Chen (1996) proposed several methods, such as simplified arithmetic operations, high-order fuzzy relationships and genetic algorithms to improve forecasting accuracy. Huarng (2001) points out that the length of intervals affected the forecasting accuracy in fuzzy time-series. Yu (2005) argues that the recurrent fuzzy relationships should be considered

in forecasting, and recommended that different weights be assigned to various fuzzy relationships.

In general, methods can be classified in four major categories:

- 1 technical analysis
- 2 fundamental analysis
- 3 traditional time series forecasting
- 4 machine learning methods.

Technical analysis is probably the most common approach to trend forecasting and a large literature is available on it. Technical analysis makes use of composite functions, such as indicators and oscillators, derived by time series, and heuristic rules able to reveal signals of change in the market trends. Popular examples of methods are moving average convergence divergence (MACD), relative strength index (RSI), stochastic oscillator. This approach relies on the belief that markets are mostly driven by psychology, more than economics. Therefore, trading opportunities can be discovered by carefully analysing the behaviour of other investors that is reflected on price movements. Indeed, detected trends are assumed to be based on supply and demand issues which often have cyclical or noticeable patterns. Although, this approach is very popular among practitioners to predict the market, it received several criticisms, especially from academia. The major source of criticism is that, rule used to identify trend signals, often rely on visual patterns on charts. The large number of parameters on which indicators and oscillators are based, the absence of a theoretical framework able to explain why this approach works and how to choose and tune the different tools, make this class of techniques largely subjective. In addition, these being mostly based on human judgements, makes technical analysis not appropriate for algorithmic trading. However, recent studies provide support to technical analysis as useful for predicting market trends. Fundamental analysis assumes that market trends are driven by then economic context and financial figures of companies traded. Fundamental analysis aims at estimating the intrinsic value of a stock, so that if the current value is lower than the intrinsic value, additional investments are expected, otherwise disinvestment will occur. Although this approach relies on economic fundamentals and can lead to profitable trading strategies, this approach is more appropriate for long-term strategies, than near-term strategies, as those employed by day trading. Both technical and fundamental analyses do not perform any quantitative analysis of time series. Traditional time series forecasting relies on linear models able to translate the body of knowledge of stochastic signal processing, providing a quantitative approach to finance. For a dated, but still valid overview of statistic forecasting see reference (Chen, 1996). Trend forecasting can be regarded as a problem of pattern matching or approximation, so the methods studied in the area of machine learning, soft computing and computational intelligence one being experimented for this task. These methods use a set of samples to generate an approximation of the underling function and relationship between data. In common, they share the aim of drawing predictions when unseen data are presented to a model. There is a rich literature related to the forecast of the market on daily basis. Among the different models, probably artificial neural networks are the most prominent example. As an example, Saad et al. (1998) discuss a comparison three architecture of neural networks, namely time delay (TDNN), recurrent (RNN) and probabilistic neural networks (PNN), for stock trend predictions.

They argue that short-term trends are particularly attractive for neural network analysis and they can be used profitably. However, false trading signals can lead to wrong decisions and losses. They advocate that neural networks are able to filter out false trading signals, if properly trained.

### 3 Proposed fuzzy model

Following is the proposed methodology to build the fuzzy model:

- 1  $x_1$  to  $x_{250}$  represent set of daily open, high, low and close values of 250 consecutive days.
- 2 Three fuzzy sets namely bullish ( $M_1$ ), neutral ( $M_2$ ) and bearish ( $M_3$ ) representing the trend information about the consecutive values are proposed.
- 3  $\mu(x)$  represents the membership value of the day  $x$  in the set. It is computed as follows:

$$\mu(x) = \{x/M_1, x/M_2, x/M_3\}$$

- 4  $G_1$  to  $G_{10}$  represent the group fuzzy values of the group of five days each. It is represented as follows:

$$G_1 = \{\mu(D_1), \mu(D_2), \mu(D_3), \mu(D_4), \mu(D_5)\}$$

$$G_2 = \{\mu(D_6), \mu(D_7), \mu(D_8), \mu(D_9), \mu(D_{10})\}$$

...

...

$$G_{10} = \{\mu(D_{46}), \mu(D_{47}), \mu(D_{48}), \mu(D_{49}), \mu(D_{50})\}$$

- 5 Finally the max of  $G_1$  to  $G_{10}$  would give the final momentum value which would be used as forecasted momentum value, FM.

The fuzzy values ranging from 0 to 1 represent very bearish to very bullish momentum values respectively.

### 4 Implementation of the proposed model

Table 1 displays the real time data containing date, open, high, low and close values of 50 consecutive days.

**Table 1** Real time data values of 50 consecutive days

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
1	15-Jan-13	6,037.85	6,068.50	6,018.60	6,056.60	0.76
2	16-Jan-13	6,049.00	6,055.95	5,992.05	6,001.85	0.15
3	17-Jan-13	6,001.25	6,053.20	5,988.10	6,039.20	0.78
4	18-Jan-13	6,059.85	6,083.40	6,048.30	6,064.40	0.46

**Table 1** Real time data values of 50 consecutive days (continued)

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
5	21-Jan-13	6,085.75	6,094.35	6,065.10	6,082.30	0.59
6	22-Jan-13	6,080.15	6,101.30	6,040.50	6,048.50	0.13
7	23-Jan-13	6,052.85	6,069.80	6,021.15	6,054.30	0.68
8	24-Jan-13	6,046.20	6,065.30	6,007.85	6,019.35	0.20
9	25-Jan-13	6,024.50	6,080.55	6,014.45	6,074.65	0.91
10	28-Jan-13	6,082.10	6,088.40	6,061.40	6,074.80	0.50
11	29-Jan-13	6,064.70	6,111.80	6,042.45	6,049.90	0.11
12	30-Jan-13	6,065.00	6,071.95	6,044.15	6,055.75	0.42
13	31-Jan-13	6,045.65	6,058.05	6,025.15	6,034.75	0.29
14	01-Feb-13	6,040.95	6,052.95	5,983.20	5,998.90	0.23
15	04-Feb-13	6,025.20	6,038.50	5,981.25	5,987.25	0.10
16	05-Feb-13	5,948.20	5,970.35	5,946.90	5,956.90	0.43
17	06-Feb-13	5,988.05	5,990.90	5,953.15	5,959.20	0.16
18	07-Feb-13	5,936.45	5,978.50	5,927.60	5,938.80	0.22
19	08-Feb-13	5,929.10	5,953.70	5,883.65	5,903.50	0.28
20	11-Feb-13	5,920.05	5,924.15	5,879.10	5,897.85	0.42
21	12-Feb-13	5,894.35	5,927.65	5,886.45	5,922.50	0.88
22	13-Feb-13	5,943.15	5,969.50	5,922.95	5,932.95	0.21
23	14-Feb-13	5,933.20	5,940.20	5,884.55	5,896.95	0.22
24	15-Feb-13	5,869.95	5,899.95	5,853.90	5,887.40	0.73
25	18-Feb-13	5,888.65	5,911.00	5,878.45	5,898.20	0.61
26	19-Feb-13	5,900.20	5,947.55	5,883.15	5,939.70	0.88
27	20-Feb-13	5,966.30	5,971.00	5,937.55	5,943.05	0.16
28	21-Feb-13	5,909.65	5,921.15	5,844.40	5,852.25	0.10
29	22-Feb-13	5,837.95	5,873.80	5,835.80	5,850.30	0.38
30	25-Feb-13	5,870.55	5,878.40	5,825.00	5,854.75	0.56
31	26-Feb-13	5,838.30	5,838.85	5,748.60	5,761.35	0.14
32	27-Feb-13	5,784.90	5,818.20	5,749.70	5,796.90	0.69
33	28-Feb-13	5,834.35	5,849.90	5,671.90	5,693.05	0.12
34	01-Mar-13	5,702.45	5,739.45	5,679.90	5,719.70	0.67
35	04-Mar-13	5,704.70	5,712.00	5,663.60	5,698.50	0.72
36	05-Mar-13	5,722.45	5,790.10	5,722.40	5,784.25	0.91
37	06-Mar-13	5,816.40	5,828.70	5,795.05	5,818.60	0.70
38	07-Mar-13	5,801.30	5,878.00	5,801.30	5,863.30	0.81
39	08-Mar-13	5,883.65	5,952.85	5,883.00	5,945.70	0.90
40	11-Mar-13	5,946.10	5,971.20	5,930.35	5,942.35	0.29
41	12-Mar-13	5,944.60	5,952.00	5,893.65	5,914.10	0.35

**Table 1** Real time data values of 50 consecutive days (continued)

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
42	13-Mar-13	5,884.80	5,893.85	5,842.25	5,851.20	0.17
43	14-Mar-13	5,845.95	5,920.15	5,791.75	5,908.95	0.91
44	15-Mar-13	5,914.90	5,945.65	5,861.00	5,872.60	0.14
45	18-Mar-13	5,816.75	5,850.20	5,814.35	5,835.25	0.58
46	19-Mar-13	5,859.50	5,863.60	5,724.30	5,745.95	0.16
47	20-Mar-13	5,740.55	5,745.30	5,682.30	5,694.40	0.19
48	21-Mar-13	5,705.90	5,757.75	5,647.95	5,658.75	0.10
49	22-Mar-13	5,659.80	5,691.45	5,631.80	5,651.35	0.33
50	25-Mar-13	5,707.30	5,718.40	5,624.40	5,633.85	0.10
51	26-Mar-13	5,613.75	5,655.30	5,612.05	5,641.60	0.68
52	28-Mar-13	5,647.75	5,692.95	5,604.85	5,682.55	0.88
53	01-Apr-13	5,697.35	5,720.95	5,675.90	5,704.40	0.63
54	02-Apr-13	5,701.70	5,754.60	5,687.15	5,748.10	0.90
55	03-Apr-13	5,740.20	5,744.95	5,650.10	5,672.90	0.24
56	04-Apr-13	5,640.65	5,644.45	5,565.65	5,574.75	0.12
57	05-Apr-13	5,568.10	5,577.30	5,534.70	5,553.25	0.44
58	08-Apr-13	5,550.50	5,569.20	5,537.05	5,542.95	0.18
59	09-Apr-13	5,568.75	5,603.05	5,487.00	5,495.10	0.07
60	10-Apr-13	5,536.25	5,569.25	5,477.20	5,558.70	0.89
61	11-Apr-13	5,601.65	5,610.65	5,542.85	5,594.00	0.75
62	12-Apr-13	5,520.70	5,544.50	5,494.90	5,528.55	0.68
63	15-Apr-13	5,508.50	5,592.85	5,500.30	5,568.40	0.74
64	16-Apr-13	5,562.45	5,699.25	5,555.85	5,688.95	0.93
65	17-Apr-13	5,708.65	5,732.15	5,669.00	5,688.70	0.31
66	18-Apr-13	5,682.70	5,794.35	5,681.85	5,783.10	0.90
67	22-Apr-13	5,789.85	5,844.85	5,789.80	5,834.40	0.81
68	23-Apr-13	5,843.10	5,844.30	5,791.55	5,836.90	0.86
69	25-Apr-13	5,856.10	5,924.60	5,853.30	5,916.30	0.88
70	26-Apr-13	5,899.75	5,907.05	5,860.50	5,871.45	0.24
71	29-Apr-13	5,877.60	5,918.65	5,868.80	5,904.10	0.71
72	30-Apr-13	5,932.60	5,962.30	5,867.80	5,930.20	0.66
73	02-May-13	5,911.40	6,019.45	5,910.95	5,999.35	0.81
74	03-May-13	5,993.50	6,000.30	5,930.15	5,944.00	0.20
75	06-May-13	5,944.90	5,976.50	5,928.45	5,971.05	0.89
76	07-May-13	5,983.45	6,050.50	5,982.95	6,043.55	0.90
77	08-May-13	6,064.15	6,083.55	6,024.95	6,069.30	0.76
78	09-May-13	6,078.35	6,084.70	6,040.45	6,050.15	0.22



**Table 1** Real time data values of 50 consecutive days (continued)

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
79	10-May-13	6,046.25	6,105.30	6,045.60	6,094.75	0.82
80	13-May-13	6,098.20	6,104.95	5,972.90	5,980.45	0.06
81	14-May-13	5,989.70	6,026.20	5,970.05	5,995.40	0.45
82	15-May-13	6,018.85	6,157.10	6,018.85	6,146.75	0.93
83	16-May-13	6,128.25	6,187.30	6,128.25	6,169.90	0.71
84	17-May-13	6,172.95	6,199.95	6,146.15	6,187.30	0.76
85	20-May-13	6,198.00	6,229.45	6,146.05	6,156.90	0.13
86	21-May-13	6,152.35	6,180.25	6,102.35	6,114.10	0.15
87	22-May-13	6,127.05	6,147.60	6,074.45	6,094.50	0.27
88	23-May-13	6,050.40	6,081.45	5,955.70	5,967.05	0.09
89	24-May-13	6,010.70	6,015.30	5,936.80	5,983.55	0.60
90	27-May-13	5,989.40	6,099.90	5,975.55	6,083.15	0.87
91	28-May-13	6,086.35	6,127.65	6,055.40	6,111.25	0.77
92	29-May-13	6,120.45	6,125.05	6,069.80	6,104.30	0.62
93	30-May-13	6,072.15	6,133.75	6,072.15	6,124.05	0.84
94	31-May-13	6,098.70	6,106.25	5,975.55	5,985.95	0.08
95	03-Jun-13	5,997.35	6,011.00	5,916.35	5,939.30	0.24
96	04-Jun-13	5,941.10	5,981.60	5,910.25	5,919.45	0.13
97	05-Jun-13	5,908.30	5,935.20	5,883.70	5,923.85	0.78
98	06-Jun-13	5,895.00	5,956.55	5,869.50	5,921.40	0.60
99	07-Jun-13	5,900.05	5,972.70	5,871.30	5,881.00	0.10
100	10-Jun-13	5,907.90	5,931.65	5,857.40	5,878.00	0.28
101	11-Jun-13	5,848.75	5,868.05	5,780.35	5,788.80	0.10
102	12-Jun-13	5,771.75	5,792.90	5,738.60	5,760.20	0.40
103	13-Jun-13	5,709.35	5,729.85	5,683.10	5,699.10	0.34
104	14-Jun-13	5,748.95	5,819.40	5,739.40	5,808.40	0.86
105	17-Jun-13	5,820.40	5,854.90	5,770.25	5,850.05	0.94
106	18-Jun-13	5,841.90	5,863.40	5,804.30	5,813.60	0.16
107	19-Jun-13	5,805.75	5,828.40	5,777.90	5,822.25	0.88
108	20-Jun-13	5,754.15	5,755.00	5,645.65	5,655.90	0.09
109	21-Jun-13	5,639.90	5,686.15	5,616.85	5,667.65	0.73
110	24-Jun-13	5,638.05	5,640.00	5,566.25	5,590.25	0.33
111	25-Jun-13	5,606.95	5,666.25	5,570.25	5,609.10	0.40
112	26-Jun-13	5,627.95	5,635.25	5,579.35	5,588.70	0.17
113	27-Jun-13	5,647.95	5,699.35	5,630.95	5,682.35	0.75
114	28-Jun-13	5,749.50	5,852.95	5,749.50	5,842.20	0.90
115	01-Jul-13	5,834.10	5,904.35	5,822.20	5,898.85	0.93

**Table 1** Real time data values of 50 consecutive days (continued)

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
116	02-Jul-13	5,885.50	5,898.80	5,852.30	5,857.55	0.11
117	03-Jul-13	5,811.95	5,815.00	5,760.40	5,770.90	0.19
118	04-Jul-13	5,794.75	5,848.20	5,786.05	5,836.95	0.82
119	05-Jul-13	5,889.95	5,900.45	5,858.45	5,867.90	0.22
120	08-Jul-13	5,833.15	5,833.85	5,775.55	5,811.55	0.62
121	09-Jul-13	5,834.60	5,864.95	5,834.60	5,859.00	0.80
122	10-Jul-13	5,869.90	5,879.35	5,802.85	5,816.70	0.18
123	11-Jul-13	5,894.50	5,948.85	5,887.95	5,935.10	0.77
124	12-Jul-13	6,000.50	6,019.00	5,951.15	6,009.00	0.85
125	15-Jul-13	5,991.20	6,038.20	5,980.95	6,030.80	0.87
126	16-Jul-13	5,930.80	5,966.05	5,910.95	5,955.25	0.80
127	17-Jul-13	5,972.25	5,989.80	5,926.75	5,973.30	0.74
128	18-Jul-13	5,984.70	6,051.10	5,974.55	6,038.05	0.83
129	19-Jul-13	6,057.20	6,066.85	6,020.25	6,029.20	0.19
130	22-Jul-13	6,009.75	6,064.15	6,004.25	6,031.80	0.46
131	23-Jul-13	6,064.30	6,093.35	6,061.30	6,077.80	0.51
132	24-Jul-13	6,032.20	6,047.25	5,962.60	5,990.50	0.33
133	25-Jul-13	5,970.40	5,990.65	5,896.40	5,907.50	0.12
134	26-Jul-13	5,937.95	5,944.50	5,869.50	5,886.20	0.22
135	29-Jul-13	5,869.95	5,886.00	5,825.80	5,831.65	0.10
136	30-Jul-13	5,836.05	5,861.30	5,747.60	5,755.05	0.07
137	31-Jul-13	5,738.35	5,752.10	5,675.75	5,742.00	0.87
138	01-Aug-13	5,776.90	5,808.50	5,676.85	5,727.85	0.39
139	02-Aug-13	5,750.05	5,761.85	5,649.00	5,677.90	0.26
140	05-Aug-13	5,682.40	5,721.00	5,661.50	5,685.40	0.40
141	06-Aug-13	5,664.90	5,664.90	5,521.80	5,542.25	0.14
142	07-Aug-13	5,549.30	5,561.45	5,486.85	5,519.10	0.43
143	08-Aug-13	5,510.05	5,577.60	5,510.05	5,565.65	0.82
144	12-Aug-13	5,606.70	5,644.10	5,557.10	5,612.40	0.64
145	13-Aug-13	5,600.25	5,704.75	5,578.90	5,699.30	0.96
146	14-Aug-13	5,715.40	5,754.55	5,690.20	5,742.30	0.81
147	16-Aug-13	5,705.45	5,716.60	5,496.05	5,507.85	0.05
148	19-Aug-13	5,497.55	5,499.65	5,360.65	5,414.75	0.39
149	20-Aug-13	5,353.45	5,417.80	5,306.35	5,401.45	0.85
150	21-Aug-13	5,494.45	5,504.10	5,268.45	5,302.55	0.14
151	22-Aug-13	5,282.80	5,418.95	5,254.05	5,408.45	0.94
152	23-Aug-13	5,428.75	5,478.80	5,377.80	5,471.75	0.93

**Table 1** Real time data values of 50 consecutive days (continued)

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
153	26-Aug-13	5,499.40	5,528.70	5,454.45	5,476.50	0.30
154	27-Aug-13	5,426.50	5,427.40	5,274.25	5,287.45	0.09
155	28-Aug-13	5,233.45	5,317.70	5,118.85	5,285.00	0.84
156	29-Aug-13	5,316.50	5,428.90	5,303.00	5,409.05	0.84
157	30-Aug-13	5,407.45	5,493.30	5,360.20	5,471.80	0.84
158	02-Sep-13	5,480.25	5,564.90	5,478.85	5,550.75	0.84
159	03-Sep-13	5,574.70	5,580.95	5,323.75	5,341.45	0.07
160	04-Sep-13	5,358.65	5,460.25	5,318.90	5,448.10	0.91
161	05-Sep-13	5,553.75	5,625.75	5,552.70	5,592.95	0.55
162	06-Sep-13	5,617.45	5,688.60	5,566.15	5,680.40	0.93
163	11-Sep-13	5,887.25	5,924.35	5,832.70	5,913.15	0.88
164	12-Sep-13	5,931.15	5,932.00	5,815.80	5,850.70	0.30
165	13-Sep-13	5,828.00	5,884.30	5,822.90	5,850.60	0.45
166	16-Sep-13	5,930.30	5,957.25	5,798.15	5,840.55	0.27
167	17-Sep-13	5,824.20	5,857.80	5,804.90	5,850.20	0.86
168	18-Sep-13	5,872.75	5,916.90	5,840.20	5,899.45	0.77
169	19-Sep-13	6,044.15	6,142.50	6,040.15	6,115.55	0.74
170	20-Sep-13	6,104.55	6,130.95	5,932.85	6,012.10	0.40
171	23-Sep-13	5,945.80	5,989.40	5,871.40	5,889.75	0.16
172	24-Sep-13	5,855.00	5,938.40	5,854.55	5,892.45	0.45
173	25-Sep-13	5,901.55	5,910.55	5,811.10	5,873.85	0.63
174	26-Sep-13	5,872.80	5,917.65	5,864.10	5,882.25	0.34
175	27-Sep-13	5,905.55	5,909.20	5,819.30	5,833.20	0.15
176	01-Oct-13	5,756.10	5,786.45	5,700.95	5,780.05	0.93
177	03-Oct-13	5,819.10	5,917.60	5,802.70	5,909.70	0.93
178	04-Oct-13	5,891.30	5,950.45	5,885.00	5,907.30	0.34
179	07-Oct-13	5,889.05	5,912.00	5,825.85	5,906.15	0.93
180	08-Oct-13	5,975.00	5,981.70	5,913.00	5,928.40	0.22
181	09-Oct-13	5,893.25	6,015.50	5,877.10	6,007.45	0.94
182	10-Oct-13	6,001.05	6,033.95	5,979.80	6,020.95	0.76
183	11-Oct-13	6,104.85	6,107.60	6,046.40	6,096.20	0.81
184	14-Oct-13	6,093.00	6,124.10	6,082.90	6,112.70	0.72
185	15-Oct-13	6,147.55	6,156.30	6,056.55	6,089.05	0.33
186	17-Oct-13	6,098.50	6,110.75	6,032.55	6,045.85	0.17
187	18-Oct-13	6,070.90	6,201.45	6,070.90	6,189.35	0.91
188	21-Oct-13	6,202.00	6,218.95	6,163.30	6,204.95	0.75
189	22-Oct-13	6,192.30	6,220.10	6,181.80	6,202.80	0.55

**Table 1** Real time data values of 50 consecutive days (continued)

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
190	23-Oct-13	6,209.55	6,217.95	6,116.60	6,178.35	0.61
191	24-Oct-13	6,162.80	6,252.45	6,142.95	6,164.35	0.20
192	25-Oct-13	6,154.00	6,174.75	6,125.95	6,144.90	0.39
193	28-Oct-13	6,155.10	6,168.75	6,094.10	6,101.10	0.09
194	29-Oct-13	6,107.55	6,228.05	6,079.20	6,220.90	0.95
195	30-Oct-13	6,230.80	6,269.20	6,222.60	6,251.70	0.62
196	31-Oct-13	6,237.15	6,309.05	6,235.90	6,299.15	0.86
197	01-Nov-13	6,289.75	6,332.60	6,286.95	6,307.20	0.44
198	03-Nov-13	6,332.05	6,342.95	6,311.15	6,317.35	0.19
199	05-Nov-13	6,282.15	6,304.75	6,244.30	6,253.15	0.15
200	06-Nov-13	6,260.55	6,269.70	6,208.70	6,215.15	0.11
201	07-Nov-13	6,228.90	6,288.95	6,180.80	6,187.25	0.06
202	08-Nov-13	6,170.15	6,185.15	6,120.95	6,140.75	0.31
203	11-Nov-13	6,110.40	6,141.65	6,067.75	6,078.80	0.15
204	12-Nov-13	6,087.25	6,108.70	6,011.75	6,018.05	0.06
205	13-Nov-13	5,998.85	6,042.25	5,972.45	5,989.60	0.25
206	14-Nov-13	6,037.00	6,101.65	6,036.65	6,056.15	0.30
207	18-Nov-13	6,111.05	6,196.80	6,110.40	6,189.00	0.91
208	19-Nov-13	6,197.25	6,212.40	6,180.20	6,203.35	0.72
209	20-Nov-13	6,186.85	6,204.35	6,106.95	6,122.90	0.16
210	21-Nov-13	6,096.50	6,097.35	5,985.40	5,999.05	0.12
211	22-Nov-13	6,027.35	6,049.60	5,972.80	5,995.45	0.29
212	25-Nov-13	6,035.95	6,123.50	6,035.95	6,115.35	0.91
213	26-Nov-13	6,099.25	6,112.70	6,047.75	6,059.10	0.17
214	27-Nov-13	6,062.70	6,074.00	6,030.30	6,057.10	0.61
215	28-Nov-13	6,092.00	6,112.95	6,068.30	6,091.85	0.53
216	29-Nov-13	6,103.90	6,182.50	6,103.80	6,176.10	0.92
217	02-Dec-13	6,171.15	6,228.70	6,171.15	6,217.85	0.81
218	03-Dec-13	6,204.25	6,225.40	6,191.40	6,201.85	0.31
219	04-Dec-13	6,187.95	6,209.15	6,149.90	6,160.95	0.19
220	05-Dec-13	6,262.45	6,300.55	6,232.00	6,241.10	0.13
221	06-Dec-13	6,234.40	6,275.35	6,230.75	6,259.90	0.65
222	09-Dec-13	6,415.00	6,415.25	6,345.00	6,363.90	0.27
223	10-Dec-13	6,354.70	6,362.25	6,307.55	6,332.85	0.46
224	11-Dec-13	6,307.20	6,326.60	6,280.25	6,307.90	0.60
225	12-Dec-13	6,276.75	6,286.85	6,230.55	6,237.05	0.12
226	13-Dec-13	6,201.30	6,208.60	6,161.40	6,168.40	0.15

**Table 1** Real time data values of 50 consecutive days (continued)

<i>Sr. no.</i>	<i>DATE</i>	<i>OPEN</i>	<i>HIGH</i>	<i>LOW</i>	<i>CLOSE</i>	<i>Mu(x)</i>
227	16-Dec-13	6,168.35	6,183.25	6,146.05	6,154.70	0.23
228	17-Dec-13	6,178.20	6,190.55	6,133.00	6,139.05	0.11
229	18-Dec-13	6,129.95	6,236.00	6,129.95	6,217.15	0.82
230	19-Dec-13	6,253.90	6,263.75	6,150.70	6,166.65	0.14
231	20-Dec-13	6,179.95	6,284.50	6,170.35	6,274.25	0.91
232	23-Dec-13	6,267.20	6,317.50	6,266.95	6,284.50	0.35
233	24-Dec-13	6,296.45	6,301.50	6,262.00	6,268.40	0.16
234	26-Dec-13	6,270.10	6,302.75	6,259.45	6,278.90	0.45
235	27-Dec-13	6,292.80	6,324.90	6,289.40	6,313.80	0.69
236	30-Dec-13	6,336.40	6,344.05	6,273.15	6,291.10	0.25
237	31-Dec-13	6,307.35	6,317.30	6,287.30	6,304.00	0.56
238	01-Jan-14	6,323.80	6,327.20	6,298.25	6,301.65	0.12
239	02-Jan-14	6,301.25	6,358.30	6,211.30	6,221.15	0.07
240	03-Jan-14	6,194.55	6,221.70	6,171.25	6,211.15	0.79
241	06-Jan-14	6,220.85	6,224.70	6,170.25	6,191.45	0.39
242	07-Jan-14	6,203.90	6,221.50	6,144.75	6,162.25	0.23
243	08-Jan-14	6,178.05	6,192.10	6,160.35	6,174.60	0.45
244	09-Jan-14	6,181.70	6,188.05	6,148.25	6,168.35	0.51
245	10-Jan-14	6,178.85	6,239.10	6,139.60	6,171.45	0.32
246	13-Jan-14	6,189.55	6,288.20	6,189.55	6,272.75	0.84
247	14-Jan-14	6,260.25	6,280.35	6,234.15	6,241.85	0.17
248	15-Jan-14	6,265.95	6,325.20	6,265.30	6,320.90	0.93
249	16-Jan-14	6,341.35	6,346.50	6,299.85	6,318.90	0.41
250	17-Jan-14	6,306.25	6,327.10	6,246.35	6,261.65	0.19

Table 2 indicates the fuzzy values achieved by grouping the data from Table 1 into 50 groups

**Table 2** Fuzzy values achieved by grouping the data

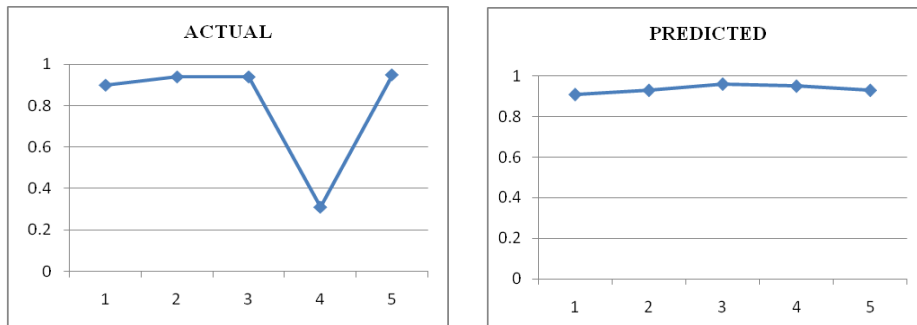
<i>Gn</i>	<i>Mu(x)</i>	<i>Gn</i>	<i>Mu(x)</i>
G1	0.78	G10	0.33
G2	0.91	G11	0.9
G3	0.42	G12	0.89
G4	0.43	G13	0.93
G5	0.88	G14	0.9
G6	0.88	G15	0.89
G7	0.72	G16	0.9
G8	0.91	G17	0.93
G9	0.91	G18	0.87

**Table 2** Fuzzy values achieved by grouping the data (continued)

<i>Gn</i>	<i>Mu(x)</i>	<i>Gn</i>	<i>Mu(x)</i>
G19	0.84	G35	0.63
G20	0.78	G36	0.93
G21	0.94	G37	0.94
G22	0.88	G38	0.91
G23	0.93	G39	0.95
G24	0.82	G40	0.86
G25	0.87	G41	0.31
G26	0.83	G42	0.91
G27	0.51	G43	0.91
G28	0.87	G44	0.92
G29	0.96	G45	0.65
G30	0.85	G46	0.82
G31	0.94	G47	0.91
G32	0.91	G48	0.79
G33	0.93	G49	0.51
G34	0.86	G50	0.93

**Table 3** Results of the implemented system

<i>ACTUAL</i>	<i>PREDICTED</i>	<i>ERROR</i>
0.9	0.91	0.01
0.94	0.93	-0.01
0.94	0.96	0.02
0.31	0.95	0.64
0.95	0.93	-0.02

**Figure 4** Comparative graph of the results achieved (see online version for colours)

The results show that the actual and predicted values are very close only for one instance. The error of the proposed system is around 0.12, which is negligible.

## 5 Conclusions

In our approach we use fuzzy logic as it does not need tones of data as in the case of ANN, and also the results are achieved fast. The methodology can be enhanced to predict the long term future trends. The proposed model is simple and easy to develop which can effectively identify the present trend and also help in predicting the immediate future trend. There is ample scope of improvement and researchers can creatively use this model for trend identification and further enhance it for further trend prediction.

The proposed system was tested on consecutive 250 days of data from the National Stock Exchange of India website. The data on which the system was tested ranges from January 2013 to January 2014. The error of the proposed system is around 0.12 and which is negligible.

The proposed future work is to de-fuzzify the trend values and achieve a crisp value of how much points the market is going to rise or fall in the short term.

## References

- Chen, S.M. (1996) 'Forecasting enrollments based on fuzzy time-series', *Fuzzy Sets and Systems*, Vol. 81, No. 3, pp.311–319.
- Huang, K.H. (2001) 'Effective lengths of intervals to improve forecasting in fuzzy time-series', *Fuzzy Sets and Systems*, Vol. 123, No. 3, pp.387–394.
- Saad, E.W., Prokhorov, D.V. and Wunsch, D.C. (1998) 'Comparative study of stock trend prediction using time delay, recurrent and probabilistic neural networks', *Neural Networks, IEEE Transactions on*, Vol. 9 No. 6, pp.1456–1470.
- Song, Q. and Chissom, B.S. (1993) 'Forecasting enrollments with fuzzy time-series – Part I', *Fuzzy Sets and Systems*, Vol. 54, No. 1, pp.1–10.
- Song, Q. and Chissom, B.S. (1994) 'Forecasting enrollments with fuzzy time-series – Part II', *Fuzzy Sets and Systems*, Vol. 62, No. 1, pp.1–8.
- Yu, H.K. (2005) 'A refined fuzzy time-series model for forecasting', *Physica A*, Vol. 346, No. 3, pp.657–681.
- Zadeh, L.A. (1965) 'Fuzzy sets', *Inform. and Control*, Vol. 8, No. 3, pp.338–353.