Proceedings of BITCON-2015 Innovations For National Development
National Conference on : Research and Development in Computer Science and Applications

Research Paper

A FUZZY LOGIC MODEL TO FORECAST STOCK MARKET MOMENTUM

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ABSTRACT
Forecasting is a very complex process and requires considering many dimensions. The stock market index values are very chaotic in nature and highly random, hence forecasting stock market values is a very challenging job. Financial forecasting that too stock market prediction is an important area of interest to stock investors, stock traders and applied researchers. To determine the momentum of the market helps in predicting future market movements and that helps to take effective buy and sell decisions. The experts in the stock markets use many attributes like historical prices, company earnings, company orders, etc. and in this paper the NIFTY-50 index historical prices are only used, hence it becomes far more difficult to forecast. The proposed fuzzy model helps in identifying the momentum (bullish, neutral or bearish) of the index. It can forecast the short term momentum by considering 14 day historic data as the base for predicting future 5 day movement or momentum. The consecutive close-open values are fuzzified to get a fuzzy momentum value, the momentum which is either bullish, bearish or neutral continues to some extent i.e. for few days and this idea helps to forecast the momentum. The results found suggest that fuzzy modeling for this purpose is very promising.
KEY WORDS: forecasting, fuzzy-logic, NIFTY 50, stock market.

1. INTRODUCTION

In 1965 Fuzzy Sets Theory was introduced by L. A. Zadeh. It is different from the traditional Set Theory. The questions that cannot be solved by two-valued logic of traditional set theory can be solved by using membership function in fuzzy logic. After 1965, fuzzy sets have been applied to many fields such as Economics, Control Theory, System Theory, Artificial Intelligence, and Decision Analysis.

Fuzzy sets work as a way to capture uncertainty and vagueness in our day to day ventures and especially technical systems like database systems. Impreciseness generally expressed using fuzzy linguistic terms are defined as fuzzy sets represent them precisely. Each fuzzy set is characterized by its membership function therefore, these functions must be carefully defined.

The National Stock Exchange of Independent India was set up by Government of India on the recommendation of Pherwani Committee in 1991. Promoted by leading Financial institutions essentially led by IDBI at the behest of the Government of India, it was incorporated in November 1992 as a tax-paying company. In April 1993, it was recognized as a stock exchange under the Securities Contracts (Regulation) Act, 1956.The S&P CNX Nifty or simply Nifty-50 covers 23 sectors of the Indian economy and offers investment managers exposure to the Indian market in one portfolio. The Nifty-50 stocks represent about 60% of the total market capitalization of the National Stock Exchange (NSE) of India.

Momentum in stock markets is defined as the way the prices are moving in the market. There are fundamentally three components of stock market momentum namely; Bullish, Neutral and Bearish. Bullish momentum suggests that the buyers are dominating the market and are trying to push the values higher. Bearish momentum suggests that the sellers are dominating the market and are trying to push the values lower and Neutral momentum suggests that neither buyers nor sellers are in control of the market and hence the prices are range bound. Every calculation is time based and time factor is very important constraint.

In this paper a fuzzy system is modeled that can forecast the short term momentum of the Nifty-50 index. The fuzzy momentum values of last 14 day data is developed and that fuzzy value is used as the prediction value for nest five day stock market movement. 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 modeling more complex human cognition and artificial intelligence.

2. PROPOSED METHODOLOGY

Here the daily data namely the O,H,L,C values that represent Open, High, Low and Close values respectively are used. Open is the first traded value when the trading starts, High is the highest traded value of the day, Low is the lowest traded value of the day and Close is the last traded value of the day just before the stock market closes.

To model the momentum it is very obvious that if closing prices are closing near day's high then the bulls are in control hence the momentum is turning bullish, inversly if closing prices are closing near day's low then the bears are in control hence the momentum is turning bearish and if neither is happening then the momentum is neutral. 14 day historic data is considered as the base for predicting future 5 day movement or momentum. The idea is to get a list of consecutive close-open values and these values are to be fuzzified. The average of individual day fuzzy momentum values is calculated and this value acts as the representative momentum of last 14-days and suggestive to the trend that migh continue for few days more.

Following is the proposed methodology to build the fuzzy model:

Each day data is the set of Open, High, Low and Close values of that day. v_i^{op} , v_i^{hi} , v_i^{lo} , v_i^{cl} represent open, high, low and close respectively of the ith day.

Direction of movement of a particular ith day is represented as d_i where,

$$d_i = \begin{cases} 1, & v_i^{cl} < v_i^{op} \\ 0, & v_i^{op} > v_i^{cl} \end{cases} \quad where, i = 1\ to\ 14 \qquad (1)$$

When $d_i = 1$ then it represents negative direction of momentum and when $d_i = 0$ then it represents positive direction momentum on the i[th] day.

The momentum value x_i is the non-negative value of the difference of close and open values of the i[th] day and is represented as:

$$x_i = abs(v_i^{cl} - v_i^{op}) \quad where, i = 1\ to\ 14 \qquad (2)$$

Mxval represents the maximum value of the momentum x_i and is represented as:

$$\text{Mxval} = \max_{1 \le x \le 1}(x_i) \qquad (3)$$

The triangular membership function is used to calculate the membership grade of the momentum values as follows:

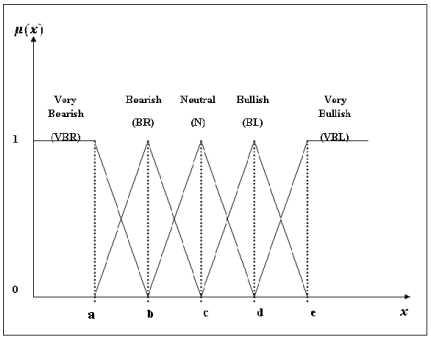

Figure 3a: Triangular membership function.

$$\mu(x)_{VBR} = \begin{cases} 1, & x \le a \\ \frac{b-x}{b-a}, & a \le x \le b \\ 0, & x \ge b \end{cases} \qquad (4)$$

$$\mu(x)_{BR} = \begin{cases} 0, & x \le a \\ \frac{x-a}{b-a}, & a \le x \le b \\ \frac{c-x}{c-b}, & b \le x \le c \\ 0, & x \ge c \end{cases} \qquad (5)$$

$$\mu(x)_{N} = \begin{cases} 0, & x \le b \\ \frac{x-b}{c-b}, & b \le x \le c \\ \frac{d-x}{d-c}, & c \le x \le d \\ 0, & x \ge d \end{cases} \qquad (6)$$

$$\mu(x)_{BL} = \begin{cases} 0, & x \le c \\ \frac{x-c}{d-c}, & c \le x \le d \\ \frac{e-x}{e-d}, & d \le x \le e \\ 0, & x \ge e \end{cases} \qquad (7)$$

$$\mu(x)_{VBL} = \begin{cases} 1, & x \ge e \\ \frac{x-d}{e-d}, & d \le x \le e \\ 0, & x \le d \end{cases} \qquad (8)$$

From equation (3) the Mxval is used to calculate the values of a to e. The values of a to e are calculated as precentage values of Mxval, i.e. a=15% of Mxval, b=30%, c=45%, d=60%, e=75% respectively.

The fuzzy momentum value of each day is represented as and is evaluated as follows:

$$\delta_i = \max\{\mu(x_i)_{VBR}, \mu(x_i)_{BR}, \mu(x_i)_{N}, \mu(x_i)_{BL}, \mu(x_i)_{VBL}\} \qquad (9)$$

The forecasted fuzzy momentum φ_k value is evaluated from the k[th] set of 14-day historical values. It is the fuzzy momentum value that would predict the momentum of the next five days of market movement. The φ_k is calculated as follows:

$$\varphi_k = [\sum_{i=1}^{14} \delta_i] / 14 \qquad (10)$$

The fuzzy linguistic interpretation γ_k of the φ_k values can be evaluated from the following equation:

$$\gamma_k = \begin{cases} \text{"Bearish"}, & 0 \le \varphi_k \le 0.42 \\ \text{"Neutral"}, & 0.42 < \varphi_k \le 0.6 \\ \text{"Bullish"}, & 0.6 < \varphi_k \le 1 \end{cases} \qquad (11)$$

When the value of γ_k is "Bearish" then the next five days the market may witness a selloff and the prices may go down, when the value of γ_k is "Neutral" then the next five days the market would be range bound without any specific direction and when the value of γ_k is "Bullish" then the prices are expected to rise in the consecutive trading sessions.

3. IMPLEMENTATION OF THE PROPOSED MODEL

The proposed model in the above section was implemented and some promising results were achieved. The set of daily data was picked from 3 different set of dates. All data presented here is downloaded from the official website of National Stock Exchange (NSE) of India. Website: http://www.nseindia.com.

Table 4.1a: Set-1 of daily data from year 2008

DATE	OPEN	HIGH	LOW	CLOSE	δ_i
04-11-2008	3050.25	3152.30	2985.00	3142.10	0.94
05-11-2008	3155.75	3240.55	2971.00	2994.95	0.00
06-11-2008	2998.45	3007.80	2860.25	2892.65	0.38
07-11-2008	2893.25	3010.00	2860.10	2973.00	0.55
10-11-2008	2973.30	3161.25	2973.30	3148.25	1.00
11-11-2008	3147.20	3147.20	2919.45	2938.65	0.00
12-11-2008	2937.90	2975.20	2794.95	2848.45	0.14
14-11-2008	2848.00	2938.80	2778.80	2810.35	0.20
17-11-2008	2813.40	2835.70	2694.50	2799.55	0.00
18-11-2008	2802.45	2802.45	2664.30	2683.15	0.19
19-11-2008	2682.75	2772.40	2617.90	2635.00	0.47
20-11-2008	2634.20	2634.20	2502.90	2553.15	0.41
21-11-2008	2553.60	2718.60	2539.80	2693.45	0.53
24-11-2008	2690.85	2740.35	2633.80	2708.25	1.00
φ_1 = **0.42**					
γ_1 = **"Bearish"**					

Table 4.1b: Consecutive 5 day daily data from table 4.1a

DATE	OPEN	HIGH	LOW	CLOSE
25-11-2008	**2708.3**	2790.7	2638.2	2654
26-11-2008	2652.45	2762.6	2643.35	2752.25
28-11-2008	2745.7	2779	2690.3	2755.1
01-12-2008	2755.15	2832.85	2669.5	2682.9
02-12-2008	2672.9	2672.9	2570.7	**2657.8**
2657.8 – 2708.3 = -50.5 points				

Table 4.2a: Set-2 of daily data from year 2009

DATE	OPEN	HIGH	LOW	CLOSE	δ_i
15-04-2009	3381.45	3497.55	3311.8	3484.15	0.91
16-04-2009	3484.35	3511.25	3354.2	3369.5	0.37
17-04-2009	3369.5	3489.85	3359.25	3384.4	1.00
20-04-2009	3384.75	3441.1	3339.45	3377.1	0.00
21-04-2009	3376.85	3414.7	3309.35	3365.3	0.00
22-04-2009	3364.6	3401.1	3296.9	3330.3	0.30
23-04-2009	3330.5	3439.9	3310.5	3423.7	0.54
24-04-2009	3423.6	3491.35	3402.9	3480.75	0.83
27-04-2009	3481.3	3517.25	3435.3	3470	0.00
28-04-2009	3469.5	3471.95	3351.5	3362.35	0.07
29-04-2009	3371.65	3486.4	3366.7	3473.95	0.89
04-05-2009	3478.7	3664.5	3478.7	3654	1.00
05-05-2009	3664.5	3682.2	3618.75	3661.9	0.00
06-05-2009	3662	3717.05	3608.65	3625.05	0.41
φ_2 = **0.45**					
γ_2 = **"Neutral"**					

Table 4.2b: Consecutive 5 day daily data from table 4.2a

DATE	OPEN	HIGH	LOW	CLOSE
07-05-2009	**3617.15**	3692.05	3617.15	3683.9
08-05-2009	3681.8	3711.25	3582.85	3620.7
11-05-2009	3615.75	3660.2	3534.55	3554.6
12-05-2009	3554.65	3691.65	3534.2	3681.1
13-05-2009	3668.75	3709.6	3610.2	**3635.25**
3635.25 - 3617.15 = 18.1 points				

Table 4.3a: Set-3 of daily data from year 2010

DATE	OPEN	HIGH	LOW	CLOSE	δ_i
27-05-2010	4915.15	5016.6	4897.6	5003.1	1.00
28-05-2010	5005.6	5077.25	5005.6	5066.55	0.50
31-05-2010	5076.1	5097.6	5038.55	5086.3	1.00
01-06-2010	5086.25	5086.95	4961.05	4970.2	0.00
02-06-2010	4970.75	5031.2	4967.05	5019.85	0.82
03-06-2010	5020.15	5125.7	5020.15	5110.5	1.00
04-06-2010	5112.6	5147.9	5091.6	5135.5	0.68
07-06-2010	5132.95	5132.95	5004.25	5034	0.00
08-06-2010	5036.7	5071.35	4967.3	4987.1	0.15
09-06-2010	4985.05	5050.6	4980.1	5000.3	1.00
10-06-2010	4999.6	5085.2	4997.6	5078.6	0.54
11-06-2010	5078.75	5139.05	5078.75	5119.35	0.67
14-06-2010	5120.15	5201.25	5120.15	5197.7	0.55
15-06-2010	5201.3	5231.45	5171.05	5222.35	0.79
φ_3 = **0.62**					
γ_3 = **"Bullish"**					

Table 4.3b: Consecutive 5 day daily data from table 4.3a

DATE	OPEN	HIGH	LOW	CLOSE
16-06-2010	**5225.05**	5255.65	5214.9	5233.35
17-06-2010	5233.65	5285.55	5206.55	5274.85
18-06-2010	5274.95	5302.3	5245.5	5262.6
21-06-2010	5266.5	5366.75	5266.5	5353.3
22-06-2010	5353.95	5354.35	5311.05	**5316.55**
5316.55 - 5225.05 = 91.5 points				

From the above observations in table 4.1a the forecasted trend value φ_1 **=0.42**, γ_1 **= "Bearish"** and the same was reflected in the consecutive five days depicted in table 4.1b, that the difference of the opening value in 25-11-2008 was **2708.3** and the closing value after five days was **2657.8**, which gave negative returns of **-50.5** points, which was in line with the predicted value by the proposed system. Similar successful results can be seen from the observations in tables 4.2a and 4.2b for the year 2009 and tables 4.3a and 4.3b for the year 2010. The observations prove that the proposed system can be used to forecast the future trends in the stock markets, in this case NIFTY-50 values, successfully.

4. CONCLUSION

In this paper a fuzzy system is modelled that can forecast the short term momentum of the Nifty-50 index. 14 day historic data is considered as the base for predicting future 5 day movement or momentum. The idea is to get a list of consecutive close-open values and these values are to be fuzzified. It is imperative that when closing values are greater than opening values then the buyers are more active and are trying to push values higher, causing a bullish momentum. When closing values are lower than opening values then sellers are trying to push down the prices and developing a bearish sentiment in the market or bearish momentum in the market. The momentum which is either bullish, bearish or neutral continues to some extent i.e. for few days and this idea helps to forecast the momentum. The proposed system is able to effectively forecast the trend, which was experimented for different set of data of different years. The experimentation was done on NIFTY-50 index values and was found successful. As future work the system can be improved to predict crisp values of how much points the market would go up or down and also the system needs to be tested for different markets, sectors and stocks.

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Note: This Paper/Article is scrutinised and reviewed by Scientific Committee, BITCON-2015, BIT, Durg, CG, India