Trend discovery of S&P CNX NIFTY 50 index values through Fuzzy logic

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Abstract. Trend indentification 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, then we go on for forecasting the future trend. Fuzzy membership functions are the key elements while creating any fuzzy system[1],[2]. 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[7],[8],[9]. The type of real time data used here is the daily values of S&P CNX NIFTY 50 index used in National Stock Exchange of India for stock futures trading.

Keywords: fuzzy logic, forecasting, moving averages, correlation, least square criterion, S&P CNX NIFTY 50.

1 Introduction

Fuzzy Sets Theory was introduced by L. A. Zadeh [1] in 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. Since 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[2]. However, these methods suffer from the problem of knowledge acquisition and subjectivity. We in our proposed model try to use the most recent 5-day real time data and fuzzify them using a modified S-function, using which we can first identify the trend represented the 5-day data, secondly we use correlation, simple linear regression and least square criterion to predict the future trend which we can expect in the 6th day[3],[4]. Here we use a modified fuzzy value manipulation method, which may some time result values which are below zero and some times positive values, but not greater than 1.

2 Identification of Present Trend

Trend indentification 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, then we go on for forecasting.

Here we collect the previous 5-day real time data and convert each value to its equivalent fuzzy membership value. Here the universe of discourse will be the range of values that lie between the lowest and highest values in those 5-days. After fuzzification the 2-day moving averages are found and this process is repeated till two values are left and finally the difference of those values are found.

Fuzzy Sets :

A fuzzy set A [x] over a universe of discourse X is a set of pairs:

$A = \{(x, \mu A(x))\}$ 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.

Membership Grade: M(x)

We propose the following fuzzy sets:

$M_O(x)$, $M_H(x)$, $M_L(x)$, $M_C(x)$: representing fuzzy values of the Open, High, Low and Close values.

$M_T(x)$: represents the present fuzzy trend value.

Using the following equation we can calculate the membership grade for every value of 'x', where 'x' is the daily NIFTY value, which the universe of discourse.

$$M(x) = \begin{cases} 1.0 & \text{if, } x \geq b \\ \dfrac{x-a}{b-a} & \text{if, } a \leq x \leq b \\ 0 & \text{if, } x \leq a \end{cases}$$

Figure.1: Membership Grade M(x)

The value of **a** is the lowest value and **b** is the highest value in the universe of discourse.

Following table (Table.1) gives an interpretation of the $\mathbf{M_T(x)}$ values

Table.1: Trend Interpretation

$\mathbf{M_T(x)}$	**Interpretation of Trend**
Less than 0	Bearish
0 to 0.01	Neutral
Above 0.01	Bullish

2 Prediction of Future Trend

With the help of the fuzzified values of previous 5-days we use Correlation, Simple Linear Regression[5],[6] and use the Least Square Criterion to predict the fuzzy value that may be achieved on the 6th day. The idea is to achieve an equation of line that can indicate the next move of the market.

Step1: We find the coefficient of correlation 'r' using the formula:

$$\mathbf{r} = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2} * \sqrt{n\sum Y^2 - (\sum Y)^2}}$$

Step2: For prediction we try to fit a line that passes through the values
Ypred = B0 + B1*X
Here Ypred is the predicted value of Y w.r.t. X.
Bo is the Y intercept and B1 is the slope.

$$Y` = \frac{\sum Y}{n}$$

$$X` = \frac{\sum X}{n}$$

$$B0 = Y` - B1*X`$$

$$B1 = \frac{\sqrt{\sum (Y-Y`)^2}}{\sqrt{(X-X`)^2}} * r$$

Step3: Using the following table (Table.2) we specify the trend which the results indicate:

Table.2: Trend Interpretation of Forecasted fuzzy value

$M_T(x)$	Interpretation of Trend
0 to 0.125	Very Bearish
0.126 to 0.25	Bearish
0.251 to 0.49	Bearish Neutral
0.491 to 0.5	Neutral
0.51 to 0.74	Bullish Neutral
0.741 to 0.875	Bullish
0.876 to 1	Very Bullish

Representation through Example for Trend Identification
Following is a table representing the historical values of S&P CNX NIFTY 50 index, that will be used for this experiment.

Sr.No.	Date	Open	High	Low	Close
1	06/13/2011	5,469.85	5511.45	5437.55	5,498.50
2	06/14/2011	5,485.60	5,520.15	5,484.20	5,500.50
3	06/15/2011	5,494.45	5,499.35	5,438.95	5,447.50
4	06/16/2011	5,419.65	5,447.50	5,389.80	5,396.75
5	06/17/2011	5,412.50	5421.15	5355.85	5,366.40

(Source: http://in.finance.yahoo.com/q/hp?s=%5ENSEI)

a	b
5355.85	5520.15

For Open values

$M_O(x)$	Ma1(x)	Ma2(x)	Ma3(x)	$MD_O(x)$	TREND
0.693852708					
0.789713938	0.97				
0.843578819	0.94	0.96			
0.38831406	0.72	0.83	0.89		
0.344796105	0.48	0.60	0.71	-0.18	BEARISH

For High values

$M_H(x)$	Ma1(x)	Ma2(x)	Ma3(x)	$MD_H(x)$	TREND
0.947048083					
1	0.97				
0.873402313	0.94	0.96			
0.557821059	0.72	0.83	0.89		
0.397443701	0.48	0.60	0.71	-0.18	BEARISH

For Low values

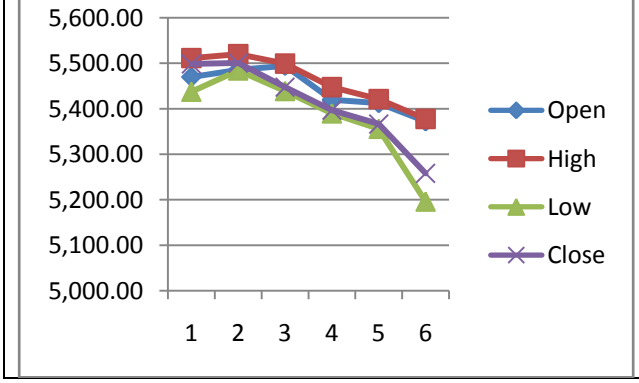
$M_L(x)$	Ma1(x)	Ma2(x)	Ma3(x)	$MD_L(x)$	TREND
0.497261108					
0.78119294	0.64				
0.505782106	0.64	0.64			
0.206634206	0.36	0.50	0.57		
0	0.10	0.23	0.36	-0.21	BEARISH

For Close values

$M_C(x)$	Ma1(x)	Ma2(x)	Ma3(x)	$MD_C(x)$	TREND
0.86822885					
0.880401704	0.87				
0.557821059	0.72	0.80			
0.248934875	0.40	0.56	0.68		
0.064211808	0.16	0.28	0.42	-0.26	BEARISH

$M_T(x)$=Average($MD_O(x)$, $MD_H(x)$, $MD_L(x)$, $MD_C(x)$)
$M_T(x)$= -0.21 which implies a **Bearish Trend**

Graph.1: Graph representing the trend



From the above graph (Graph.1) it can be observed that the slopes of the Open, High, Low and Close values are down indicating a down trend hence it can be concluded that the trend is bearish.
The experiment was conducted for various sets of real time values and it was found that our system can identify the trend to a very large extent.

Representation through Example for Trend Forecasting :
Following is a table representing the historical values of S&P CNX NIFTY 50 index, which will be used for this experiment.

(Source: http://in.finance.yahoo.com/q/hp?s=%5ENSEI)

Sr.No	Date	Open	High	Low	Close
1	06/14/2011	5,485.60	5,520.15	5,484.20	5,500.50
2	06/15/2011	5,494.45	5,499.35	5,438.95	5,447.50
3	06/16/2011	5,419.65	5,447.50	5,389.80	5,396.75
4	06/17/2011	5,412.50	5421.15	5355.85	5,366.40
5	06/20/2011	5,372.20	5,377.40	5,195.90	5,257.90
6	**06/21/2011**	**5,280.80**	**5,322.45**	**5,257.00**	**5,275.85**

We would try to estimate trend that may emerge on the 6th observation by using the previous 5 observations. On the basis of Open values we estimate High, Low and Close values.
Following are the fuzzy values of the above observations:

Sr.No	$M_O(x)$	$M_H(x)$	$M_L(x)$	$M_C(x)$
1	0.893446415	1	0.889128759	0.939398612
2	0.92074017	0.935851966	0.749575944	0.775944487
3	0.690053971	0.775944487	0.597995374	0.619429453
4	0.668003084	0.694680031	0.493292213	0.525828836
5	0.543716268	0.559753277	0	0.191210486
6	**0.261835004**	**0.390285274**	**0.18843485**	**0.246569005**

Using the steps1 and 2 we found the following fuzzy values:

	Actual	Predicted	Error (Actual – Predicted)
$M_H(x)$	**0.390285274**	0.431423155	-0.041137881
$M_L(x)$	**0.18843485**	0.193792457	-0.00536
$M_C(x)$	**0.246569005**	0.272831093	-0.02626
Average M(x)	**0.275096376**	0.2993489	-0.024252525

From the above table it can be observed that the error value is quite less, so the approximation of predicted values is more or less closer to actual values.
The actual average comes to **0.275** which depicts a **Bearish Neutral trend** and we predicted it to be **0.299** which depicts a **Bearish Neutral trend**. So our prediction closely represents the actual trend for the next day (6th day).
The experiment was conducted for various sets of real time values and it was found that our system can predict the trend for the immediately next trading day to a very large extent.

3 Conclusion

The Standard & 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.

The attractive feature of the stock market that is, every investor has the image to make millions in return from the financially buying and selling stock. Unfortunately, the reality of the nature of the market paints a less optimistic picture. Although, researchers had proposed many methods do try and do so, traditionally, the best performers have been the investors who use their professional knowledge of the markets to predict the next trend of the stock price. Therefore, a trustworthy forecasting tool is extremely desired. Because, the more accuracy the forecasting tool does, the more profitable will be made.

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. From the above suggested

method, the fuzzification of the NIFTY values is done in an easy way to assess the short term trend.

We took the actual 5-day data and fuzzified it, we successfully made the system understand the current trend and then we successfully made the system predict the future trend for the 6^{th} day.

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 trend prediction.

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.

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