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Fuzzy Logic Relation Based Stock Market Forecasting Model

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Abstract

Time series models have been used to make prediction of stock market, weather forecasting, road accident, etc. The proposed model is applied for stock market forecasting and it is show that proposed method work best as compared to other models.

Keywords: Fuzzy time series, fuzzy logical relationship group, stock market sensex.

AMS Mathematics Subject Classification: 47H10, 54H25

INTRODUCTION

Fuzzy set theory was introduce by Zadeh [17] in 1965. It is different from the traditional set theory by using membership function. Fuzzy sets have been applied to many fields such as decision analysis, Economics, Control theory, stock markets.

Fuzzy time series models provide us more flexibility in dealing with forecasting problems. Song et. al. presented some forecasting methods [14,15] to forecast the enrollments of the university of Alabama. Huang et al. [4] used the differences of the enrollments to present a method of forecast the enrollments of the university of Alabama, based on fuzzy time series.

Jilani T.A. et. al [8] gives a new approach is based on prediction of the trend using third order fuzzy relationship and applied this new method for TAIFEX forecasting.

In this paper we proposed a new approach for stock market forecasting and found that the proposed method is comparably better than other fuzzy time series model with respect to forecasting accuracy.

SOME BASIC CONCEPTS

The concept of fuzzy logic and fuzzy set theory [17] was introduced to cope with the ambiguity and uncertainly of most of the real world problems. Thus a time series introduced with fuzziness is termed as fuzzy time series. In this section the basic concept of fuzzy set theory as well as quantile regression are reviewed and some of the essentials are being reproduced to make the study self contained.

Let $V = \{y_1, y_2, y_3 - - - y_n\}$ be the universe of discourse and B_i be the fuzzy set of V defined as

$$B_i = f_{B_i}(y_1) + f_{B_i}(y_2) + f_{B_i}(y_3) + - - - f_{B_i}(y_n)$$

where f_{B_i} (.) is the membership function of the fuzzy set B_i and $f_{B_i}(y_i)$ represents degree of membership of y_i in B_i.

Let $Z(t), (t = 0,1,2 - --)$ be the universe of discourse and Z(t) ⊆ R. assume that $f_i\ (t), i = 1,2 - -$ is defined in the universe of discourse $Z(t)$and $F(t)$ is a collection of $f_i(t)$, when $i = 0,1,2 - - -$, then $F(t)$ is called fuzzy time series of $Z(t)$. Using fuzzy relation, we define

$F(t) = F(t-1) o\ R(t, t-1)$ where $R(t, t-1)$ is a fuzzy relation and o is the max - min composition operator, then $F(t)$ is caused by $F(t-1)$ where $F(t)$and$F(t-1)$ are Fuzzy sets.

Let $F(t)$ be a Fuzzy time series and let $R(t, t-1)$ be a first order model of $F(t)$.If $R(t, t-1) = R(t-1, t-2)$ for any time t then $F(t)$ is called a time invariant fuzzy time series.

If $R(t, t-1)$ is dependent on time t that is $R(t, t-1)$ may be different from $R(t-1, t-2)$ for any time t then $F(t)$ is called a time variant fuzzy time series.

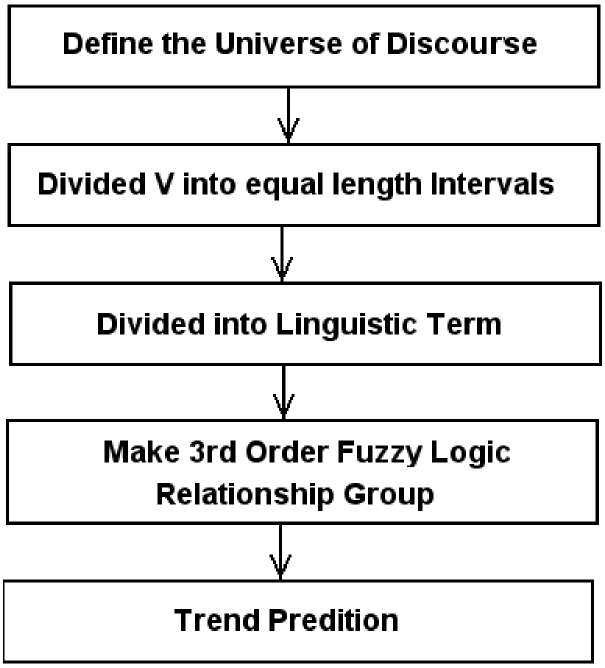
Song and Chissom [13] proposed the time variant fuzzy time series model and forecasted the enrollments of the University of Alabama based on the model.

Let $F(t)$ be a fuzzy time series. If $F(t)$ is caused by $F(t-1), F(t-2), --$ $F(t-n)$,than the n[th] order fuzzy logical relationship is represented by $F(t-n), --$ $F(t-3), F(t-2),$ $F(t-1) \rightarrow F(t)$ $where$ $F(t-1), F(t-2), (t-3) ---$ $F(t-n)$ and $F(t)$ are called fuzzy sets. Where $F(t-1), F(t-2), F(t-3) ---$ $F(t-n)$ is called the antecedent and $F(t)$ is called the consequent of the n[th] order fuzzy logical relationships.

A set of n[th] order fuzzy logical relationships have some antecedents that form an n[th] order fuzzy logical relationship group.

PROPOSED METHOD

In this section we present a new method for stock market forecasting based on fuzzy logical relationships. The Flow Chart of proposed method is now presented as follows



STEP-I

We define the universe of discourse.

$V = [V_{min} - V_1, V_{max} - V_2]$

Where V_{min} and V_{max} are the minimum and maximum values in the universe of discourse V and V_1, V_2 are the universe of discourse.

STEP-II

To divide the universe of discourse into n equal length intervals $V_1, V_2 --- V_n$.

STEP-III

Define the linguistic term $B_1, B_2, B_3 ------ B_n$ for each interval $V_1, V_2 --- V_n$ of the universe of discourse V as follows.

B_1=1/V_1+0.5/V_2+0/V_3+0/V_4 $---$ 0/$V_{n-2} + V_{n-1} + 0/V_n$

B_2=0.5/V_1+1/V_2+0.5/V_3+0/V_4 $---$ 0/V_n

B_3=0/V_1+0.5/V_2+1/V_3+0.5/V_4 $---$ 0/V_n

B_n=0/V_1+0/V_2+0/V_3+$---$ 0.5/$V_{n-1} + ---1/V_n$

Where $V_1, V_2 --- V_n$ are equal length partitions of the universe of discourse V and $B_1, B_2, B_3 ------ B_n$, are the corresponding fuzzy terms of $V_1, V_2 --- V_n$.

If the average sensex of day i lie in the interval V_j then the value is fuzzified in to B_j with membership grade $\mu_{B_i}(y) = 1$ when $1 < j \leq n$

Table 1. Sensex data between 03.11.2014 to 31.12.2014 (40 Day's) at which sensex close.

Date	Sensex Closed	Date	Sensex Closed
3-11-14	27860	8-12-14	28119
5-11-14	27915	9-12-142	27797
7-11-14	27868	10-12-14	27831
10-11-14	27874	11-12-14	27602
11-11-14	27910	12-12-14	27350
12-11-14	28008	15-12-14	27319
13-11-14	27940	16-12-14	26781
14-11-14	28046	17-12-14	26710
17-11-14	28177	1812-14	27126
18-11-14	28163	19-12-14	27371
19-11-14	28032	22-12-14	27701

20-11-14	28067	23-12-14	27506
21-11-14	28334	24-12-14	27208
24-11-14	28499	26-12-14	27241
25-11-14	28338	29-12-14	27395
26-11-14	28386	30-12-14	27403
27-11-14	28438	31-12-14	27499
28-12-14	28693	24-12-14	27208
1-12-14	28559	26-12-14	27241
2-12-14	28444	29-12-14	27395
3-12-14	28442	30-12-14	27403
4-12-14	28562	31-12-14	27499
5-12-14	28458	31-12-14	27499

We define universe of discourse .

$V = [26700,28800]$ and partition it into seven intervals.

V_1=[26700,27000],V_2=[27000,27300],V_3=[27300,27600],V_4=[27600,27900] ,

V_5 =[27900,28200],V_6 =[28200,28500],V_7=[28500,28800]

Mid value of above intervals which is required for calculating forecasting value

$M_1 = 26850, M_2 = 27150, M_3 = 27450, M_4 = 27750,$
$M_5 = 28050,\ M_6 = 28350, M_7 = 28650$

The trend value is determined using last three forecasted values $y_{n-2}, y_{n-1}, and\ \ y_n,$

To calculate Kappa use formula

If $\{(y_{n-1} - y_{n-2}) - (y_{n-2} - \ y_{n-3})\} > K$

Then the trend will go upward and forecasted value calculated by

$$t_j = \frac{2}{\frac{0.25}{m_{J-1}} + \frac{1.0}{m_J} + \frac{0.75}{m_{J+1}}}$$

If $\{(y_{n-1} - y_{n-2}) - (y_{n-2} - y_{n-3})\} < K$

Then the trend will go downward and forecasted value calculated by

$$t_j = \frac{2}{\frac{0.75}{m_{J-1}} + \frac{1.0}{m_J} + \frac{0.25}{m_{J+1}}}$$

If $\{(y_{n-1} - y_{n-2}) - (y_{n-2} - y_{n-3})\} = K$ then the trend will remain unchanged and forecasted value will be calculated by formula

$$t_j = \frac{2}{\frac{0.5}{m_{J-1}} + \frac{1.0}{m_J} + \frac{0.5}{m_{J+1}}}$$

where $m_{j-1,} m_j$ and m_{j-1} are the mid points of the intervals V_{j-1}, V_j and V_{j+1} construct Fuzzy logical relationship group (FLRG) and equating the value of Kappa(K) and expected trend shown in the following table.

Table 2: Third order fuzzy logic relationship group

Date	Sensex Closed	Fuzzy Rule	FLRG	Kappa(k) = -10	Trends	Forcasting
3-11-14	27860	A_4	A_4A_5			
5-11-14	27915	A_4	$A_4A_5A_4$			
7-11-14	27868	A_4	$A_5A_4A_4$			
10-11-14	27874	A_4	$A_4A_4A_5$	-102	Downward	27787
11-11-14	27910	A_5	$A_4A_5A_5$	-6	Upward	28012
12-11-14	28008	A_5	$A_5A_5A_5$	30	Upward	28050
13-11-14	27940	A_5	$A_4A_4A_5$	62	Upward	28050
14-11-14	28046	A_5	$A_5A_5A_5$	-166	Downward	28050
17-11-14	28177	A_5	$A_5A_5A_5$	210	Upward	28050
18-11-14	28163	A_5	$A_5A_5A_5$	-11	Downward	28050
19-11-14	28032	A_5	$A_5A_5A_5$	-145	Downward	28050
20-11-14	28067	A_5	$A_5A_5A_6$	-117	Downward	28087
21-11-14	28334	A_6	$A_5A_6A_6$	166	Upward	28312
24-11-14	28499	A_6	$A_6A_6A_6$	232	Upward	28350
25-11-14	28338	A_6	$A_6A_6A_6$	-102	Downward	28350
26-11-14	28386	A_6	$A_6A_6A_6$	-326	Downward	28350
27-11-14	28438	A_6	$A_6A_6A_7$	209	Upward	28461
28-11-14	28693	A_7	$A_6A_7A_7$	4	Upward	28612

1-12-14	28559	A_7	$A_7A_7A_6$	203	Upward	28536
2-12-14	28444	A_6	$A_7A_6A_6$	-389	Downward	28461
3-12-14	28442	A_6	$A_6A_6A_7$	19	Upward	28461
4-12-14	28652	A_7	$A_6A_7A_6$	113	Upward	28499
5-12-14	28458	A_6	$A_7A_6A_5$	122	Upward	28273
8-12-14	28119	A_5	$A_6A_5A_4$	-224	Downward	28123
9-12-142	27797	A_4	$A_5A_4A_4$	-235	Downward	27921
10-12-14	27831	A_4	$A_4A_4A_4$	17	Upward	27750
11-12-14	27602	A_4	$A_4A_4A_3$	356	Upward	27636
12-12-14	27350	A_3	$A_4A_3A_3$	-263	Downward	27561
15-12-14	27319	A_3	$A_3A_3A_1$	-23	Downward	27373
16-12-14	26781	A_1	$A_3A_1A_1$	221	Upward	26923
17-12-14	26710	A_1	$A_1A_1A_2$	-509	Downward	26887
18-12-14	27126	A_2	$A_1A_2A_3$	467	Upward	27223
19-12-14	27371	A_3	$A_2A_3A_4$	487	Upward	27523
22-12-14	27701	A_4	$A_3A_4A_3$	-171	Downward	27599
23-12-14	27506	A_3	$A_4A_3A_2$	85	Upward	27373
24-12-14	27208	A_2	$A_3A_2A_2$	-525	Downward	27261
26-12-14	27241	A_2	$A_2A_2A_3$	-103	Downward	27187
29-12-14	27395	A_3	$A_2A_3A_3$	331	Upward	27412
30-12-14	27403	A_3	$A_3A_3A_3$	121	Upward	27450
31-12-14	27499	A_3	A_3A_3	-146	Downward	27450

Also we equate average forecasting error rate (AFER) by

(AFER)= $\frac{\sum_i \left|F_j - B_j\right|/B_j}{n}$ where $i = 1,2, - - - - - n, n = 40 - - -$ (1)

and Mean Square error (MSE) by

(MSE)= $\frac{\sum_i (F_j - B_j)^2}{n}$ where $i = 1,2, - - - - - n, n = 40 - - -$ (2)

where B_j is the actual value of day j and f_j is the forecasted value of day j

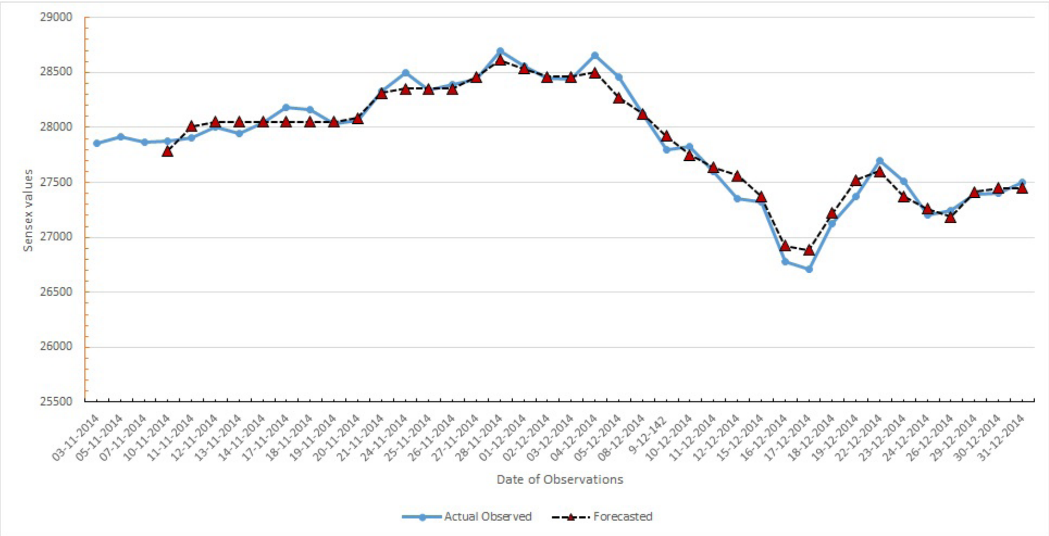


Table 3. Calculation of MSE and AFER where B j is the actual value of day j and F j is the forecasted value of day j show in the following table

B_j Actual Value	F_j Forcasted Value	$F_j - B_j$	$\|F_j - B_j\|$	$\| F_j - B_j\|/B_j$	$(F_j - B_j)^2$
27860					
27915					
27868					
27874	27787	-87	87	0.003121188	7569
27910	28012	102	102	0.003654604	10404
28008	28050	42	42	0.001499572	1764
27940	28050	110	110	0.003937008	12100
28046	28050	4	4	0.000142623	16
28177	28050	-127	127	0.004507222	16129
28163	28050	-113	113	0.004012357	12769
28032	28050	18	18	0.000642123	324
28067	28087	20	20	0.000712581	400
28334	28312	-20	20	0.000776452	400
28499	28350	-149	149	0.005228254	22201
28338	28350	12	12	0.00042346	144
28386	28350	-36	36	0.001268231	1296
28438	28461	23	23	0.000808777	529

28693	28612	-81	81	0.002822988	6561
28559	28536	-23	23	0.00080535	529
28444	28461	17	17	0.000597666	289
28442	28461	19	19	0.000668026	361
28562	28499	-113	113	0.002205728	12769
28458	28273	-185	185	0.006500808	34225
28119	281213	4	4	0.000142253	16
27797	27921	124	124	0.004460913	15376
27831	27750	-81	81	0.002910424	6561
27602	27636	34	34	0.001231795	1156
27350	27561	211	211	0.007714808	44521
27319	27373	54	54	0.001976646	2916
26781	26923	142	142	0.005302267	20164
26710	26887	177	177	0.006626732	31329
27126	27223	97	97	0.003575905	9409
27371	27523	152	152	0.005553323	23104
27701	27599	-102	102	0.003682178	10404
27506	27373	-133	133	0.004835309	17689
27208	27261	53	53	0.001947956	2809
27241	27187	-54	54	0.001982306	2916
27395	27412	17	17	0.000620551	289
27403	27450	47	47	0.001715141	2209
27499	27450	-49	49	0.001781883	2401

Using equation (1) & (2) and Table 3 we calculate AFER=.002509885 , MSE=8133.3

CONCLUSION

In this paper we have proposed a new method for time series forecasting having simple computational algorithm of complexity of linear order. The proposed method first predicts the trend of the future value and then use the proposed quantile based fuzzy forecasting approach. As compared to the other methods, the complexity of the proposed method is lower then other methods. The suitability of the method is examined for sensex forecasting. As future plans, we will extend this paper to obtain further improved results using other soft computing approaches.

REFERENCE

[1] Chen. S.M. “Forecasting enrollments based on Fuzzy time series". Fuzzy sets and systems, Vol.81,1996, pp-311-319.

[2] Chen. S.M. “Forecasting enrollments based on high-order Fuzzy time series". Cybermetrics and Fuzzy sets and systems, An International Journal Vol.33,2002, pp-1-16.

[3] George A and Veeramani P. “On some results of Analysis for Fuzzy metric space" Fuzzy Sets and System 64, 1994, pp. 395-399.

[4] Hwang J.R., Chen S.M. and Lee, E.H., “Handling forecasting problem's using fuzzy time series", Fuzzy sets and system, Vol. 100, 1998, pp. 217-228.

[5] Huarng K.,"Heuristic Models of fuzzy time series for forecasting", Fuzzy sets and system, Vol.123, Issue 3, 2001a, pp.369-386.

[6] Huarng K., “Effective lengths of intervals to improve forecasting in fuzzy time series", Fuzzy sets and systems Vol.123 issue 3, 2001b, pp 387-394.

[7] Jilani T.A., Burney S.M.A. et. all, “Multivariate high order fuzzy time series forecasting for car road accidents", International Journal of Computational Intelligence, Vol. 4, Issue 1, 2007b, pp 15-20.

[8] Jilani T.A., Burney A.S. and Ardil C., “A new quantile Based Fuzzy Time Series Forecasting Model" International Journal of Computer, Electrical, Automation, Control and Information Engineering, Vol. 2, No. 3, 2008,

[9] pp 15-21.

[10] Karmosil I and Michalek J., “Fuzzy metric and Statical metric space" Kybernetical 11, 1975, pp.326-334.

[11] Khodadad Khan A.F.M. et. al., “Stock market timing decisions using Neuro Rough Set forecasting model", Frontiers in Finance, Vol.1, 2015 pp.; 19-27

[12] Li. H and Kozma. R. “A dynamic neural network method for time series prediction using the KIII Model," In proceedings of the 2003, International Joint Conference of Neural Networks. Vol.1, 2003, pp. 347-352.

[13] Lee L.W. et. all, “Handling forecasting problems based on two-factor high order time series, “IEEE Transactions on Fuzzy Systems, Vol. 14, issue 3, 2006, pp. 468-477.

[14] Li. S. T. and Cheng Y.C. “Deterministic fuzzy time series model for forecasting enrollments", Computer's and Mathematics with Applications, Vol. 53, 2007, pp. 1904-1920.

[15] Song Q. and Chissom B.S. “Forecasting enrollments with fuzzy time series Part II", Fuzzy sets and system, Vol.62, 1994, pp-1-8.

[16] Song Q., “A note on fuzzy time series model selection with sample auto-co-relationm function", Cybermetics and Systems: An International Journal, Vol.34, 2003, pp.93-107.

[17] Saxena Preetika and Easo Santhosh “A new method for forecasting Enrollments based on fuzzy time series with higher forecast accurancy rate," Int. J. Computer technology and applications, Vol.3 (6), 2012, pp. 2033-2037.

[18] Zadeh L.A., “Fuzzy sets and Control" 8, 1965, pp. 338-353.