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A computational method (CM) for prediction based on student improvements and comparisons with different mean practices

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Abstract
In this paper, the compatibility of the developed model has been explored in the Crop Production, forecast by implementing the historical chronological data of farm (India) rice production and the predicted values obtained have been compared with the computational method(CM) using various mean techniques.

Keywords
Fuzzy Time Series, Fuzzy Logical Relationship(FLR), Mean Square Error(MSE), Arithmetic Mean(AM), Geometric Mean(GM) and Harmonic Mean(HM).

AMS Subject Classification
05C72.

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Contents

1. Introduction

The forecast section of the forecast data is analyzed with forecast stock, temperature, foreign exchange daily price, crop production, education enrollment (Song & Sysom)[1]. The properties and definitions of the fuzzy time series are defined in Zadeh [4]. When handling predictions based on fuzzy time sequences, the length of the intervals is very important, which greatly affects the predictive accuracy ratio (song & sysom) [2, 3]. The computational method gave better results by comparing time variation with fuzzy time sequences [5, 6].

2. Fuzzy time series

Definition 2.1. *Let U be the universe of discourse, where $U = \{g_i\}_{i=1}^{n}$. A fuzzy set in the universe of discourse U is defined as follows: $F_i = \sum_{i=1}^{n} \frac{M_{F_i}(g_i)}{g_i}$, Where M_{F_i} is the membership function of the fuzzy set F_i, $M_{F_i}: U \to [0,1], M_{F_i}(g_j)$ is the degree of membership of g_j in the fuzzy set $F_j, M_{F_i}(g_j) \in [0,1]$ and $1 \leq j \leq n$. Let $X(t)(t = 0,1,2,...)$ be the universe of discourse in which fuzzy sets are defined in the universe of discourse. Assume that $M(t)$ is a collection of $F_i(t)(i = 1,2,...)$, then $M(t)$ is called a fuzzy time series of $X(t)(t = 0,1,2...)$.*

Definition 2.2. *Assume that there is a fuzzy relationship $FR(t-1,t)$, such that $M(t) = M(t-1) \circ FR(t-1,t)$, where the symbol $\circ$ represents the max-min composition operator, then $M(t)$ is called caused by $M(t-1)$. The relation FR is called first order model of $M(t)$. Further, if fuzzy relation $FR(t,t-1)$ of $M(t)$ is independent of time t, that is to say for different times t_1 and t_2, $FR(t_1,t_1-1) = FR(t_2,t_2-1)$, then $M(t)$ is called a time invariant fuzzy time series.*

Definition 2.3. *Let $M(t-1) = F_i$ and let $M(t) = F_j$, where F_i and F_j are fuzzy sets, then the FLR between $M(t-1)$ and $M(t)$ can be denoted by $F_i \to F_j$, where F_i and F_j are called the left-hand side(LHS) and the right hand side (RHS) of the FLR, respectively[5].*

Definition 2.4. *FLR having the same left-hand side can be grouped into a FLR Group. For example, assume that the following FLR exist:* $F_i \to F_{ja}, F_i \to F_{jb}, F_i \to F_{jc}, ..., F_i \to F_{jm}$.

3. Computational method (CM) using different mean techniques

Definition 3.1. ***Step 1:*** *The universe of discourse is considered as* $U = [H_{min} - D_1, H_{max} + D_2]$ *into intervals of equal length, where* H_{max} *and* H_{min} *are the minimum value and the maximum value of the historical data, respectively,* D_1 *and* D_2 *are two proper positive real values to divide the universe of discourse* U *into n intervals* $l_1, l_2, ..., l_n$ *of equal length.*
Step 2: *The universe of discourse* $U = [400, 1100], F_1, F_2, ...$ *and* F_7 *are linguistic terms represented by fuzzy sets, where* $l_1 = [400, 500], l_2 = [500, 600], l_3 = [600, 700], l_4 = [700, 800], l_5 = [800, 900], l_6 = [900, 1000]$ *and* $l_7 = [1000; 1100]$;
Step 3: *Define the linguistic terms represented by fuzzy sets, shown as follows:* $F_1 = \sum_{i=1}^{7} \frac{M_{F_1}(g_i)}{l_i}, M_{F_1}(g_1) = 1, M_{F_1}(g_2) = 0.5, M_{F_1}(g_i) = 0, i = 3, 4, 5, 6, 7.$
$F_2 = \sum_{i=1}^{7} \frac{M_{F_2}(g_i)}{l_i}, M_{F_2}(g_1) = 0.5, M_{F_2}(g_2) = 1, M_{F_2}(g_3) = 0.5, i = 4, 5, 6, 7.$
....
$F_7 = \sum_{i=1}^{7} \frac{M_{F_7}(g_i)}{l_i}, M_{F_7}(g_6) = 0.5, M_{F_7}(g_7) = 1, M_{F_7}(g_i) = 0, i = 1, 2, 3, 4, 5,$ *where* $F_1, F_2, ...$ *and* F_7 *are linguistic terms represented by fuzzy sets.*
Step 4: *Assume that the fuzzified data of the ith year is* F_j *and assume that there is only one fuzzy logical relationship in the fuzzy logical relationship groups in which the current state of the fuzzy logical relationship is* F_j*, shown as follows:* $\backslash F_j \to F_k$*". where* F_j *and* F_k *are fuzzy sets and the maximum membership value of* F_k *occurs at interval* l_k*, then the forecasted data of the* $(i+1)^n$ *year is the midpoint* m_k *of the interval* l_k.
Step 5: Rules for forecasting LV_j *- lower value of* l_j
UV_j *- upper value of* l_j
L_j *- length of* l_j
The midpoint MPk of l_k
V_n *- value of state* $'n'$
$FV(AM)_j$ *- forecasted value of the current state* $'j'$
$FV(GM)_j$ *- forecasted value of the current state* $'j'$
$FV(HM)_j$ *- forecasted value of the current state* $'j'$
$[x]$ *- largest integer value*

3.1 Computational Algorithms

For $i = 3, 4, 5, ...$(End of time series data)
Obtained fuzzy logical relation for $\backslash F_j \to F_k$"
$V = 0$ and $x = 0$
1. $D_n = |(V_n – 2V_{n-1} + V_{n-2}|$
2. a) if $MP_j + Dn/6 \geq LV_k \& MP_j + D_n/6 \leq UV_k$ then $V = V + MP_j + D_n/6, x = x+1$
b) if $MP_j - D_n/6 \geq LV_k \& MP_j - D_n/6 \leq UV_k$ then $V = V + MP_j - D_n/6, x = x+1$
c) if $MP_j + D_n/4 \geq LV_k \& MP_j + D_n/4 \leq UV_k$ then $V = V + MP_j + D_n/4, x = x+1$
d) if $MP_j - D_n/4 \geq LV_k \& MP_j - D_n/4 \leq UV_k$ then $V = V + MP_j - D_n/4, x = x+1$
e) if $MP_j + D_n/2 \geq LV_k \& MP_j + D_n/2 \leq UV_k$ then $V = V + MP_j + D_n/2, x = x+1$
f) if $MP_j - D_n/2 \geq LV_k \& MP_j - D_n/2 \leq UV_k$ then $V = V + MP_j - D_n/2, x = x+1$
g) if $MP_j + D_n \geq LV_k \& MP_j + Dn \leq UV_k$ then $V = V + MP_j + D_n, x = x+1$
h) if $MP_j - D_n \geq LV_k \& MP_j - Dn \leq UV_k$ then $V = V + MP_j - D_n, x = x+1$
i) if $MP_j + 2D_n \geq LV_k \& MP_j + 2D_n \leq UV_k$ then $V = V + MP_j + 2D_n, x = x+1$
j) if $MP_j - 2D_n \geq LV_k \& m_j - 2D_n \leq UV_k$ then $V = V + MP_j - 2D_n, x = x+1$
k) if $MP_j + 3D_n \geq LV_k \& MP_j + 3D_n \leq UV_k$ then $V = V + MP_j + 3D_n, x = x+1$
l) if $MP_j - 3D_n \geq LV_k \& MP_j - 3D_n \leq UV_k$ then $V = V + MP_j - 3D_n, x = x+1$
3. $FV(AM)_k = [(V + MP_k)/(x+1) + 0.5]$
$FV(GM)_k = [(V * MP_k)^{(1/(x+1))} + 0.5]$
$FV(HM)_k = [(x+1) * V * MP_k/(V + MP_k) + 0.5]$, Next i

4. Example

S.No	Year	AP*	S.No	Year	AP*	S.No	Year	AP*
1	1981	1025	9	1989	795	17	1997	499
2	1982	512	10	1990	970	18	1998	590
3	1983	1005	11	1991	742	19	1999	911
4	1984	852	12	1992	635	20	2000	862
5	1985	440	13	1993	994	21	2001	801
6	1986	502	14	1994	759	22	2002	1067
7	1987	775	15	1995	883	23	2003	917
8	1988	465	16	1996	599			

AP* - Actual Production (kg/ha)
MSE(Mean Square Error) = $\frac{\sum_{i=1}^{n} |FV_i - AV_i|^2}{n}$ and $FE(\%) = (|FV–AV|/AV) * 100$
Here FE-Forecasted Error, FV - Forecasted Value, AV - Actual Value
Average Forecasting Error(AFE) = Sum of Forecasting Error/Number of Errors

S.No	Year	AP*	PLV
1	1981	1025	A7
3	1983	1005	A7
4	1984	852	A5
5	1985	440	A1
6	1986	502	A2
7	1987	775	A4
8	1988	465	A1

S.No	Year	AP*	PLV
9	1989	795	A4
11	1991	742	A4
12	1992	635	A3
13	1993	994	A6
14	1994	759	A4
15	1995	883	A5
16	1996	599	A2
17	1997	499	A1
19	1999	911	A6
20	2000	862	A5
21	2001	801	A5
22	2002	1067	A7
23	2003	917	A6

PLV*-Production in Linguistic Variables

5. Fuzzy logical relationship of the historical Lahi production

$A_7 \to A_2, A_2 \to A_7, A_7 \to A_5, A_5 \to A_1, A_1 \to A_2,$
$A_2 \to A_4, A_4 \to A_1, A_1 \to A_4, A_4 \to A_6, A_6 \to A_4,$
$A_4 \to A_3, A_3 \to A_6, A_6 \to A_4, A_4 \to A_5, A_5 \to A_2,$
$A_2 \to A_1, A_1 \to A_2, A_2 \to A_6, A_6 \to A_5, A_5 \to A_5,$
$A_5 \to A_7, A_7 \to A_6$

S.No	Year	AP*	CM* (AM)	CM* (GM)	CM* (HM)
1	1981	1025	-	-	-
2	1982	512	-	-	-
3	1983	1005	-	-	-
4	1984	852	850	914	840
5	1985	440	450	445	445
6	1986	502	541	545	538
7	1987	775	750	766	742
8	1988	465	450	447	424
9	1989	795	750	735	727
10	1990	970	950	928	924
11	1991	742	750	771	746
12	1992	635	658	659	640
13	1993	994	974	949	955
14	1994	759	746	732	724
15	1995	883	851	864	839
16	1996	599	550	548	524
17	1997	499	445	457	433
18	1998	590	554	543	520
19	1999	911	950	939	915
20	2000	862	859	857	845
21	2001	801	833	849	854
22	2002	1067	1050	1049	1024
23	2003	917	957	958	945
		AFE	3.8	4.6	5.2
		MSE	907	1386	1816

6. Conclusion

In Computational method, we get the smallest Mean Square Error using Arithmetic Mean(AM) compared with other means (Geometric Mean(GM) and Harmonic Mean(HM)).

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