

# A New Time Series Based Fuzzy Logic Approach for Prediction of Atmospheric Temperature

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**Abstract** - Temperature prediction could be a temporal and statistic based mostly method. Weather prediction has drawn heap of analysis interest in recent years. The prediction of temperature has essential applications in numerous fields like climate watching, weather prediction, agriculture, energy, aviation, communication, pollution spread etc. The fuzzy aggregation has powerful logic expression ability and is in a position to precise inaccurate and unsure in sequence. during this paper, a Fuzzy data – Rule base technique is employed to predict the close part temperature for Indian coastal cities. The current study utilizes historical temperature likewise as info of varied meteorologic parameters to develop a prediction method in fuzzy rule domain to estimate temperature. Daily observations of Mean water level Pressure, ratio and Temperature for all three seasons area unit analyzed to predict the Temperature for a given values of Mean water level Pressure and ratio. Symbolic logic has principally been utilized in totally different quite field either in taking call, or system and statement. Symbolic logic is one that may represent a knotty scenario into a straightforward kind in an exceedingly language that's simply caught by humans. Similarly, to represent the character of weather simply understood by normal individuals, this is often the results of foretelling supported meteorological information. We tend to propose a Testing the strength of Exponential Regression Model for prediction of atmosphere temperature. The planned methodology gets higher average statement accuracy rate than a number of the prevailing strategies on temperature prediction

**Keywords**—Event, fuzzy logic, time series analysis, time series data mining

## I - Introduction

### A. FORECASTING

It is obvious that prediction activities play associate degree vital role in our way of life. each day the prognosis tells United States of America what the weather are going to be like tomorrow. we are able to forestall large damage by prediction the approaching of storms or typhoons. we tend to sometimes forecast several things involved with our way of life, like economy, exchange, increment, weather, etc. to form a forecast with 100 percent accuracy is also not possible, however we are able to do our greatest to cut back the prediction errors or increase the speed of the prediction method. Forecasting could be a truth of knowing what might

happen to a system within the next coming back time periods [4]. Temporal prediction, or statistic prediction, takes associate degree existing series of information  $x_t, x_{t-1}, x_{t-2}, \dots, x_{t-m}$  and forecasts the info values  $x_{t+1}, x_{t+2}, \dots, x_{t+m}$ . The goal is to watch or model the prevailing information series to permit future unknown information values to be forecasted accurately [11]. As weather could be a continuous, data-intensive and dynamic method, the parameters needed to predict temperature square measure staggeringly complicated such there's uncertainty in prediction even for a brief amount [8]. These properties create temperature prediction a threate challenge. The property of artificial neural networks that they not solely analyze the statistic information however conjointly learn from it for future predictions makes them applicable for statistic based mostly temperature prediction.

Forecasting strategies is also classified into 3 types: judgmental forecasts, univariate strategies, and variable strategies. Essential Forecasts supported subjective call, intuition, and the other connected data. In univariate strategies, the forecasts rely solely on gift and past values of the only series being forecasted. In variable technique, the forecasts of a given variable rely, a minimum of part, on values of 1 or a lot of overtime series variables.

### B. FUZZY LOGIC:

The fuzzy conception suggests that the obscure and lacking the precise and clarity, which suggests the values or boundaries will vary per context or scenario, rather than being fastened once and for all. really the fuzzy has completely different linguistics, however these will become clearer solely through any specification, as well as a better definition of the context within which they're prepared zee. The reasoning of symbolic logic appears like human reasoning, rather than the whole knowledge to be looking forward to crisp line and to possess solely 2 standards which can incomplete or ambiguous, symbolic logic able to method this case and to supply approximate resolution. A conditional fuzzy proposition or rule has the form: IF w is Z THEN x is Y, This rule ought to be interpreted: x could be a member of Y to the degree that w could be a member of Z, for example; IF expertise is high THEN earnings is high.

### C. FUZZY BASED CLASSIFICATION

Fuzzy rule-based systems (FRBSs) square actions acknowledge ways inside soft computing, supported fuzzy ideas to handle advanced real-world issues. They need become a robust methodology to tackle numerous issues like uncertainty, impreciseness, and non-linearity [7]. They're usually used for classification, classification, and regression tasks. FRBSs are deployed in a very variety of engineering and science areas.

FRBSs are referred to as fuzzy abstract thought systems or just fuzzy systems. Once applied to exact tasks, they additionally could receive specific names like fuzzy associative recollections or fuzzy controllers. They're supported the fuzzy pure mathematics that aims at representing the in sequence of human specialists in an exceedingly set of fuzzy IF-THEN rules. Rather than victimization crisp sets as in classical rules, fuzzy rules use fuzzy sets.

#### D. TIME SERIES FORECASTING

An ordered sequence of discovered values is understood as statistic. If the discovered values symbolize measured values, it's usually unimaginable to assign precise numerical values to the discovered information, they then possess information uncertainty. This paper issues with the statistic comprised of general i.e., unsure discovered values. Within the case of your time series the unsurely of the entity discovered values yet because the interpretation of a sequence of uncertain discovered values area unit of interest. Humans area unit forever curious about oncoming events; they're vital owing to its effectiveness in human life.

Definition 1: Let  $U = \{ u_1, u_2, \dots, u_n \}$  be a universe of discourse (universal set); a fuzzy set  $A$  of  $U$  is defined  $A = \{ \langle u, \mu_A(u) \rangle \mid u \in U \}$ , where  $\mu_A$  is a membership function of a given set  $A$ ,  $\mu_A : U \rightarrow [0, 1]$ .

Definition 2 If there exists a fuzzy relationship  $R(t-1, t)$ , such that  $F(t) = F(t-1) \circ R(t-1, t)$ , where  $\circ$  is an arithmetic operator, then  $F(t)$  is said to be caused by  $F(t-1)$ . The relationship between  $F(t)$  and  $F(t-1)$  can be denoted by  $F(t-1) \rightarrow F(t)$ .

There are two types of time series data:

1. Continuous time series: an observation is recorded at every instant of time, denoted using observation  $x$  at time  $t$ ,  $x(t)$ .
2. Discrete time series: an observation is recorded at regularly intervals, denoted using observation  $x_t$ . A variable is a value or a number that change in increased or decreased pattern over time. There are two mainly categories of variables, independent variable and dependent variable. The autonomous variable and dependent variable are differing in an experiment. The

independent variable is a variable that is varied or manipulated in the experiments by researchers; it refers to what is the weight during the experiment. The dependent variable is the variable that is simply measured by the researchers; it is the response that is measured. The dependent variable responds to the autonomous variable. It is called dependent because it depends on the independent variable. We cannot have a dependent variable without an independent variable.

## II. Literature study

This type of system typically thought-about as a computer. Intelligence was created and inserted into the pc so as to try and do the task like that may be done by humans. And computing doesn't currently concerning perceive what the intelligence system, however additionally to reconstruct [3]. Temperature Prediction model has been projected exploitation Fuzzy statistic. The new fuzzy statistic model known as the two-factor time-variant fuzzy statistic model for temperature statement [7]. The experimental results show that the results of Algorithm-B\* are higher than the results of Algorithm-A and Algorithm-B. These algorithms have benefits, each they'll provide smart results. The time complexity of the planned algorithms are  $O(cwm)$ , severally, wherever  $c$  is that the variety of divided teams within the historical knowledge,  $w$  is that the window basis, and  $m$  is that the variety of components within the universe of discourse. a unique method was developed to forecast temperature and also the Taiwan commodities exchange (TAIFEX), supported the two-factor high-order fuzzy statistic [27]. for every price in a very real-valued statistic is drawn by a fuzzy set, after that, it represents by fuzzy sets kind a fuzzy statistic. ANFIS is design that functionally same with Sugeno fuzzy rule primarily based model. ANFIS design is additionally almost like the neural network with radial perform with less bound restrictions. It might be same that ANFIS may be a method that is employed in creating the adjustment rule learning algorithmic program to a collection of knowledge. In ANFIS is additionally doable to adapt the foundations [10]

## III. Simulation methodology:

In this problem we consider a temperature data containing observations of 15 days of the continuous dependent variable  $Y$  and independent variable  $X$ . Table 1 shows the temperature data over four years and fifth year predicted value through Time Series Analysis. Let  $y_j$  denote the value of the variable  $y$  for observations,  $j$  ( $j = 1 \dots N$ ) Where  $N$  is number of days, and let  $x_i$  be the observed value of the independent variable  $x$  for observation of temperature. Suppose we have constants 'a' and 'b' for an exponential function

$$y_j = a e^{(a+b)x} \quad (1)$$

$$\log_e y = \log_e a e^{(a+b)x} \quad (2)$$

$$\log_e y = \log_e a + (a+b) x \quad (3)$$

$$\log_e y = \log_e a + (a+b)x \quad (4)$$

Now consider  $Y = \log_e y$  ;  $A = \log_e a$ ,  $m = a+b$  and  $X = x - M$  , Where  $M$  is the mean of  $N$  observations.

We get the equation;  $Y = A + mX$  (which is a linear equation of exponential values of a dependant variable  $X$ )

To calculate the values of  $A$  and  $m$  we have the following equations:

$$A = \frac{\sum Y - b \sum X}{n} \quad (5) \quad \text{and} \quad m = \frac{n \sum XY - \sum X \sum Y}{n \sum X^2 - (\sum X)^2} \quad (6)$$

Now  $X = x - M$ ,  $X = x - 6.5$  (6.5 is the mean value of 12 observations of  $x$ )

$$\sum X = \sum x - \sum 6.5$$

We get,  $\sum X = 0$

Putting  $\sum X = 0$  in above values of constants  $A$  and  $m$  we get,

$$A = \frac{\sum Y}{n} \quad (7) \quad \text{and}$$

$$m = \frac{\sum XY}{\sum X^2} \quad (8)$$

**For the year 2014**, after putting the values of  $X$ ,  $Y$  and  $n$  we get the values of the constants:

$m = -0.45$  and  $A = 17$ , Taking antilog of  $A$  we get,  $a = \text{antilog } A = 24154953.2$  and  $b = -24154953.4$

**For the year 2015**, after putting the values of  $X$ ,  $Y$  and  $n$  we get the values of the constants:

$m = -0.44$  and  $A = 16.33$  Taking antilog of  $A$  we get,  $a = \text{antilog } A = 12401566.3$  and  $b = -12401566.3$

**For the year 2016**, after putting the values of  $X$ ,  $Y$  and  $n$  we get the values of the constants:

$m = -0.61$  and  $A = 20.87$  Taking antilog of  $A$  we get,  $a = \text{antilog } A = 1154192343.55$  and  $b = 1154192343.10$

**For the predicted year 2017**, after putting the values of  $X$ ,  $Y$  and  $n$  we get the values of the constants:

$m = -0.36$  and  $A = 15.93$  Taking antilog of  $A$  we get,  $a = \text{antilog } A = 8313018.5$  and  $b = -8313018.82$

#### Comparison of slopes for four year:

x	y 1	y 2	y 3	y 4
1	14.408564	79.825933	62.81409	58.192967
2	9.8206709	51.382055	34.185029	40.736364
3	6.2619362	33.073407	18.604364	28.516355
4	3.9927868	21.288566	10.124969	19.962079
5	2.5459133	13.702944	5.5102664	13.973897
6	1.623346	8.8202589	2.9988275	9.7820368
7	1.0350911	5.6773909	1.6320384	6.8476421

8	0.6600032	3.6544015	0.8881969	4.7935009
9	0.4208366	2.3522514	0.4833794	3.3555566
1	0	0.2683373	1.5140883	0.2630674
1	1	0.1710994	0.9745826	0.143168
1	2	0.1090978	0.6273157	0.0779157
1	3	0.0695638	0.4037882	0.0424037
1	4	0.0443559	0.2599088	0.0230772
1	5	0.0282825	0.1672971	0.0125592
				0.3948527

**Table 6.10: Comparison of slopes for four years**

We get the different slope for different years

Year	m	b
2014	-0.45	24154953
2015	-0.44	12401566.3
2016	-0.61	1154192344.10
2017	-0.36	-8313018.82

#### Slope of four different years

On scrutiny the four completely different slopes of 4 years we have a tendency to get that the expected slope of the fourth year is concerning the typical of the 3 year slopes thence we will say that the fourth year prediction is that the smart quality prediction for the patient information. The statistical reports in the following pages shows the various reports and analysis of patient data that can be represented using figure 3.5

## IV. Conclusion

In the present paper, Fuzzy set theory has been used for predicting atmospheric temperature for inland cities of India from meteorological parameters viz. Relative Humidity and Mean sea level pressure. Database of 4 year comprising of daily observations of Temperature, Relative Humidity and Mean sea level pressure have been utilized to develop a knowledge Rule base in Fuzzy domain. It provides a replacement technique to resolve the matter of a way to improve the prediction accuracy and predict unknown information of far-famed information within the statistic prediction issues.

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January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2014	2.2	1.9	1.8	1.8	1.7	1.5	2.0	2.0	1.7	1.8	1.6	1.4	1.3	1.3	1.5
2015	2.3	1.6	1.9	1.5	1.7	1.3	1.7	1.3	1.2	1.5	1.3	1.2	1.8	1.6	2.0
2016	2.1	2.1	2.2	2.2	2.3	2.3	2.2	2.1	2.1	2.2	2.2	2.2	2.0	1.5	1.6
<b>Mean</b>	51.33	43.33	47.00	43.00	45.67	41.00	45.67	40.67	38.67	43.00	40.33	38.67	42.33	35.33	41.00
<b>Index</b>	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.03
Expected 2017	0.90	0.76	0.86	0.79	0.87	0.78	0.83	0.71	0.67	0.79	0.74	0.71	0.70	0.44	0.54

Table 3.1: Temperature data, for three years and prediction of next year using Exponential regression

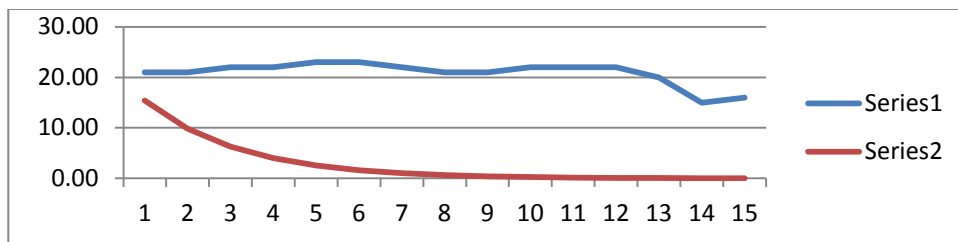


Figure 3.1: Graph showing temperature data prediction in 2014

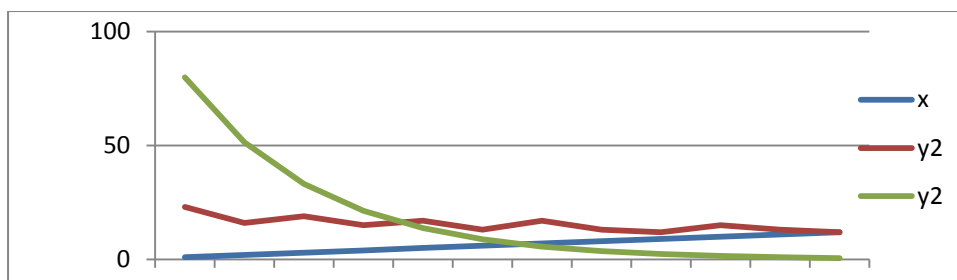


Figure 3.2: Graph showing temperature data prediction in 2015

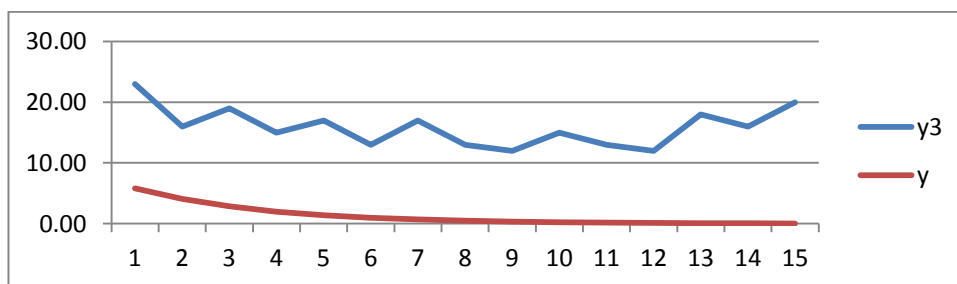


Figure 3.3: Graph showing temperature data prediction in 2016

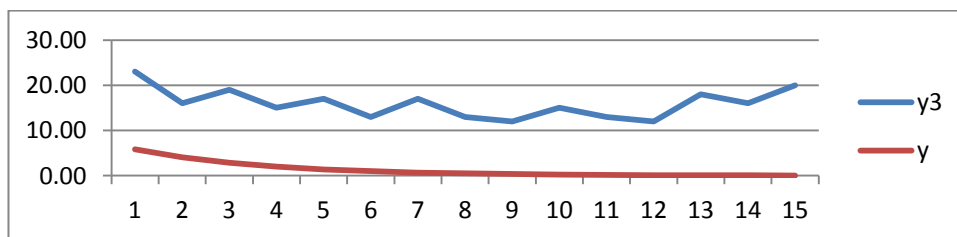


Figure 3.4: Graph showing temperature data prediction in 2017

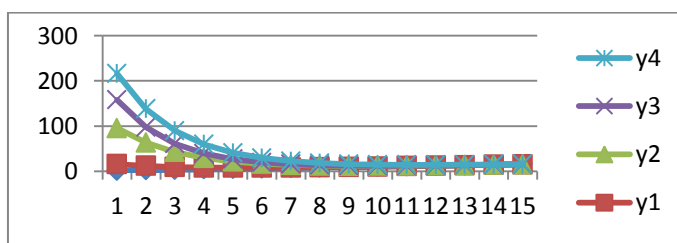


Figure 3.5: Comparison of slops for four years