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ANNUAL RAINFALL PREDICTION IN NILGIRIS USING FUZZY LOGIC

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Abstract - Weather forecasting is one of the most subservient and arduous operational responsibilities carried out by meteorological services all over the world. Among all weather undertakings, rainfall plays the most authoritative role in human life. The developed fuzzy logic model is made up of two well-designed modules; the knowledge base and fuzzy reasoning or decision-making unit. Two operations were performed on the fuzzy logic model; the fuzzification operation and defuzzification operation. The present study explores the ability of fuzzy logic in modelling rainfall in Nilgiris district.

Keywords: Forecasting, Fuzzy logic, Fuzzy Rule, wind speed, Temperature.

1. INTRODUCTION

Investigation of time series data is one of the significant features of modern researchers in the purview of knowledge discovery. Time series data is collected over a specific period of time such as hourly, daily, weekly, monthly, quarterly or yearly. Weather forecasting is very favourable but exciting task. Weather data involves of various atmospheric features such as wind speed, humidity, pressure and temperature etc. Rainfall is a complex atmospheric process, which depends upon many weather correlated features. Accurate and timely rainfall prediction can be helpful in many ways such as formation the water resources management, issuance of early flood warnings, managing the flight operations and restraining the transport and construction activities. Accurate rainfall prediction is more complex today due to climate variations. Application of fuzzy set theory has promptly increased with establishing its utility in numerous areas of the scientific world. In fuzzy logic approach, it is possible to express crisp intervals in terms of linguistic subsets of fuzzy expressions like low, medium, high, good, moderate, poor etc. The fuzzy logic possibility and its degree of effect due to the ambiguous input variables are considered by some as being generated in the human mind and is often referred to as expert knowledge. Expert knowledge is expressed as a vague or ambiguous expression and not inform of any quantified value. Based on the generated idea that the possibility and degree of effect from vague and abstruse inputs exists, then the knowledge based rule can be expressed in the form of statements, called fuzzy statements or production rules. In this research work, the focus is on the development of fuzzy logic model for predicting rainfall in Nilgiris district.

2. LITERATURE REVIEW

Bardossyet al.(1995) instigated fuzzy logic in cataloguing atmospheric circulation patterns. Ozelkan et al.(1996) compared the concert of regression analysis and fuzzy logic in studying the relationship between monthly atmospheric circulation patterns and precipitation.

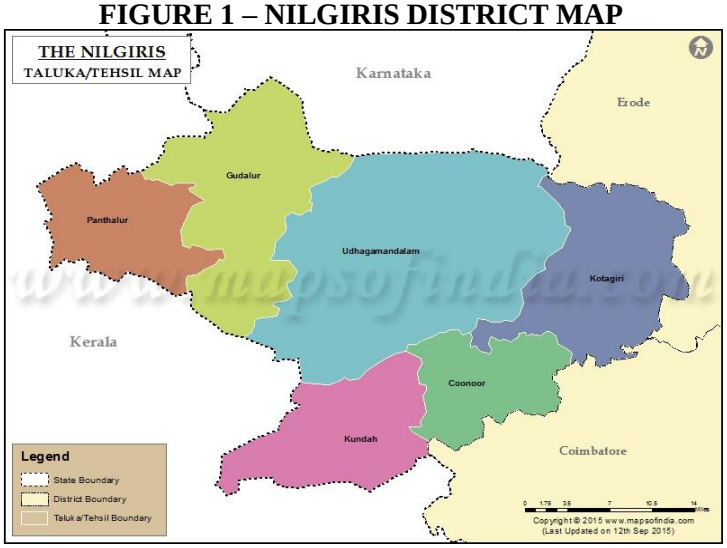
Halide and Ridd (2002) recycled fuzzy logic to rainfall prediction. The fuzzy logic method is recycled to model and foretell local rainfall data.

Fuzzy inference models obtainable better results than the two multiple regression models Brown-Brandle et al. (2003). Fuzzy inference models return a lower percentage of error when compared to the linear multiple regression model Hasan et al. (1995). Similar research by Wong et al. (2003) equated the results of fuzzy rule-based rainfall prediction with a trustworthy method which uses radial basis function networks and orographic effect.

Carrano et al. (2004) compared non-linear regression modelling and fuzzy knowledge – based modelling, and irradiated that fuzzy models are most fitting when subjective and qualitative data are exploited and the numbers of logical observations are small. Therefore, the problems accompanying with the statistical model need to address and the fuzzy rule-based model is the most adroit alternative means. The model predicted outputs were compared with actual rainfall data.

3. AREA AND DATA OF STUDY

FIGURE 1 – NILGIRIS DISTRICT MAP



The Nilgiris District is sited in the Western Ghats. It is fenced by the Coimbatore District, Erode, Kerala State and Karnataka State on the eastern, western and the northern side respectively. The Nilgiris District is a renowned summer choice for the tourists from all of India. Udhagamandalam widely called as the Queen of Hill Stations in India.

The universal climatic infirmity in this district is cool. High altitude of this district results low temperature, which is auxiliary lowered by undue moisture content of the atmosphere ensuing from the adoration by the vegetation. Ooty topographies a subtropical highland climate under cold climate classification. Although its location in the tropics, in gap with most of South India, Ooty generally structures mild conditions throughout the year. However, night time in the months of January and February is stereotypically cold.

Temperatures are relatively consistent throughout the year; with average high temperatures ranging from about 20–30 °C and average low temperatures between approximately 5–12 °C.

4. METHODOLOGY

This method resides of two input variables and one output variable. The month wise wind speed and the temperature are the input variables and the amount of rainfall anticipated will be the output of each month. The values of the input variables (Temperature and Wind Speed) are alienated into five linguistic variable terms, which are very Poor, Poor, normal, Good, very Good.

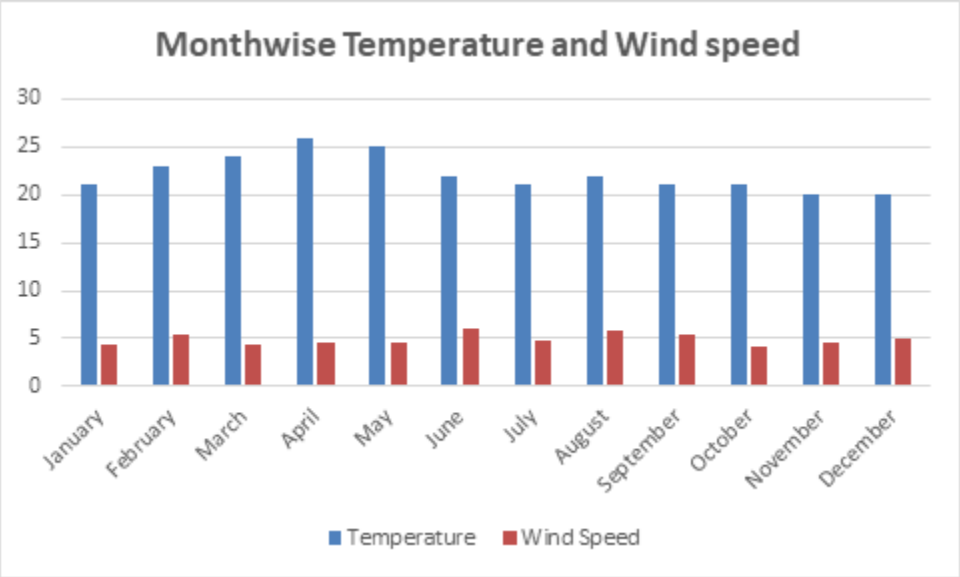
TABLE-1

SI. No	Linguistic variables	Notations
1.	Very Poor	VP
2.	Poor	PR
3.	Normal	NR
4.	Good	GD
5.	Very Good	VG

The month wise temperature and wind speed of Nilgiris district in the year 2020 is given in FIGURE 2. The minimum and maximum temperature in this district were 20℃ and 26℃ respectively. Also the minimum and maximum wind Speed of the district in the year 2020 were 4.2 Km/hr and 6 Km/hr.

The data was collected from statistical department of Nilgiris district. The district rainfall data was chosen from the areas such as Gudalur, Kotagiri, Udhagamandalam and Connor.

FIGURE -2



Temperature Equation

The temperature sorts from 20 ℃ - 28 ℃ . The membership value of the temperature is defined as:

$$\mu_{VP}(T) = \begin{cases} -0.5T + 11 & if \ 20 \le T \le 22 \\ 0 & if \ T > 22 \end{cases}$$

$$\mu_{PR}(T) = \begin{cases} 0.5T - 10 & if \ 20 \le T \le 22 \\ -0.5T + 12 & if \ 22 \le T \le 24 \\ 0 & if \ T > 24 \end{cases}$$

$$\mu_{NR}(T) = \begin{cases} 0.5T - 11 & if \ 22 \le T \le 24 \\ -0.5T + 13 & if \ 24 \le T \le 26 \\ 0 & if \ T > 26 \end{cases}$$

$$\mu_{GD}(T) = \begin{cases} 0.5T - 12 & if \ 24 \le T \le 26 \\ -0.5T + 14 & if \ 26 \le T \le 28 \\ 0 & if \ T < 24 \end{cases}$$

$$\mu_{VG}(T) = \begin{cases} 0.5T - 13 & if \ 26 \le T \le 28 \\ 0 & if \ T < 26 \end{cases}$$

Wind Speed Equation

The temperature sorts from 4 Km/hr - 6 Km/hr. The membership value of the wind speed is defined as:

$$\mu_{VP}(W) = \begin{cases} -2W + 9 & if \ 4 \le W \le 4.5 \\ 0 & if \ W > 4.5 \end{cases}$$

$$\mu_{PR}(W) = \begin{cases} 2W - 8 & if \ 4 \le W \le 4.5 \\ -2W + 10 & if \ 4.5 \le W \le 5 \\ 0 & if \ W > 5 \end{cases}$$

$$\mu_{NR}(W) = \begin{cases} 2W - 9 & if \ 4.5 \le W \le 5 \\ -2W + 11 & if \ 5 \le W \le 5.5 \\ 0 & if \ W > 5.5 \end{cases}$$

$$\mu_{GD}(W) = \begin{cases} 2W - 10 & if \ 5 \le W \le 5.5 \\ -2W + 12 & if \ 5.5 \le W \le 6 \\ 0 & if \ W < 5 \end{cases}$$

$$\mu_{VG}(W) = \begin{cases} 2W - 11 & if \ 5.5 \le W \le 6 \\ 0 & if \ W < 5.5 \end{cases}$$

5. RESULT AND DISCUSSION

The factors used for the prediction of rainfall are temperature and wind speed. The output variable value is clustered into five linguistic variables which are very poor, poor, normal, good, very good.

For very poor Rainfall:

$R = \frac{M-1}{-0.02}$ if $0 \le R \le 50$

For poor Rainfall:

$R = \frac{M}{0.02}$ if $0 \le R \le 50$

$R = \frac{M-2}{-0.02}$ if $50 \le R \le 100$

For normal Rainfall:

$R = \frac{M+1}{0.02}$ if $50 \le R \le 100$

$R = \frac{M-3}{-0.02}$ if $100 \le R \le 150$

For good Rainfall:

$R = \frac{M+2}{0.02}$ if $100 \le R \le 150$

$R = \frac{M-4}{-0.02}$ if $150 \le R \le 200$

For very good Rainfall:

$R = \frac{M+3}{0.02}$ if $150 \leq R \leq 200$

The table given below shows how the two input and the output values are related. The table is constructed using a data derive from United States Department of Agriculture (USDA). The data consist of documented amount of rainfall for a particular month and the values of temperature and wind speed.

TABLE-2: RELATIONSHIP BETWEEN TEMPERATURE, WIND SPEED AND AMOUNT OF RAINFALL

WS / TP	VP	PR	NR	GD	VG
VP	VP	VP	PR	PR	NR
PR	VP	VP	PR	NR	NR
NR	PR	PR	NR	NR	GD
GD	PR	NR	NR	GD	GD
VG	NR	NR	GD	GD	VG

If (temperature is very poor and Wind speed is very poor) then Rainfall is very poor.

If (temperature is poor and Wind speed is poor) then Rainfall is very poor.

If (temperature is poor and Wind speed is very poor) then Rainfall is poor.

If (temperature is normal and Wind speed is very Good) then Rainfall is Good.

Defuzzification implicates transformation of the linguistic variables to numerical or crisp values; these workings embrace the centroid defuzzification method.

The formula for this system is given by $Y = \frac{\sum\mu(Vk)x\ Vk}{\sum\mu(Vk)}$ where k = 1,2…n and V_k is the value of the variable, $\mu(V_k)$ is the membership of the variable and Y is the crisp rainfall value.

FIGURE -3

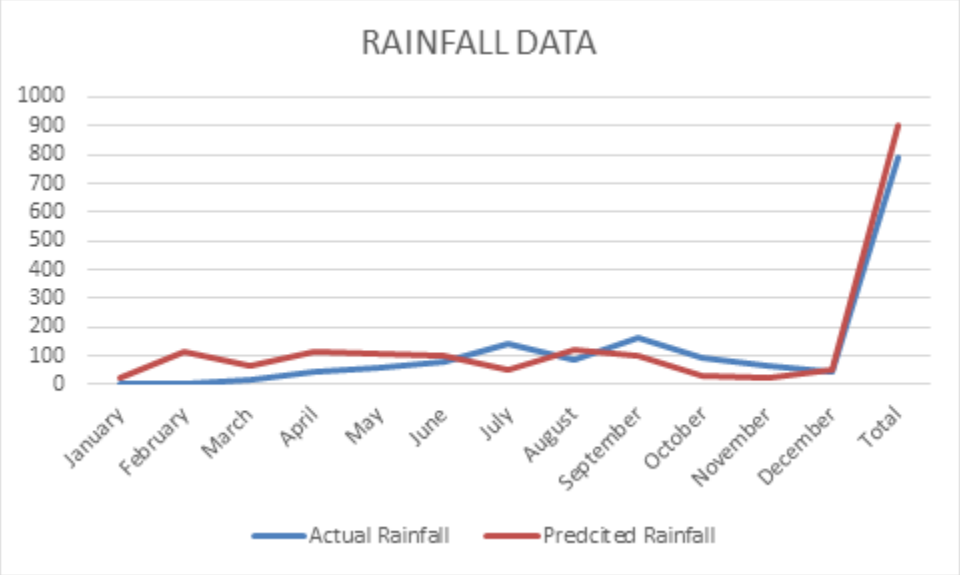


FIGURE -3 shows that there are few deviations in the actual rainfall and predicted rainfall data.

6. CONCLUSION

This paper familiarized the logical model for rainfall result and its passion prediction. In this method, the fitting membership functions for all parameters and the advance of emerging resourceful comments make the methodology easy to be focused and executed. The models accessible can be improved extra by increasing the agreed of input parameters, adjusting the set of rules, hybriding with other approaches and seasonal data.

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