Analysis of Defuzzification Method for Rainfall Event

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ABSTRACT: Fuzzy Logic is present trend for decision making, classification and prediction where problem can be formulated by mapping input variable with output variable or where simple solution does not exists. There are three basic steps for fuzzy inference system such as Fuzzification, rule evaluation and Defuzzification. Fuzzification means converting numeric value into linguistic value. Human intuition method is well accepted method for the membership function value assignment throughout the world. Fuzzy inference engine produce the result after rule evaluation also in terms of linguistic value. All results are aggregated and defuzzified by any Defuzzification method. It is very difficult to know which process will be suitable for which type of data.

So, the main objective of this paper is to explore the basic concept of Defuzzification method for the rain fall event with the help of wind speed and temperature variable by simulating on matlab analyze the obtained results for different-different fuzzyfication methods the rain fall event in "MatLab".

KEYWORDS: Fuzzy Logic, Linguistic value, MF, Bisector, MOM, LOM, SOM etc.

1. INTRODUCTION

Fuzzy logic is an extension of classical logic, The main difference between fuzzy logic and classical logic is that fuzzy set using for membership of a variable .

Fuzzy logic has many advantages over classical logic in areas like artificial intelligence where a simple true/false statement is insufficient.

A fuzzy set operation is an operation on fuzzy sets. These operations are generalization of crisp set operations. There is more than one possible generalization. The most widely used operations are called standard fuzzy set operations. These are three operations: fuzzy complements, fuzzy intersections, and fuzzy unions.

There are three main methods or steps of fuzzy inference system as given in figure1.1.

1. Fuzzification
2. Rule Evaluation
3. Defuzzification.

Fuzzification is the first step of the fuzzy inference system which is used to convert crisp values to the linguistic value.

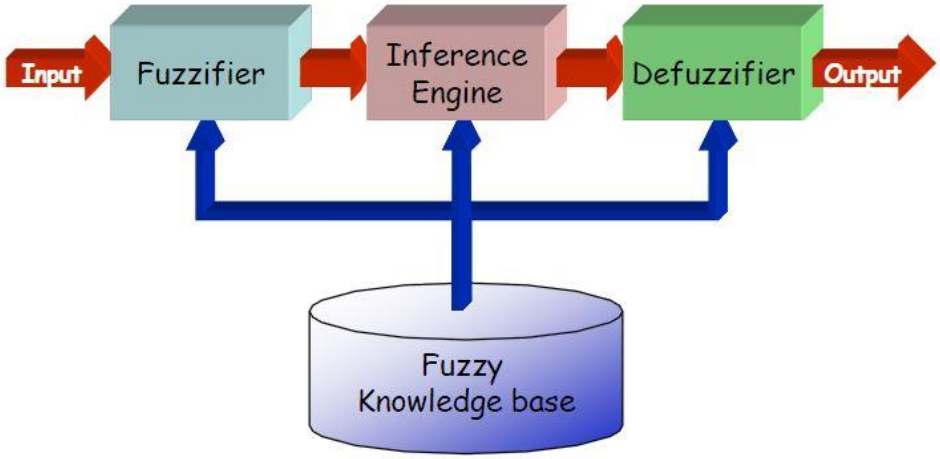

Figure1.1: Fuzzy Inference System

A fuzzy rule is defined as a conditional statement in the form:

IF **x** is A

THEN **y** is B

Where:

x and y are linguistic variables;

A and B are linguistic values determined by fuzzy sets on the universe of discourse X and Y, respectively.

Defuzzification is the process of producing a quantifiable result in fuzzy logic, given fuzzy sets and corresponding membership degrees. It is typically needed in fuzzy control systems. These will have a number of rules that transform a number of variables into a fuzzy result, that is, the result is described in terms of membership in fuzzy sets. There are five basic Defuzzification methods as given below:

1. Centroid
2. Bisector
3. MOM
4. LOM
5. SOM

LITERATURE REVIEW

Jimoh, R. G.2013 [1]. "Modeling Rainfall Prediction using Fuzzy Logic" has discusedThe fact that effective planning leads to high performance does not call for any debate. In this context of study, knowledge of other variables like temperature and wind speed, it is easier to predict likelihood of rainfall and even the volume .

Mahbub Hasan, in 2013 [2] "Predicting Rainfall Using the Principles of Fuzzy Set Theory and Reliability Analysis " has discussed Selection of variable and the fundamental logic of the values TP and was and WS was an attempt to identify amount of RF and its time of occurance as the consequent part of the fuzzy interence model Introducing.

Somia A. Asklany, in 2011 [3] "Rainfall events prediction using rule-based fuzzy inference system" has introduced intelligent models for rainfall events prediction for two Egyptian meteorological stations based on fuzzy inference system. We have proven that when using such technique it is desirable to merge the experiences of forecasters and theoretical studies with efficiency and the accuracy of the computer systems by procedure based on algorithm.

TeerawatThongwan, AnongritKangrang and SahalaphHomwuttiwongin 2011[4],"An Estimation of Rainfall using Fuzzy Set-Genetic Algorithms Model" has discussed This study applied a fuzzy

model for estimating the rainfall. Genetic algorithm technique was used to calibrate membership function condition of fuzzy sets model.

M.Kannan, S.Prabhakaran,P.Ramachandran, in 2010 [5]."Rainfall Forecasting Using Data Mining Technique " has discussed Rainfall time series may be unfounded. The topic of monsoon-rainfall data series is highly complex; the role that multiple linear regressions might play in this topic is one for future research—it appears, from the evidence here, not to be useful as a predictive model.

Dr. ShipraBanik,Dr. Mohammed Anwer, A.F.M. KhodadadKhan,Rifat Ara Rouf,Farah Habib Chanchary, in 2009[6]."Forecasting Bangladeshi monsoon rainfall using neural network and genetic algorithm approaches" has discussed Rainfall forcasting is important for many areas of human activities such as agriculture, water resources, hydroelectric power projects, happening of droughts or floods and others.

Gholam Abbas Fallah-Ghalhary**,** Mohammad Mousavi-Baygi **and** Majid Habibi Nokhandan **2009[7] "Annual Rainfall Forecasting by Using Mamdani Fuzzy Inference System"** In this study, we attempted to forecast the rainfall (six month ahead) based on Fuzzy Inference System techniques. As the RMSE values on test data are comparatively less, the prediction models are reliable.

J. Saade and Hassan B. Diab, 2004 [8]. "Defuzzification Methods and New Techniques for Fuzzy Controllers" has discussed the common defuzzification methods; i.e.,WAF, QM, COG and MOM in the light of the elements of a fuzzy controller.

3. PROBLEM STATEMENT AND OBJECTIVE

Defuzzification is the process of converting linguistic results into crisp value, but there are several methods for this conversion. It is very difficult to select or chose a method for the Defuzzification in any application.

The main objectives of this research are following:

- Study of Defuzzification method
- Prediction of rainfall event on MATLAB using following method
    - Centroid
    - Bisector
    - MOM
    - LOM

- SOM

- Comparative analysis of Defuzzification method for rain fall event

4. PROPOSED SYSTEM

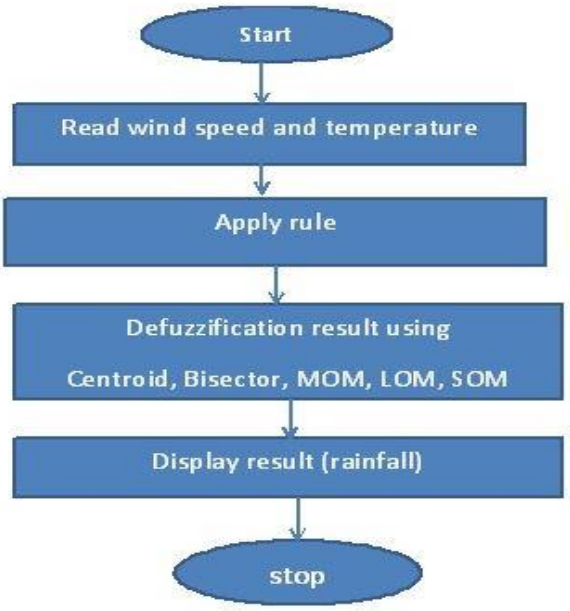

Figure: 3.1 Flowchart of proposed system

5. IMPLEMENTATION

- **Using Fuzzy inference system**

Proposed system is implemented on the Matlab. There are three main steps of implementation Fuzzification, rule evaluation and Defuzzification.

Steps to open fuzzy inference system
(a) Open matlab in computer/laptop
(b) Type fuzzy in command window

(c) FIS editor will appear on the screen, create FIS variables as per requirements
(d) Choose multiple of membership function required in the FIS variable.
(e) Set the range of membership function and types of it.

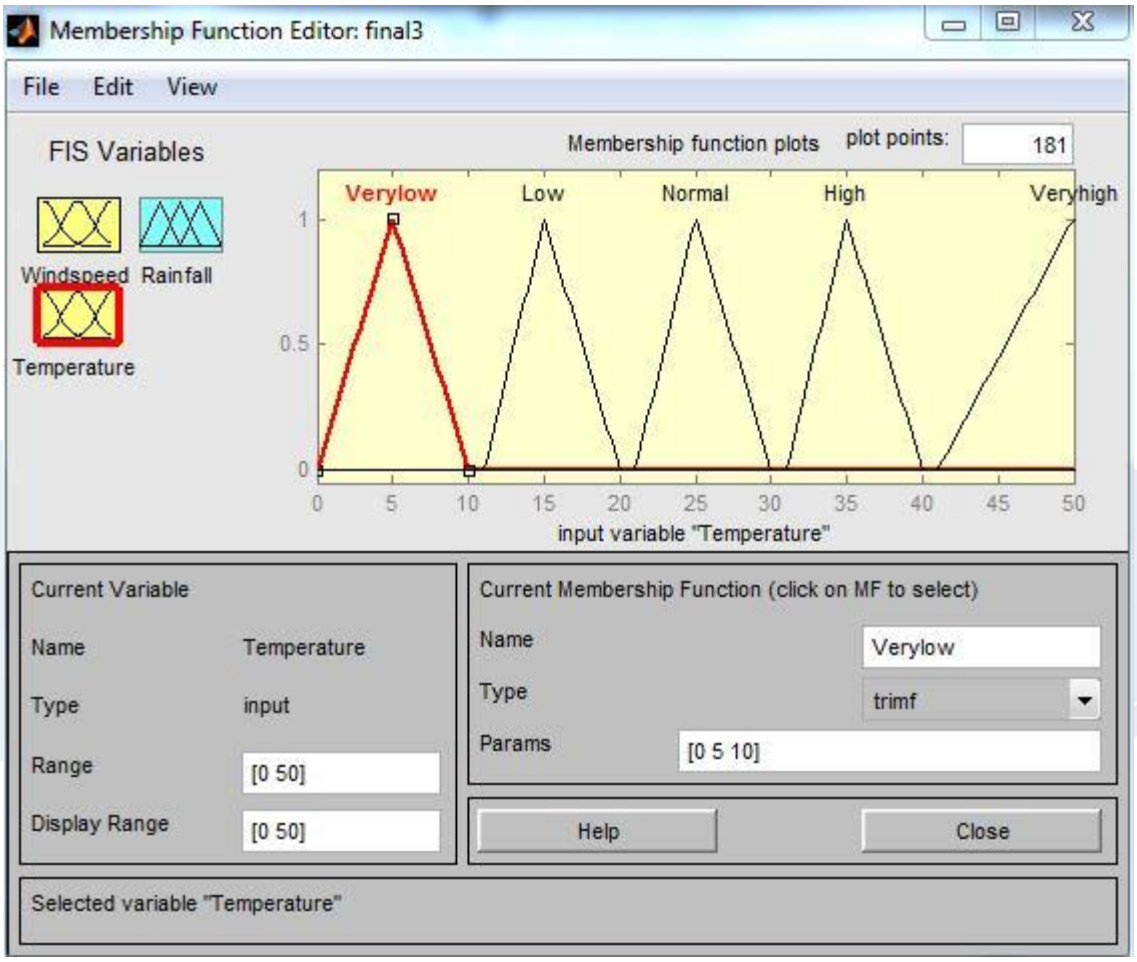

Figure 4.1(a): Membership function

Fuzzification for input variables wind “speed”:

LINGUISTIC VALUES	RANGE (km/h)
VERY LOV	0-4
LOW	5-8
NORMAL	9-13
HIGH	14-18
VERY HIGH	>18

Table 5.1(a): wind speed

Fuzzification for input variables “temperature”:

LINGUISTIC VALUES	RANGE (C®)
VERY LOV	0-10
LOW	11-20
NORMAL	21-30
HIGH	31-40
VERY HIGH	>40

Table 5.1(b): Temperature

Fuzzification for output variables “rainfall”:

LINGUISTIC VALUES	RANGE (mm)
VERY LOW	0-320
LOW	321-640
NORMAL	641-960
HIGH	961-1280
VERY HIGH	1281-1600

Table 4.1(c): Rainfall

MF value construction for input variables “wind speed”:

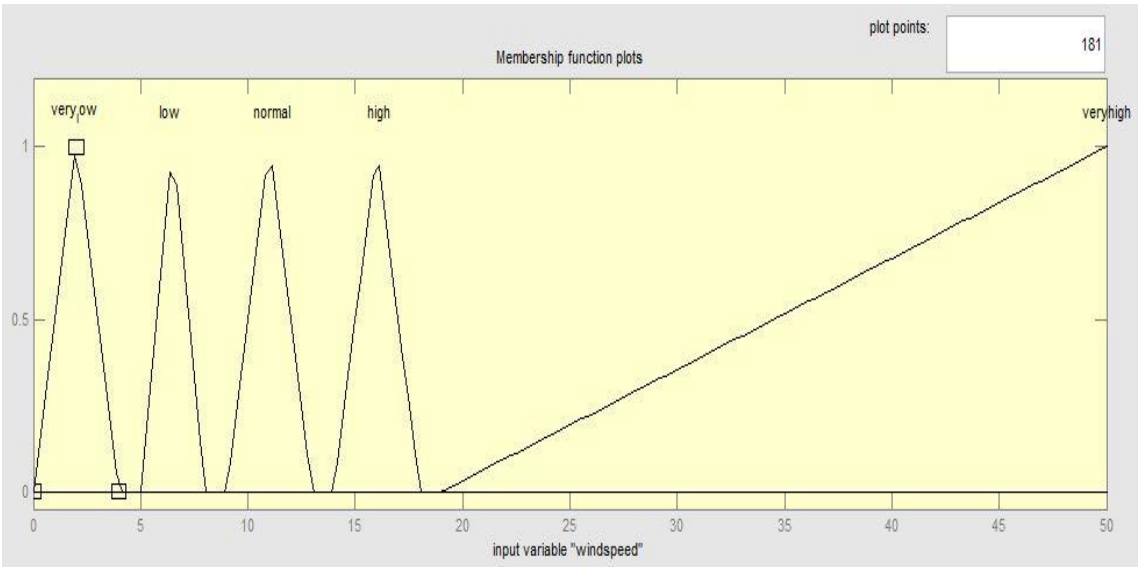

Figure 5.1(b): Wind speed

MF value construction for input variables temperature:

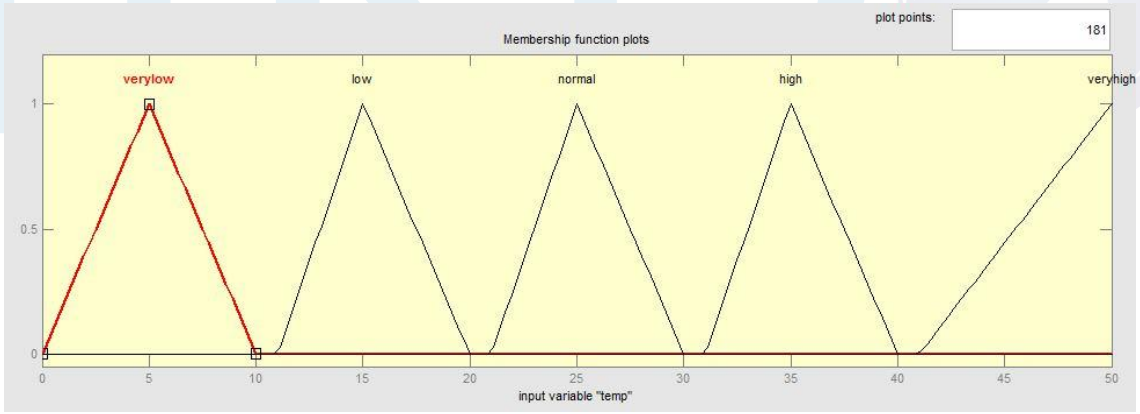

Figure 5.1(c): Temperature

MF value construction for output variables rainfall:

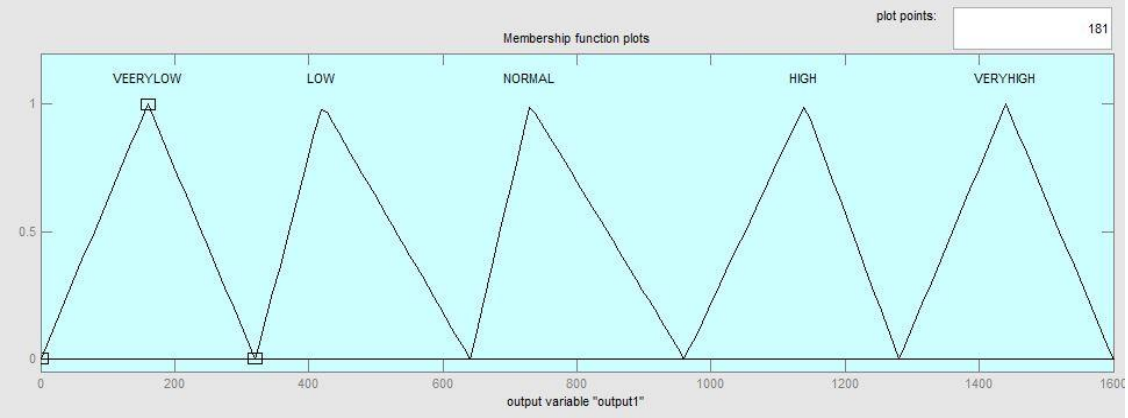

Figure4.1(d): Rainfall

Rules

This fuzzy rule emulation we have created following fuzzy rule.

Rule creation for fuzzy inference system:

1. If (wind speed is very low) and (temp is very low) then (output is very low)
2. If (wind speed is low) and (temp is low) then (output is very low)
3. If (wind speed is normal) and (temp is very low) then (output is low)
4. If (wind speed is very high) and (temp is very low) then (output is normal)
5. If (wind speed is very high) and (temp is very high) then (output is high)
6. If (wind speed is normal) and (temp is very low) then (output is low)
7. If (wind speed is high) and (temp is very low) then (output1 is low)
8. If (wind speed is very high) and (temp is very low) then (output is normal)
9. If (wind speed is very low) and (temp is low) then (output is very low)
10. If (wind speed is low) and (temp is low) then (output is very low)
11. If (wind speed is normal) and (temp is low) then (output is low)

12. If (wind speed is high) and (temp is low) then (output is normal)

13. If (wind speed is very high) and (temp is low) then (output is high)

14. If (wind speed is very low) and (temp is normal) then (output1 is low)

15. If (wind speed is low) and (temp is normal) then (output is low)

16. If (wind speed is normal) and (temp is normal) then (output is normal)

17. If (wind speed is high) and (temp is normal) then (output is normal)

18. If (wind speed is very high) and (temp is normal) then (output is high)

19. If (wind speed is very low) and (temp is high) then (output is low)

20. If (wind speed is low) and (temp is high) then (output is normal)

21. If (wind speed is normal) and (temp is high) then (output is normal)

22. If (wind speed is high) and (temp is high) then (output is high)

23. If (wind speed is very high) and (temp is high) then (output is high)

24. If (wind speed is very low) and (temp is very high) then (output is normal)

25. If (wind speed is normal) and (temp is very high) then (output is high)

This rule are added in matlab with the help of fuzzy rule editor as given blow.

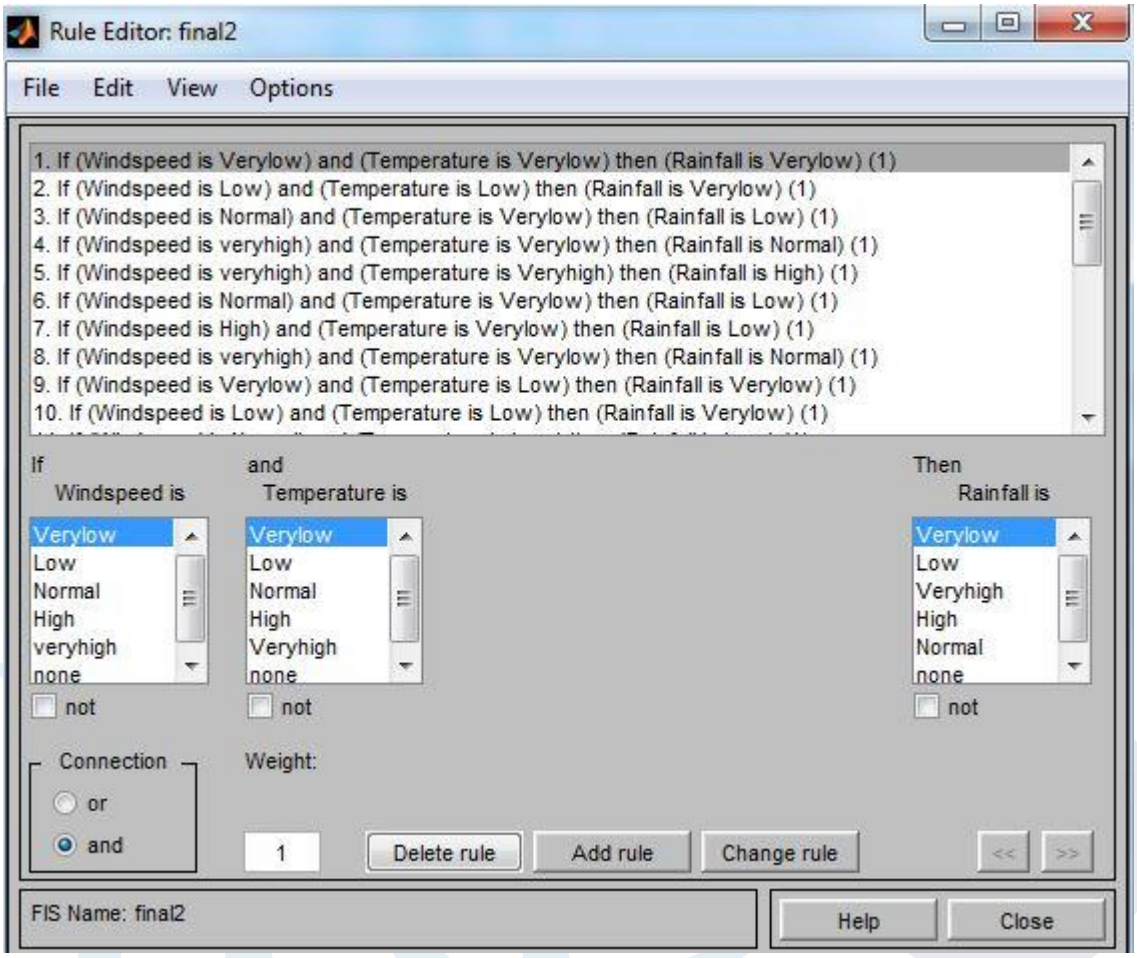

Fig 5.1(e): Rules created in Fuzzy Inference system

6.RESULT AND ANALYSIS

We have test the result for two case calculating for result.

6.1 Snape sort result for rule 4 Using Centroid for case 1

"Case 1 is a using matlab by default common input data wind speed range 25 and temperature range 25".

Compare for the result

Wind speed range 25 is very high and temperature range 25 is normal. Then total rain fall is high. This result compare in all rules and rule no 18 is match.

Using Centroid method Case-1 Rule 18 Rainfall is High Range (961-1280)

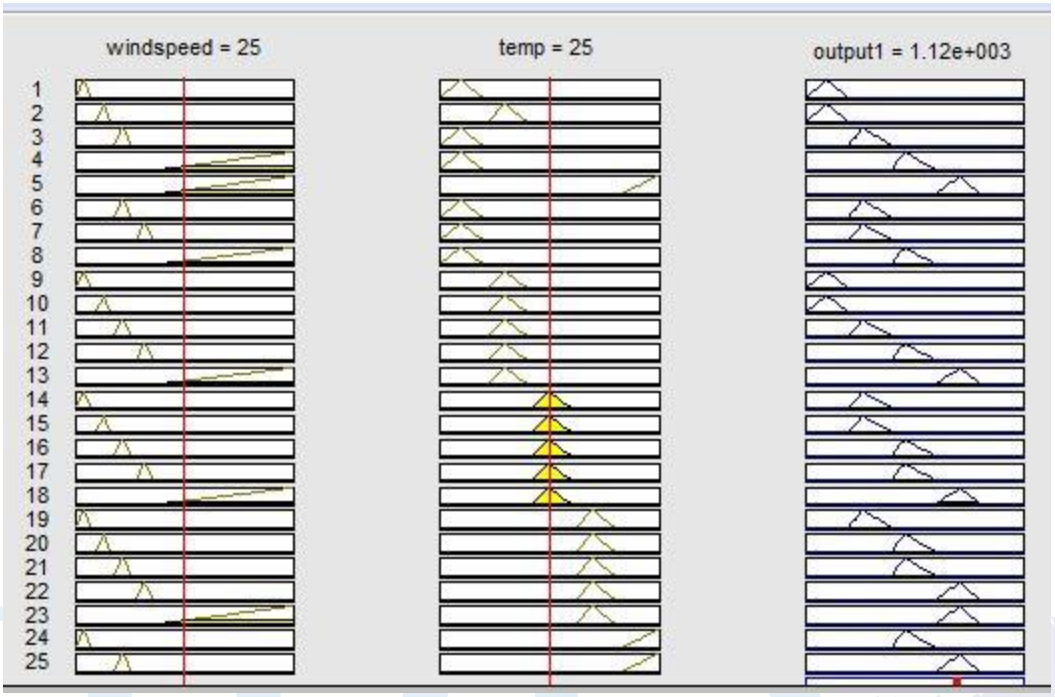

Figure 6.1(a): Result viewer window

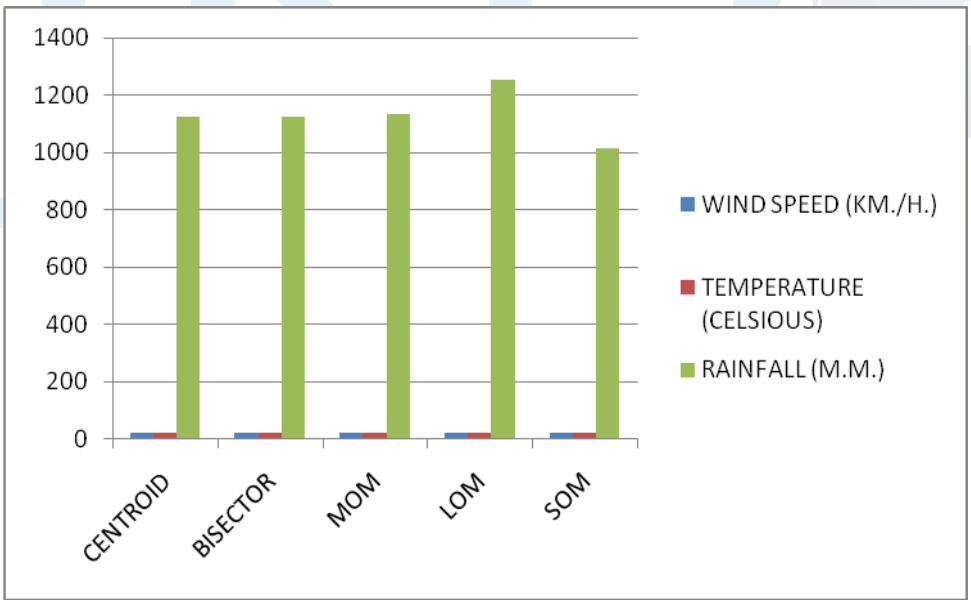

Figure 6.1(b): Comparative analysis of Defuzzification method – 1

DEFUZZIFICATION METHOD	WIND SPEED (KM./H.)	TEMPERATURE (CELSIOUS)	RAINFALL (M.M.)
CENTROID	25	25	1123
BISECTOR	25	25	1123
MOM	25	25	1133
LOM	25	25	1253
SOM	25	25	1013

Table 6.1(a): Comparative Analysis of Defuzzification Methods for rainfall event-1

6.2 Snape sort result for rule 18 Using Centroid for case 2

"Case 2 is a using matlab by different-different input data wind speed and temperature range different-different"

Compare for result

Wind speed range 23.1 is very high and temperature range 6.27 is very low. Then total rain fall is normal. This result compare in all rules and rule no 4 is match.

Using Centroid method Case-2 Rule 4 Rainfall is Normal Range (641-960)

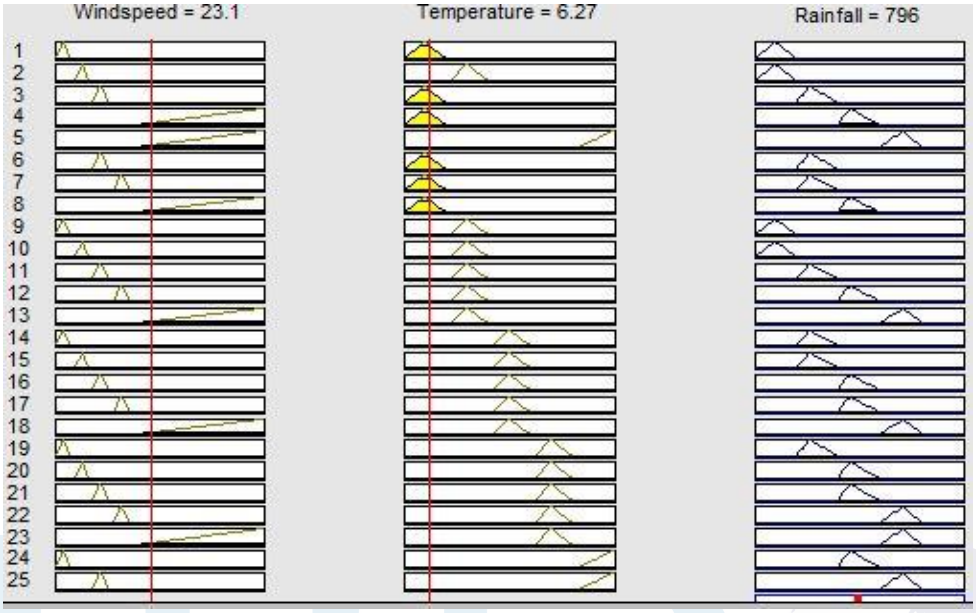

Figure 6.1(c): Result viewer window case 2

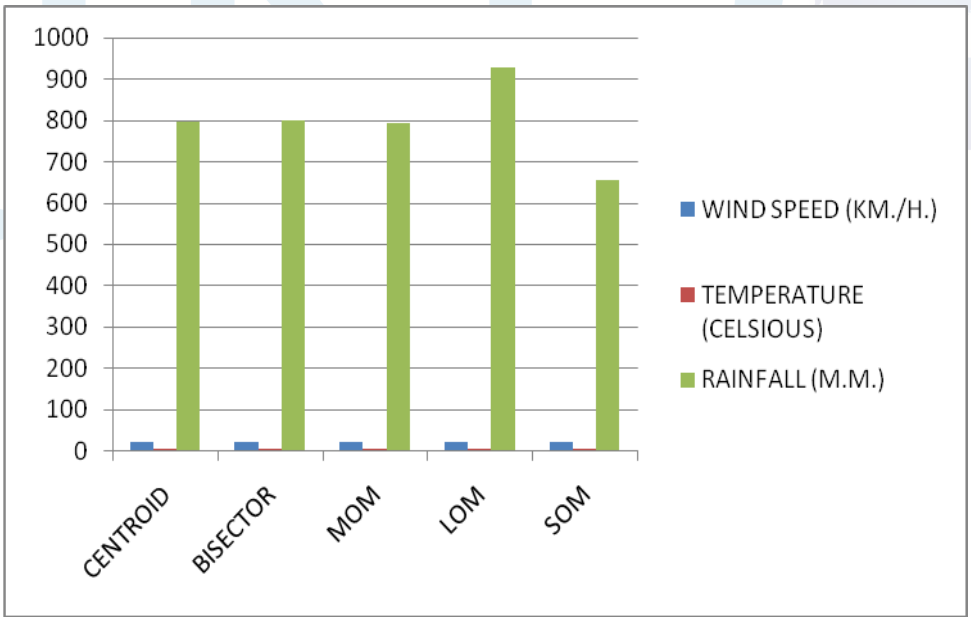

Figure 6.1(d): Comparative analysis of Defuzzification method – case2

DEFUZZIFICATION METHOD	WIND SPEED (KM./H.)	TEMPERATURE (CELSIOUS)	RAINFALL (M.M.)
CENTROID	23.1	6.27	796
BISECTOR	23.1	6.27	800
MOM	23.1	6.27	792
LOM	23.1	6.27	928
SOM	23.1	6.27	656

Table 6.1(b): Comparative analysis of Defuzzification method – case2

Conclusion:

As par experimental observation Centroid and Bisector Defuzzification method has given same output for the same input value for rainfall event. While MOM has predicted little bit more then Centroid and Bisector method which is tolerable. LOM has predicted much more then Centroid, Bisector and Mom while SOM has predicted much less then Centroid, Bisector and Mom while SOM.

Future Scope:

In future analyze which Defuzzification method is suitable for which type of application and data can be done.

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