

Implementation of Fuzzy Mamdani Method in Diabetes

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Abstract

Fuzzy Logic is the extension of classical logic that has a value of vagueness or fuzziness between True and False. But how much true and Falsity of a value depends on the weight of its Membership value. To design a Fuzzy Logic in Diabetes of Human beings is focused in this paper. Generally Diabetes can occur when a body does not produce enough insulin or it cannot use insulin. This paper describes Mamdani Single Rule with Single Antecedent and Single rule with multiple antecedents with Fuzzy input value and Crisp input values in Diabetes data Fuzzy Set and verify how the output comes using Composition of Max-Min and Max-Product. To diagnosis the Diabetes different systems are used by the most of the researchers. But their accuracy is not accurate because the diabetes based some other parameters are not discussed so far.

Keywords: Fuzzy Sets, Fuzzy logic, Diabetes, Fuzzy Interference system

1. Introduction

1.1 Fuzzy Set

[14] The Fuzzy set was first proposed by Zadeh, in the year 1965 [14]. To handle uncertainty in a lot of the real world applications the Fuzzy sets are used. The extension and generalization of basic set theory is known as Fuzzy Sets. Members of the Fuzzy set to have different membership value in the interval [0,1]. Fuzzy sets does not have sharp boundaries. There is a gradual transition between full memberships to non-membership. Fuzzy set theory can be used in a wide range of domains in which information is incomplete or imprecise such as bio informatics.

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In real time a system, where the information is inherent, it has various levels of precision, to solve these kinds of problems Fuzzy Sets are used. [1, 2, 3] Elements with a zero degree of membership are normally not listed [11].

1.2 Diabetics

Due to the unhealthy lifestyle in India, one of the fatal diseases like Diabetics is increasing at a faster rate. These diseases occur when the patient's pancreas unable to produce enough insulin or the body could not utilize the insulin produced efficiently. In the developed countries Diabetics are increasingly rapidly like an epidemic. Based on the data from International Diabetes Foundations in 2005 over 246 million people around worldwide have been treated for Diabetics [1, 2, 3].

1.3 Fuzzy Logic

Fuzzy logic is the development of standard logic which is based on Fuzzy sets. It is a logic which gives rich and meaningful addition to basic logic [18]. It is an approach to compute rather than true or false Boolean logic, fuzzy logic is used based on degrees of truth. The concept of fuzzy logic was introduced by Dr. Zadeh of the University of California in the year 1960 [17]. Fuzzy logic deals with reasoning with inexact or fuzzy concepts. Hence the well established isomorphism's between Boolean algebra, set theory and propositional logic can be extended in a natural way between fuzzy algebra, fuzzy set theory and fuzzy logic [16].

1.4 Fuzzy Inference System (Fis)[19] With Mamdani

In the theory of fuzzy logic a value could be true and false simultaneously people who are not familiar with fuzzy logic would have thought that fuzzy logic is a very complicated and unpleasant. However, once people know it, he would be very interested and will be newcomers to participate studying fuzzy logic. Mamdani method is explained with [13] Max-Min method. Mamdani method was introduced by Ebrahim Mamdani in 1975 [5, 13].

In section 2 preliminaries are explained. Methods discussed in Section 3 and results described in section 4.

II. Preliminaries

2.1 Crisp Set

Crisp Set is a collection of all elements selected from the domain, the elements satisfying some criteria. Here discuss only two cases whether the given element is member of a Crisp set or it is not. [4, 10].

2.2. Fuzzy Set [10].

Fuzzy set is the extension of Crisp set. Crisp set define two values to its elements i.e., if the elements present in it, its value is 1 otherwise its value is zero whereas fuzzy sets gives different degree of values in the interval [0, 1] to its elements which is called membership values.

2.3 Fuzzy number [20]

A fuzzy set A on R must possess at least the following three properties to qualify as a fuzzy number,

- A must be a normal fuzzy set;
- A_α must be closed interval for every $\alpha \in [0, 1]$
- The support of A , A_{0+} must be bounded [9,10]

2.4 Fuzzy Triangular numbers (FTN) [9, 10]

Let the Real numbers a , b , and c such that b is greater than a , and less than c . Then the FTN, $A = (a, b, c)$ is a Fuzzy Number with membership function:

$$m(x) = \begin{cases} \frac{x-a}{b-a} & , a \leq x \leq b \\ \frac{c-x}{c-b} & , b \leq x \leq c \\ 0 & , x < a, x > c \end{cases}$$

3. Methods

Sample data that is used in this research is primary data from Diabetic patients of Age group between 15 years to 80 years and their respective HBA1C values [1]. Data will be processed using the approach of Fuzzy Inference System (FIS) Mamdani.

In this paper, the implementation of Fuzzy logic focused on diabetes data. Diabetes performed by range of age from 15 years to 80 years . The linguistic values and their corresponding membership functions (values) of

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age and HBA1C have been taken for this work. Let the vertical and horizontal axis be Age and corresponding membership functions.

CASE 1: Single Rule with Single Antecedent (Crisp Input)

Rule: IF x is A THEN y is B

Input: x is \bar{A}

Conclusion: y is B'

Using the definition 2.1, 2.2 and definition 2.4, Figure 1 represents Fuzzy Mamdani [15] Max-Min Composition and also Max-Product composition [15] for the Age $x = 29$ years (crisp input).

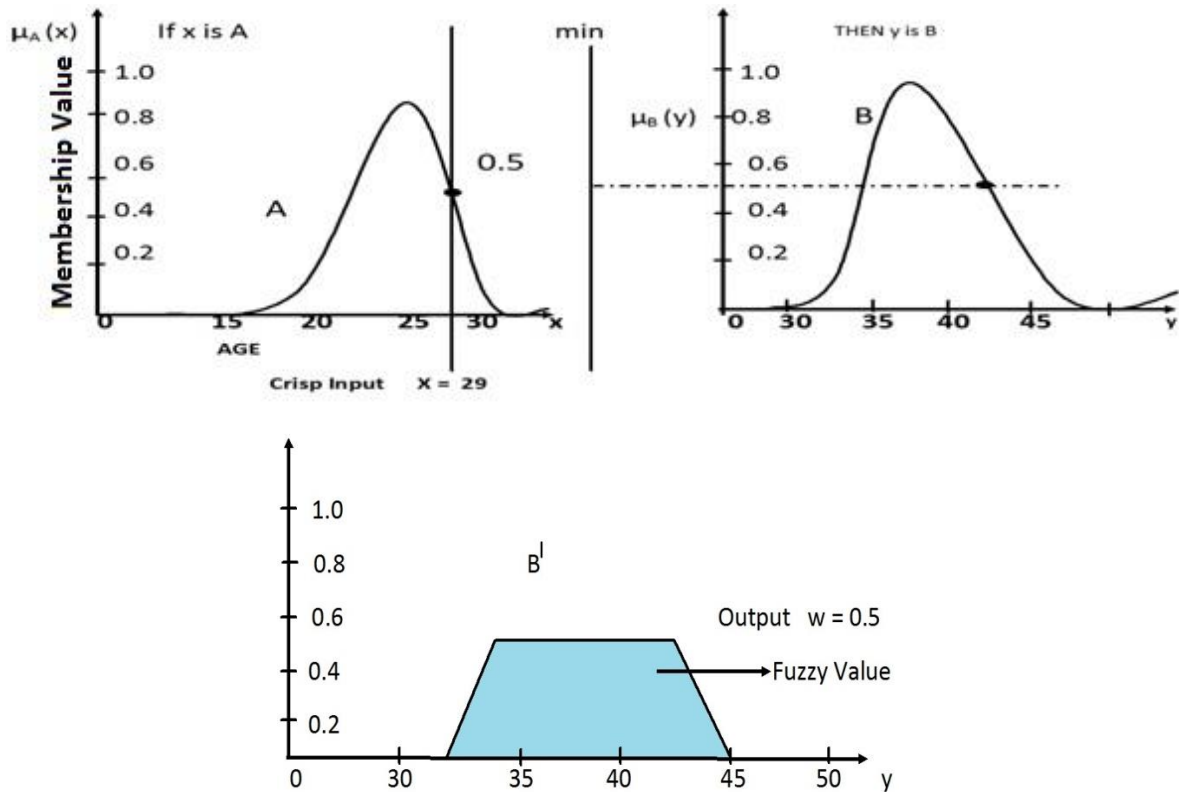


Figure 1. Mamdani Max-Min Composition- Crisp Input

CASE 2: Single Rule with multiple Antecedents [12] with Fuzzy, crisp input

Rule: IF x is A and y is B THEN z is C

Input: x is \bar{A} and y is \bar{B}

Conclusion: z is C [12]

Using the definition 2.1, 2.2 and the definition 2.4 Figure 2 shows vertical and horizontal axis represents Diabetes patients age and corresponding membership values. Here Single rule with multiple antecedent methods are explained. In x - fuzzy region weight w_1 is 0.8 and in y – fuzzy region w_2 is 0.3.

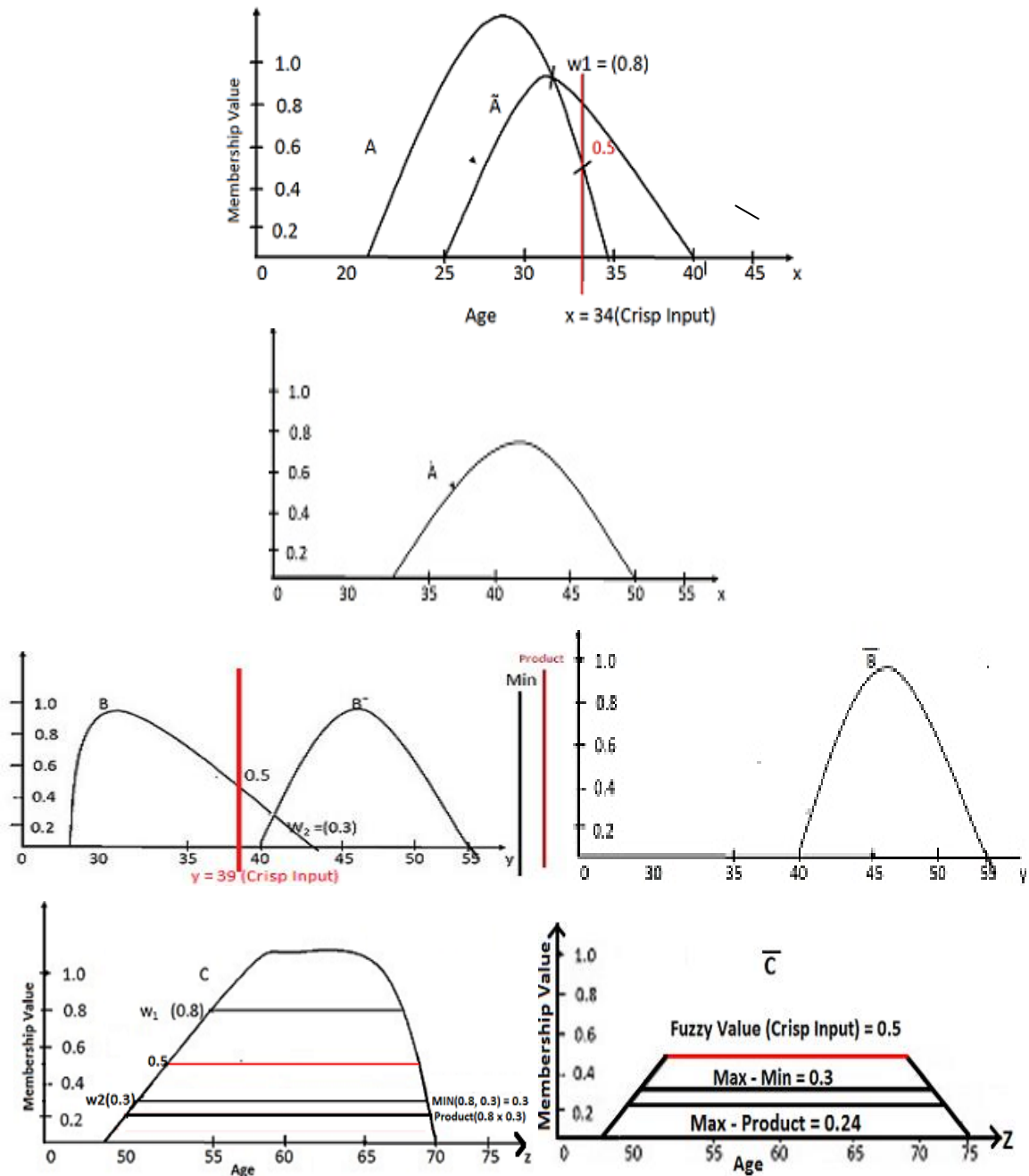


Figure 2. Fuzzy Mamdani Max-Min, Max-product Composition

4 Results

- From single rule with single antecedents methods crisp input value $x = 29$ gives Fuzzy value i.e. weight 0.5 using Max-min composition methods. corresponding membership values i.e. weight = 0.5 gives Fuzzy Values that is Fuzzy output. And also Max-Product gives the same value as weight is 0.5 because here only one weight is there so the product of all weight will be the same as the given weight.

- From single rule with multiple antecedents methods there are two weights $w_1 = 0.8$, $w_2 = 0.3$ using Max-min composition it gives 0.3 in the Z fuzzy region and also using Max-Product composition it gives 0.24 weight also falls in Fuzzy z region.

For Crisp Input $x=34$ and $y=39$ gives weight 0.5, 0.5 respectively and using Max-min composition weight 0.5 gives and it also falls in Fuzzy region z.

5. Conclusion

Here Fuzzy logic Mamdani rule are applied in Diabetes. This paper shows simple implementation of Fuzzy logic in diabetic data. Further research can be done using this methods to diagnosis Diabetes and compare how this method is effective than other method.

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