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A Framework for Selection of Membership Function Using Fuzzy Rule Base System for the Diagnosis of Heart Disease

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Abstract**—** Today's technology prediction of a heart disease using intelligent system is a real challenge to modern technology. In this paper different membership functions using a fuzzy rule based system for the diagnosis of the heart disease has been presented. The system has seven inputs .These are Chest pain type, resting blood pressure in mm(Trestbps),Serum cholesterol in mg(Chol),numbers of years as a smoker(years), fasting of blood sugar(fbs), maximum heart rate achieved(thalrest), resting blood rate(tpeakbps). The angiographic disease status of heart of patients has been recorded as an output. It is to mention that the diagnosis of heart disease by angiographic disease status is assigned by a number between 0 to 1,that number indicates whether the heart attack is mild or massive. Here an effort has been made to decide suitable membership function for proper diagnosis of heart disease.Different membership functions used are triangular, trapezoidal, Gaussian ,Z shaped, bell shaped ,sigmoid based ,Gaussians combination membership functions. Based on the minimum value of absolute residual the particular membership function can be decided using the fuzzy rule base system for the proper diagnosis heart disease status of a patient.

Index Terms**—** Fuzzy Logic, Membership Function, Fuzzy Rule Base System

I. Introduction

Heart disease, sometime define as coronary artery disease (CAD), is a well-known term that can be referred to any condition that affects the heart. Most of the people with heart disease have symptoms such as chest pain, blockage and fatigue, as many as 50% have no symptoms until a heart attack occurs.

R.Das,Ibrahim Turkoglu b, Abdulkadir Sengur[1] have used a neural network based model for the diagnosis of heart disease from the available data. Initially the data have been partitioned for the purpose of the usage of the neural network and for the validation of data sets. Three types of neural networks have been used. The authors have made a comment that a multilayer feed forward neural network has shown the excellent performance among the three types of neural networks.

Vanisree K,Jyothi Singaraju[2] have used a Decision Support System for the diagnosis of Congenital heart disease from the available database .They have used back propagation neural network which contains one input layer, one output layer and one or more hidden layers. As the name implies the input layer receives signals from the external nodes and transmits these signals to other layers without performing any computation at that layer. The output layer receives the signals from an input layer through a weighted connection links, performs computations at that layer and produces output of the network

It has been trained using a supervised delta learning rule. The dataset used in this study are the signs, symptoms and the results of physical evaluation of a patient. The proposed system has achieved an accuracy of 90%.

Priti Srinivas Sajja, Dipti M Shah[3] have used a knowledge-oriented decision support system for the diagnosis of abdomen pain .They have used a modified Prolog rule format, for their decision making process and have created awareness in the area especially where trained manpower is in scarce.

Ali.Adeli, Mehdi.Neshat[4] have used a fuzzy expert system for the diagnosis of heart disease. The authors have used several variables viz as chest pain type, blood pressure, cholesterol, resting blood sugar, resting maximum heart rate, sex, electrocardiography (ECG), exercise, old peak (ST depression induced by exercise relative to rest), thallium scan and age as inputs. The status of the patients as healthy or sick has been used as output. Four types of sickness have been used as output. These are Sick s1,Sick s2, Sick s3, Sick s4.

Narendra S. Chaudhari and Avishek Ghosh [5] have used a projection algorithm with an objective to map p-dimensional patterns to q-dimensional space such that the structure of the data is preserved. They have implemented an extension of Sammon's algorithm using fuzzy logic approach. Finally they have shown that their result was excellent.

Ranjana Raut, S. V. Dudul[6] have used a neural network based approach for intelligent system in the diagnosis of heart disease. They have used classifiers based on various neural networks namely multilayer perceptron, Jordan recurrent neural network, generalized feed forward neural network, Modular Radial Basic Function, Self Organizing Feature Map, other techniques like Support Vector Machine and conventional statistical techniques such as Data Analysis and CART. They have proposed Muitilayer Perceptron Neural Network based classifier has shown the excellent result as compared to others.

K. Usha Rani[12] have used a classification approach based on neural network. They have used single and multilayer neural network mode for classification of heart disease dataset. For training the network, they have used back propagation algorithm and parallelism technique at the same time at each neuron in all hidden and output layers to speed up the learning process. They have proved that neural network based technique has given satisfactory result.

K.Rajeswari, V.vaithiyanatham, P.Amirtharaj[13] have proposed a Decision support system for reliable heart disease risk prediction of Indian patients using machine learning technique. They have used genetic algorithm to determine high impact pattern and their optimal value. They have used theoretical approaches to implement the machine learning algorithm.

Ersin Kaya, Bulent Oran and Ahmet Arslahn[14] have used a fuzzy rule based classifier for diagnosis of congential heart disease which defines structural and functional disease of heart. They have used weighted vote method and single winner method . The result has shown that the weighted vote method generally has increased the classification accuracy of congenital heart disease.

E.P.Ephzibah1, V. Sundarapandian[15]have proposed a neuro fuzzy expert system that finds a solution to diagnose the disease using some of the evolutionary computing techniques like genetic algorithm, fuzzy rule based learning and neural networks. Their proposed neuro-fuzzy method refers to the combination of artificial neural network and fuzzy logic based system in which the 13 attributes have been applied taken from UCI Machine learning repository. The result has helped the doctors to arrive at a conclusion about the presence or absence of heart disease in patients.

Shradhanjali Rout[16] have used a Fuzzy Petri net based system instead of fuzzy expert system and have analyzed the system through fuzzy rule based reasoning algorithm. They have used 11 attributes for input and 1 attribute as output for diagnosis of the of heart disease. They have shown that their result was excellent by using their proposed petri net based fuzzy system.

Various authors ([1][2][6][12]) have used several neural network models like back propagation neural network, multilayer perceptron neural network, radial basis neural network etc. Their effort was to detect the heart disease using fuzzy expert system, but they have not shown how much accuracy they have achieved in their result. That is the reason for taking this work as described in this paper.

In this paper an effort has been made to diagnose the heart disease by using fuzzy rule base. Initially 7 attributes of patients have been used as input values from the Clevand database[11]. The data values used have been portioned into several intervals based on certain intermediate values of the available data values. Thereafter fuzzy rule base has been applied on the partitioned input data values. Based on the fuzzy value of the output variable, the heart disease can be ascertained.In this context various membership functions have been used for each input variable and output variable. Finally absolute residual and mean absolute residual have been calculated using the output value produced by fuzzy rule base in comparison to the actual output value as available in the database [11].

In the first section the necessity of this research work and related literature review have been furnished. The methodology used including various fuzzy membership functions (triangular, trapezoidal, gaussian, Z shaped, bell shaped ,sigmoid based ,gausssian combination membership have been discussed in the second section. The detailed procedures of research work have been elaborately stated in the third section. This includes fuzzification of input data, formation of rule base, estimation of heart status using fuzzy rule base and various membership functions. Based on the minimum value of mean absolute residual, the particular membership function has been selected for fuzzification in the rule base. In the fourth section the estimated heart status using fuzzy rule base as against the original heart status has been furnished. The justification of this research work has been discussed in the fifth section.

II. Methodology

2.1 Expert System

A knowledge base can be formed by combining the knowledge of multiple human experts. A rule is a conditional statement that links given conditions to actions or outcomes. A frame is another approach used to capture and store knowledge in a knowledge base. It relates an object or item to various facts or values. A frame-based representation is ideally suited for object-oriented programming techniques. Expert systems making use of frames to store knowledge are also called frame-based expert systems.

2.2 Fuzzy Membership Function

Fuzzy membership functions determine the membership functions of objects to fuzzy set of all variables. A membership function provides a measure of the degree of similarity of an element to a fuzzy set. There are different shapes of membership functions, triangular, trapezoidal, gaussian, bell-shape,Z shape, sigmoid base, gaussian combination.

2.2.1 Triangular membership function

Let p, q and r represent the three vertices of the X coordinates and $\mu_A(x)$ represents the Y coordinate in a fuzzy set A,where A is the membership value .In this equation p: lower boundary and r: upper boundary where membership degree is zero, q: the centre where membership degree is 1.

$$\mu_A(x) = \begin{cases} 0 & if\ x \le p \\ \dfrac{x-p}{q-p} & if\ p \le x \le q \\ \dfrac{r-x}{r-q} & if\ \mathrm{q} \le x \le r \\ 0 & if\ x \ge r \end{cases} \qquad (1)$$

2.2.2 Trapezoidal Membership function

The trapezoidal curve is a function of μ_A of vector x, and depends on four scalar parameters p, q, r and *s* where p and s allocate the "feet" of the trapezoid and the parameters q and r allocate the "shoulders."

$$\mu_A(x:p,q,r,s) = \begin{cases} 0 & if\ x \le p \\ \dfrac{x-p}{q-p} & if\ p \le x \le q \\ \dfrac{r-x}{r-q} & if\ \mathrm{q} \le x \le r \\ 0 & if\ x \le r \end{cases} \qquad (2)$$

2.2.3 Gaussian Membership function

The gaussian curve is a function of μ_A of vector x, and depends on three scalar parameters p, q and *s* where p: center and q: width and s: fuzzification factor(in expression s=2).The gaussian membership function μ_A of vector x has been represented by

$$\mu_A(x:p,q,s) = \exp\left[-\frac{1}{2}\left|\frac{x-p}{q}\right|^s\right] \ldots \qquad (3)$$

2.2.4 Z shape base Membership function

The Z shape base membership function is a spline based function of μ_A of vector x, and depends on two scalar parameters p and *q that locate the* extremes of the sloped portion of the curve.The z shape base membership function μ_A of vector x has been represented by

$$\mu_A(x:p,q) = \begin{cases} 1 & if\ x \le p \\ 1-2\left(\dfrac{x-p}{q-p}\right)^2 & if\ p \le x \le p+q/2 \\ 2\left(\dfrac{x-q}{q-p}\right)^2 & if\ \ (\mathrm{p+q})/2 \le x \le q \\ 0 & if\ x \le q \end{cases} \ldots \qquad (4)$$

2.2.5 Bell shape base Membership function

The Bell shape base membership function μ_A of vector x, depends on three scalar parameters p,q and *r*, where the parameter *q* is usually positive. The parameter *r* locates the center of the curve.

$$\mu_A(x:p,q,r) = \frac{1}{1+\dfrac{|x-r|^{2q}}{p}} \ldots\ldots \qquad \ldots(5)$$

2.2.6 Sigmoid base Membership function

The sigmoid function, μ_A(x,[p,r]), as given in the following equation by $\mu_A(x,p,r)$ is a mapping on a vector x, and depends on two parameters *p* and *r*. Depending on the sign of the parameter *p*, the sigmoidal membership function is inherently open to the right or to the left, and thus is appropriate for representing concepts such as "very large" or "very negative." More conventional-looking membership functions can be built by taking either the product or difference of two different sigmoidal membership functions.

$$\mu_A(x:p,r) = \frac{1}{1+e^{-p(x-r)}} \ldots\ldots \qquad \ldots(6)$$

2.2.7 Gaussian combination Membership function

$$\mu_A(x;\sigma,c) = e^{\frac{-(x-c)^2}{2\sigma^2}} \ \ldots\ldots \quad (7)$$

The function gauss2mf is a combination of two parameters sig and c. The first function, specified by sig1 and c1, determines the shape of the left-most curve. The second function specified by sig2 and c2 determines the shape of the right-most curve. Whenever c1 < c2, the gauss2mf function reaches a maximum value of 1. Otherwise, the maximum value is less than one.

Absolute residual

The absolute residual is represented by

$$\left|(\text{estimated status - actual status})\right|$$

Sum of absolute residual $=\sum_{i=1}^{n}$ absolute residual

Mean absolute residual is

$$(\text{sum of absolute residual})/n$$

III. Implementation

Step 1:

From Clevand database [11],out of 76 attributes, 7 attributes have been taken as input and 1 attribute has been used as output. The input attributes are chest pain type, resting blood pressure in mm(Trestbps),serum cholesterol in mg(Chol),number of years the person behaves as a smoker(years), fasting of blood sugar (fbs), maximum heart rate achieved(thalrest), resting blood rate(tpeakbps).The output attribute is the angiographic disease status of heart of patients.

Step 2:

The first input field "Chest pain type" comprises of four types as denoted by numerical value. The value 1 indicates" typical angina", 2 indicates "atypical angina, 3 indicates "non-angina" and 4 indicates "asymptomatic angina" .The second and third input fields are resting blood pressure measured in mm and serum cholesterol measured in mg respectively. The fourth input field is the number of years the person behaves as a smoker that denoted by a numeric value. The fifth input field indicates the contents of fasting blood sugar. When fasting blood sugar is greater than or equal to 120 mg, the level of fasting blood sugar is 1 otherwise 0.The sixth and seventh input fields are maximum heart rate achieved and resting blood rate respectively. The output field refers to the angiographic disease status of heart of patients. It is to state that diagnosis of heart disease is made by the angiographic disease status which is a number between 0 to 1. Where 0 indicates the diameter of coronary arteries is less than 50% of original diameter and 1 indicates the diameter of coronary arteries is more than 50% of its original diameter.

Step 3:

The data items(7 attributes per patient) have been used as input. The input data items have been furnished in table 1.

Table 1: Input data values

Patients No	Chest pain type	Resting blood pressure (t restbps)	Serum cholesterol (chol)	Numbers of Years as a smoker (years)	Fasting of blood sugar (fbs)	Maximumheart rate achieve (thalrest)	Resting blood rate (tpeakbps)
1	1	145	233	20	1	60	90
2	4	120	229	35	0	78	140
3	3	130	250	0	0	84	195
4	2	130	204	0	0	71	160
5	2	120	236	20	0	73	165
6	4	120	354	0	0	84	165
7	4	140	203	25	1	86	185
8	4	140	192	25	0	86	180
9	2	140	294	0	0	85	204
10	2	120	263	30	0	70	165
11	3	172	199	35	1	91	220
12	3	150	168	40	0	60	192
13	2	110	229	0	0	75	175
14	4	140	239	30	0	86	180
15	3	130	275	20	0	62	165

Step 4:

Thus input and output variables have been classified based on their interim values, which have been furnished in table 2.

Table 2: Input data values with respect to Fuzzy Set

Chest pain type	**Numeric value**
Typical angina	1
Atypical angina	2
Non typical-angina	3
Asymptomatic angina	4
Fasting blood sugar (fbs)	**Fuzzy set value**
fbs=0,(fbs<=120mg)	no
fbs=1,(fbs>120mg)	yes
years as (years_input4)	**Fuzzy set value**
years_input4<=30	Low possibility
years_input4>30	High possibility
Resting blood rate achieved (tpeakbps)	**Fuzzy set value**
tpeakbps < =140	low
tpeakbps >140	high

Resting blood pressure(trestbps)	**Fuzzy set value**
t restbps<=145(from 110 -145)	min
t restbps>145(from 145 -above)	max
Serum cholesterol (chol)	**Fuzzy set value**
chol<=240	min
chol>240	max
Maximum heart rate achieved (thalrest)	**Fuzzy set value**
Thalrest< =70	Min
thalrest,>70	Max
Angiographic disease	**Fuzzy**
0(diameter of coronary arteries <=50%	mild
1(diameter of coronary arteries >50%	massive

Step 5:

The fuzzy rules have been applied on the data to estimate the angiographic status of heart of the patients .The fuzzy rules have been furnished in table 3.

Table 3: Rule base

1.if(Chest_pain_type is typical angina) and (trestbps is min)and(chol is minlevel) and(years_input4 is low_possibility)and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is low_blood_rate) then (heart_disease is mild)

2.if(Chest_pain_type is asymptomatic_angina) and (trestbps is min)and(chol is maxlevel) and(years_input4 is low_possibility)and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is high_blood_rate) then (heart_disease is massive)

3.if(Chest_pain_type is nontypical angina) and (trestbps is min)and(chol is maxlevel) and(years_input4 is high_possibility)and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is high_blood_rate) then (heart_disease is mild)

4.if(Chest_pain_type is atypical angina) and (trestbps is min)and(chol is maxlevel) and(years_input4 is low_possibility)and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is high_blood_rate) then (heart_disease is mild)

5.if(Chest_pain_type is atypical angina) and (trestbps is min)and(chol is maxlevel) and(years_input4 is high_possibility) and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is low_blood_rate) then (heart_disease is mild)

6.if(Chest_pain_type is asymptomatic angina) and (trestbps is max)and(chol is minlevel) and(years_input4 is low_possibility)and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is low_blood_rate) then (heart_disease is mild)

7.if(Chest_pain_type is asymptomatic_angina) or (trestbps is max)or(chol is maxlevel) and(years_input4 is low_possibility)or(fbs is sugar_level_no) or (thalrest is min_heart_rate)or(tpeakbps is high_blood_rate) then (heart_disease is massive)

8.if(Chest_pain_type is asymptomatic angina) and (trestbps is max)and(chol is maxlevel) and(years_input4 is high_possibilit y)and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is low_blood_rate) then (heart_disease is mild)

9.if(Chest_pain_type is atypical angina) and (trestbps is min)and(chol is maxlevel) and(years_input4 is high_possibility)and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is low_blood_rate) then (heart_disease is mild)

10.if(Chest_pain_type is nontypical angina) and (trestbps is min)and(chol is maxlevel) and(years_input4 is high_possibility) and(fbs is sugar_level_no) and (thalrest is min_heart_rate)and(tpeakbps is low_blood_rate) then (heart_disease is mild)

Step 6:

Initially triangular membership function has been applied to all input and output variables. The fuzzy rule base toolbox of Matlab 7 have been applied and that has produced the estimated output as furnished in table 4.

Step 7:

Thereafter trapezoidal, Z shaped, Bell shaped, sigmoid and Gaussian combination membership functions have been applied to all input and output variables. The fuzzy rule base toolbox of Matlab 7 has been applied to produce the estimated output as furnished in table 4.

Table 4: Original heart status and estimated heart status

A	B	C	D	E	F	G	H	I
1	0	0.415	0.433	0.276	0.460	0.401	0.499	0.500
2	1	0.575	0.510	0.845	0.500	0.608	0.510	0.566
3	0	0.515	0.415	0.276	0.425	0.508	0.499	0.499
4	0	0.515	0.400	0.276	0.425	0.434	0.499	0.499
5	0	0.415	0.478	0.233	0.425	0.434	0.459	0.499
6	0	0.515	0.478	0.278	0.460	0.434	0.498	0.400
7	1	0.575	0.628	0.833	0.500	0.575	0.500	0.566
8	0	0.515	0.500	0.313	0.425	0.401	0.498	0.499
9	0	0.515	0.500	0.313	0.425	0.401	0.498	0.499
10	0	0.515	0.500	0.278	0.460	0.508	0.499	0.400
11	0	0.415	0.478	0.276	0.460	0.434	0.499	0.499
12	0	0.515	0.500	0.276	0.425	0.434	0.498	0.499
13	1	0.575	0.535	0.833	0.500	0.508	0.510	0.566
14	0	0.515	0.478	0.276	0.425	0.401	0.499	0.499
15	0	0.515	0.500	0.276	0.425	0.401	0.498	0.499

Step 8:

The absolute residual value of the estimated output with respect to the original status have been calculated based on certain commonly used membership function(triangular, Gaussian, trapezoidal, z shaped),which have been furnished in table 5.The absolute residual value of the estimated output with respect to the original status have been calculated based on other membership function (Bell shaped, sigmoid and Gaussian combination)with have been furnished Table 6

Table 5: Absolute residual based on membership function

A	J	K	L	M
1	0.415	0.433	0.276	0.46
2	0.425	0.490	0.155	0.5
3	0.515	0.415	0.276	0.425
4	0.515	0.400	0.276	0.425
5	0.415	0.478	0.233	0.425
6	0.515	0.478	0.278	0.46
7	0.425	0.372	0.167	0.5
8	0.515	0.500	0.313	0.425
9	0.515	0.500	0.313	0.425
10	0.515	0.500	0.278	0.46
11	0.415	0.478	0.276	0.46
12	0.515	0.500	0.276	0.425
13	0.425	0.465	0.167	0.425
14	0.515	0.478	0.276	0.425
15	0.515	0.500	0.276	0.425

Table 6: Absolute residual based on membership function

A	N	O	P
1	0.415	0.433	0.276
2	0.425	0.490	0.155
3	0.515	0.415	0.276
4	0.515	0.400	0.276
5	0.415	0.478	0.233
6	0.515	0.478	0.278
7	0.425	0.372	0.167
8	0.515	0.500	0.313
9	0.515	0.500	0.313
10	0.515	0.500	0.278
11	0.415	0.478	0.276
12	0.515	0.500	0.276
13	0.425	0.465	0.167
14	0.515	0.478	0.276
15	0.515	0.500	0.276

A= Patients No, B= Original status (Available from the database), C= Estimated Status (using triangular membership function), D= Estimated Status (using trapezoidal membership function)E= Estimated Status (using Gaussian membership function)F= Estimated Status (using Z shaped membership function)G= Estimated Status (using bell shaped membership function)H= Estimated Status (using sigmoid membership function)I= Estimated Status (using Gaussian combination membership function)

A= Patients No, J= Absolute residual using Triangular membership function, K= Absolute residual using Trapezoidal membership function, L= Absolute residual using Gaussian membership function M= Absolute residual using Z shaped membership function N= Absolute residual using bell shaped membership function O= Absolute residual using sigmoid based membership function P= Absolute residual using Gaussian combination membership function**.**

Step 9:

The mean of absolute residual of the estimated output value for each membership function has been calculated and furnished in table 7.

Table 7: Mean absolute residual against membership function

Membership function	Mean absolute residual
Triangular	0.4770
Trapizoidal	0.4726
Gaussian	0.2567
Z shapes	0.2470
Bell shapes	0.4770
Sigmoid Shape	0.4726
Gaussian combination	0.2667

Step 10:

From table 7 it has been observed that mean of absolute residual based on Z shape membership function has achieved minimum value as compared to triangular and trapezoidal, Gaussian, bell shape, Gaussian combination membership functions. Therefore it is desirable that Z shaped membership function has to be used in the fuzzy rule base for the diagnosis of heart disease.

IV. Result

Since the Z shaped membership function is suitable for implementation of fuzzy rule base for heart disease diagnosis system. The fuzzy rule based system using Z shaped membership function can be used for the diagnosis of heart disease. The estimated status of heart disease based on fuzzy rule base using Z shaped membership function has been furnished in table 8.Snapshot of Z shaped membership function based Rule editor has been furnished in figure 1.

A= Patients No,

B=Original status Available from the database

F=Estimated Status using Z shape membership function

D=Absolute residual values using Z shape membership function

Table 8: Estimated status, actual status based on Z shape membership function

A	B	F	D
1	0	0.460	0.46
2	1	0.500	0.5
3	0	0.425	0.425
4	0	0.425	0.425
5	0	0.425	0.425
6	0	0.460	0.46
7	1	0.500	0.5
8	0	0.425	0.425
9	0	0.425	0.425
10	0	0.460	0.46
11	0	0.460	0.46
12	0	0.425	0.425
13	1	0.500	0.5
14	0	0.425	0.425
15	0	0.425	0.425

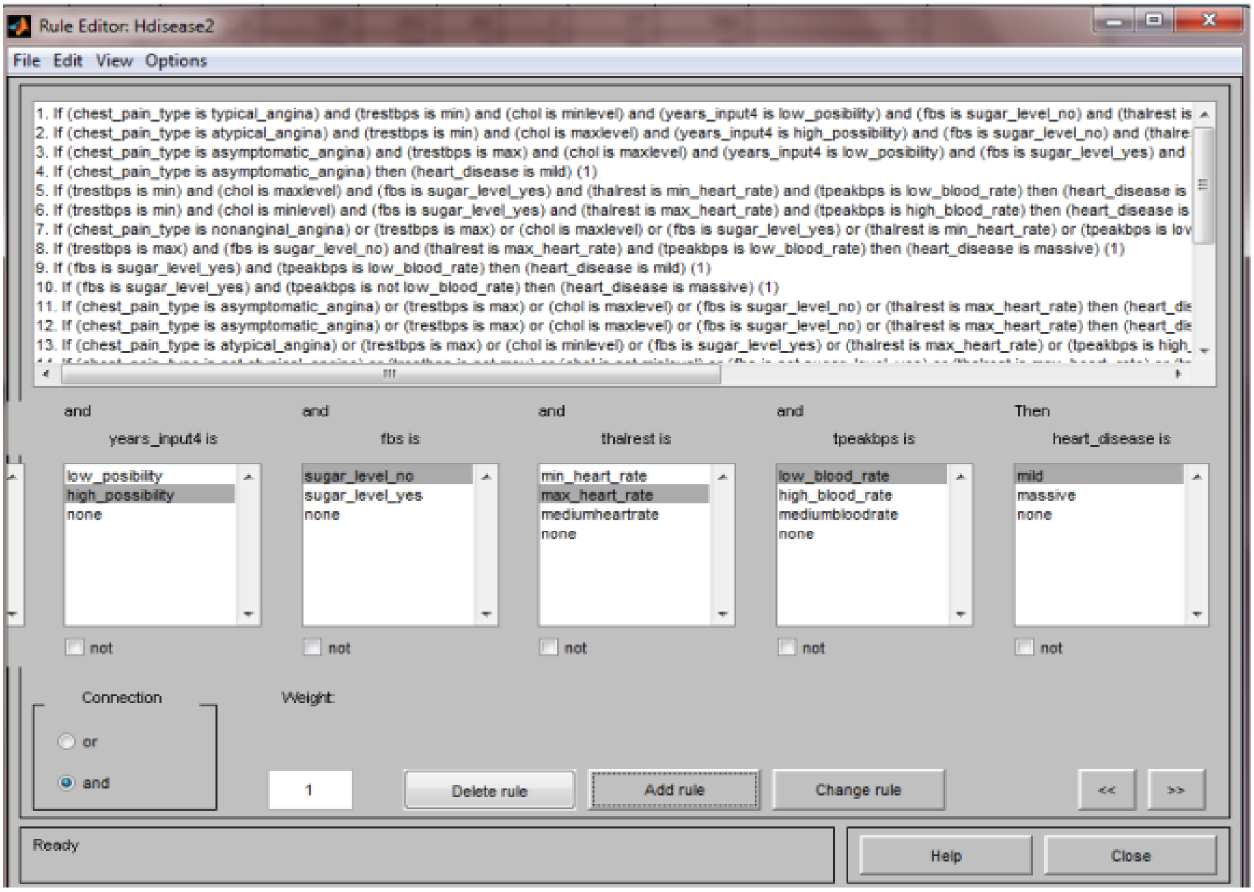

Fig. 1: Rule editor of Z shaped membership function

V. Conclusion

It has been shown that Fuzzy rule base system using Z shaped membership function has given the best result as compared to other membership functions. For patient 1 with the characteristics blood pressure during resting time as 145, serum cholesterol as 233 mg, maximum heart rate as 60,blood rate during rest as 90 , the person is having fasting blood sugar, the person can be treated as a smoker for 20 years with a typical angina(chest pain type angina value 1), the output (angiographic disease status) has been observed as 0.460 using fuzzy rule base system. The original status for patient 1 is 0. Thus for patients 1 ,the absolute residual (derivation from original) is 0.460.For patient 2, the observed output status using fuzzy rule base system is 0.500 as against the original status as 1 with absolute residual (derivation from original) is 0.5.For patient 19, the observed status using fuzzy rule base is 0.500 as against the original status as 1 with absolute residual (derivation from original) is 0.5.Accordingly the output (angiographic disease status) for all the patients can be ascertained.

References

[1] Resul Das a, Ibrahim Turkoglu b, Abdulkadir Sengur b; "Effective diagnosis of heart disease through neural networks ensembles ", www.elsevier.com/locate/eswa , Expert systems with applucations Vol 36 number 4, May , 2009, ISSN0957–4174,page no 7675–7680

[2] Vanisree K,Jyothi Singaraju,"Decision Support System for Congenital HeartDisease Diagnosis based on Signs and Symptoms using Neural Networks", International Journal of Computer Applications (0975 – 8887),volume 19– No.6, April 2011. page no 6-12

[3] PritiSrinivas Sajja,Dipti M shah, " Knowledgebased Diagnosis of Abdomen Pain using Fuzzy Prolog Rules", Journal of EmergingTrends in Computing and Information science", vol 1,no.2, Oct 2010, E-ISSN2218-6301,page no 55-60

[4] Ali.Adeli, Mehdi.Neshat ," A Fuzzy Expert System for Heart Disease Diagnosis" Proceedings of the International Multi Conference of Engineers and computer scientists 2010 vol 1, ISBN 978-988-17012-8-2,ISSN 2078-0958, March 2010,page no136-139.

[5] Narendra S. Chaudhuri and Avishek Ghosh,"Feature Extraction using fuzzy rule base system", International Journal of Computer Science and Applications", "Vol. 5, No. 3, page no 1 – 8",

[6] Ranjana Raut, S. V. Dudul,"Intelligent Diagnosis of Heart Diseases using Neural Network Approach",International Journal of Computer Applications (0975 – 8887), Volume 1 – No. 2,page no 97-102

[7] V. Sundarapandian, E.P.Ephzibah," Framing Fuzzy Rules using support sets for Effective Heart Disease Diagnosis", International Journal of Fuzzy Logic Systems (IJFLS) Vol.2, No.1, February 2012,page no 11-16

[8] Novruz Allahverdi, Serhat Torun, Ismail Saritas," Design of a Fuzzy Expert System for Determination of Coronary Heart Disease Risk",International Conference on Computer Systems and Technologies - CompSysTech'07,page no IIIA.14-5to - IIIA.14-8

[9] Jyoti Soni, Ujma Ansari, Dipesh Sharma,Sunita Soni," Predictive Data Mining for Medical Diagnosis: An Overview of Heart Disease Prediction",International Journal of Computer Applications (0975 – 8887)Volume 17– No.8, March 2011,page no 43-48

[10] K. Polat & S. Sahan & S. Güne," A new method to medical diagnosis: artificial immune recognition system (AIRS) with fuzzy weighted pre-processing and application to ECG arrhythmia", Expert Systems with Applications 31 (2) (2006) ,page no264–269

[11] "archieve.ics.uci.edu/ml/datasets K.Usha Rani," Analysis of heart Disease dataset using neural Network Technique",Inaternational Journal of Data Mining & Knowledge Management Process(IJDKP), Vol.1,No.5, September 2011, page no 1-8.

[12] K.Rajeswari,V.vaithiyanatham,P.Amirtharaj,"Prediction of Risk score for Heart Disease in india using Machine Intelligence",International Conference on Information and network Technology 2011,IPCSIT Press,Singapore,vol no 4,page no 18-22.

[13] Ersin Kaya, Bulent Oran and Ahmet Arslan,"A Diagnostic fuzzy rule Based System for Congential Heart Disesae", World Academy of Science, Engineering and Technology, 54 2011, page no 252-256

[14] E.P.Ephzibah1, V. Sundarapandian," A Neuro Fuzzy Expert System for Heart Disease Diagnosis", Computer Science & Engineering: An International Journal (CSEIJ), Vol.2, No.1, February 2012,page no 17-23

[15] Shradhanjali Rout," Fuzzy Petri Net Application: Heart Disease Diagnosis", procedings of International Conference on Computing and Control Engineering (ICCCE 2012), April, 2012, ISBN 978-1-4675-2248-Published by Coimbatore Institute of Information Technology,Page no 1-9

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