

DESIGN AND ANALYSIS OF HEART DISEASE DIAGNOSIS SYSTEM USING FUZZY LOGIC

Submitted in partial fulfillment of the requirements for
the award of Master of Science degree in
Mathematics (M.Sc. Mathematics)

by

RSANJANA (Reg.no.39630010)



**DEPARTMENT OF
MATHEMATICS SCHOOL OF SCIENCE AND
HUMANITIES**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC 12B
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JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI-600119

April-2021



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Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai-600119

www.sathyabama.ac.in

DEPARTMENT OF MATHEMATICS

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work **R SANJANA (39630010)** who carried out the project entitled "**DESIGN AND ANALYSIS OF HEART DISEASE DIAGNOSIS SYSTEM USING FUZZY LOGIC**" under my supervision from January 2021 to April 2021.

Internal Guide (Dr. C. KAVITHA)

(Dr. M. NIRMALA)
Head of the Department

Submitted for Vivavoce Examination held on _____

Internal Examiner

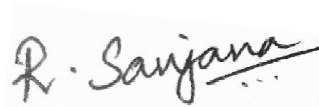
External Examiner

DECLARATION

I **R SANJANA (39630010)** hereby declare that the Project Report entitled “**DESIGN AND ANALYSIS OF HEART DISEASE DIAGNOSIS SYSTEM USING FUZZY LOGIC**” done by me under the guidance of **Dr.C.KAVITHA** at **Sathyabama Institute of Science and Technology** is submitted in partial fulfillment of the requirements for the award of Master of Science degree in Mathematics (M.Sc. Mathematics).

DATE: CHENNAI

03.2021

A handwritten signature in black ink, reading "R. Sanjana", with a horizontal line underneath the name.

PLACE: 26.

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

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I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. C. KAVITHA** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Mathematics** who were helpful in many ways for the completion of the project.

ABSTRACT

The major cause of disability and premature death in the whole world is cardiovascular disease. The class of disease involving the heart or blood vessels is cardiovascular disease. Medical practitioners are necessary to predict cardiac disease in patients before it occurs. Today, computer technology has increased dramatically in the field of medicine. For diagnosing diseases based on various parameters and methodology, fuzzy logic has become increasingly popular. Here, the fuzzy heart diagnosis system is being used. The proposed fuzzy expert system comprises three main steps, namely fuzzification, rule-base and defuzzification. There are multiple input parameters and one output parameter in this method. MATLAB is a fourth-generation high-level programming language and virtual environment for numerical computation, visualization, and programming, developed by MathWorks which is used to analyze data.

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LIST OF ABBREVIATIONS

Abbreviation	Expansion
FIS	FuzzyInferenceSystem
ANFIS	AdaptiveNeuroFuzzyInferenceSystem
GA	GeneticAlgorithm
ANN	ArtificialNeuralNetwork
CSA	CrowSearchAlgorithm
MATLAB	MatrixLaboratory
CANFIS	CoactiveNeuro FuzzyInferenceSystem
DEF	DengueHemorrhagicFever
COVID	CoronaVirus Disease
ECG	ElectroCardioGram
MF	MembershipFunction

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CHAPTER-1

1. INTRODUCTION

The use of computer technology plays a vital role in this generation in all areas and is no exception in the field of medical diagnosis. The computer area has a high level of complexity and irregularity and the application of expert systems has been developed, including fuzzy logic, artificial networks, and genetic algorithms. Cardiac disease is one of the world's leading causes of death. Therefore, diagnosis of cardiac disease is important in everyday life, but the diagnosis of cardiac disease is sometimes difficult for experts because of the risk factor. Through the implementation of the fuzzy expert system in MATLAB software, diagnosis of heart disease can be identified. The dataset used in the study was compiled by the American Heart Association and we can diagnose or predict the risk of heart disease using the patient information collected.

FUZZY LOGIC

The term Fuzzy refers to the boundary which is not clear. In the real world, many times we undergo a situation that we can't determine whether the state is true or false, in that case, fuzzy logic provides a very valuable flexibility for reasoning. Fuzzy logic is a form of many-valued logic and is an approach to computing based on "degrees of truth" rather than the usual "true or false". For true, it takes the value as '1' and for false, it takes the value as '0'. Therefore, Fuzzy logic handles the concept of partial truth.

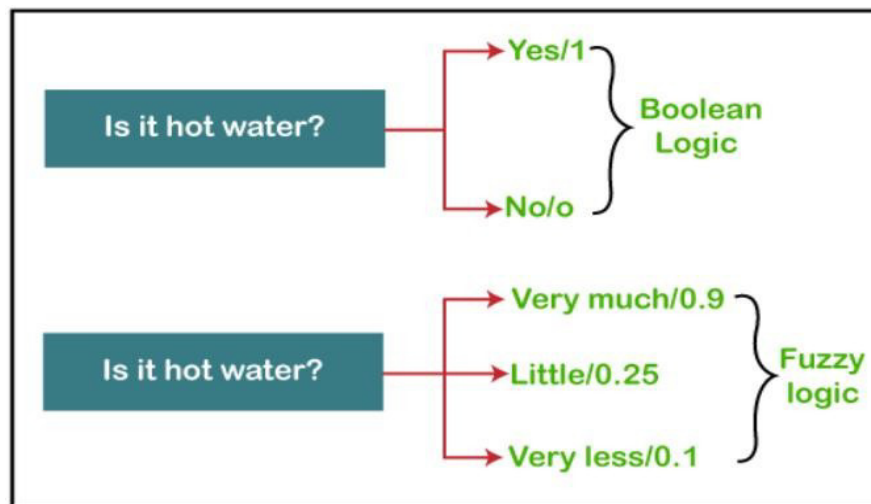


Fig1.1 FuzzyLogic

FUZZYSET

In fuzzy sets, each element is mapped to $[0,1]$ by membership function.
 $\mu_A: X \rightarrow [0,1]$ where $[0,1]$ means real numbers between 0 and 1 (including 0 and 1)

Let us consider washing machines to make it easy to understand. Washing machines are using fuzzy logic now. They are able to feel how much a load is and determine how much water and detergent, how quickly the agitation is and how long the wash cycles extend. For the dirty laundry, there is no single standard. Fuzzy logic allows the computer to decide "between". The water is clear at the start of the wash load. When it gets dirtier, the computer senses the discoloration, which makes it not so easy for light to pass through. In order to control settings, the sensors use fuzzy logic to get clean load.

CRISPSET

A set is defined using a characteristic function that assigns a value of either 0 or 1 to each element of the universe of discourse, thereby discriminating between members and non-members of the crisp set under consideration. In the context of fuzzy sets theory, we often refer to crisp sets as "classical" or "ordinary" sets. Classical sets are called crisp sets i.e. either an element belongs to a set or not.

MEMBERSHIPFUNCTION

- It is a function that maps elements in the universe of discourse to a value in the interval set $[0,1]$ with each element/member having a degree of membership.
- Membership functions allow us to graphically represent a fuzzy set. The x-axis represents the universe of discourse, whereas the y-axis represents the degrees of membership in the $[0,1]$ interval.
- Membership functions are the building blocks of fuzzy set theory i.e., fuzziness in a fuzzy set is determined by its MF. Accordingly, the shapes of MFs are important for a particular problem since they effect on a fuzzy inference system. They may have different shapes like triangular, trapezoidal, Gaussian, etc.

TriangularMembershipFunction

It is defined by a lower limit a , an upper limit m and a value b , where $a < m < b$.

Short form of this function is `trimf` in MATLAB tool.

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

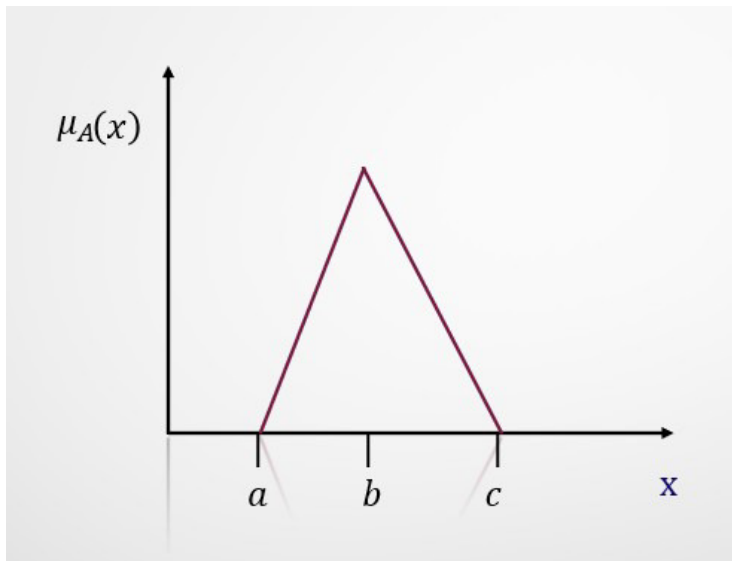


Fig1.2 Triangular Membership Function

TrapezoidalMembershipFunction

It is defined by a lower limit a , an upper limit d , a lower support limit b , and an upper support limit c , where $a < b < c < d$.

$$\mu_A(x) = \begin{cases} 0, & x < a \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ 1, & b \leq x \leq c \\ \frac{d-x}{d-c}, & c \leq x \leq d \\ 0, & x > d \end{cases}$$

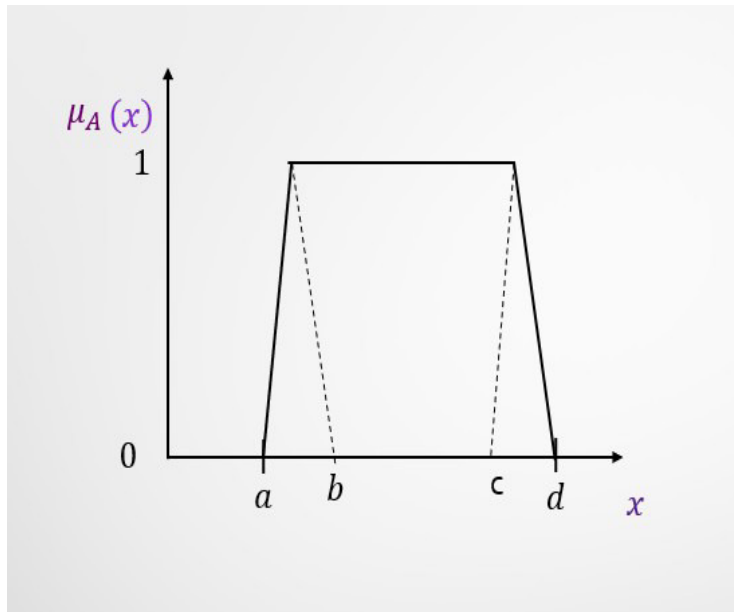


Fig1.3TrapezoidalMembershipFunction

FUZZIFICATION

Fuzzification is the process of converting a crisp input value to a fuzzy value that is performed by the use of the information in the knowledge base. Although various types of curves can be seen in literature, Gaussian, triangular, and trapezoidal MFs are the most commonly used in the fuzzification process.

DEFUZZIFICATION

Defuzzification is the process of producing a quantifiable result in crisp logic, given fuzzy sets and corresponding membership degrees. It is the process that maps a fuzzy set to a crisp set. 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.

EXISTING SYSTEM

In the available system, the prediction is made using the Fuzzy expert system. The vast number of 14 input parameters is used in the prediction process which may sometimes lead to confusion and errors. Here the range of each parameter is set wide thereby reducing the accuracy of the system.

CHAPTER-2

2. LITERATURE SURVEY

Tanmay Kasbe and Ravi Singh Pippal have proposed a project in 2017 using a method of fuzzy expert system to identify heart disease risk in the patients and he used MATLAB tool as a development tool.

Mehrdad Aghamohammadi, Manvi Madan, Jung Ki Hong, Ian Watson have proposed a project in 2019 and used the method of Genetic Algorithm (GA) and Adaptive Neuro Fuzzy Inference System (ANFIS) for predicting the Heart Attack.

Ravina Sangha, Akshay Satras, Lisha Swamy, Gopal Deshmukh have proposed a project in 2016 and used the methodology of Artificial Neural Networks (ANN) to find prediction of Student's Placement Eligibility.

Salah L. Zubaidi, Hussein Al-Bugharbee, Sandra Ortega-Martorell have proposed a project in 2020 and used the methodology of ANFIS CSA-ANN (Crow Search Algorithm and ANN) and it is a Novel Methodology for Predicting Urban Water Demand.

Naji Ammar, Marizan Sulaiman, Ahmad Fateh, Mohamad Nor have proposed a project in 2017 and used the methodology of ANFIS and Artificial Neural Network for Analysing Load Forecasting of Power System.

Yang Wang, Yanyan Chen, Jianhui Lai have proposed a project in 2016 and used the methodology of FIS for finding the Traffic Prediction..

T. Afanasieva, N. Yarushkina, M. Toneryan have proposed a project in 2015 and used the methodology of Fuzzy Time Series models for the Analysis of Time series forecasting.

Abou-Bakr Ramadan, Ahmed El-Garhy, Fathy Zaky, Mazhar Hefnawi have proposed a project in 2012 and used the method of some fuzzy Deterministic models for predicting new environment.

Vaidehi V, Monica S, Deepika M have proposed a project in 2008 and used the methodology of Artificial Intelligence which is used to build a prediction system to predict the future occurrence of an event. Stock markets are excellent examples where this prediction system can be applied and the possibility of a rise or a fall in the market price is predicted. The entire prediction system is realized using Java.

XiaonanLuoa, WenbangHoua, Yi Lib, ZhongWangb have proposed aproject in 2006 and used the method of Fuzzy Neural Network (FNN) for predictingclothingthermal comfort.

Negar Ziasabounchi, ImanAskerzade have proposed a project in 2014 andused the methodology of ANFIS to find Classification Model for Heart DiseasePrediction.

LathaParthiban and R.Subramanian have proposed a project in 2007 andusedthemethodofCoactiveNeuroFuzzyInferenceSystem(CANFIS)andGeneticAl gorithmfor theHeartDisease PredictionSystem.

Ali.Adeli, Mehdi.Neshathave proposed a project in 2010 andused themethodofFuzzy logicexpert system for thepredictionofheartdisease.

SozanSulaimanMaghdid, Tarik Ahmed Rashid, Sheeraz Ahmed, KhalidZaman,M.KhalidRabbanihaveproposedaprojectin2019andusedthemethodof Artificialneuralnetwork,adaptiveneuro-fuzzyinferencesystem,fuzzyinferenceSystem (FIS),neural networkfor thepredictionof Heart Attack.

Poongodi,M.,Manjula,L.,Pradeepkumar,S.andUmadeviMhaveproposedaproj ectin2012andusedsomefuzzylogicmodeltofindtherisksofgettingcancerfor selected pilot people will be discovered by applying the mamdani Fuzzy LogicModelandsuggestionswillbesubmittedtothepersonstoeliminatetheserisks.

S.Mohanaselvi and G.Hemapriya have proposed a project in 2019 and usedsomeapplicationsoffuzzylogicinpredictingthedamageofearthquake.

Muhamad Muslihudin, SitiMukodimah, Erma Dwiyani, Trisnawati, WahidahHashim, AndinoMaseleno have proposed a project in 2019 and used the methodof fuzzy logic in predicting the DengueHemorrhagic Fever (DHF) distribution inPringsewuArea.

Ann Nosseir, YahiaFathy have proposed a project in 2020 and used theapplications and concepts of fuzzy logic and Artificial Neural Network for the EarlyPredictionofStudent Performance.

Vaishali Jain and SupriyaRaheja have proposed a project in 2015 and usedsometechniquesoffuzzy logicandpredictedtherateofdiabetes rate.

Mohammed Gaber, Amr Mohamed Wahaballa, Ayman Mahmoud Othman, Aboelkasim Diab have proposed a project in 2017 and used fuzzy logic for the prediction of traffic accidents.

Deepak Painuli, Divya Mishra, Suyash Bhardwaj, Mayank Aggarwal have proposed a project in 2020 and used the methodology of fuzzy logic and fuzzy rule-based system and expert system for predicting a deadly virus COVID 19.

CHAPTER-3

3. AIMANDSCOPE

AIM

In this project, an innovative system of experts for the prediction of cardiac diseases is introduced using patient data. The information is interpreted with the MATLAB tool. We can predict if the individual is affected or not by cardiac conditions, if we provide certain patient details.

SCOPE

Medical technological innovation encompasses the wider range of events that detect or invent new medical technology, develop and spread it into healthcare. In Medical technology, the role of doctor is indispensable although there are many improvements. However, it's not certain that the doctor will always be available for us.

With the fuzzy expert system, we can overcome this discrepancy. In this we use Fuzzy logic as a tool for heart disease prediction.

This system can further decrease the time we spend in a physician's consultation. The result is the same for the doctor and the machine, but the only difference is that the result in comparison to your doctor is less expensive.

In the future, a mobile application can be developed to allow people to obtain all information in a practical way.

CHAPTER-4

4. METHODOLOGY

FUZZY INFERENCE SYSTEM

Fuzzy Inference System is the key unit of a fuzzy logic system having decision making as its primary work. It uses the "IF...THEN" rules along with connectors "OR" or "AND" for drawing essential decision rules.

Fuzzy inference is a method that interprets the values in the input vector and based on some set of rules, assigns values to the output vector. In fuzzy logic, the truth of any statement becomes a matter of a degree.

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made or patterns discerned. The process of fuzzy inference involves all of the pieces described so far, i.e., membership functions, fuzzy logic operators, and if-then rules. Two main types of fuzzy inference systems can be implemented: Mamdani-type (1977) and Sugeno-type (1985). These two types of inference systems vary somewhat in the way outputs are determined.

Characteristics of Fuzzy Inference System

Fuzzy Inference system is a computer paradigm based on fuzzy set theory, fuzzy if-then rules and fuzzy reasoning. The applications of FIS are data classification, decision analysis, expert systems, time series predictions, robotics and pattern recognition. The different names of FIS are fuzzy rule – based system, fuzzy model, fuzzy associative memory, fuzzy logic controller and fuzzy system.

The output from FIS is always a fuzzy set irrespective of its input which can be fuzzy or crisp set. It is necessary to have fuzzy output when it is used as a controller. A defuzzification unit would be there with FIS to convert fuzzy variables into crisp variables. A fuzzy inference system is the key unit of a fuzzy logic system. The typical structure of a fuzzy inference system consists of various functional blocks. It uses new methods to solve everyday problems.

Construction of FIS

The following five functional blocks will help you understand the construction of FIS,

- RuleBase–It contains fuzzy IF-THEN rules.
- Database–It defines the membership functions of fuzzy sets used in fuzzy rules.
- Decision-making Unit–It performs operation on rules.
- Fuzzification Interface Unit–It converts the crisp quantities into fuzzy quantities.
- Defuzzification Interface Unit–It converts the fuzzy quantities into crisp quantities.

Following is a block diagram of fuzzy inference system.

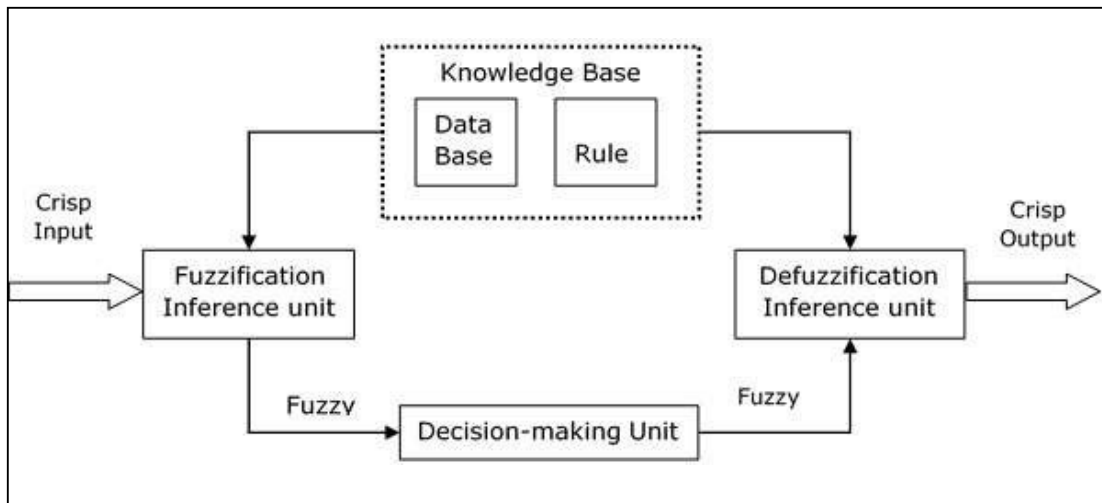


Fig4.1 Fuzzy Inference System

Working of FIS

The working of the FIS consists of the following steps,

- A fuzzification unit supports the application of numerous fuzzification methods, and converts the crisp input into fuzzy input.
- A knowledge base- collection of rule base and database is formed upon the conversion of crisp input into fuzzy input.
- The defuzzification unit fuzzy input is finally converted into crisp output.

Mamdani Fuzzy Inference System

This system was proposed in 1975 by Ebrahim Mamdani. Basically, it was anticipated to control a steam engine and boiler combination by synthesizing a set of fuzzy rules obtained from people working on the system.

Following steps need to be followed to compute the output from this FIS,

- Step 1 – Set of fuzzy rules need to be determined in this step.
- Step 2 – In this step, by using input membership function, the input would be made fuzzy.
- Step 3 – Now establish the rule strength by combining the fuzzified inputs according to fuzzy rules.
- Step 4 – In this step, determine the consequent of rule by combining the rule strength and the output membership function.
- Step 5 – For getting output distribution combine all the consequents.
- Step 6 – Finally, a defuzzified output distribution is obtained.

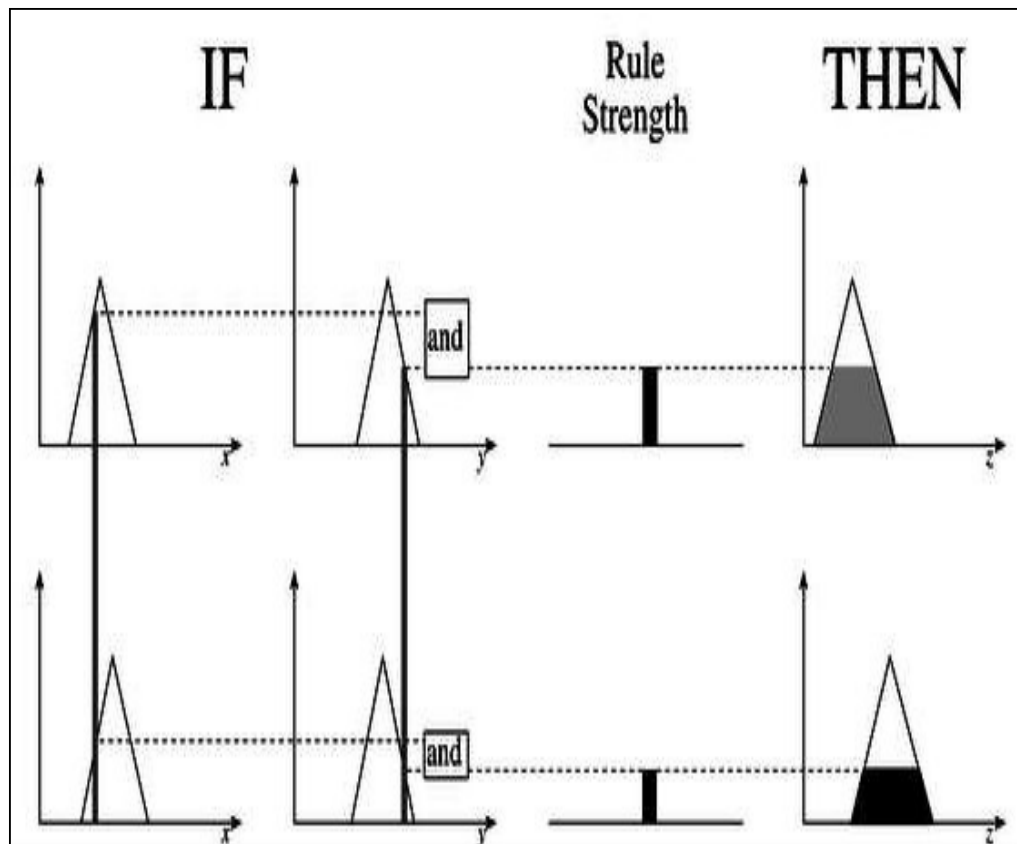


Fig 4.2 Mamdani Fuzzy Inference System

FuzzyInferenceSystemEditor

Here, 7 inputs are used to obtain 1 output.

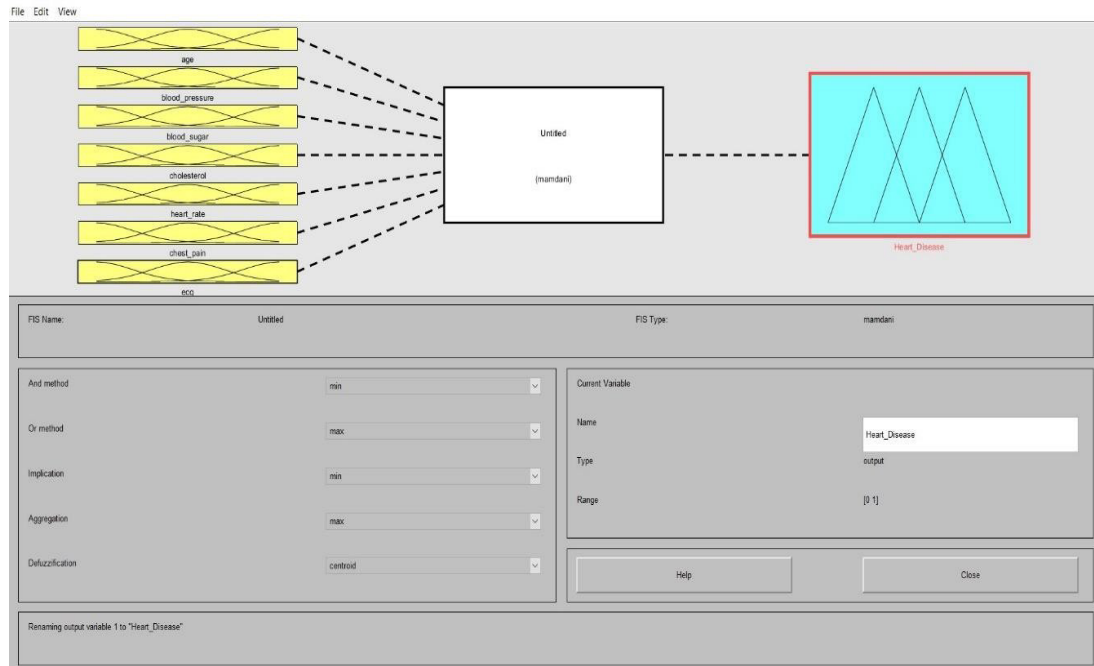


Fig4.3FISEditor

MEMBERSHIPFUNCTIONEDITOR

The Membership function editor is used to define the shapes of all the membership functions associated with each variable. The Membership function editor is the tool that lets us display and edit all of the membership functions associated with all of the input and output variables for the entire fuzzy inference system.

The membership function of a fuzzy set is the generalization of the indicator functions in classical set. Fuzziness in a fuzzy set is characterized by its membership functions. It classifies the element in the set, whether it is discrete or continuous. The membership functions can also be formed by graphical representations. The graphical representations may include different shapes.

Membership functions are the building blocks of fuzzy set theory. Membership functions were introduced by Zadeh in the first paper on fuzzy sets (1965).

Zadeh, in his theory of fuzzy sets, proposed using a membership function [with a range covering the interval (0, 1)] operating on the domain of all possible values.

As there are infinite numbers of ways to characterize fuzziness, there are infinite numbers of ways to graphically depict the MFs that describe the fuzziness. The choice of which method to use depends on the problem size and problem type. Instead of choosing the shape of MF, setting the interval and number of MFs are also very important.

CHAPTER–5

5. RESULTS AND DISCUSSIONS

Numerical Analysis

In this system, 7 inputs are used which are age, blood pressure, blood sugar, cholesterol, heart rate, chest pain and ECG. The output field refers to diagnosis of heart disease in the patient and the result shows that the patient has the heart risk or not. This input field influences the result much more comparing to other input fields. For age, blood pressure, chest pain and blood sugar, we consider 4 fuzzy set values whereas for cholesterol, heart rate and ECG, we consider 3 fuzzy sets. The output field consists of range between 0 and 4. Here increasing value shows the increasing heart disease risk.

Table 5.1 Age table

Input field	Ranges	Fuzzy set value
Age	<38	young
	33-45	medium
	40-58	old
	>52	Very old

The input value of age is given by, if the value is less than 38, the fuzzy set value is young and if the value is in between 33-45, the fuzzy set value is medium and if the value is in between 40-58, the fuzzy set value is old and if the value is greater than 52, the fuzzy set value is very old.

Table 5.2 Blood pressure table

Input field	Ranges	Fuzzy set value
Blood pressure	<120	Normal
	120-129	Medium
	130-139	High
	>140	Very high

The input value of blood pressure is given by, if the value is less than 120, the fuzzy set value is normal and if the value is in between 120-129, the fuzzy set value is medium and if the value is in between 130-139, the fuzzy set value is high and if the value is greater than 140, the fuzzy set value is very high.

Table 5.3 Blood Sugar table

Input field	Ranges	Fuzzy set value
Blood Sugar	90-120	Good
	121-150	control Fair
	151-180	control
	>180	Unsatisfactory control Poor control

The input value of Blood sugar is given by, if the value is in between 90-120, the fuzzy set value is good control and the value is in between 121-150, the fuzzy set value is fair control and if the value is in between 151-180, the fuzzy set value is unsatisfactory control and if the value is greater than 180, the fuzzy set value is poor control.

Table 5.4 Cholesterol table

Input field	Ranges	Fuzzy set value
Cholesterol	<200	Low
	200-239	High
	>240	Very high

The input value of cholesterol is given by, if the value is lesser than 200, the fuzzy set value is low and if the value is in between 200-239, the fuzzy set value is high and if the value is greater than 240, the fuzzy set value is very high.

Table 5.5 Heart rate table

Input field	Ranges	Fuzzy set value
Heart rate	<60	Low
	60-100	Medium
	>100	High

The input value of heart rate is given by, if the value is lesser than 60, the fuzzy set value is low and if the value is in between 60-100, the fuzzy set value is medium and if the value is greater than 100, the fuzzy set value is high.

Table5.6Chestpaintable

Inputfield	Ranges	FuzzyssetValue
Chestpain	0-2	Typical
	1-3	AnginaAtypical
	2-4	AnginaNonTypical
	3-5	Angina AsymptomaticAngina

The input value of chest pain is given by, if the value is in between 0-2, the fuzzy set value is Typical Angina and if the value is in between 1-3, the fuzzy set value is Atypical Angina and if the value is in between 2-4, the fuzzy set value is Non Typical Angina and if the value is in between 3-5, the fuzzy set value is Asymptomatic Angina.

Table5.7ECGtable

Inputfield	Ranges	FuzzyssetValue
ECG	<0.4	Normal
	0.4-1.8	ST_T
	>1.8	abnormalHypertrophy

The input value of ECG is given by, if the value is lesser than 0.4, the fuzzy set value is Normal and if the value is in between 0.4-1.8, the fuzzy set value is ST_T abnormal and if the value is greater than 1.8, the fuzzy set value is Hypertrophy.

Table5.8Heartdiseasetable

Outputfield	Ranges	FuzzyssetValue
Heartdisease	-1-1	Healthy
	1-2	Low
	2-3	riskRisk
	3-4	Highrisk
	4-5	Veryhighrisk

The output value of heart disease is given by, if the value is in between -1-1, the fuzzy set value is healthy and if the value is in between 1-2, the fuzzy set value is low risk and if the value is in between 2-3, the fuzzy set value is risk and if the

value is in between 3-4, the fuzzy set value is high risk and if the value is in between 4-5, the fuzzy set value is very high risk.

Ranges of Membership function

In fuzzy logic, the membership function represents the degree of truth. Here the representation of each input and output membership function is shown in the figure 5.1 to figure 5.8.

Input membership function

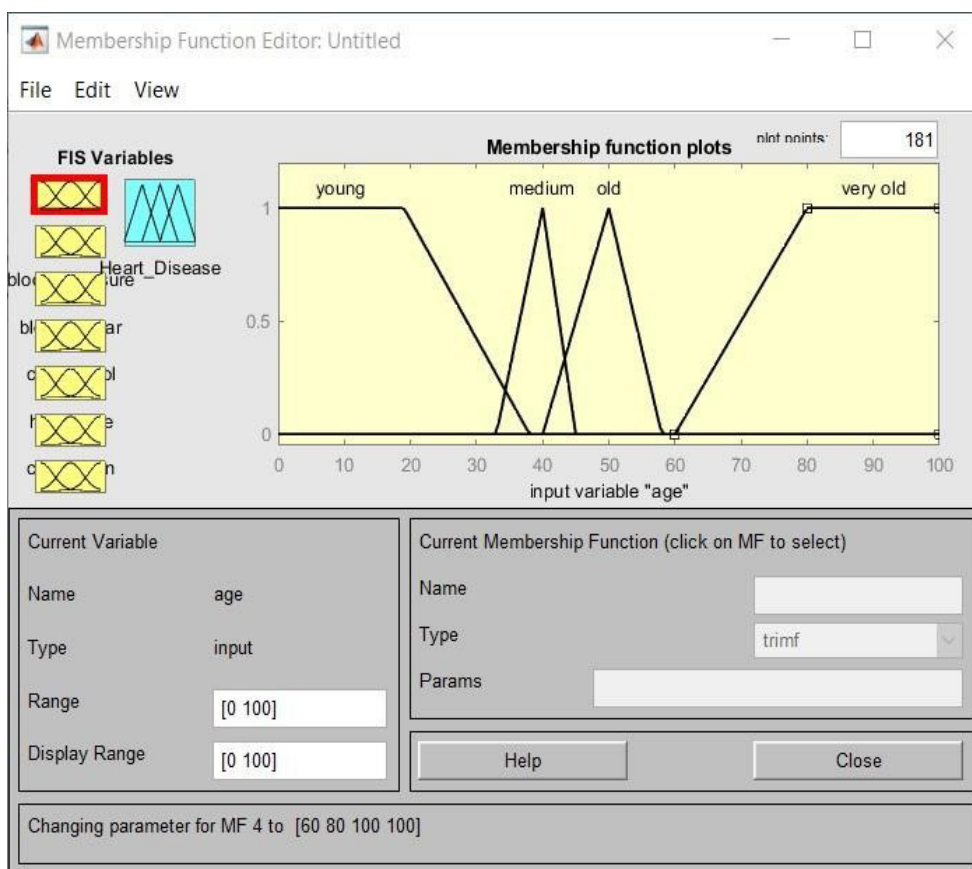


Fig5.1 Membership function of age

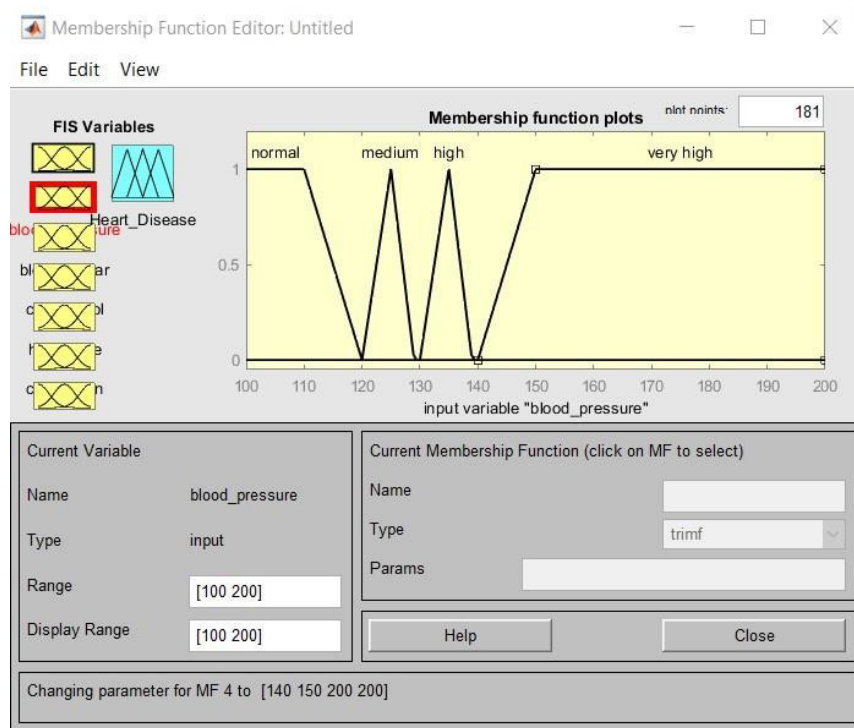


Fig5.2 Membership function of blood pressure

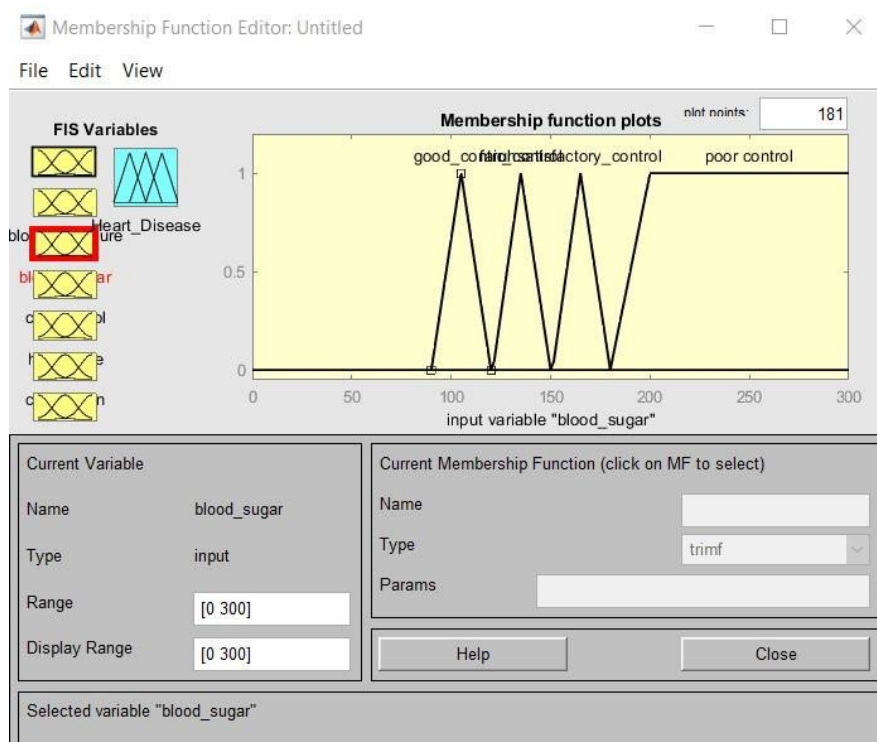


Fig 5.3 Membership function of blood sugar

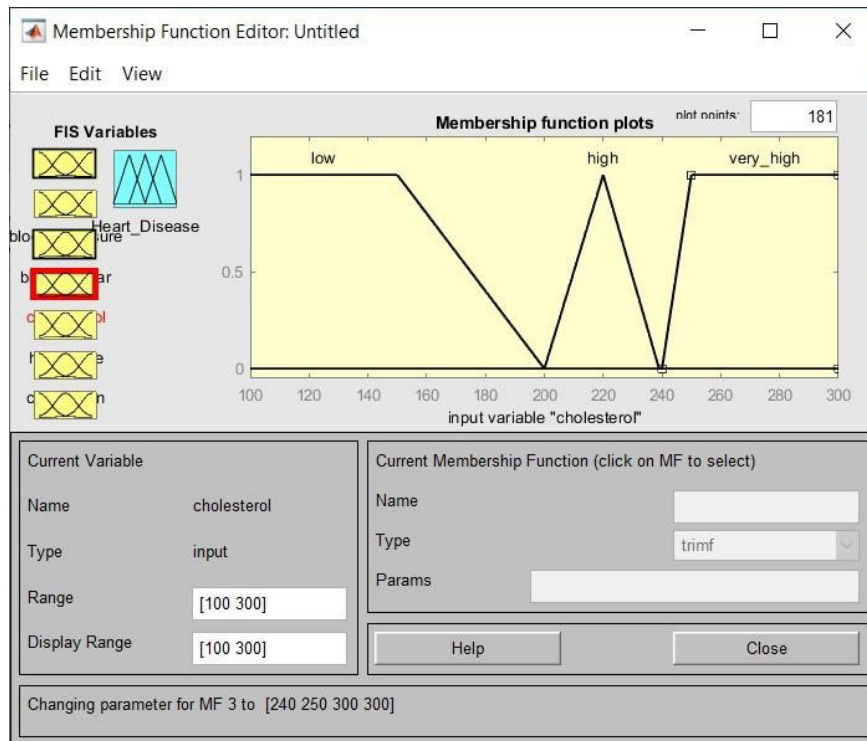


Fig5.4 MembershipfunctionofCholesterol

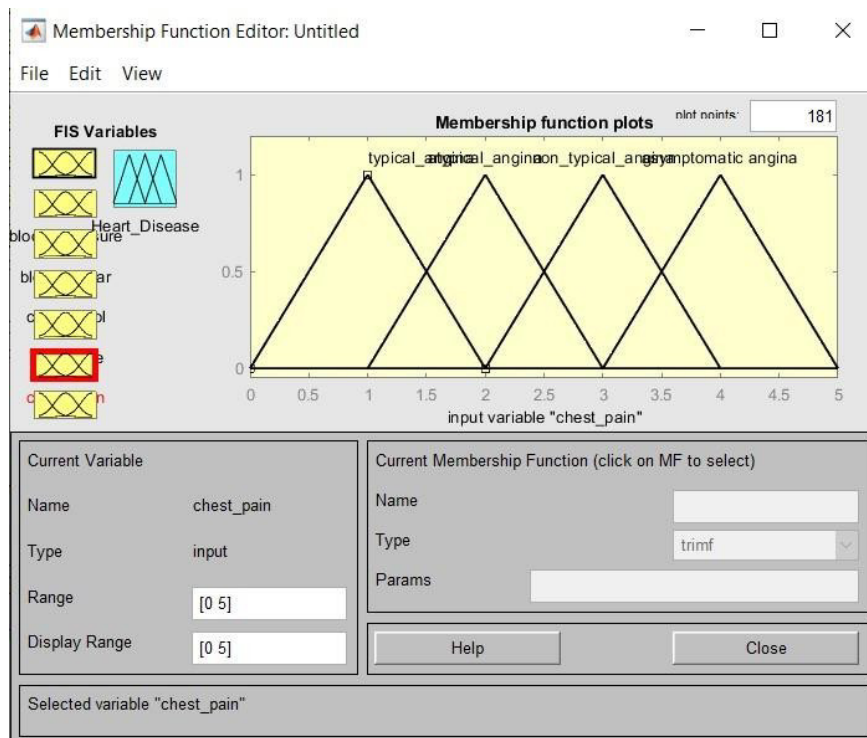


Fig5.5Membershipfunctionofheartrate

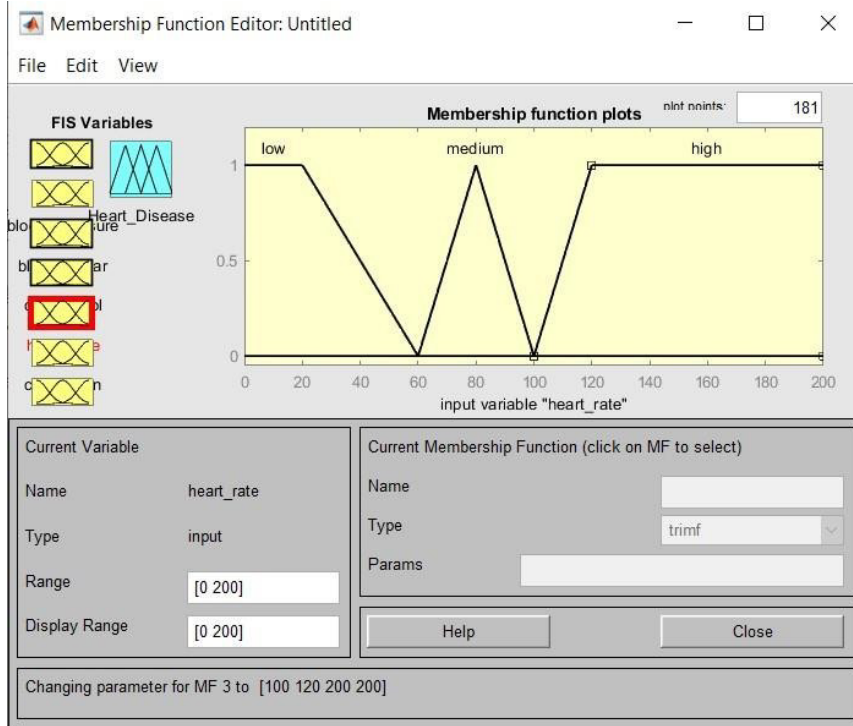


Fig 5.6 Membershipfunctionofchestpain

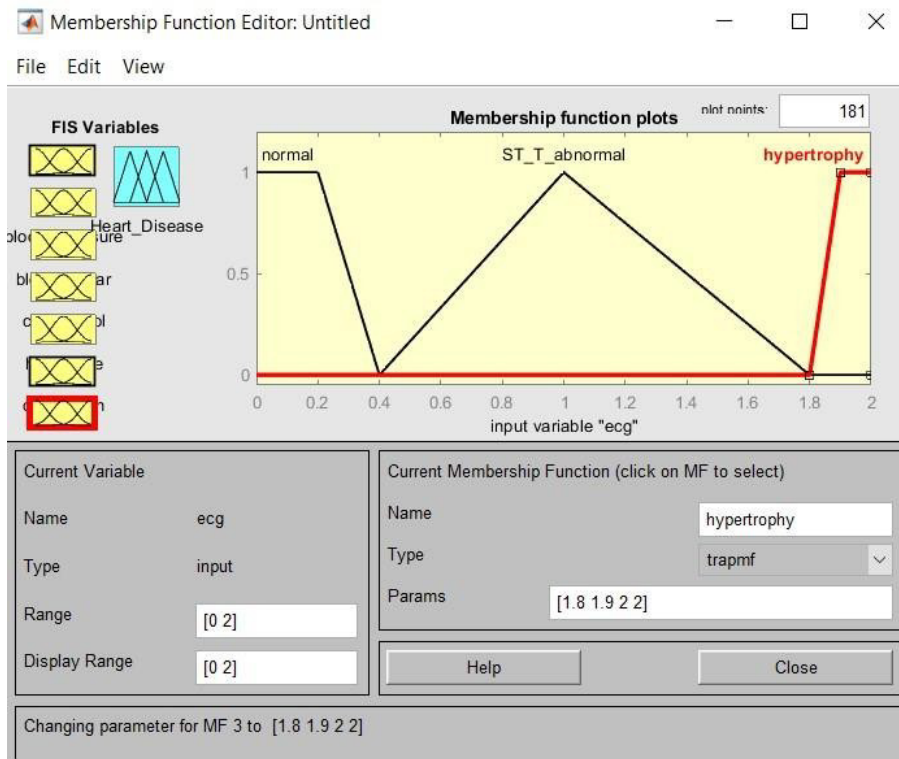


Fig5.7MembershipfunctionofECG

Outputmembershipfunction

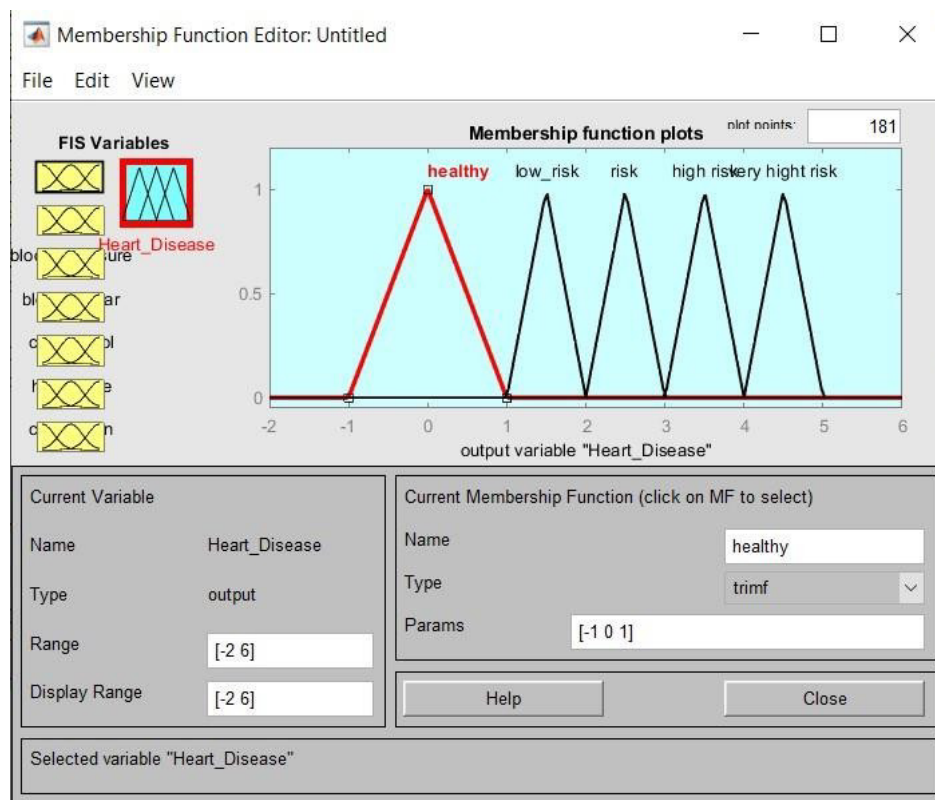


Fig5.8 Membership function of heart disease

Rule editor

The rule editor is for editing the rules that define the behaviour of the system. This rule editor allows us to construct the rules automatically. Create rules by selecting an item in each input and output variable box, selecting one connection item, and clicking add rule.

5.3.1 Rule base

The rule base is the main part in fuzzy inference systems, and quality of results in a fuzzy system depends on the fuzzy rules.

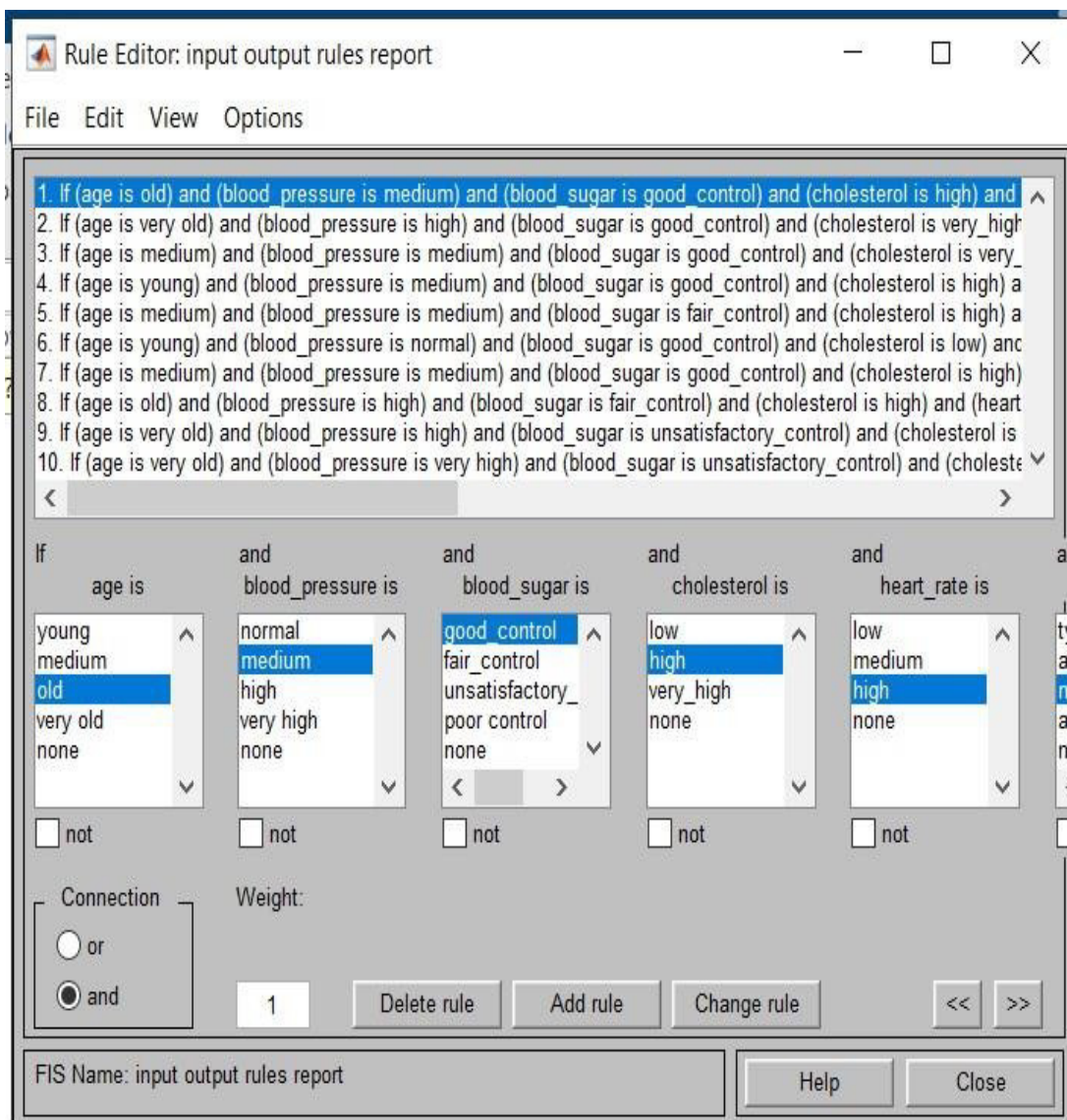


Fig5.9Surfaceplotofrules

The work has been implemented with the given input and output values, which are taken from American Heart Association. Below Fig 5.10 and Fig 5.11 show the rule viewer and graphical result.

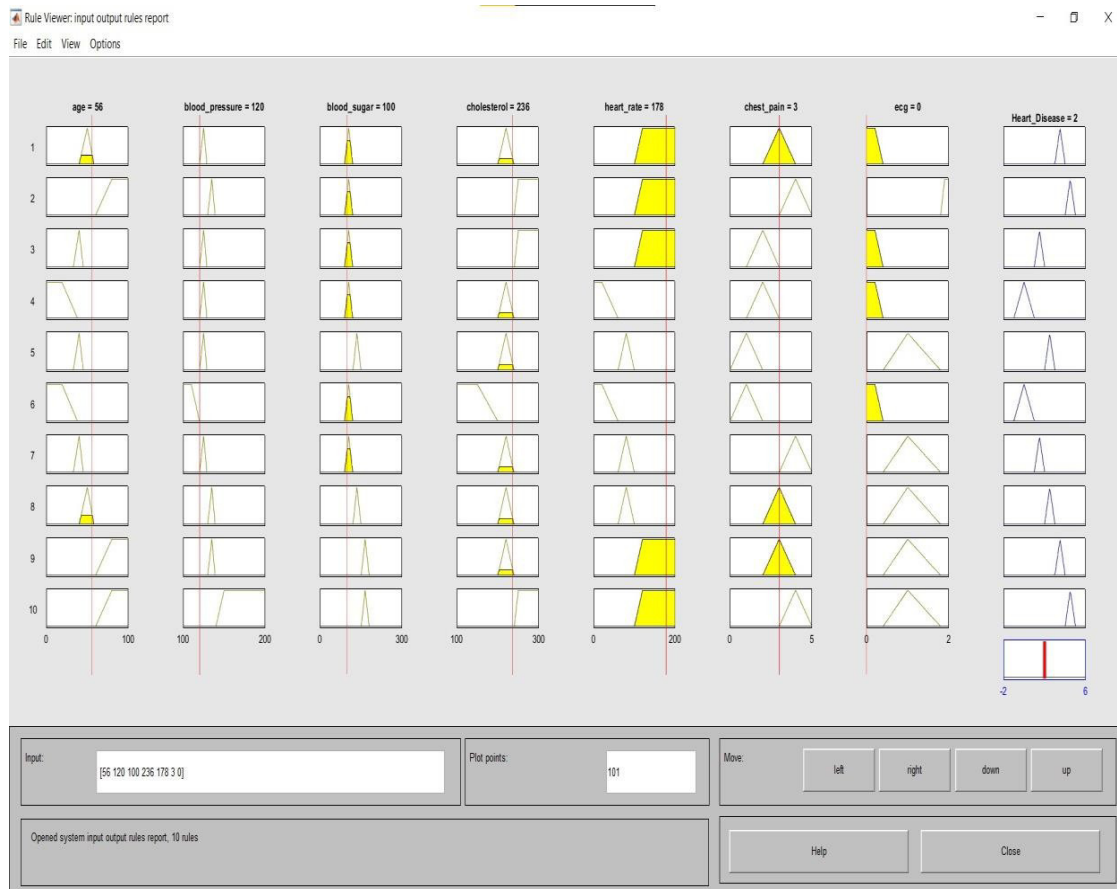


Fig5.10 ruleviewer1

With the help of above matlab rule viewer, the result can be verified easily. In the Fig5.1, if we give the input values of age which has a fuzzy set value as old (56) and the input value of blood pressure which has a fuzzy set value as normal (120) and the input value of blood sugar which has the fuzzy set value as good control (100) and the input value of cholesterol which has the fuzzy set value as high (236) and the input value of heart rate which has the fuzzy set value as high (178) and the input value of chest pain which has the fuzzy set value as Non-Typical Angina (3) and the input value of ECG which has the fuzzy set value as normal (0) we can get the output value as 2, in which the patient is suffering from a heart disease at a risk stage.

The proposed system is more efficient and accurate as compared to other existing diagnosis systems.

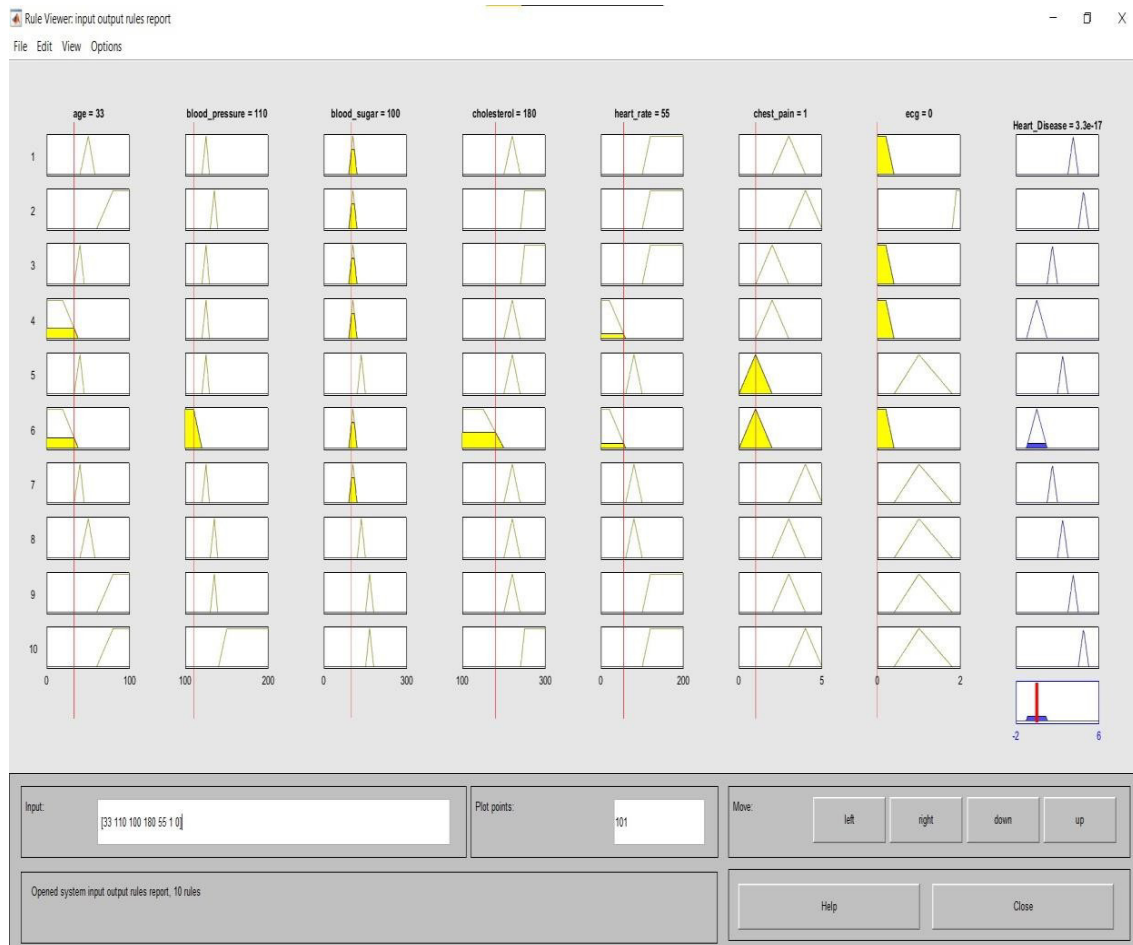


Fig5.11ruleviewer2

If we give the input value of age which has a fuzzy set value as young (33) and the input value of blood pressure which has a fuzzy set value as normal (110) and the input value of blood sugar which has the fuzzy set value as good control (100) and the input value of cholesterol which has the fuzzy set value as low (180) and the input value of heart rate which has the fuzzy set value as low (56) and the input value of chest pain which has the fuzzy set value as Typical Angina (1) and the input value of ECG which has the fuzzy set value as normal (0) we can get the output value as 0 we get the output value as 3.3×10^{-17} which is approximately 0, in which the patient is not suffering from heart disease and the person is healthy.

CHAPTER-6

6. CONCLUSION

This paper helps people understand their cardiac health without having to rely on experts. The forecast was made through the collection of information, implementation of evaluation methods and the creation of knowledge from clinical patient data. Compared to the previous cardiac diagnostic study, the proposed system has improved performance and precision. In terms of usability, it is a very easy expert system and can also be used alone by patients.

In future, Research into another similar system or other data sets should be undertaken to test its quality in order to provide a more precise result. We can generate more new rule bases in this proposed system to increase accuracy.

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