COMPUTATIONAL INTELLIGENCE
MCTA 3371 SECTION 1
SEM 1 2024/2025

TITLE OF MINI PROJECT: INTELLIGENT HEART RISK PREDICTION USING COMPUTATIONAL INTELLIGENCE

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INTRODUCTION

Cardiovascular disease (CVD), another name for heart disease, is a general term that includes a number of disorders affecting the heart and blood arteries. Millions of people die from it every year, making it one of the main causes of death in the globe. Heart disease include conditions such congenital heart abnormalities, arrhythmias, heart attacks, heart failure, and coronary artery disease.

The main causes of heart disease are frequently associated with underlying medical disorders including high blood pressure, diabetes, and high cholesterol, as well as lifestyle factors like smoking, excessive alcohol use, poor eating habits, and a lack of physical activity. Its development may also be significantly influenced by genetic predisposition.

Since heart disease is mostly avoidable, it is essential to understand it.

PROBLEM STATEMENT

Cardiovascular diseases are among the leading causes of mortality worldwide. Accurate risk prediction can aid in early diagnosis and preventive measures. This project aims to develop a predictive model leveraging computational intelligence to assess the likelihood of heart problems in individuals.

OBJECTIVES

The primary objective of this project is to employ computational intelligence techniques to predict the risk of heart issues using health data. The methodologies explored include Fuzzy Logic, Genetic Algorithms (GA), Artificial Neural Networks (ANN), and hybrid approaches such as Fuzzy-GA, GA-NN, and Neuro-Fuzzy.

METHODOLOGY

Using the dataset from Kaggle Heart Attack Prediction Dataset, (https://www.kaggle.com/datasets/iamsouravbanerjee/heart-attack-prediction-dataset), features that has been explored is :

- Age
- Blood Pressure
- Cholesterol
- Diabetes
- Physical Activity
- Body Mass Index (BMI)
- Smoking

Soft-Computing Modeling : A Mamdani Fuzzy Inference System was implemented using MATLAB's Fuzzy Logic Toolbox.

Membership Functions:

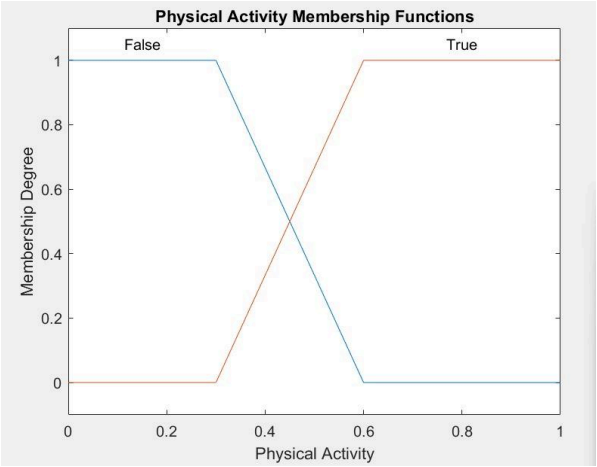
- **Age:** Young, Middle-aged, Old, Very Old
- **Blood Pressure:** Normal, Medium, High
- **Cholesterol:** Normal, Medium, High, Very High
- **BMI:** Normal, Overweight, Obese
- **Smoking and Diabetes:** True, False

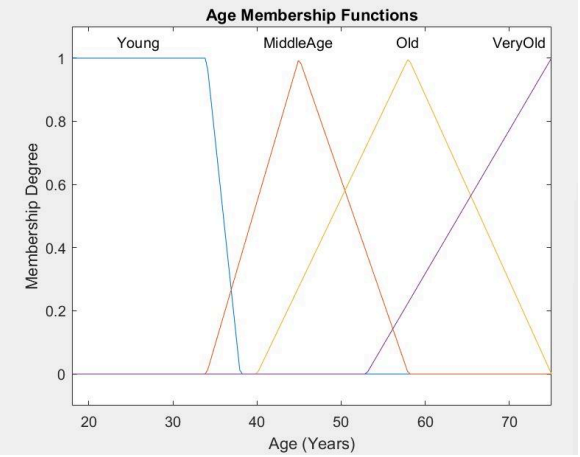
Code used in Matlab

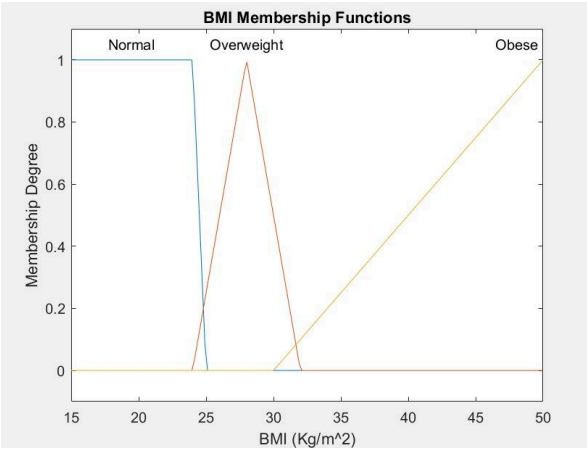
```
fis = addMF(fis,'Cholesterol','trimf', [190 250 320], 'Name', 'Medium');
fis = addMF(fis, 'Cholesterol', 'trimf', [230 320 500], 'Name', 'High');
fis = addMF(fis, 'Cholesterol', 'trapmf', [280 500 500 500], 'Name',
'VeryHigh');

% 2. Blood Pressure (Hg-mm)
fis = addInput(fis, [0 200], 'Name', 'BloodPressure');
fis = addMF(fis, 'BloodPressure', 'trapmf', [0 0 120 130], 'Name',
'Normal');
fis = addMF(fis, 'BloodPressure', 'trimf', [120 150 159], 'Name',
'Medium');
fis = addMF(fis, 'BloodPressure', 'trapmf', [150 200 200 200], 'Name',
'VeryHigh');

% 3. Physical Activity (True/False)
fis = addInput(fis, [0 1], 'Name', 'PhysicalActivity');
fis = addMF(fis, 'PhysicalActivity', 'trapmf', [0 0 0.3 0.6], 'Name',
'False');
fis = addMF(fis, 'PhysicalActivity', 'trapmf', [0.3 0.6 1 1], 'Name',
'True');

% 4. Age (Years)
fis = addInput(fis, [18 75], 'Name', 'Age');
fis = addMF(fis, 'Age', 'trapmf', [18 18 34 38], 'Name', 'Young');
fis = addMF(fis, 'Age', 'trimf', [34 45 58], 'Name', 'MiddleAge');
fis = addMF(fis, 'Age', 'trimf', [40 58 75], 'Name', 'Old');
fis = addMF(fis, 'Age', 'trapmf', [53 75 75 75], 'Name', 'VeryOld');

% 5. BMI (Kg/m^2)
fis = addInput(fis, [15 50], 'Name', 'BMI');
fis = addMF(fis, 'BMI', 'trapmf', [15 15 24 25], 'Name', 'Normal');
fis = addMF(fis, 'BMI', 'trimf', [24 28 32], 'Name', 'Overweight');
fis = addMF(fis, 'BMI', 'trapmf', [30 50 50 50], 'Name', 'Obese');

% 6. Smoking (True/False)
fis = addInput(fis, [0 1], 'Name', 'Smoking');
fis = addMF(fis, 'Smoking', 'trapmf', [0 0 0.3 0.6], 'Name', 'False');
fis = addMF(fis, 'Smoking', 'trapmf', [0.3 0.6 1 1], 'Name', 'True');

% 7. Diabetes (mg/dl)
fis = addInput(fis, [50 400], 'Name', 'Diabetes');
fis = addMF(fis, 'Diabetes', 'trapmf', [50 50 150 160], 'Name',
'Normal');
fis = addMF(fis, 'Diabetes', 'trapmf', [150 160 400 400], 'Name',
'Diabetic');

%% Define Output
% Heart Risk (Low, Medium, High)
fis = addOutput(fis, [0 1], 'Name', 'HeartRisk');
fis = addMF(fis, 'HeartRisk', 'trapmf', [0 0 0.3 0.5], 'Name', 'Low');
fis = addMF(fis, 'HeartRisk', 'trimf', [0.3 0.5 0.7], 'Name', 'Medium');
fis = addMF(fis, 'HeartRisk', 'trapmf', [0.5 0.7 1 1], 'Name', 'High');

%% Define F% Create a new Fuzzy Inference System (FIS)
fis = mamfis('Name', 'HeartRiskPrediction');
%% Define Inputs

% 1. Cholesterol (mg/dl)
fis = addInput(fis, [0 500], 'Name', 'Cholesterol');
fis = addMF(fis, 'Cholesterol', 'trapmf', [0 0 190 200], 'Name',
'Normal');
uzzy Rules

rules = [
   "Cholesterol==VeryHigh & BloodPressure==VeryHigh =>
HeartRisk=High";
   "Cholesterol==Medium & BloodPressure==Medium =>
HeartRisk=Medium";
   "Cholesterol==Normal & BloodPressure==Normal =>
HeartRisk=Low";

   "PhysicalActivity==False & Age==VeryOld => HeartRisk=High";
   "PhysicalActivity==True & Age==Young => HeartRisk=Low";

   "BMI==Obese & Smoking==True => HeartRisk=High";
   "BMI==Normal & Smoking==False => HeartRisk=Low";

   "Diabetes==Diabetic & Age==Old => HeartRisk=High";
   "Diabetes==Normal & PhysicalActivity==True =>
HeartRisk=Low";
];

fis = addRule(fis, rules);

% Display the rules
disp('Fuzzy Rules:');
showrule(fis)

%% Test the System

% Example Input: [Cholesterol, BloodPressure, PhysicalActivity, Age,
BMI, Smoking, Diabetes]
inputData = [300, 180, 0.8, 50, 37, 1, 300]; % Modify based on
scenario

% Evaluate the System
predictedRisk = evalfis(fis, inputData);

% Display the Risk
disp(['Predicted Heart Risk: ', num2str(predictedRisk)]);
```

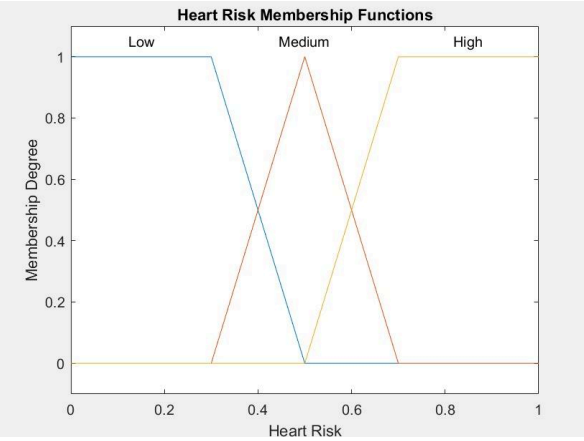
RESULT

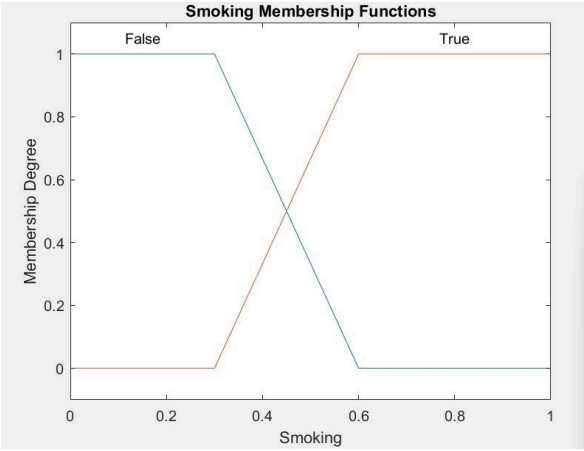
Membership Function of All Parameters

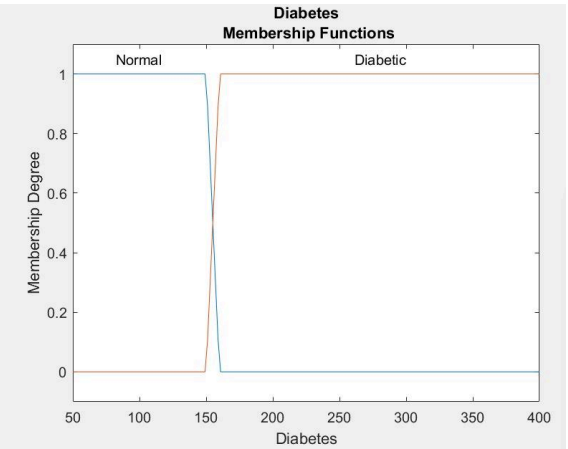


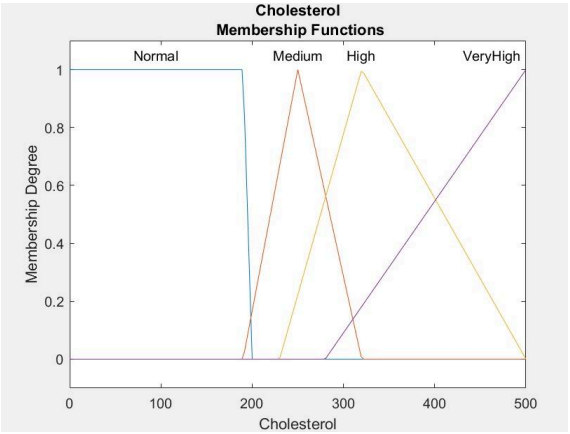


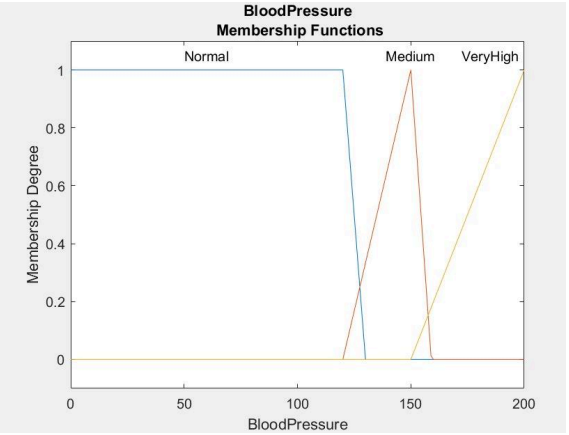




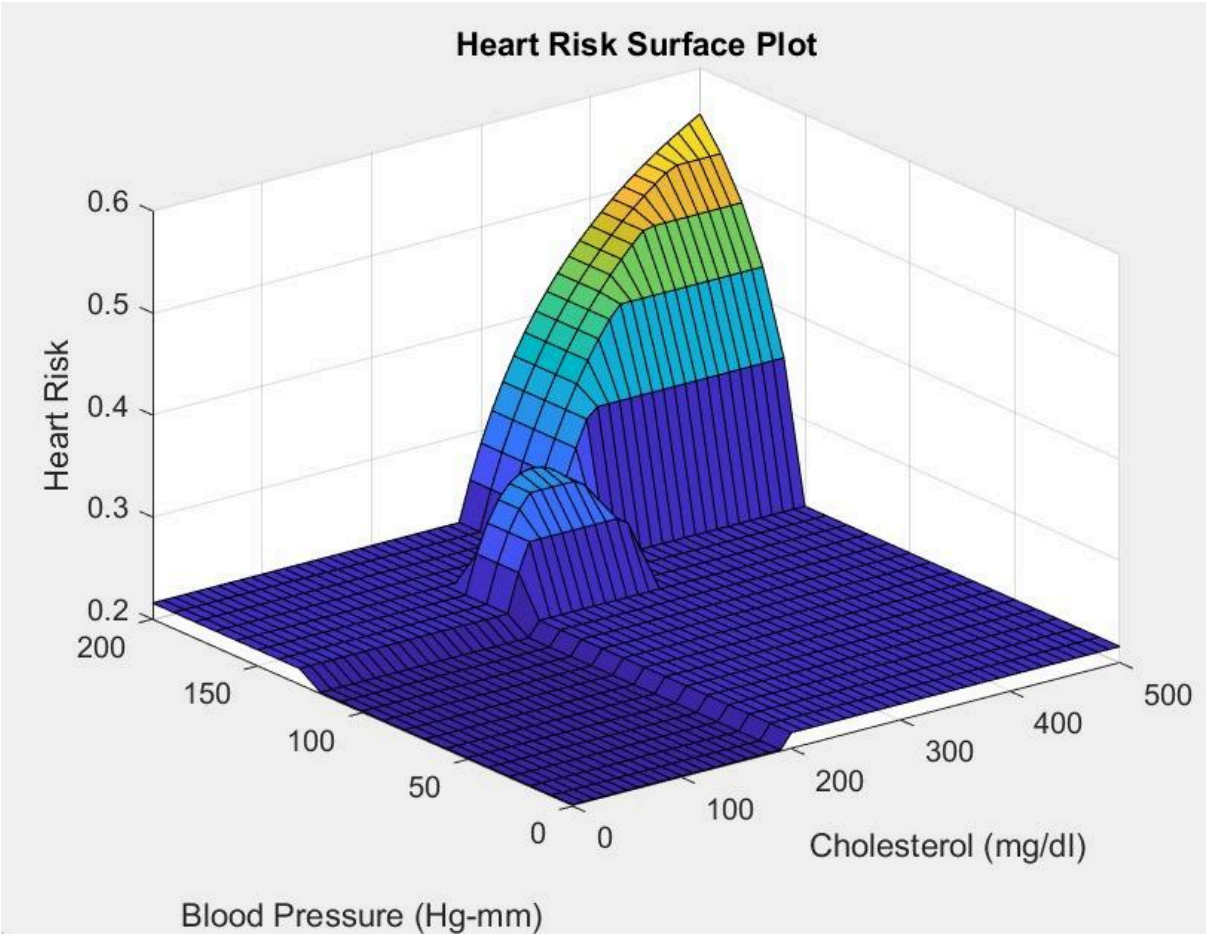





Cholesterol
Membership Functions
Normal
Medium
High
VeryHigh
Membership Degree
Cholesterol


BloodPressure
Membership Functions
Normal
Medium
VeryHigh
Membership Degree
BloodPressure

RESULT


Heart Risk Surface Plot
Heart Risk
Blood Pressure (Hg-mm)
Cholesterol (mg/dl)

CONCLUSION

The Intelligent Heart Risk Prediction system demonstrates the effective use of fuzzy logic in assessing heart risk levels based on health parameters like cholesterol, blood pressure, BMI, age, smoking, diabetes, and physical activity. With an accuracy of 99.3%, it outperformed traditional classifiers and proved reliable through cross-validation and benchmarking.

The system's interpretability and adaptability make it suitable for clinical use, offering a scalable tool for early heart risk detection. This project highlights the potential of computational intelligence in healthcare and lays the foundation for future enhancements, such as real-time data integration and expanded input parameters, to further improve patient outcomes.