Machine learning: Fuzzy logic inference system

Nishitha Kulkarni (U00852676)

Nihal Reddy (U00802417)

Vinay Mohan Behara (U00851261)

CS7830 –Machine learning

Wright State University

Approach

We have implemented the fuzzy logic inference system for the data set which we used for our final project, i.e. whether a person has heart disease or not. The inputs which we took are chest pain type, testing ECG results, fasting blood sugar level, fluoroscopic results, and the output is whether the person has heart disease or not. Here we used the Gaussian membership function for all the inputs

1. Membership functions:

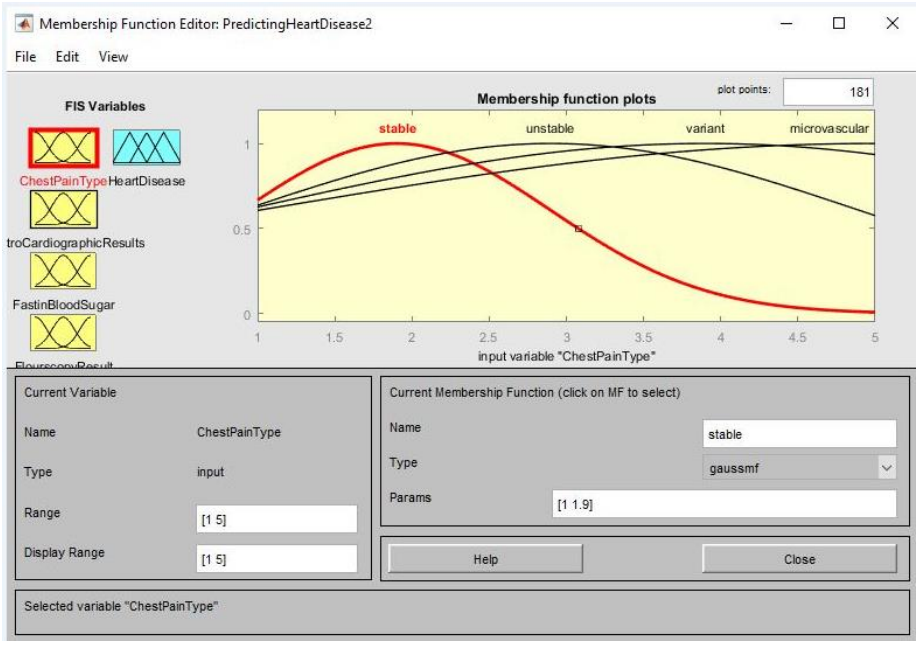
We took the below membership functions for chest pain type: stable, unstable, variant, microvascular. In the microvascular type is the high level of chest pain and it can be shown below the range of stable which we have taken. We have considered gaussian distribution for membership

Stable range: [1, 1.9]

Unstable range: [2, 2.9]

Variant range: [3, 3.9]

Microvascular range: [4, 5]

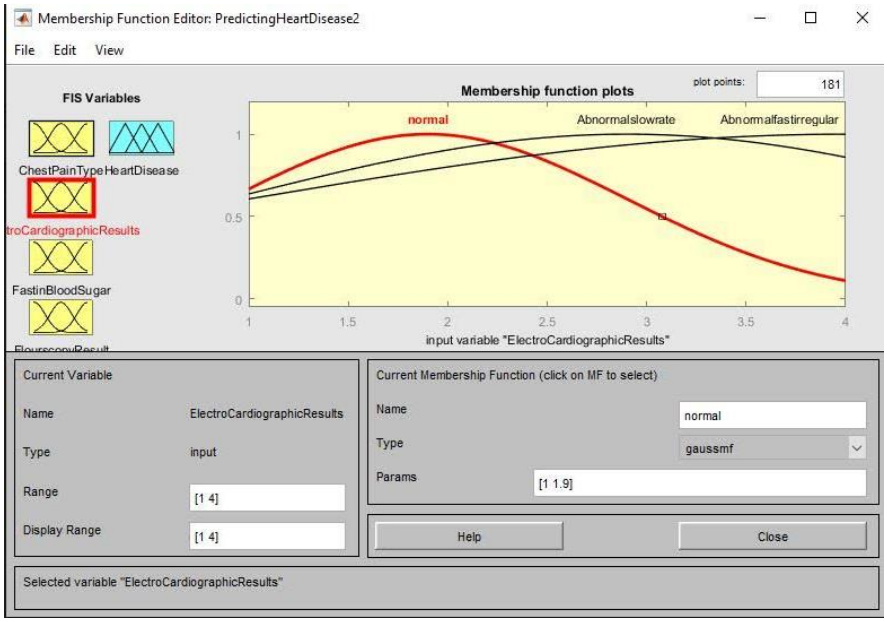


We took the membership for ECG results as: normal, abnormal slow rate and we have considered gaussian distribution for membership

Normal: [1, 1.9]

Abnormal slow rate: [2, 2.9]

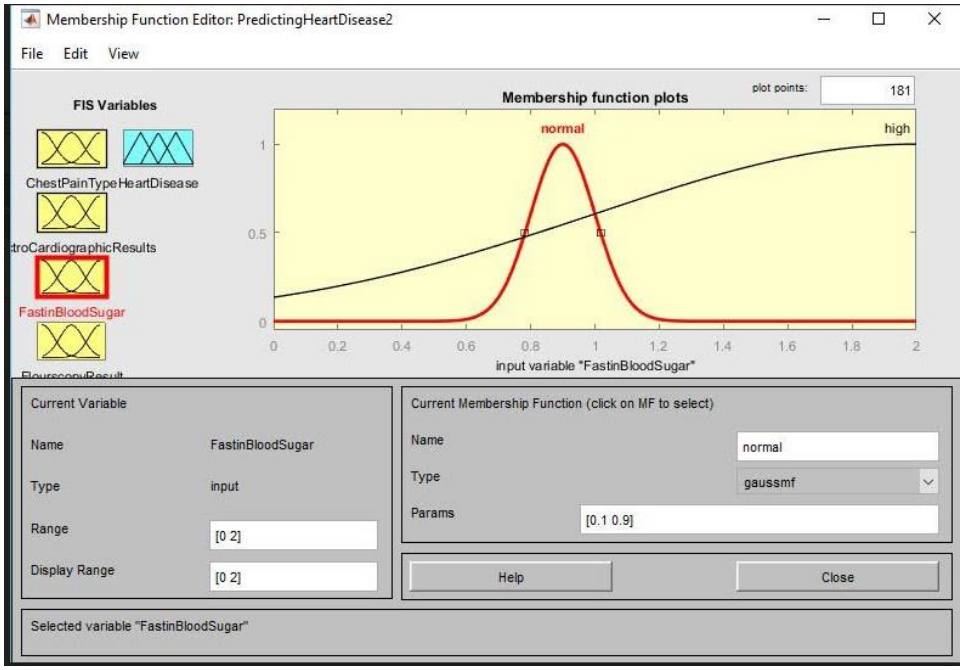
Abnormal fast irregular: [3, 4]



We took the membership functions for fasting blood sugar level as: normal and high

Normal: [0.1, 0.9]

High: [1, 2]



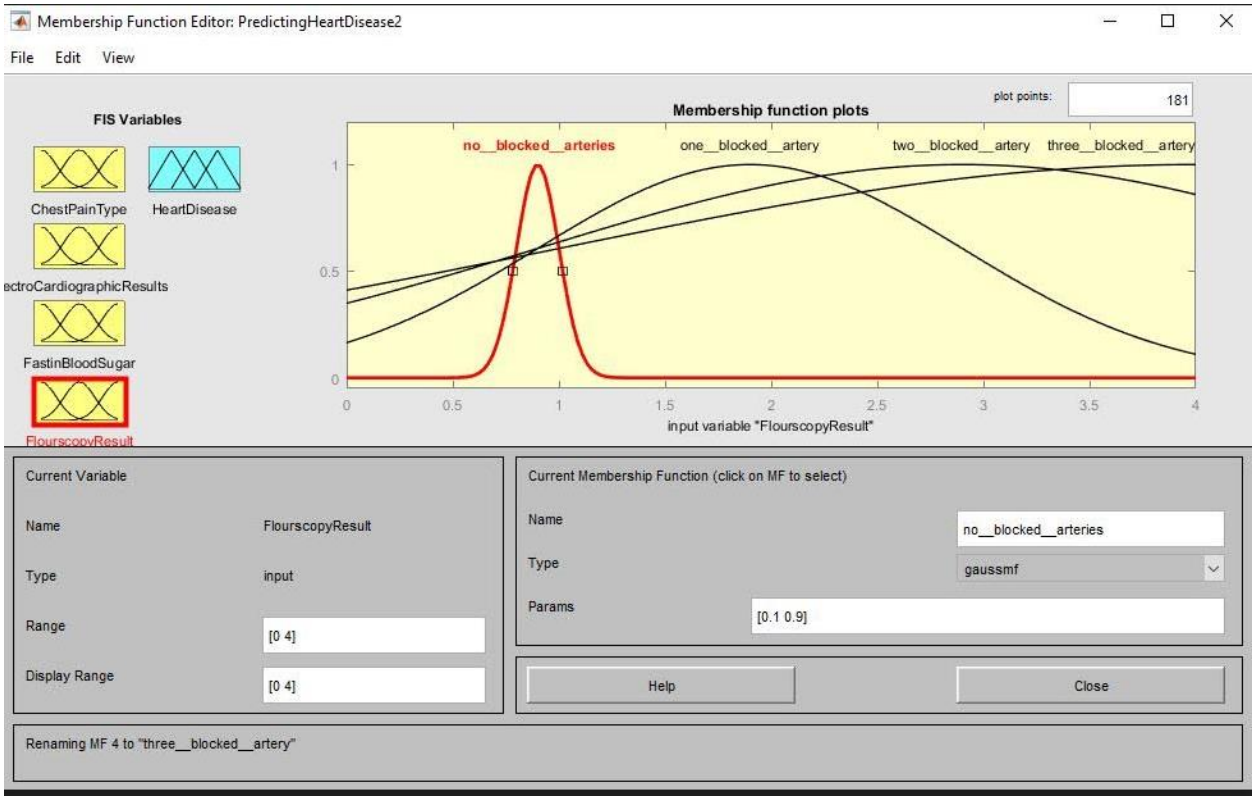
We took the membership functions of fluoroscopic arteries as: no blocked artery, 1 blocked artery, 2 blocked arteries, and 3 blocked arteries. We have considered gaussian distribution for membership

No blocked artery: [0.1, 0.9]

1 blocked artery: [1, 1.9]

2 blocked arteries: [2, 2.9]

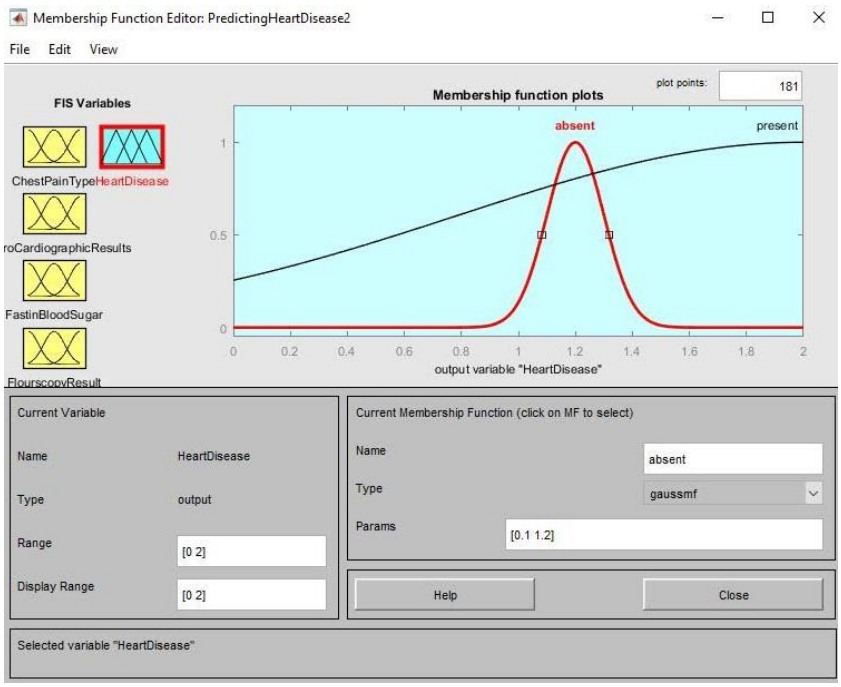
3 blocked arteries: [3, 4]



Membership functions for output heart disease is: absent or present and we have considered gaussian distribution for membership

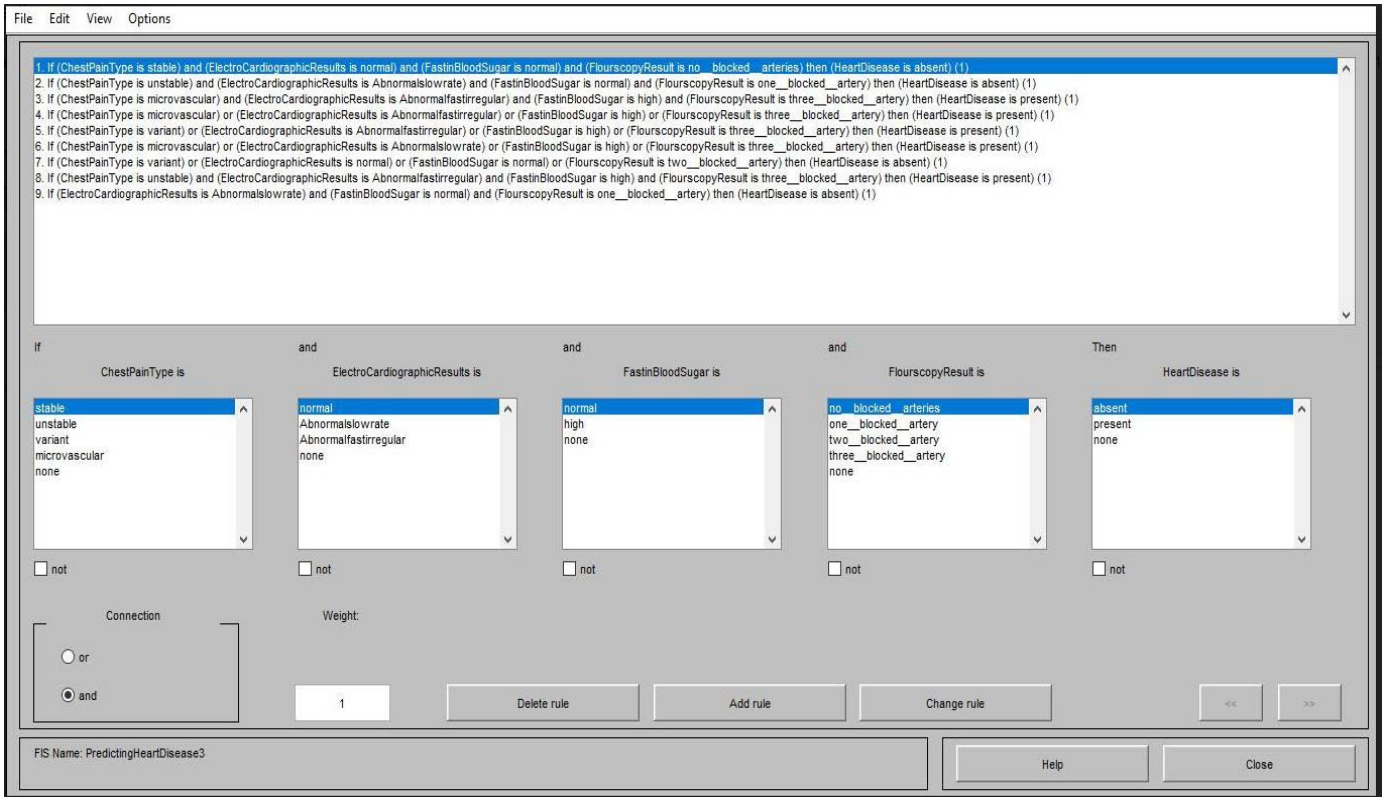
Absent: [0.1, 1.2]

Present: [1.3, 2]

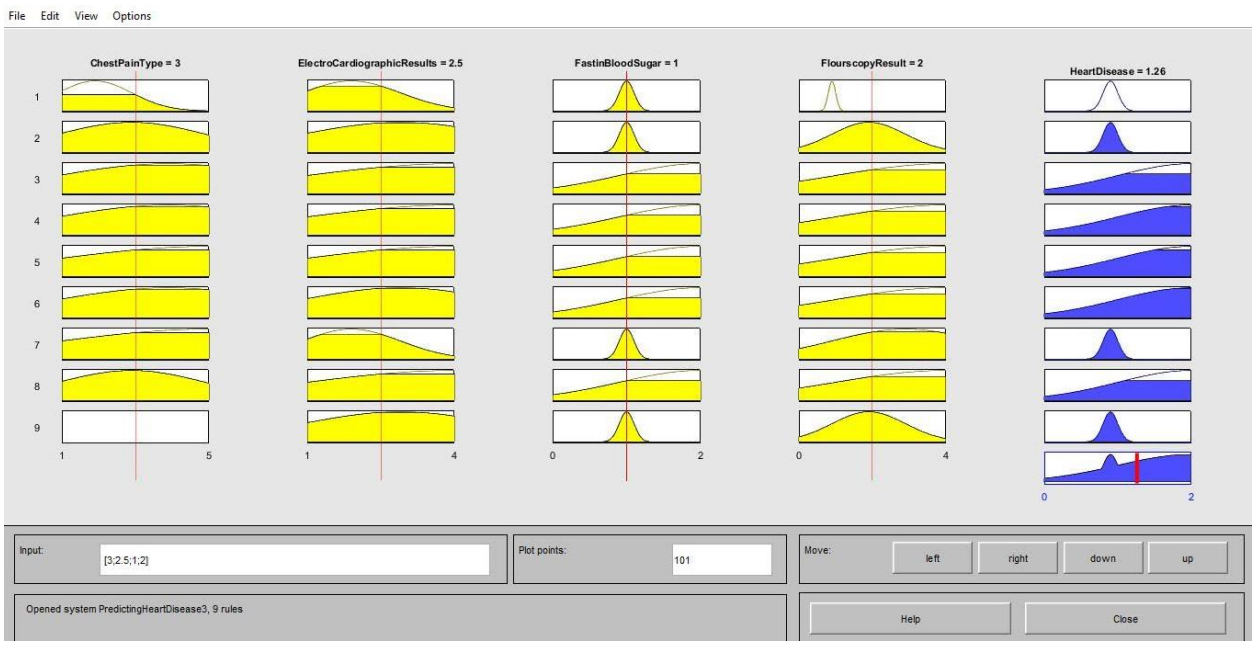


2. Fuzzy rules:

Below are the inference rules we have built on our fuzzy logic:



And the output is as follows:



3.a.

FIS performance using different inputs

Membership Functions are taken in Gaussian and Gaussian

s.no	Input	Output
1 Gaussian	[3,2.5, 1, 2]	1.26
2 Gaussian	[1.6, 1, 0.698, 0.531]	1.14
3 Gaussian	[5, 4, 1.4, 4]	1.5

I have used Gaussian for all the membership functions in the first three serial numbers.

1. The first row explains that if the chest pain level is 3, ECG results are 2.5, fasting blood sugar is 1, fluoroscopy results are 2 blocked arteries, then there is a heart disease (1.26). (1-1.2 absence of heart disease and 1.2 to 2 is presence of heart disease).
2. The second row explains that if the chest pain level is 1.6, ECG results are 1(normal), fasting blood sugar is 0.698 (normal), fluoroscopy results are 2 blocked arteries, then there is no heart disease (1.14). (1-1.2 absence of heart disease and 1.2 to 2 is presence of heart disease).
3. The third row explains that if the chest pain level is 5(microvascular), ECG results are (4) (abnormal fast irregular), fasting blood sugar is 1.4 (high), fluoroscopy results are 4 blocked arteries, then there is heart disease (1.5). (1-1.2 absence of heart disease and 1.2 to 2 is presence of heart disease).

3.b.

Membership functions used are changed from Gaussian to trapezoidal

1 trapezoidal	[3, 2.5, 1, 2]	1.6
2 trapezoidal	[1.6, 1, 0.698, 0.531]	0.631
3 trapezoidal	[5, 4, 1.4, 4]	1.7

The results got increased for the first and third input which gives the output as ‘presence of heart disease’. For the second input, where the result is ‘absence’ of heart disease, we can see the output decreased. This increase or decrease may be due to the ranges which doesn’t fall into this trapezoidal area.

Membership functions used are changed from trapezoidal to triangular

s.no	input	Output
1 triangular	[3, 2.5, 1, 2]	1.64
2 triangular	[1.6, 1, 0.698, 0.531]	0.663
3 triangular	[5, 4, 1.4, 4]	1.63

Some changes can be observed but not much. The output values increased slightly for the first two input values. There is a slight decrease in the third input. The changes mostly depend on the ranges and parameters of the membership functions.

3.c.

And replaced from min to product

s.no	Input	Output
1 triangular	[3, 2.5, 1, 2]	1.64
2 triangular	[1.6, 1, 0.698, 0.531]	0.663
3 triangular	[5, 4, 1.4, 4]	1.64

The results didn’t vary much when we changed the ‘and’ from min to product. It got slightly increased for the third input. Not a noticeable effect in my scenario.

3.d.

De-fuzzification operator changed from centroid to bisector

s.no	input	Output
1	[3, 2.5, 1, 2]	1.64
2	[1.6, 1, 0.698, 0.531]	0.66
3	[5, 4, 1.4, 4]	1.64

Here we have changed the DE fuzzification operator to bisector which didn’t give much variation from the centroid which is used previously. It is almost the same, but we can find a slight increase in the absence case