Chapter: 5

FINDING THE HEART DISEASE BY KNOWING THE THRESHOLD VALUE OF THE FAST FOOD EATERS USING FUZZY RULE (FR)

5.1 Introduction

This chapter briefs about analyzing the Heart Disease (HD) by knowing the threshold value of the fast food eaters using Fuzzy Rule (FR). The previous chapter, section 4.4 clarifies that the major risk factors of obesity are unhealthy diet and lifestyle modifications. Unfortunately, fast food plays a vital role in our day today life. Healthy food is the fundamental need of our everyday life. Yet, now-a-days fast food culture is becoming more prevalent in urban zone and this kind of fast food contains elevated cholesterol, sugar, fat and so on. Fast food causes chronic diseases, cardiovascular diseases, diabetes, hypertension, heart sickness and cancer.

Unhealthy diet and lifestyle modifications are the significant risk factors for heart disease. In this chapter, the analyzation is made on how much intake of fast food will lead to heart diseases and the threshold value for the fast food eaters by using Fuzzy Inference System (FIS). Finally the threshold value for fast food eaters can be analyzed by themselves using FR. Physical inactivity is the primary reason for obesity. The physical inactivity of a person is inversely proportional to his/her activity level.

The FR based system is applied here, which is based on the fuzzy logic. The objective of this research work is to analyze the cause of HD and to find the threshold value for the fast food eaters using FR. The process of threshold estimation is designed in such a way that the fast food eaters can utilize it themselves with the help of Mamdhani rule in Matlab. This chapter explores the risk of heart diseases of the fast food eaters using the FR based system and it helps us to find whether the person is at the risk of developing heart disease or not. As per the expert’s opinion, it is concluded that the system comprises of 64 rules and six attributes, out of which four attributes are input attributes and two are output attributes. The input and
output attributes of the system will decide how much intake of fast food will lead to the heart disease.

5.2 FAST FOOD

Eat healthy and live healthy is one of the essential requirements for long-life. However, today's reality has been changed to fast food adoption. India’s fast food industries are developing by 40 percent a year. Statistics places India in the tenth position in fast food consumption. Unhealthy eating routine is the reason for around 85% of cardiovascular sickness. Andrea freeman [10] depicts a noteworthy wellspring of nourishment in low-wage urban neighborhoods over the United States. Mohammad Hossein Rouhani et al. [42] portrays with the couple of information that the accessibility of fast food is related to the quality of eating routine in developing countries. Furthermore he discusses the effect of fast food consumption among Isfahani young ladies. Janet Curie et al [27] studied how changes in the supply of fast food eateries influence weight results of 3 million youngsters and 3 million pregnant ladies.

5.3 SIDE EFFECTS (HEART DISEASE) OF FAST FOOD CONSUMPTION

- A large number of fast food dishes contain sodium, which causes hypertension.
- Intake of fast food builds the Body Mass Index (BMI) and will bring about unnecessary stress on joints and heart.
- High cholesterol often results from consuming excessive saturated fat and cholesterol. This elevated cholesterol can prompt the danger of both heart ailments and stroke.
- Fast foods such as cheese, burgers and fried shrimp that are high in fat and cholesterol can bring about a development of plaque in the arteries overtime. This condition is called as atherosclerosis, it influences the heart function and creates unsafe blood clusters.
- A study conducted in Hamburg, Germany found that fast food additionally causes both intense and long-term harm to the cardiovascular system.
5.4 Dataset

According to expert’s opinion, the data are fixed for the system. Here the specialists are dietitians from Chennai. This system comprises of four attributes for input and two attributes for output (result). Input attributes are 1) Activity level of the person 2) Fast food intake level 3) Calories level 4) Obesity (BMI) level. The output attributes are 1) Risk of heart disease and 2) Precautions.

5.5 Input attributes

Four attributes are fixed as input attributes according to the expert’s opinion. They are

a) Activity level of the person: The activity level relies upon the day to day work of the people and there are five categories of people, namely extra active, very active, moderately active, lightly active, sedentary lifestyle person

- Extra active person (very hard exercise/sports and physical job or training)
- Very active person (hard exercise / sports 6-7 days a week)
- Moderately active person (moderate exercise/sports 3-5 days a week)
- Lightly active person (light exercise/sports 1-3 days a week)
- Sedentary (little or no exercise)

b) Fast food intake level

There are several types of fast foods available, of which only 4 types of fast food are considered here, namely burgers, pizzas, French fries, sandwiches. The range of fast food intake level is given by 1-14 pieces per week. Which is measured in five levels, namely very low, low, medium, high and very high.

c) Calories level

Calories level ranges between 2200-3000 (for men) and 1800-2400 (for women). Five different types of levels are fixed here very low, low, medium, high and very high [9].
d) Obesity (BMI) level

Obesity occurs when a person consumes more calories than they burn through exercises and normal daily activities.

- BMI of 25 or greater is considered as overweight.
- BMI of 30 or greater is considered as obesity.
- The Range of BMI levels are 19-21, 22-24, 25-29, 30-35, >40 being very low, low, medium, high, and very high respectively.

<table>
<thead>
<tr>
<th>Activity level of the person</th>
<th>Extra active person</th>
<th>Very active person</th>
<th>Moderately active person</th>
<th>Lightly active person</th>
<th>Sedentary person</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.of days</td>
<td>[0.7,0.7,0.6]</td>
<td>[0.7,0.6,0.6]</td>
<td>[0.5,0.4,0.3]</td>
<td>[0.3,0.2,0.1]</td>
<td>[0.0,0.0,0.1]</td>
</tr>
<tr>
<td>Fast food intake level</td>
<td>Very low</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>No.of pieces per week</td>
<td>[0.2,0.1,0.0]</td>
<td>[0.5,0.4,0.3]</td>
<td>[0.7,0.6,0.5]</td>
<td>[0.9,0.8,0.7]</td>
<td>[0.14,0.12,0.11]</td>
</tr>
<tr>
<td>Calories Level</td>
<td>Very low</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Calorie ranges</td>
<td>[0.2300,0.2250,0.2200]</td>
<td>[0.2450,0.2400,0.2350]</td>
<td>[0.2550,0.2500,0.2450]</td>
<td>[0.2700,0.2600,0.2550]</td>
<td>[0.2900,0.2800,0.2700]</td>
</tr>
<tr>
<td>Obesity (BMI) level</td>
<td>Very low</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Range of BMI</td>
<td>[0.21,0.20,0.19]</td>
<td>[0.24,0.23,0.22]</td>
<td>[0.29,0.27,0.25]</td>
<td>[0.35,0.34,0.33]</td>
<td>[0.42,0.41,0.40]</td>
</tr>
</tbody>
</table>

5.6 Output attributes

The output attributes says whether the person is getting the risk of heart disease or not and the precautions are given below.
a) Risk of heart diseases

The range of heart disease is [0, 1]. If 0 means the absence of risk and 1 means presence of risk of getting heart disease. The five different types are no risk, low risk, moderate risk, risk and high risk.

b) Precautions

The precautions depend upon the fast food eaters. The five different types of precautions are no need, take low calorie fast food, avoid daily intake of fast food, and change our activity level, exercise.

<table>
<thead>
<tr>
<th>Table 5.2: Data sets for Output attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of heart disease</td>
</tr>
<tr>
<td>Range of heart disease</td>
</tr>
<tr>
<td>Precautions</td>
</tr>
</tbody>
</table>

5.7 Rule Based system

Poonam et.al [49] concentrates on the nuts and bolts of Fuzzy Logic and its application in Rule-Based Systems to make them competent to handle a present reality issue. Additionally, extraordinary research issues connected with FRBS have been talked about. Likewise, a movement control framework is proposed and implemented using MATLAB. Manisha Barman et.al [40] introduced a FR based framework for the analysis of the coronary illness, that created framework has seven sources of information. They are Chest torment sort, resting the circulatory strain in mm (Trestbps), Serum cholesterol in mg (Chol), numbers of years as a smoker (years), fasting of blood sugar (fbs), most extreme heart rate achieved (thalach), resting blood rate (trestbpd). The angiographies status of heart of patients has been recorded as a yield. Kantesh Kumar Oad et.al [32] planned a fuzzy rule
based framework by using an information mining method which lessened the aggregate number of properties. E.P.Ephzibah et.al [21] proposes a specialist framework in light of neuro-fuzzy procedure for coronary illness determination. It contemplates the report that individuals in India will experience the ill effects of the Heart disease because of their poor dietary patterns and their way of living. Sanjeev Kumar et.al [64] distinguishes the heart diseases in the individual by utilizing Fuzzy Expert System. The Rule base is the main part of the Fuzzy Inference System (FIS) and the quality of results in a fuzzy system depends on the fuzzy rules and this system includes 64 rules. The antecedent part of a rule has one section, in this system designed with another rule bases (64 rules, 15 rules, 10 rules and 5 rules) and the results shows that the 64 rules system is the best in comparison with the results of the other rule bases. On the other hand, results with 64 rules relies on the expert’s idea. It gives the best suggestion for the fast food eaters who can find themselves.

**Table 5.3: Risk of Heart disease for extra active persons while taking fast food**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Person activity level</th>
<th>Fast food intake level</th>
<th>Calories level</th>
<th>BMI level</th>
<th>Risk of heart diseases</th>
<th>Precaution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Extra active person</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>2.</td>
<td>Extra active person</td>
<td>Low</td>
<td>Low</td>
<td>Very low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>3.</td>
<td>Extra active person</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>4.</td>
<td>Extra active person</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>5.</td>
<td>Extra active person</td>
<td>Very high</td>
<td>Very high</td>
<td>Medium</td>
<td>Low risk</td>
<td>No need</td>
</tr>
<tr>
<td>6.</td>
<td>Extra active person</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>S.No</td>
<td>Person activity level</td>
<td>Fast food intake level</td>
<td>Calories level</td>
<td>BMI level</td>
<td>Risk of heart diseases</td>
<td>Precaution</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------</td>
<td>-----------------------</td>
<td>----------------</td>
<td>----------</td>
<td>------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>1.</td>
<td>Very active person</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>2.</td>
<td>Very active person</td>
<td>Low</td>
<td>Low</td>
<td>Very low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>3.</td>
<td>Very active person</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>4.</td>
<td>Very active person</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low risk</td>
<td>Take a low calorie fast food</td>
</tr>
<tr>
<td>5.</td>
<td>Very active person</td>
<td>Very high</td>
<td>Very high</td>
<td>High</td>
<td>Risk</td>
<td>Avoid daily intake of fast food</td>
</tr>
<tr>
<td>6.</td>
<td>Very active person</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>S.No</td>
<td>Person activity level</td>
<td>Fast food intake level</td>
<td>Calories level</td>
<td>BMI level</td>
<td>Risk of heart diseases</td>
<td>Precaution</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------</td>
<td>-----------------------</td>
<td>----------------</td>
<td>-----------</td>
<td>------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>1.</td>
<td>Moderate active person</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>2.</td>
<td>Moderate active person</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>3.</td>
<td>Moderate active person</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Moderate risk</td>
<td>Exercise</td>
</tr>
<tr>
<td>4.</td>
<td>Moderate active person</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Risk</td>
<td>Exercise, Take a low calorie fast food</td>
</tr>
<tr>
<td>5.</td>
<td>Moderate active person</td>
<td>Very high</td>
<td>Very high</td>
<td>High</td>
<td>Risk</td>
<td>Exercise, Take a low calorie fast food</td>
</tr>
<tr>
<td>6.</td>
<td>Moderate active person</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>Low risk</td>
<td>Take a low calorie fast food</td>
</tr>
</tbody>
</table>

Table 5.5: Risk of heart disease for Moderate active person while taking fast food
<table>
<thead>
<tr>
<th>S.No</th>
<th>Person activity level</th>
<th>Fast food intake level</th>
<th>Calories level</th>
<th>BMI level</th>
<th>Risk of heart diseases</th>
<th>Precaution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lightly active person</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>2.</td>
<td>Lightly active person</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low risk</td>
<td>Take a low calorie fast food</td>
</tr>
<tr>
<td>3.</td>
<td>Lightly active person</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Moderate risk</td>
<td>Exercise</td>
</tr>
<tr>
<td>4.</td>
<td>Lightly active person</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Risk</td>
<td>Exercise, Take a low calorie fast food</td>
</tr>
<tr>
<td>5.</td>
<td>Lightly active person</td>
<td>Very high</td>
<td>Very high</td>
<td>High</td>
<td>Risk</td>
<td>Exercise, Take a low calorie fast food</td>
</tr>
<tr>
<td>6.</td>
<td>Lightly active person</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>Low risk</td>
<td>Take a low calorie fast food</td>
</tr>
<tr>
<td>S.No</td>
<td>Person activity level</td>
<td>Fast food intake level</td>
<td>Calories level</td>
<td>BMI level</td>
<td>Risk of heart diseases</td>
<td>Precautions</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------</td>
<td>------------------------</td>
<td>----------------</td>
<td>-----------</td>
<td>------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>1.</td>
<td>Sedentary person</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>No risk</td>
<td>No need</td>
</tr>
<tr>
<td>2.</td>
<td>Sedentary person</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low risk</td>
<td>Take a low calorie fast food</td>
</tr>
<tr>
<td>3.</td>
<td>Sedentary person</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Moderate risk</td>
<td>Exercise</td>
</tr>
<tr>
<td>4.</td>
<td>Sedentary person</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Risk</td>
<td>Exercise,</td>
</tr>
</tbody>
</table>

**Table 5.7: Risk of heart disease for sedentary person while taking fast food**
<table>
<thead>
<tr>
<th></th>
<th>person</th>
<th>Very high</th>
<th>Very high</th>
<th>Very high</th>
<th>High risk</th>
<th>Change your activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Sedentary person</td>
<td>Very high</td>
<td>Very high</td>
<td>Very high</td>
<td>High risk</td>
<td>Change your activity</td>
</tr>
<tr>
<td>6</td>
<td>Sedentary person</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td>Low risk</td>
<td>Take a low calorie fast food</td>
</tr>
<tr>
<td>7</td>
<td>Sedentary person</td>
<td>High</td>
<td>Very high</td>
<td>Very high</td>
<td>High risk</td>
<td>Change your activity</td>
</tr>
<tr>
<td>8</td>
<td>Sedentary person</td>
<td>Very high</td>
<td>High</td>
<td>High</td>
<td>Risk</td>
<td>Exercise, Take a low calorie fast food</td>
</tr>
<tr>
<td>9</td>
<td>Sedentary person</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Risk</td>
<td>Exercise, Take a low calorie fast food</td>
</tr>
<tr>
<td>10</td>
<td>Sedentary person</td>
<td>Medium</td>
<td>Very high</td>
<td>Very high</td>
<td>High risk</td>
<td>Change your activity</td>
</tr>
<tr>
<td>11</td>
<td>Sedentary person</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Moderate risk</td>
<td>Exercise</td>
</tr>
<tr>
<td>12</td>
<td>Sedentary person</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Moderate risk</td>
<td>Exercise</td>
</tr>
</tbody>
</table>

5.8 FUZZY RULES FOR FAST FOOD EATERS

According to the expert’s opinion the input and output attributes are shown in the above table using FIS. The 64 rules are shown with the help of Mamdani rule in Matlab and the rules are given below.
Rule-1
If (the person is extra active) and (fast food intake level is very low) and (calorie level is very low) and (BMI level is very low) then (the results are no risk) (Precaution is not needed).

Rule-2
If (the person is extra active) and (fast food intake level is low) and (calorie level is low) and (BMI level is very Low) then (the results are No risk) (Precaution is not needed).

Rule-3
If (the person is extra active) and (fast food intake level is Medium) and (calorie level is Medium) and (BMI level is Low) then (the results are not risky) (Precaution is not needed).

Rule-4
If (the person is extra active) and (fast food intake level is High) and (calorie level is Higher) and (BMI level is Low) then (the results are not risky) (Precaution is not needed)

Rule-5
If (the person is extra active) and (fast food intake level is Very High) and (calorie level is higher) and (BMI level is Medium) then (the results are Low risk) (Precaution is not needed).

Rule-6
If (the person is extra active) and (fast food intake level is Very Low) and (calorie level is Low) and (BMI level is Low) then (the results are not risky) (Precaution is not needed).
Rule- 7

If (the person is extra active) and (fast food intake level is High) and (calorie level is very high) and (BMI level is Medium) then (the results are Low risk) (Precaution is to take low calorie fast food).

Rule -8

If (the person is extra active) and (fast food intake level is Very High) and (calorie level is higher) and (BMI level is Medium) then (the results are Low risk) (Precaution is to take low calorie fast food).

Rule- 9

If (the person is extra active) and (fast food intake level is Low) and (calorie level is high) and (BMI level is Medium) then (the results are not risky) (Precaution is not needed).

Rule- 10

If (the person is extra active) and (fast food intake level is Medium) and (calorie level is very high) and (BMI level is Medium) then (the results are Low risk) (Precaution is to take low calorie fast food).

Rule- 11

If (the person is extra active) and (fast food intake level is Low) and (calorie level is Medium) and (BMI level is Low) then (the results are Low risk) (Precaution is to take low calorie fast food).

Rule- 12

If (the person is extra active) and (fast food intake level is High) and (calorie level is Medium) and (BMI level is Medium) then (the results is Low risk) (Precaution is to Take low calorie fast food).
Rule -13

If (the person is extra active) and (fast food intake level is Low) and (calorie level is very Low) and (BMI level is Very Low) then (the results are not risky) (Precaution is not needed).

Rule -14

If (the person is very active) and (fast food intake level is very Low) and (calorie level is very Low) and (BMI level is Very Low) then (the results is not risky) (Precaution is not needed).

Rule -15

If (the person is very active) and (fast food intake level is Low) and (calorie level is Low) and (BMI level is Very Low) then (the results is not risk) (Precaution is not needed).

Rule- 16

If (the person is very active) and (fast food intake level is Medium) and (calorie level is Medium) and (BMI level is Low) then (the results is not risky) (Precaution is not needed).

Rule -17

If (the person is very active) and (fast food intake level is very high) and (calorie level is very high) and (BMI level is higher) then (the result is risky) (Precaution is to take low calorie fast food).

Rule -18

If (the person is very active) and (fast food intake level is very high) and (calorie level is very high) and (BMI level is high) then (the result is risk) (Precaution is to avoid daily intake of fast food).
Rule -19

If (the person is very active) and (fast food intake level is very low) and (calorie level is Low) and (BMI level is Low) then (the results are not risky) (Precaution is not needed).

Rule- 20

If (the person is very active) and (fast food intake level is high) and (calorie level is very high) and (BMI level is Medium) then (the results are at Low risk) (Precaution is to take low calorie fast food).

Rule -21

If (the person is very active) and (fast food intake level is very high) and (calorie level is high) and (BMI level is Medium) then (the results are at Low risk) (Precaution is to take low calorie fast food).

Rule- 22

If (the person is very active) and (fast food intake level is Low) and (calorie level is high) and (BMI level is Medium) then (the results are at Low risk) (Precaution is to take low calorie fast food).

Rule- 23

If (the person is very active) and (fast food intake level is Medium) and (calorie level is very high) and (BMI level is Medium) then (the results are at Low risk) (Precaution is to take low calorie fast food).

Rule -24

If (the person is very active) and (fast food intake level is Low) and (calorie level is Medium) and (BMI level is Low) then (the results are not risky) (Precaution is not needed).
Rule -25

If (the person is very active) and (fast food intake level is high) and (calorie level is Medium) and (BMI level is Medium) then (the result is at Low risk) (Precaution is to take low calorie fast food).

Rule- 26

If (the person is very active) and (fast food intake level is Low) and (calorie level is very Low) and (BMI level is Low) then (the results is not risky) (Precaution is not needed).

Rule -27

If (the person is moderately active) and (fast food intake level is Very Low) and (calorie level is Very Low) and (BMI level is Very Low) then (the result is not risky) (Precaution is not needed).

Rule- 28

If (the person is moderately active) and (fast food intake level is Low) and (calorie level is Low) and (BMI level is Low) then (the result is not risky) (Precaution is not needed).

Rule -29

If (the person is moderately active) and (fast food intake level is Medium) and (calorie level is Medium) and (BMI level is Medium) then (the result is Moderately risk) (Precaution is to do exercise).

Rule- 30

If (the person is moderately active) and (fast food intake level is high) and (calorie level is high) and (BMI level is high) then (the result is risky) (Precaution is to exercise and take low calorie fast food).

Rule -31

If (the person is moderately active) and (fast food intake level is Very high) and (calorie level is Very high) and (BMI level is high) then (the result is risky) (Precaution is to exercise and take low calorie fast food).
Rule -32
If (the person is moderately active) and (fast food intake level is Very Low) and (calorie level is Low) and (BMI level is Low) then (the result is Low risky) (Precaution is to take low calorie fast food).

Rule -33
If (the person is moderately active) and (fast food intake level is high) and (calorie level is Very high) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).

Rule- 34
If (the person is moderately active) and (fast food intake level is Very high) and (calorie level is high) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).

Rule- 35
If (the person is moderately active) and (fast food intake level is Low) and (calorie level is high) and (BMI level is Medium) then (the result is Moderate risk) (Precaution is to do exercise).

Rule -36
If (the person is moderately active) and (fast food intake level is Medium) and (calorie level is Very high) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).

Rule -37
If (the person is moderately active) and (fast food intake level is Low) and (calorie level is Medium) and (BMI level is Low) then (the result is Low risk) (Precaution is to take low calorie fast food).

Rule- 38
If (the person is moderately active) and (fast food intake level is high) and (calorie level is Medium) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).
Rule -39
If (the person is moderately active) and (fast food intake level is Low) and (calorie level is very Low) and (BMI level is Low) then (the result is Low risk) (Precaution is to take low calorie fast food).

Rule- 40
If (the person is lightly active) and (fast food intake level is Very Low) and (calorie level is Very Low) and (BMI level is Very Low) then (the result is not risky) (Precaution is not needed).

Rule- 41
If (the person is lightly active) and (fast food intake level is Low) and (calorie level is Low) and (BMI level is Low) then (the result is Low risk) (Precaution is to take low calorie fast food).

Rule- 42
If (the person is lightly active) and (fast food intake level is Medium) and (calorie level is Medium) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).

Rule- 43
If (the person is lightly active) and (fast food intake level is high) and (calorie level is high) and (BMI level is High) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule- 44
If (the person is lightly active) and (fast food intake level is Very high) and (calorie level is Very high) and (BMI level is High) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule- 45
If (the person is lightly active) and (fast food intake level is Very Low) and (calorie level is Low) and (BMI level is Low) then (the result is a Low risk) (Precaution is to take low calorie fast food).
Rule - 46
If (the person is lightly active) and (fast food intake level is high) and (calorie level is Very high) and (BMI level is Very High) then (the result is risky) (Precaution is to change your activity Level).

Rule - 47
If (the person is lightly active) and (fast food intake level is Very high) and (calories level is high) and (BMI level is High) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule - 48
If (the person is lightly active) and (fast food intake level is Low) and (calorie level is high) and (BMI level is High) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule - 49
If (the person is lightly active) and (fast food intake level is Medium) and (calorie level is Very high) and (BMI level is High) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule - 50
If (the person is lightly active) and (fast food intake level is Low) and (calorie level is Medium) and (BMI level is Low) then (the result is Low risk) (Precaution is to take low calorie fast food).

Rule - 51
If (the person is lightly active) and (fast food intake level is high) and (calorie level is Medium) and (BMI level is Medium) then (the result is Moderate risk) (Precaution is to do exercise).

Rule - 52
If (the person is lightly active) and (fast food intake level is Low) and (calorie level is Very Low) and (BMI level is Low) then (the result is risky) (Precaution is to do exercise).
Rule- 53
If (the person is sedentary) and (fast food intake level is Very Low) and (calorie level is Very Low) and (BMI level is Very Low) then (the result is No risk) (Precaution is No need).

Rule-54
If (the person is sedentary) and (fast food intake level is Low) and (calorie level is Low) and (BMI level is Low) then (the result is Low risk) (Precaution is to take low calorie fast food).

Rule- 55
If (the person is sedentary) and (fast food intake level is Medium) and (calorie level is Medium) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).

Rule- 56
If (the person is sedentary) and (fast food intake level is high) and (calorie level is high) and (BMI level is high) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule-57
If (the person is sedentary) and (fast food intake level is Very high) and (calorie level is Very high) and (BMI level is Very high) then (the result is Highly risky) (Precaution is to change your activity level).

Rule- 58
If (the person is sedentary) and (fast food intake level is very low) and (calorie level is Low) and (BMI level is Low) then (the result is Low risk) (Precaution is to take low calorie fast food).

Rule- 59
If (the person is sedentary) and (fast food intake level is high) and (calorie level is Very high) and (BMI level is high) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).
Rule- 60

If (the person is sedentary) and (fast food intake level is very high) and (calorie level is high) and (BMI level is high) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule -61

If (the person is sedentary) and (fast food intake level is Low) and (calorie level is high) and (BMI level is high) then (the result is risky) (Precaution is to do exercise and take low calorie fast food).

Rule- 62

If (the person is sedentary) and (fast food intake level is Medium) and (calorie level is Very high) and (BMI level is Very high) then (the result is Highly risky) (Precaution is to change your activity level).

Rule -63

If (the person is sedentary) and (fast food intake level is Low) and (calorie level is Medium) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).

Rule- 64

If (the person is sedentary) and (fast food intake level is high) and (calorie level is Medium) and (BMI level is Medium) then (the result is Moderately risky) (Precaution is to do exercise).

Figure 5.1: Mamdhan rules for input and output attributes for the fast food eaters
Figure 5.1 explains about the four input attributes and two output attributes. The left side figure shows four boxes with the input attributes like 1) Activity level of the person 2) Fast food intake level 3) Calories level 4) BMI level. Center part represents, the FIS and the two boxes at the right side shows the output attributes which are 1) Risk of heart disease 2) Precaution are given.

![Figure 5.1: Diagram of input and output attributes](image)

**Figure 5.2: Mamdani rules for fast food**

Figure 5.2 clarifies about the 64 rules to know the threshold estimation of the fast food eaters which they themselves can predict when they will get the heart disease using Mamdani rule in fuzzy rule editor in Matlab.

![Figure 5.2: Mamdani rules](image)

**Figure 5.3: Mamdani surface viewer for fast food eaters**

Figure 5.3 represents the activity level of the person and fast food intake level, which will decide the risk of getting heart disease.

![Figure 5.3: Surface viewer](image)
Figure 5.4: MAMDHANI RULE VIEWER FOR FAST FOOD EATERS

5.9 Conclusion

In this chapter, the FR based system is used to predict the threshold esteem for the fast food eaters. According to the figure 5.4 here the conclusion is made. The six attributes are used here out of which four attributes are input attributes and two attributes are output attributes. The finding is planned in a way that the fast food eaters can use it themselves to see if the individual is having the risk of getting heart diseases or not. The conclusion of this study is that if a person is sedentary, even the low consumption of fast food will lead to the risk of heart disease.