UNIVERSITI TEKNOLOGI MARA

ISP568
Fuzzy Logic System

Full Report

CS2594A

SMART APPLICATION DIET ORGANIZER

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1.0 Introduction

1.1 Project Description

A proper diet plan is crucial for every athlete to perform at their best during competition. The peak of performance is related to how well they maintain energy level as their stamina when playing sport. A well-planned diet will provide enough energy and nutrients that can help enhance athletics' performance. The ideal diet plan for the athlete is similar to a general public healthy diet. However, not all athletes may have the exact dietary requirement as some need different diet plans depending on the type and intensity of their training. Dieticians play essential roles in preparing an optimal diet for athletes' daily routines. Hence, applying the concept of fuzziness to the system may help dieticians find the proper diet for each athlete's activities demands.

1.2 Problem Statement

The problem statement is the negligence of finding the right diet strategies among athletes in Malaysia.

Therefore, a solution to the problem, the application that will be developed should prepare the athletes' diet plan based on the sport and physique of the athlete. The process of solving athletes' dietary problems involved recommendations of the best diet strategies after a series of analyses had been conducted. Furthermore, the request for an optimal diet plan will focus on athlete calories goals. Hence, the calories goals became athlete diet plan objectives. Based on athletes' data, including sports involved, weight, and height. The application will display the number of calories that need to be taken by the athletes. Then, the right diet plan is organized for athlete training, recovery, and weight control to achieve the ideal body mass for the sports competition.

1.3 Objective

The main objective of this project is to enhance athletic performance, help athletes meet sports requirements and contribute to the body of knowledge in athlete diets.

1.3.1 To enhance athletic performance

Diet discipline plays a vital role in maintaining athletes' stamina and performance. Athletes must be at the height of their physical condition to stay one step ahead of competitors. However, constant training and intense exercise will drain an athlete's energy and performance. Therefore, the athlete must take prudent action in maintaining the empowered calorie reservation.

1.3.2 To help athletes meet sports requirements

In the central competitive arena, athletes must adhere to the regulation and requirements of the respective sport. Athletes shall be within the boundary set up by the governing body. Some sports, such as heavyweight competitions, may require athletes with a specific weight threshold to participate. Hence, supplying the proper diet for athletes can help to achieve the optimal body shape and weight.

1.3.3 To contribute a body of knowledge in athlete diets

Most athletes are equipped with dieticians and nutritionists to manage their dietary needs. Due to the advancement of technology in Artificial Intelligence and Fuzzy Logic Systems, the development of a system that can represent the knowledge of human experts and understand the fuzziness behind dietary management will provide insight for athletes for suitable diet strategy and reasoning. Therefore, the system will benefit intermediary athletes and diet experts to find the proper diet.

1.4 Scope of Project

Scopes of the system are targeted towards athletes as the primary main user. Eating balanced and nutritious foods can improve athletic performance, whether an elite athlete or a hobbyist. Some of the benefits of a well-balanced diet include:

- Improved cardiovascular health
- Improved respiratory function
- Stronger immune system
- Stronger bone and muscles
- Improved metabolism and rate of recovery

The Smart Application Diet Organizer (SADO) system will be a fuzzy-based system that can aid athletes to plan their diet based on their personal needs. Upon completion, this system will propose to the athlete a diet plan that they can follow that is optimum for their needs based on their inputs.

This system will be specializing in athletes' diets so that they can achieve peak performance in their respective sports. Different types of athletes also have different needs, which means the system will cater to each athlete's needs in various sports. Most significantly is the distinction of nutrition needed by an endurance athlete or an athlete involved in a more explosive sport.

This system can also be used by a coach, which they can use to evaluate the diets of their athletes and monitor their nutrition intake. Sometimes, an athlete's coach might be more suitable in considering what their athlete needs, not just what they think they need. They also have a better-honed insight of the requirements necessary to be successful in their sport, considering that coaches will most likely have more experience in the sport than their athletes. Based on this, it might be a good idea that the system be used by the coach of an athlete rather than the athletes themselves to gain more reliable inputs.

This system is not only a system for the athletes. Hobbyists can also use it to manage their diets towards a healthier lifestyle. If the user inputs to the system as a non-elite athlete, the system will recommend a less extreme diet. Hobbyists can also look forward to using this system when looking to peak for a state meet or competition if they consider managing their weight and diets a couple of weeks out from their competition.

1.5 Project Significance

The work of a nutritionist is not an easy one, and access to an expert nutritionist is challenging as there are not many nutritionists around. This is where the Smart Application Diet Organizer (SADO) plays its role to overcome the issue. Compared to orthodox methods, many significances can be observed when using this expert system.

The first of many significances of using this system is probably the most obvious. Hiring a personal nutritionist will always be costly because they are experts in their domain. There aren't many experts that are willing to charge their service on the cheap. If you consider this fact, using this expert system is hugely beneficial.

The second significance of using this system is that it is accessible 24/7. Nutritionists are humans. No matter how hard they are willing to work, they will surely need rest with a minimum of 6 hours. Therefore, when we finally decide to deploy the system in the future, we will make sure the system will be available to the users all the time, 24 hours and 7 days a week. Users will then be able to use this system without booking an appointment first and travelling a long way.

Thirdly, we keep in mind to make sure that the system will be as mobile as possible. A possible solution will be deploying to the web, which can be accessed from all devices that have an internet connection. Another alternative will be deploying to the mobile platform to make sure that users will have access to the system wherever they are.

Another significance of this system is that multiple users can use it. For example, access to a nutritionist is limited. Many procedures usually need to be followed to meet these experts. They can also only entertain not more than one client at a time.

Lastly, the number of times users can use this system will be unlimited. Whenever you want, wherever you want and no matter how many times, the system will always be ready to serve. An expert nutritionist will usually have to deal with many clients, so how often you refer to the expert will depend on the availability and how much energy is left at their expenditure. So, if you compare that to the system, we are proposing, this is a significant upgrade, and the system still holds much more potential for improvement in the future.

1.6 Literature Review

The foundation of human life is a healthy diet. "Healthy eating is about getting the right amount of nutrients-proteins, fats, carbohydrates, vitamins and minerals that you need to maintain good tour health" (H Barazesh F Oloumi, 2017). This aspect is abundantly visible in competitive situations such as sports. According to our findings, "Athletes are required to maintain the proportional and balanced diet strategies throughout the periodize training from endurance, intensity, competition and recovery phase" (Holmes, 2018). Therefore, each level of training requires a different plan for athletes' performance, energy, and recovery.

Athlete Stimulant Addiction

Based on our findings, it is evident that stimulant addiction is a common topic of discussion in the sports industry. According to Larry D. Bowers' Abuse of Performance-Enhancing Drugs in Sport, "the use of stimulants such as amphetamine, cocaine, strychnine, and ephedrine in modern sports to improve focus and delay fatigue was reported in the early 1900s." Athletes often overlook the need for a healthy diet instead of relying on pills and stimulants to keep their bodies in shape. Long-term harm is caused by a lack of an appropriate food plan. As a result of poor and inadequate dietary balance, athletes cannot perform successfully in competition or sustain severe damage in a short amount of time.

Ketogenic Diet is Unhealthy for Athletes

Many studies have been undertaken to understand nutritional goals and diet methods better. From 2018 to 2020, there is an increasing study trend in the ketogenic diet. According to the directions, the requirement for a healthy diet is still being researched to determine whether high quantities of saturated fats can increase athlete performance. In contrast, according to a 2019 study, "Despite increased fat oxidation and glycogen stores, no clear performance benefits were noted" (Fionn T

McSwiney, 2019). As a result, despite the rise of hazardous diet approaches such as the ketogenic diet, it is evident that a healthy and balanced diet is still essential for athletes. Athlete's diet is a group of foods that assist athletes to enhance their physical condition, control their weight, and heal diseases by strengthening their immune systems.

Dietitian is Important Role

Furthermore, the impact of a dietician is significant in determining athletes' food consumption and hydration patterns. According to a new study published in the Journal of Applied Science and Technology, dieticians can make critical decisions in diet prescription and meal planning to ensure athletes from various sports backgrounds meet their nutritional demands. Therefore, we may conclude from the research that dietitians and sports nutrition can provide the knowledge facts demonstrated by the study. Aside from that, the dietician is also responsible for providing a menu with appropriate variety and substantial food. "Sports nutritionists played an important role in ensuring that the menu addressed the needs of players from diverse cultural and sporting backgrounds" (Fiona Pelly, 2000). As a result, the needs of dietitians in the sports business will inevitably substantially impact athlete performance.

2.0 Linguistic Variables and Values

Most traditional tools for building modelling, reasoning, or computing are often related to crisp, accurate numerical characters. However, in this project, SADO will implement membership functions of fuzzy sets for weight, height, age, BMI, the intensity of training to present the calorie goals for athletes.

2.1 Weight

Weight of an athlete is crucial. They must maintain, or increase, or decrease them depending on the athlete on the type of training they practice. Unlike civilians, athlete's version of weight is slightly different. The data gathered here are based on the average of athletes' sports type for each category (light, average, heavy) measured in kg in Malaysia. Simply BMI is not enough, that is why weight is crucial as well to measure the degree of membership to determine their calorie intake.

Table 2.1.1 shows the range of weight according to their linguistic values:

Linguistic variable	*Linguistic values*	*Range (kg)*
Weight	Light	50 – 68
	Average	55 – 82
	Heavy	68 – *110*

Table 2.1.1 Linguistic Values and Range for Weight

Where:

Y*: Weight value is a member of the set ($\mu_{WEIGHT}(X) = 1$)
Y : Weight value is a member of the set ($0 < \mu_{WEIGHT}(X) < 1$)
N : Weight value is not a member of the set ($\mu_{WEIGHT}(X) = 0$)

Weight (kg)	*Light*	*Average*	*Heavy*
50	Y*	N	N
55	Y	N	N
60	Y	Y	N
68	N	Y*	N
70	N	Y	Y
80	N	Y	Y
82	N	N	Y
90	N	N	Y
100	N	N	Y
110	N	N	Y*

Table 2.1.2 Fuzzy Sets of Weight Category

2.2 Height

The height of an athlete will be measured with a certain degree of membership. The unit measurement used in calculating the height of an athlete will be in cm, centimetres. The linguistic values used to the athlete's height are short, average and tall. The ranges used are also more specific towards Malaysia's athletes. The height of an athlete will directly impact their BMI measurement, thus also modifying their calorie intake. The following table shows how the linguistics variables used are classified into a specific range of numbers.

Linguistic variable	*Linguistic values*	*Range*
Height	Short	160 – 165
	Average	162.5 – 177.5
	Tall	175 - 180

Table 2.2.1 Linguistic Values and Range for Height

The following table shows the fuzzy set for the linguistic variable 'Height'.

Where :

Y: Height value is a member of the set ($\mu_{HEIGHT}(X) = 1$)
N: Height value is not a member of the set ($\mu_{HEIGHT}(X) = 0$)

Height (cm)	*Short*	*Average*	*Tall*
160	Y	N	N
162.5	Y	N	N
165	N	Y	N
167.5	N	Y	N
170	N	Y	N
172.5	N	Y	N
175	N	Y	N
177.5	N	N	Y
180	N	N	Y

Table 2.2.2 Fuzzy Sets of Height Category

2.3 Age

The age required by an athlete will be measured with a certain degree of membership. The linguistic values included in variable age are young, middle-aged, and old. The age is used to determine the suitable age with their best recommendation for nutrition intake. For the athletes, different ages will get another requirement for the calorie intake. The ranges used are appropriate to the essential Malaysian athlete's ages category. Table 2.3.1 shows the range for the age according to their linguistic values:

Linguistic variable	*Linguistic values*	*Range*
Age	Young	20 - 30
	Middle-Age	25 - 55
	Old	50 - 60

Table 2.3.1 Linguistic Values and Range for Age

Table 2.3.2 shows the fuzzy set for the linguistic variable 'Age'.

Where:

Y: Age value is a member of the set ($\mu_{Age}(X) = 1$)

N: Age value is not a member of the set ($\mu_{Age}(X) = 0$)

Age	*Young*	*Middle-Age*	*Old*
20	Y	N	N
25	Y	N	N
30	N	Y	N
35	N	Y	N
40	N	Y	N
45	N	Y	N
50	N	Y	N
55	N	N	Y
60	N	N	Y
65	N	N	Y

Table 2.3.2 Fuzzy Sets of Age Category

2.4 BMI

Body Mass Index (BMI) is calculated using an athlete's body weight and height. This index is used to determine whether an athlete has a target body weight per height or not. The formula for calculating BMI for the system measurements uses weight in kilograms then divided by height in meters, squared. There are 4 major BMI categories underweight, normal, overweight, and obese. The following BMI categories are classified into linguistic values represented by a specific range

Table 2.4 shows the range of the BMI according to the category below:

Linguistic variable	*Linguistic values*	*Range*
BMI	Underweight	16 – 18.5
	Normal	17 – 26
	Overweight	23 – 30.5
	Obese	29 –31

Table 2.4.1 Linguistic Values and Range for BMI

The BMI range is a ratio between body mass and height shown in table 2.4.2.

Where:

Y: BMI value is a member of the set ($\mu_{BMI}(X) = 1$)
N: BMI value is not a member of the set ($\mu_{BMI}(X) = 0$)

BMI (kgm^{-2})	*Underweight*	*Normal*	*Overweight*	*Obesity*
15.5	Y	N	N	N
17	Y	N	N	N
18.5	N	Y	N	N
20	N	Y	N	N
21.5	N	Y	N	N
23	N	Y	N	N
24.5	N	Y	Y	N
26	N	N	Y	N
27.5	N	N	Y	N
29	N	N	Y	N
30.5	N	N	N	Y
32	N	N	N	Y

Table 2.4.2 Fuzzy Sets of BMI Category

2.5 Intensity of Training

Their level of membership will decide athletes' training intensity. Hours per day are used to calculate the power of training. The linguistic values associated with training intensity are low, moderate, and high. The table below shows the range for each linguistic value.

Linguistic variable	*Linguistic values*	*Range*
Intensity of Training	Low	0 - 4
	Moderate	3 - 6
	High	5 - 8

Table 2.5.1 Linguistic Values and Range for Intensity of Training

The following table shows the fuzzy set for the linguistic variable 'Intensity of Training'.

Where:

Y: Intensity of training value belongs to the set ($0 < \mu_{IOT}(X) < 1$)
Y*: Intensity of training value is the ideal member of the set ($\mu_{IOT}(X) = 1$)
N: Intensity of training value is not a member of the set ($\mu_{IOT}(X) = 0$)

The intensity of Training (hour/day)	*Low*	*Moderate*	*High*
0	Y*	N	N
1	Y	N	N
2	Y	N	N
3	Y	N	N
4	N	Y	N
5	N	Y*	N
6	N	Y	Y
7	N	N	Y
8	N	N	Y*

Table 2.5.2 Fuzzy Sets of Intensity of Training Category

2.6 Calorie Goals

Calorie goals required by athletes will be calculated with a certain degree of membership. Unit measurement of calorie goals is measured by kilocalorie, kcal. The linguistic values related to calorie goals are casual, low, moderate, and high. Furthermore, a low-calorie goal indicates athlete requires less calorie reservation, whereas a moderate level shows athletes need to have an optimum value of energy storage, and high represent the mass amount of calorie reservation required for the athletes.

Linguistic variable	*Linguistic values*	*Range*
Calorie goals	Casual	500 - 1300
	Low	1000 - 1800
	Moderate	1500 - 2300
	High	2000 - 2800
	Bulking	2500 - 2900

Table 2.6.1 Linguistic variable and values for calorie goals

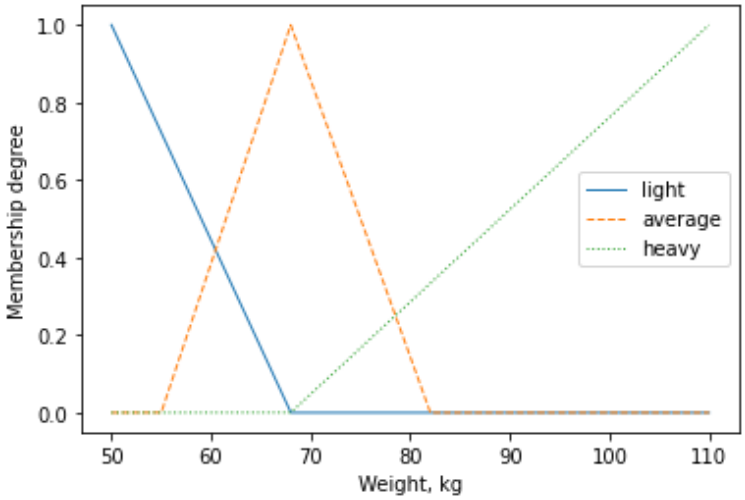
3.0 Graph Representation

3.1 Weight

Based on the linguistic variables and values in 3.1 Weight, the range of values can be formulated into the fuzzy set as follows:

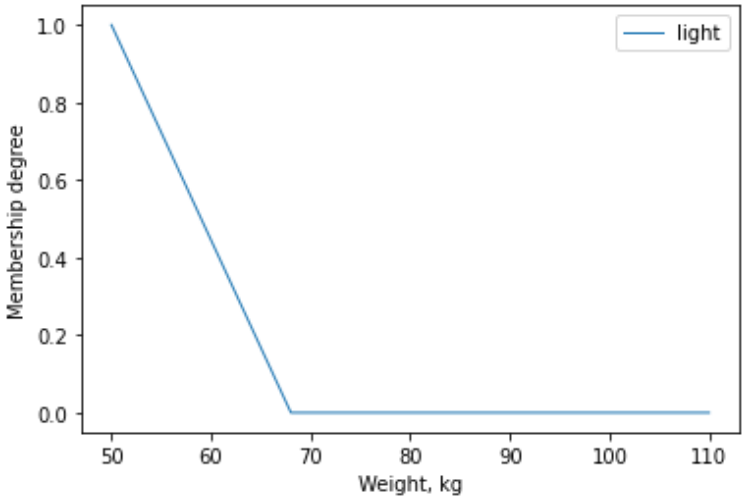
Light = (1/50, 0/68)
Average = (0/55, 1/68, 0/82)
Heavy = (0/68, 1/110)

Therefore, for each value, the Fuzzy Graph is shown in Graph 3.1.1.



Graph 3.1.1 Fuzzy Representation of Weight

3.1.1 Light Weight Membership Function



Graph 3.1.2 Triangular Function of Light Weight

The membership function for lightweight can be described as:

$$\mu_{light}(x, a, b) = \begin{cases} 1, & if\ x < a \\ (b-x)/(b-a), & if\ a \leq x \leq b \\ 0, & if\ b < x \end{cases}$$

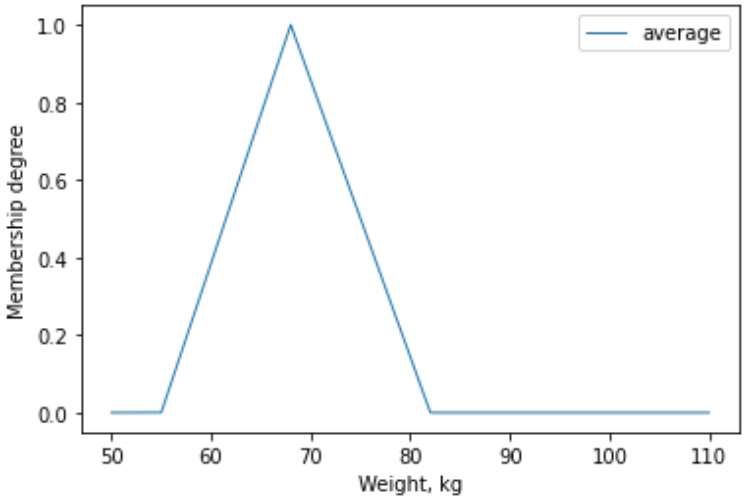
Given that, a = 50 and b = 68. The straight-line equation of casual calorie goals is:

$y = 1 \ldots (1)$

$y = -0.0556x + 3.78 \ldots (2)$

$y = 0 \ldots (3)$

3.1.2 Average Weight Membership Function



Graph 3.1.3 Triangular Function of Average Weight

The membership function for average weight can be described as:

$$\mu_{average}(x, a, b, c) = \begin{cases} 0 & if\ x < a \\ (x-a)/(b-a) & if\ a \leq x \leq b \\ (c-x)/(c-b), & if\ b \leq x \leq c \\ 0, & if\ c < x \end{cases}$$

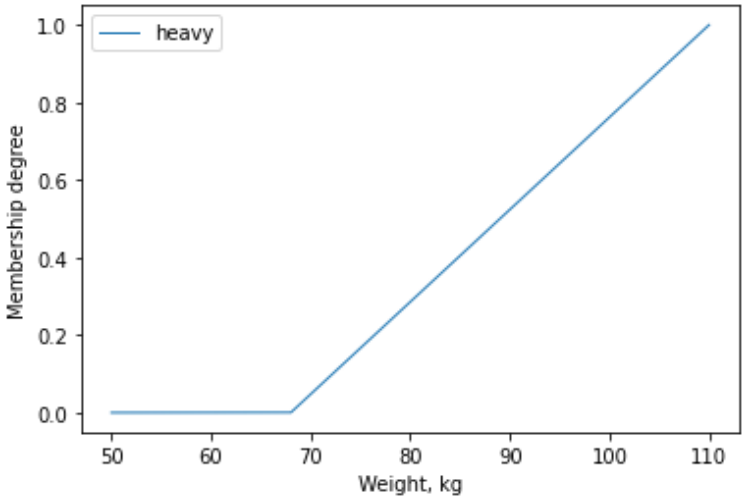
Given that, a = 55 and b = 68, c = 82. The straight-line equation of average weight is:

$y = 0.0769x - 4.2295 \ldots (1)$

$y = -0.0769x + 6.3058 \ldots (2)$

3.1.3 Heavy Weight Membership Function

The membership function for heavyweight can be described as:



Graph 3.1.4 Triangular Function of Light Weight

The membership function for heavyweight can be described as:

$$\mu_{heavy}(x, a, b) = \begin{cases} 1, & if\ \ b < x \\ (b-x)/(b-a), & if\ a\ \leq x\ \leq b \\ 0, & if\ x\ < a \end{cases}$$

Given that, a = 68 and b = 110. The straight-line equation of heavy weight goals is:

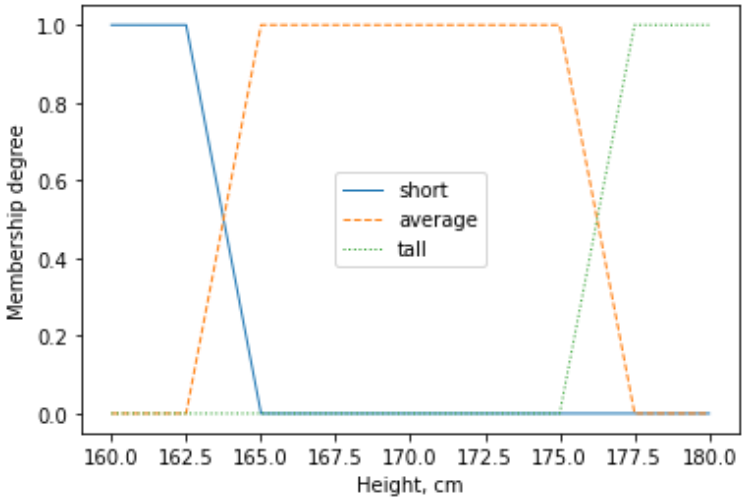
$y = 1 \ldots (1)$
$y = 0.0238x - 1.6190 \ \ldots (2)$
$y = 0 \ldots (3)$

3.2 Height

Based on the linguistic variable of Height and the values shown in 2.2 Height, the fuzzy sets can be determined as:

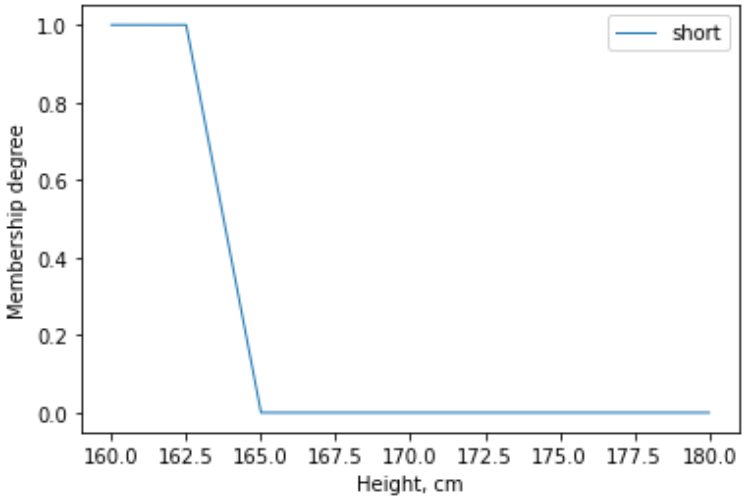
Short = (1/162.5, 0/165)
Average = (0/162.5, 1/165, 1/175, 0/177.5)
Tall = (0/175, 1/177.5)

The fuzzy set for variable Height is shown in Graph 3.2.1



Graph 3.2.1 Fuzzy Representation of Height

3.2.1 Short Height Membership Function



Graph 3.2.2 Fuzzy Representation of Short Height

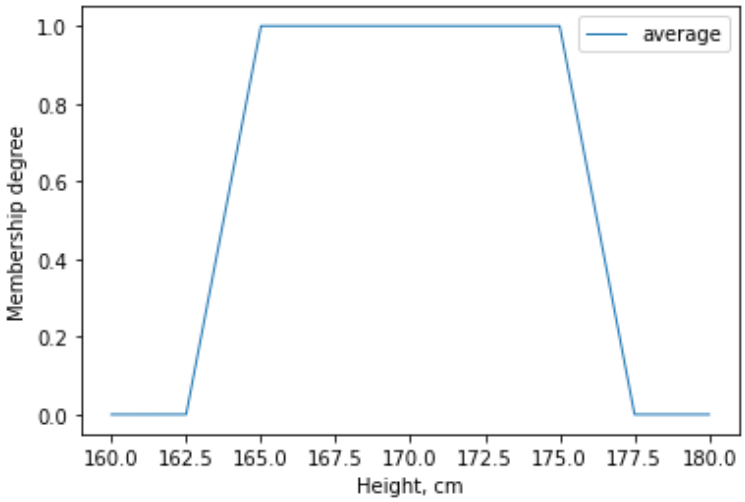
The membership function for short height can be defined as:

$$\mu_{short}(x, a, b) = \begin{cases} 1, & if\ x < a \\ (b-x)/(b-a), & if\ a \leq x \leq b \\ 0, & if\ b < x \end{cases}$$

Given that, a = 162.5 and b = 165. The straight-line equation of short heights is:

$$y = 1 \ldots (1)$$
$$y = -0.4x + 66 \ldots (2)$$
$$y = 0 \ldots (3)$$

3.2.2 Average Height Membership Function



Graph 3.2.3 Fuzzy Representation of Average Height

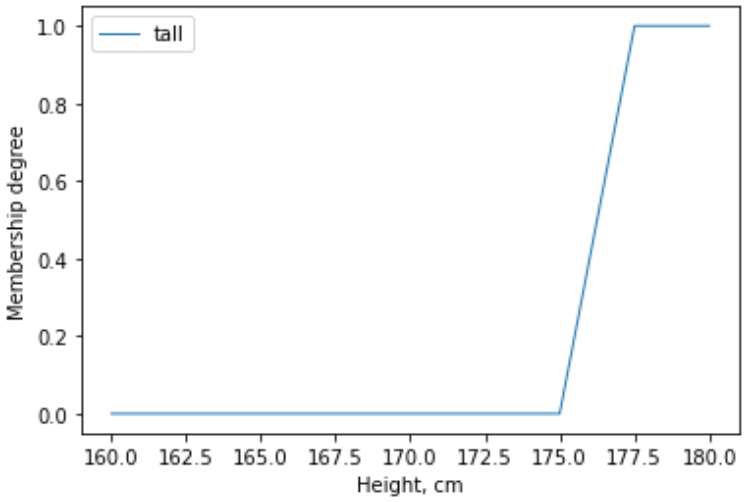
The membership function for average height can be defined as:

$$\mu_{average}(x, a, b, c, d) = \begin{cases} 0, & if\ x < a \\ (x-a)/(b-a), & if\ a \leq x \leq b \\ 1, & if\ b \leq x \leq c \\ (d-x)/(d-c), & if\ c \leq x \leq d \\ 0 & if\ d < x \end{cases}$$

Given that, a = 162.5, b = 165, c = 175 and d = 177.5. The straight-line equation of average height is:

$$y = 0 \ldots (1)$$
$$y = 0.4x - 65 \ldots (2)$$
$$y = 1 \ldots (3)$$
$$y = 0.4x - 71 \ldots (4)$$
$$y = 0 \ldots (5)$$

3.2.3 Tall Height Membership Function



Graph 3.2.4 Fuzzy Representation of Tall Height

The membership function for tall height can be defined as:

$$\mu_{tall}(x, a, b) = \begin{cases} 1, & if\ \ b < x \\ (x-a)/(b-a), & if\ a\ \leq x\ \leq b \\ 0, & if\ x < a \end{cases}$$

Given that, a = 175 and b = 177.5. The straight-line equation of tall height
is:

$y = 1 \ldots (1)$
$y = 0.4x - 70\ \ldots (2)$
$y = 0 \ldots (3)$

3.3 Age

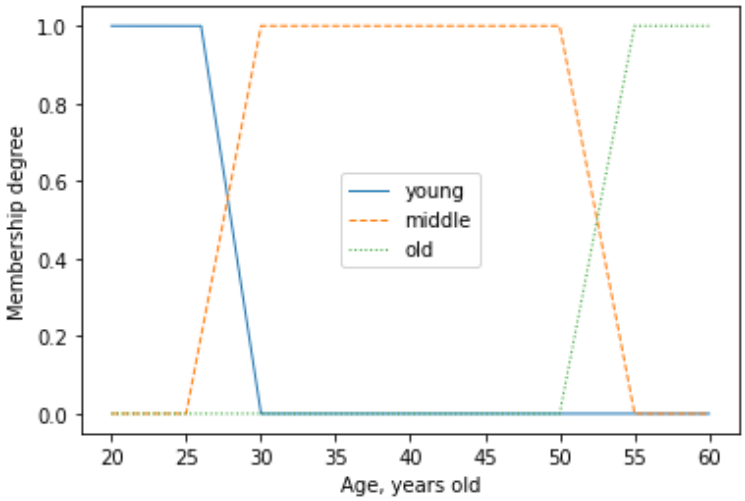
Based on the linguistic variable of Age and each of its value in 2.3 Age, the fuzzy sets can be determining as below:

Young = (1/20, 1/25, 0/30, 0/35, 0/40, 0/45, 0/50, 0/55, 0/60, 0/65)

Middle Age = (0/20, 0/25, 1/30, 1/35, 1/40, 1/45, 1/50, 0/55, 0/60, 0/65)

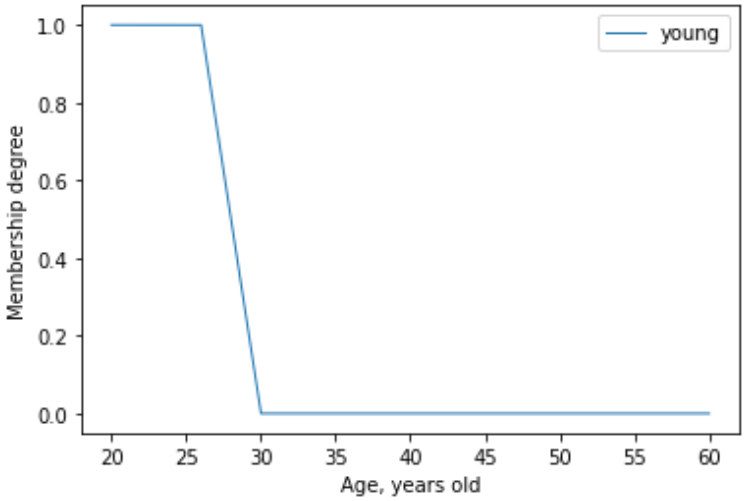
Old = (0/20, 0/25, 0/30, 0/35, 0/40, 0/45, 0/50, 1/55, 1/60, 1/65)

The fuzzy set for variable Height is shown in Graph 3.3.1



Graph 3.3.1 Fuzzy Representation of Age

3.3.1 Young Age Membership Function



Graph 3.3.2 Trapezoidal Function of Young age

The membership function for young age can be defined as:

$$\mu_{young}(x, a, b) = \begin{cases} 1, & if\ x < a \\ (b-x)/(b-a), & if\ a \leq x \leq b \\ 0, & if\ b < x \end{cases}$$

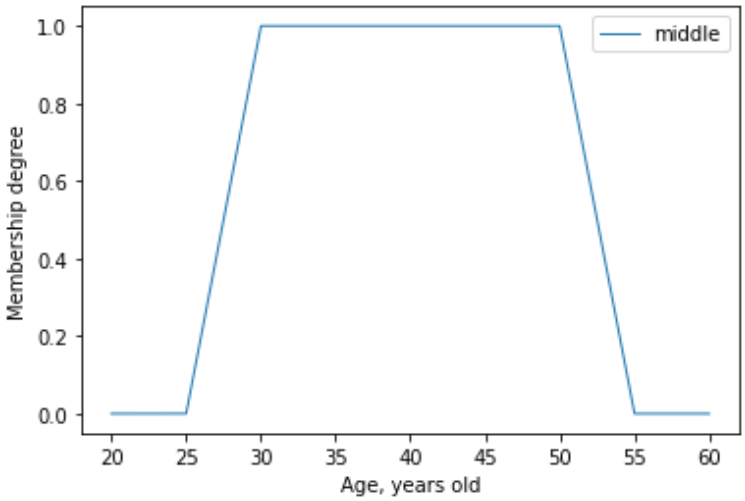
Given that, a = 25 and b = 30. The straight-line equation of young age is :

y = 1… (1)

y = -0.2x + 6…. (2)

y = 0…(3)

3.3.2 Middle-Age Membership Function



Graph 3.3.3 Trapezoidal Function of Middle-Age

The membership function for middle age can be describe as:

$$\mu_{middle\text{-}age}(x, a, b, c, d) = \begin{cases} 0, & if\ x < a \\ (x-a)/(b-a), & if\ a \leq x \leq b \\ 1, & if\ b \leq x \leq c \\ (d-x)/(d-c), & if\ c \leq x \leq d \\ 0 & if\ d < x \end{cases}$$

Given that, a = 25, b = 30, c = 50, d = 55. The straight-line equation of middle-age:

y = 0 …(1)

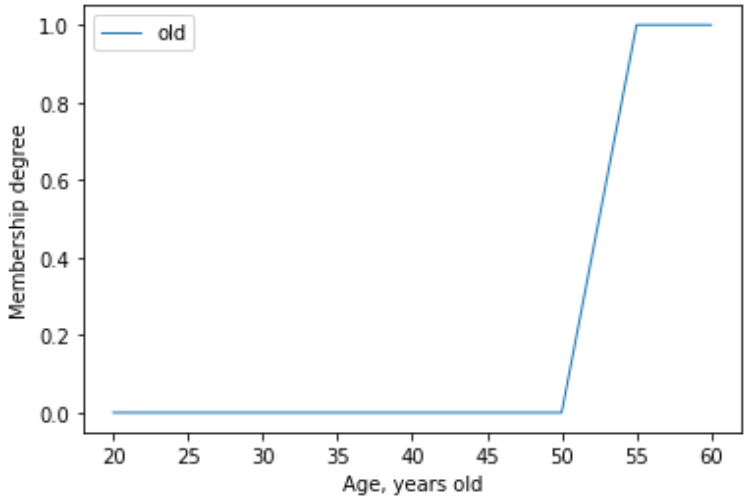
y = 0.2x – 5…(2)

y= 1…(3)

y= -0.2x + 11…(4)

y=0…(5)

3.3.3 Old Membership Function



Graph 3.3.3 Trapezoidal Function of Old Age

The membership function for old age can be defined as:

$$\mu_{old}(x, a, b) = \begin{cases} 1, & if\ \ b < x \\ (b-x)/(b-a), & if\ a \leq x \leq b \\ 0, & if\ x < a \end{cases}$$

Given that, a = 50 and b = 55. The straight-line equation of old age:

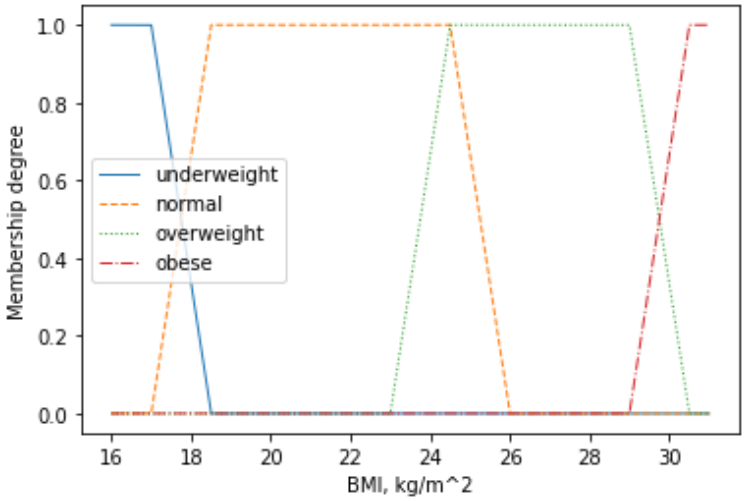
y = 0 … (1)
y= 0.2x – 10…(2)
y= 1…(1)

3.4 BMI

Based on the linguistic variable of BMI and each of its value in 2.4 BMI, the fuzzy sets can be determining as below:

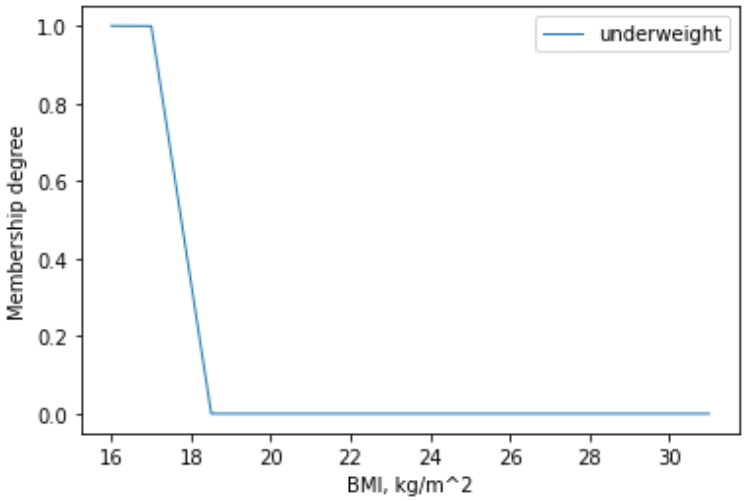
Underweight = (1/17, 0/18.5)
Normal = (0/17, 1/18.5, 1/24.5, 0/26)
Overweight = (0/23, 1/24.5, 1/29, 0/30.5)
Obese = (0/29, 1/30.5)

The BMI fuzzy set is shown in Graph 3.4.



Graph 3.4.1 BMI Fuzzy Set

3.4.1 Underweight BMI Membership Function



Graph 3.4.2 Trapezoidal Function of Underweight BMI.

The membership function for underweight BMI can be described as:

$$\mu_{\text{underweight}}(\mathrm{x}, \mathrm{a}, \mathrm{b}) = \begin{cases} 1, & if\ \mathrm{a} < x \\ \dfrac{b-x}{b-a}, & if\ a \leq x \leq b \\ 0, & if\ b < x \end{cases}$$

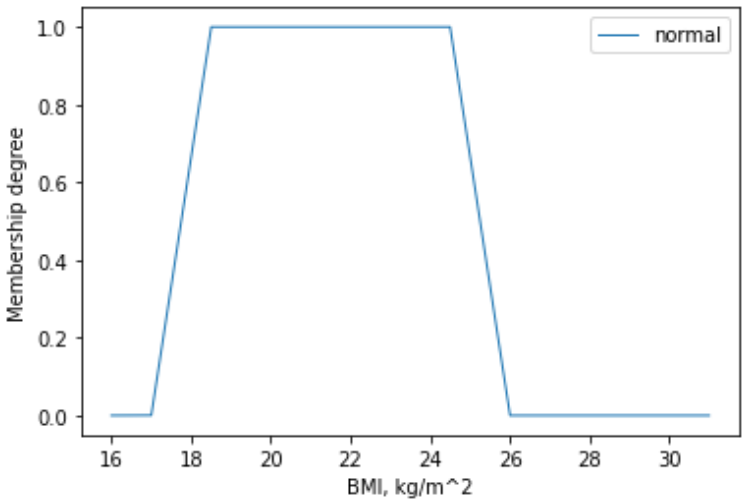
Given that, a = 17, b = 18.5. The straight-line equation of underweight BMI is:

$$y = 1 \ldots (1)$$

$$y = -0.6667x + 12.3333 \ldots (2)$$

$$y = 0 \ldots (3)$$

3.4.2 Normal BMI Membership Function



Graph 3.4.3 Trapezoidal Function of Normal BMI.

The membership function for normal BMI can be described as:

$$\mu_{normal}(x, a, b, c, d) = \begin{cases} 0, & if x < a \\ \frac{x-a}{b-a}, & if\ a \le x \le b \\ 1, & if\ b < x < c \\ \frac{d-x}{d-c}, & if\ c \le x \le d \\ 0, & if\ d < x \end{cases}$$

Given that, a = 17, b = 18.5, c = 24.5, and d = 26. The straight-line equation of normal BMI is:

$$y = 0 \dots (1)$$

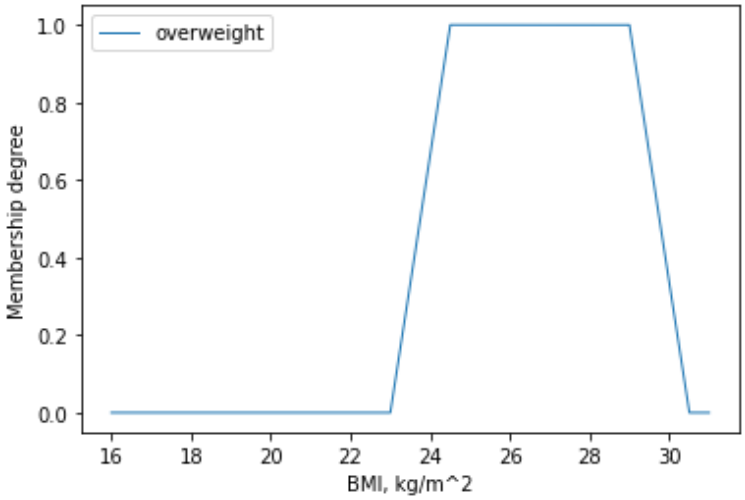
$$y = 0.6667x - 11.3333 \dots (2)$$

$$y = 1 \dots (3)$$

$$y = -0.6667x + 17.3333 \dots (4)$$

$$y = 0 \dots (5)$$

3.4.3 Overweight BMI Membership Function



Graph 3.4.3 Trapezoidal Function of Overweight BMI

The membership function for overweight BMI can be described as:

$$\mu_{\text{overweight}}(x, a, b, c, d) = \begin{cases} 0, & if x < a \\ \frac{x-a}{b-a}, & if\ a \le x \le b \\ 1, & if\ b < x < c \\ \frac{d-x}{d-c}, & if\ c \le x \le d \\ 0, & if\ d < x \end{cases}$$

Given that, a = 23, b = 24.5, c = 29, and d = 30.5. The straight-line equation of overweight BMI is:

$y = 0 \ldots (1)$

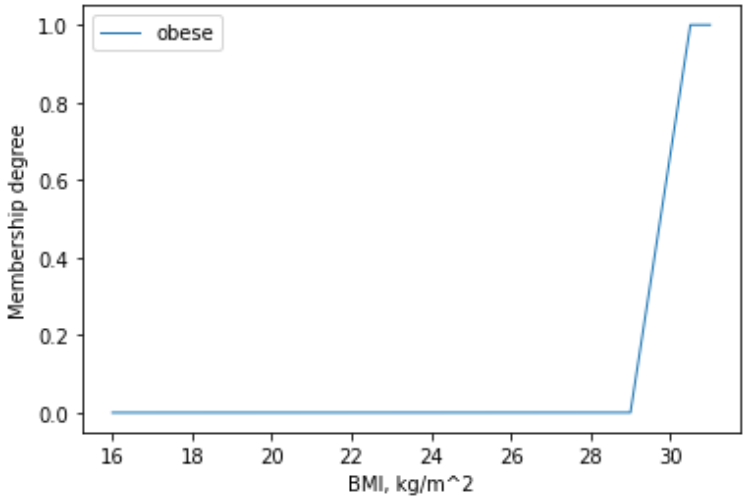
$y = 0.6667x - 15.3333 \ldots (2)$

$y = 1 \ldots (3)$

$y = -0.6667x + 20.3333 \ldots (4)$

$y = 0 \ldots (5)$

3.4.4 Obese BMI Membership Function



Graph 3.4.3 Trapezoidal Function of Obese BMI

The membership function for obese BMI can be described as:

$$\mu_{obese}(x, a, b) = \begin{cases} 0, & if x < a \\ \dfrac{x-a}{b-a}, & if\ a \le x \le b \\ 1, & if\ b < x \end{cases}$$

Given that, a = 29, b = 30.5. The straight-line equation of obese BMI is:

$$y = 0 \ldots (1)$$

$$y = 0.6667x - 19.3333 \ldots (2)$$

$$y = 1 \ldots (3)$$

3.5 Intensity of Training

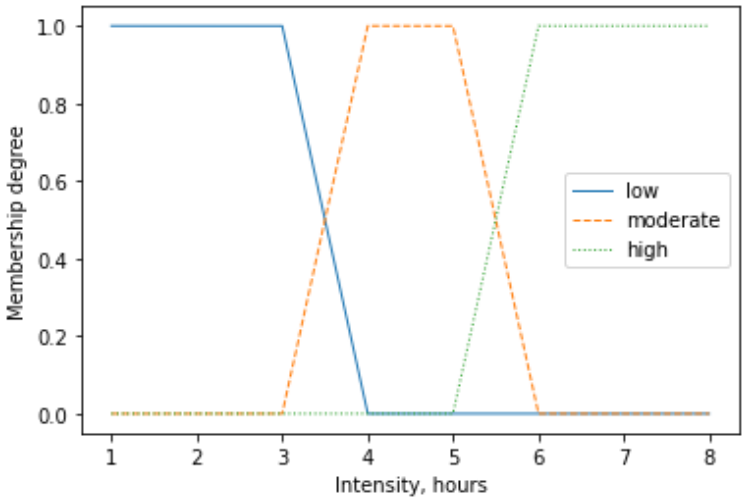
Based on the linguistic variable of intensity of training and each of its value in 2.5 Intensity of Training, the fuzzy sets can be determining as below:

Low = {1/1, 1/2, 1/3, 0/4, 0/5, 0/6, 0/7, 0/8}

Moderate = {0/1, 0/2, 0/3, 1/4, 1/5, 0/6, 0/7, 0/8}

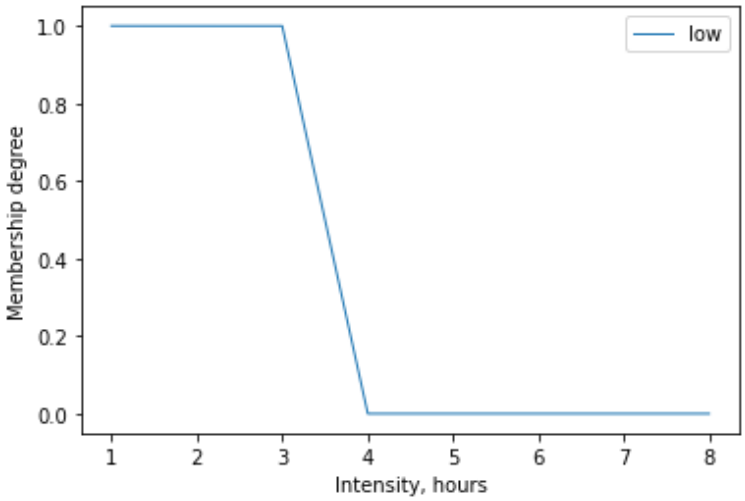
High = {0/1, 0/2, 0/3, 0/4, 0/5, 1/6, 1/7, 1/8}

The intensity of the training fuzzy set is shown in Graph 3.5.1.



Graph 3.5 Fuzzy Set of the Linguistic Variable *Intensity of Training*

3.5.1 Low Intensity of Training Membership Function



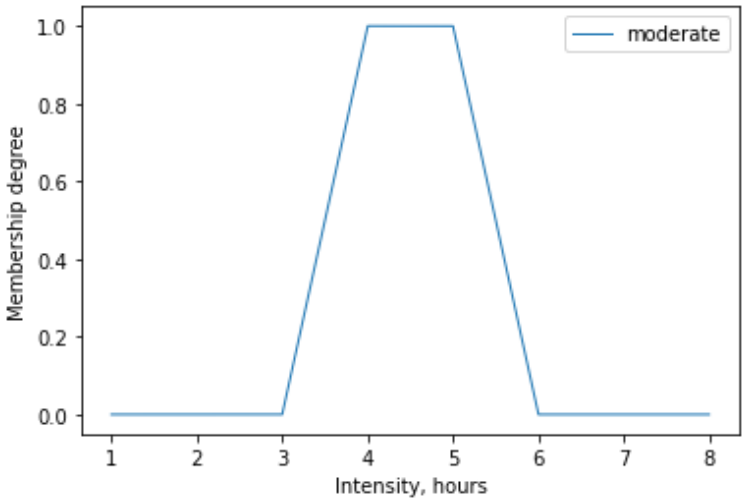
Graph 3.5.1 Trapezoidal Membership Functions of Low Intensity of Training

The membership function for low intensity if training can be described as:
Given that, a = 3 and b = 4 The straight-line equation of moderate intensity of training is:

$$\mu_{low}(x, a, b) = \begin{cases} 1, & if\ x < a \\ (b-x)/(b-a), & if\ a \leq x \leq b \\ 0, & if\ b < x \end{cases}$$

y = 1
y = -x + 4
y = 0

3.5.2 Moderate Intensity of Training Membership Function



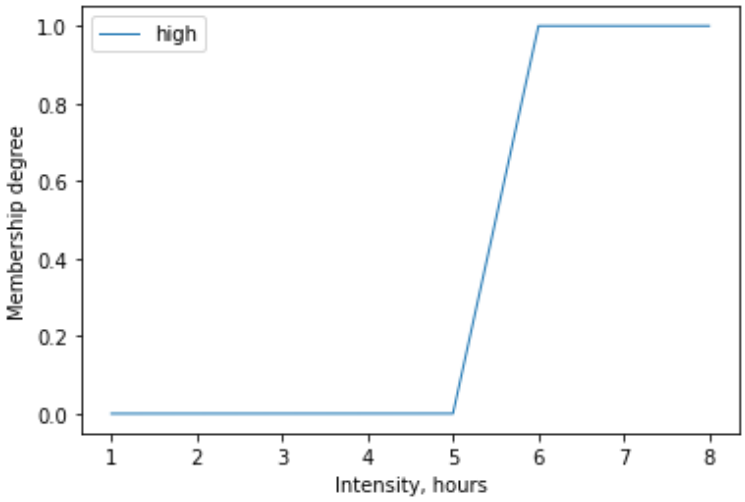
Graph 3.5.2 Trapezoidal Membership Functions of Moderate Intensity of Training

The membership function or moderate intensity if training can be described as:

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

Given that, a = 3, b = 4, c = 5, d = 6 The straight-line equation of moderate intensity of training is:
y = 0
y = x - 3
y = 1
y = -x + 6
y = 0

3.5.3 High Intensity of Training Membership Function



Graph 3.5.3 Trapezoidal Membership Functions of High Intensity of Training

The membership function for low intensity if training can be described as:

$$\mu_{high}(x,a,b) = \begin{cases} 0, & if\ x < a \\ \frac{(x-b)}{(b-a)}, & if\ a \le x \le b \\ 1, & if\ b < x \end{cases}$$

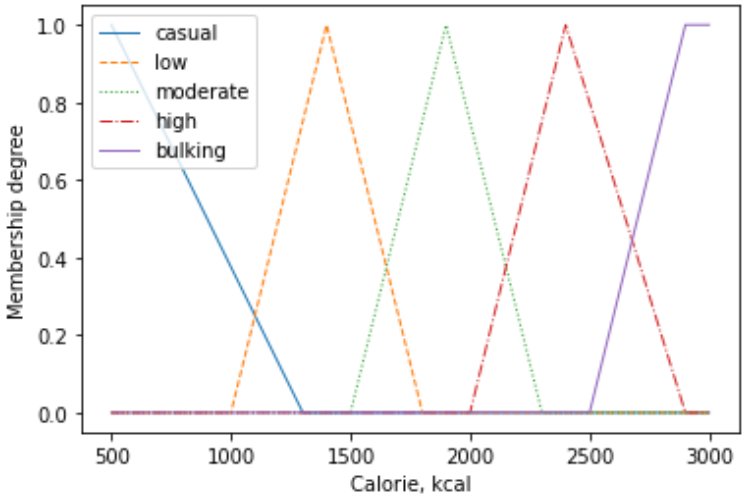
Given that, a = 5 and b = 6 The straight-line equation of moderate intensity of training is:
y = 0
y = x - 5
y = 1

3.6 Calorie Goals

Based on the linguistic variables and values in 2.6 Calorie Goals, the range of values can be formulated into fuzzy set as follows:

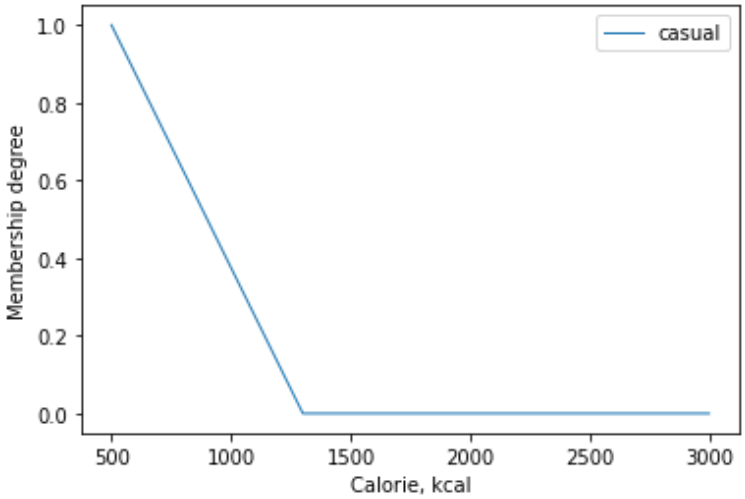
Casual = (1/500, 0/1300)
Low = (0/1000, 1/1400, 0/1800)
Moderate = (0/1500, 1/1900, 0/2300)
High = (0/2000, 1/2400, 0/2800)
Bulking = (0/2500, 1/2900)

Therefore, for each value of variables, the Fuzzy Graph is shown in Graph 3.6.1.



Graph 3.6.1 Fuzzy Representation of Calorie Goals

3.6.1 Casual Calorie Goals Membership Function



Graph 3.6.2 Triangular Function of Casual Calorie Goals

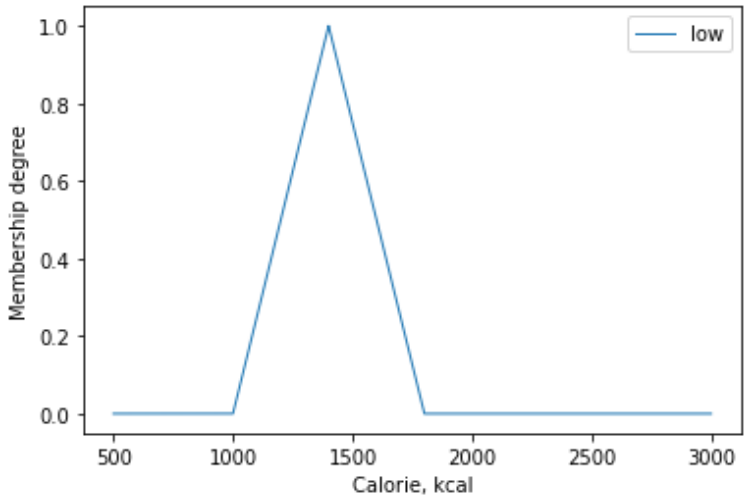
The membership function for casual calorie goals can be described as:

$$\mu_{casual}(x, a, b) = \begin{cases} 1, & if\ x < a \\ (b-x)/(b-a), & if\ a \leq x \leq b \\ 0, & if\ b < x \end{cases}$$

Given that, a = 500 and b = 1300. The straight-line equation of casual calorie goals is:

$y = 1 \ldots (1)$
$y = -0.00125x + 1.625 \ldots (2)$
$y = 0 \ldots (3)$

3.6.2 Low Calorie Goals Membership Function



Graph 3.6.3 Triangular Function of Low-Calorie Goals

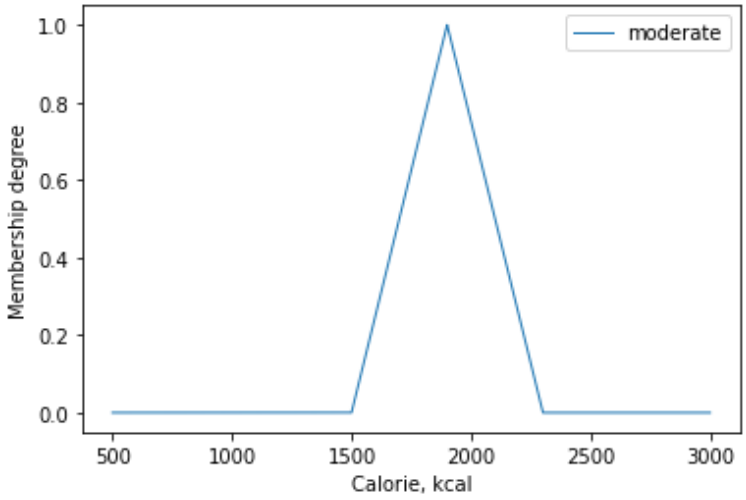
The membership function for casual calorie goals can be described as:

$$\mu_{low}(x, a, b) = \begin{cases} 0 & if\ x < a \\ (x-a)/(b-a) & if\ a \leq x \leq b \\ (c-x)/(c-b), & if\ b \leq x \leq c \\ 0, & if\ c < x \end{cases}$$

Given that, a = 1000, b = 1400 and c = 1800. The straight-line equation of casual calorie goals is:

$y = 0.0025x - 2.5 \ldots (1)$
$y = -0.0025x + 4.5 \ldots (2)$

3.6.3 Moderate Calorie Goals Membership Function



Graph 3.6.4 Triangular Function of Moderate Calorie Goals

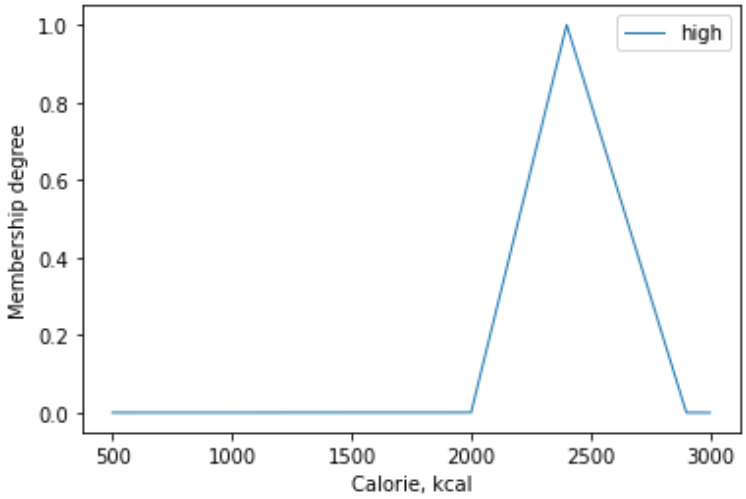
The membership function for casual calorie goals can be described as:

$$\mu_{moderate}(x, a, b) = \begin{cases} 0 & if\ x < a \\ (x-a)/(b-a) & if\ a \leq x \leq b \\ (c-x)/(c-b), & if\ b \leq x \leq c \\ 0, & if\ c < x \end{cases}$$

Given that, a = 1500, b = 1900 and c = 2300. The straight-line equation of casual calorie goals is:

$$y = 0.0025x - 3.75 \ldots (1)$$
$$y = -0.0025x + 5.75 \ldots (2)$$

3.6.4 High Calorie Goals Membership Function



Graph 3.6.5 Triangular Function of High Calorie Goals

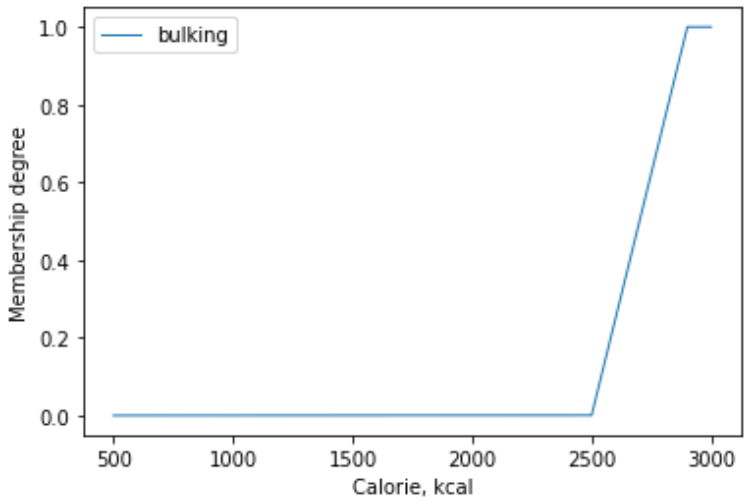
The membership function for high calorie goals can be described as:

$$\mu_{high}(x, a, b) = \begin{cases} 0 & if\ x < a \\ (x-a)/(b-a) & if\ a \leq x \leq b \\ (c-x)/(c-b), & if\ b \leq x \leq c \\ 0, & if\ c < x \end{cases}$$

Given that, a = 2000, b = 2400 and c = 2900. The straight-line equation of casual calorie goals is:

$y = 0.0025x - 5 \ldots (1)$
$y = -0.002x + 5.8 \ldots (2)$

3.6.5 Bulking Calorie Goals Membership Function



Graph 3.6.5 Trapezoidal Function of Bulking Calorie Goals

The membership function for high calorie goals can be described as:

$$\mu_{bulking}(x, a, b) = \begin{cases} 0, & if\ x < a \\ (b-x)/(b-a), & if\ a \leq x \leq b \\ 1, & if\ b < x \end{cases}$$

Given that, a = 2500 and b = 2900. The straight-line equation of casual calorie goals is:

$y = 0 \ldots (1)$
$y = 0.002x - 6.25 \ldots (2)$
$y = 1 \ldots (3)$

4.0 Fuzzy Rules

In this chapter we will describe the construction of the fuzzy rules

4.1 Define Linguistic Variables

Linguistic Variable: Weight, m						
Linguistic Value	Notation	Numerical range				Numerical Range (Normalized)
		Low	High	Low	High	
Light	L	50	68	0	0.3	[0.0, 0.3]
Average	A	55	82	0.1	0.5	[0.1, 0.5]
Heavy	H	68	110	0.3	1	[0.3, 1.0]

Linguistic Variable: Height, m						
Linguistic Value	Notation	Numerical range				Numerical Range (Normalized)
		Low	High	Low	High	
Short	S	160	165	0	0.3	[0.0, 0.3]
Average	A	162.5	177.5	0.1	0.9	[0.1, 0.9]
Tall	T	175	180	0.8	1	[0.8, 1.0]

Linguistic Variable: Age, years old						
Linguistic Value	Notation	Numerical range				Numerical Range (Normalized)
		Low	High	Low	High	
Young	Y	20	30	0	0.25	[0.00, 0.25]
Middle	M	25	55	0.13	0.88	[0.13, 0.88]
Old	O	50	60	0.75	1	[0.75, 1.00]

Linguistic Variable: Intensity of training, hours						
Linguistic Value	Notation	Numerical range				Numerical Range (Normalized)
		Low	High	Low	High	
Low	L	1	4	0	0.43	[0.00, 0.43]
Moderate	M	3	6	0.29	0.71	[0.29, 0.71]
High	H	5	8	0.57	1	[0.57, 1.00]

Linguistic Variable: BMI, bmi						
Linguistic Value	Notation	Numerical range				Numerical Range (Normalized)
		Low	High	Low	High	
Underweight	U	17	18.5	0	0.08	[0.00, 0.08]
Normal	N	18	25.5	0.06	0.47	[0.06, 0.47]
Overweight	O	23	30.5	0.33	0.75	[0.33, 0.75]
Obese	OB	28	35	0.61	1	[0.61, 1.00]

Linguistic Variable: Calorie (kcal)						
Linguistic Value	Notation	Numerical range				Numerical Range (Normalized)
		Low	High	Low	High	
Casual	C	500	1300	0	0.3	[0.0, 0.3]
Low	L	1000	1800	0.2	0.5	[0.2, 0.5]
Moderate	M	1500	2300	0.4	0.6	[0.4, 0.6]
High	H	2000	2800	0.5	0.8	[0.5, 0.8]
Bulking	B	2500	3300	0.7	1	[0.7, 1.0]

4.2 Elicit and Construct fuzzy Rules

	INPUT					OUTPUT
Rules	Weight	Height	Age	IT	BMI	Calorie Goal
1	L	S	Y	L	U	C
2	A	S	Y	L	U	C
3	H	S	Y	L	U	C
4	L	A	Y	L	U	C
5	A	A	Y	L	U	L
6	H	A	Y	L	U	L
7	L	T	Y	L	U	L
8	A	T	Y	L	U	L
9	H	T	Y	L	U	L
10	L	S	M	L	U	C
11	A	S	M	L	U	C
12	H	S	M	L	U	L
13	L	A	M	L	U	L
14	A	A	M	L	U	L
15	H	A	M	L	U	L
16	L	T	M	L	U	L
17	A	T	M	L	U	L
18	H	T	M	L	U	M
19	L	S	O	L	U	L
20	A	S	O	L	U	L
21	H	S	O	L	U	L
22	L	A	O	L	U	L
23	A	A	O	L	U	L
24	H	A	O	L	U	M
25	L	T	O	L	U	L
26	A	T	O	L	U	M
27	H	T	O	L	U	M
28	L	S	Y	M	U	C
29	A	S	Y	M	U	C
30	H	S	Y	M	U	L
31	L	A	Y	M	U	L
32	A	A	Y	M	U	L
33	H	A	Y	M	U	L
34	L	T	Y	M	U	L
35	A	T	Y	M	U	L
36	H	T	Y	M	U	M
37	L	S	M	M	U	L
38	A	S	M	M	U	L
39	H	S	M	M	U	L
40	L	A	M	M	U	L

Rules	Weight	Height	Age	IT	BMI	Calorie Goal
41	A	A	M	M	U	L
42	H	A	M	M	U	M
43	L	T	M	M	U	M
44	A	T	M	M	U	M
45	H	T	M	M	U	H
46	L	S	O	M	U	L
47	A	S	O	M	U	L
48	H	S	O	M	U	L
49	L	A	O	M	U	L
50	A	A	O	M	U	M
51	H	A	O	M	U	M
52	L	T	O	M	U	M
53	A	T	O	M	U	M
54	H	T	O	M	U	H
55	L	S	Y	H	U	L
56	A	S	Y	H	U	L
57	H	S	Y	H	U	L
58	L	A	Y	H	U	L
59	A	A	Y	H	U	L
60	H	A	Y	H	U	M
61	L	T	Y	H	U	L
62	A	T	Y	H	U	M
63	H	T	Y	H	U	M
64	L	S	M	H	U	L
65	A	S	M	H	U	L
66	H	S	M	H	U	L
67	L	A	M	H	U	L
68	A	A	M	H	U	M
69	H	A	M	H	U	M
70	L	T	M	H	U	M
80	A	T	O	H	U	H
81	H	T	O	H	U	H
82	L	S	Y	L	U	C
83	A	S	Y	L	N	C
84	H	S	Y	L	N	L
85	L	A	Y	L	N	L
86	A	A	Y	L	N	L
87	H	A	Y	L	N	L
88	L	T	Y	L	N	L
89	A	T	Y	L	N	L
90	H	T	Y	L	N	M

Rules	Weight	Height	Age	IT	BMI	Calorie Goal
91	L	S	M	L	N	L
92	A	S	M	L	N	L
93	H	S	M	L	N	L
94	L	A	M	L	N	L
95	A	A	M	L	N	L
96	H	A	M	L	N	M
97	L	T	M	L	N	M
98	A	T	M	L	N	M
99	H	T	M	L	N	H
100	L	S	O	L	N	L
101	A	S	O	L	N	L
102	H	S	O	L	N	L
103	L	A	O	L	N	L
104	A	A	O	L	N	M
105	H	A	O	L	N	M
106	L	T	O	L	N	M
107	A	T	O	L	N	M
108	H	T	O	L	N	H
109	L	S	Y	M	N	L
110	A	S	Y	M	N	L
111	H	S	Y	M	N	L
112	L	A	Y	M	N	L
113	A	A	Y	M	N	L
114	H	A	Y	M	N	M
115	L	T	Y	M	N	M
116	A	T	Y	M	N	M
117	H	T	Y	M	N	H
118	L	S	M	M	N	L
119	A	S	M	M	N	L
120	H	S	M	M	N	M
121	L	A	M	M	N	M
122	A	A	M	M	N	M
123	H	A	M	M	N	H
124	L	T	M	M	N	M
125	A	T	M	M	N	H
126	H	T	M	M	N	H
127	L	S	O	M	N	L
128	A	S	O	M	N	L
129	H	S	O	M	N	M
130	L	A	O	M	N	M

Rules	Weight	Height	Age	IT	BMI	Calorie Goal
131	A	A	O	M	N	M
132	H	A	O	M	N	H
133	L	T	O	M	N	H
134	A	T	O	M	N	H
135	H	T	O	M	N	H
136	L	S	Y	H	N	L
137	A	S	Y	H	N	L
138	H	S	Y	H	N	L
139	L	A	Y	H	N	L
140	A	A	Y	H	N	M
141	H	A	Y	H	N	M
142	L	T	Y	H	N	M
143	A	T	Y	H	N	M
144	H	T	Y	H	N	H
145	L	S	M	H	N	L
146	A	S	M	H	N	L
147	H	S	M	H	N	M
148	L	A	M	H	N	M
149	A	A	M	H	N	M
150	H	A	M	H	N	H
151	L	T	M	H	N	H
152	A	T	M	H	N	H
153	H	T	M	H	N	H
154	L	S	O	H	N	L
155	A	S	O	H	N	M
156	H	S	O	H	N	M
157	L	A	O	H	N	M
158	A	A	O	H	N	H
159	H	A	O	H	N	H
160	L	T	O	H	N	H
161	A	T	O	H	N	H
162	H	T	O	H	N	H
163	L	S	Y	L	O	C
164	A	S	Y	L	O	L
165	H	S	Y	L	O	L
166	L	A	Y	L	O	L
167	A	A	Y	L	O	L
168	H	A	Y	L	O	L
169	L	T	Y	L	O	L
170	A	T	Y	L	O	M

Rules	Weight	Height	Age	IT	BMI	Calorie Goal
171	H	T	Y	L	O	M
172	L	S	M	L	O	L
173	A	S	M	L	O	L
174	H	S	M	L	O	L
175	L	A	M	L	O	L
176	A	A	M	L	O	L
177	H	A	M	L	O	M
178	L	T	M	L	O	M
179	A	T	M	L	O	M
180	H	T	M	L	O	H
181	L	S	O	L	O	L
182	A	S	O	L	O	L
183	H	S	O	L	O	M
184	L	A	O	L	O	M
185	A	A	O	L	O	M
186	H	A	O	L	O	H
187	L	T	O	L	O	M
188	A	T	O	L	O	H
189	H	T	O	L	O	H
190	L	S	Y	M	O	L
191	A	S	Y	M	O	L
192	H	S	Y	M	O	L
193	L	A	Y	M	O	L
194	A	A	Y	M	O	L
195	H	A	Y	M	O	M
196	L	T	Y	M	O	M
197	A	T	Y	M	O	M
198	H	T	Y	M	O	H
199	L	S	M	M	O	L
200	A	S	M	M	O	L
201	H	S	M	M	O	M
202	L	A	M	M	O	M
203	A	A	M	M	O	M
204	H	A	M	M	O	H
205	L	T	M	M	O	H
206	A	T	M	M	O	H
207	H	T	M	M	O	H
208	L	S	O	M	O	L
209	A	S	O	M	O	M
210	H	S	O	M	O	M

Rules	Weight	Height	Age	IT	BMI	Calorie Goal
211	L	A	O	M	O	M
212	A	A	O	M	O	H
213	H	A	O	M	O	H
214	L	T	O	M	O	H
215	A	T	O	M	O	H
216	H	T	O	M	O	H
217	L	S	Y	H	O	L
218	A	S	Y	H	O	L
219	H	S	Y	H	O	M
220	L	A	Y	H	O	M
221	A	A	Y	H	O	M
222	H	A	Y	H	O	H
223	L	T	Y	H	O	M
224	A	T	Y	H	O	H
225	H	T	Y	H	O	H
226	L	S	M	H	O	L
227	A	S	M	H	O	M
228	H	S	M	H	O	M
229	L	A	M	H	O	M
230	A	A	M	H	O	H
231	H	A	M	H	O	H
232	L	T	M	H	O	H
233	A	T	M	H	O	H
234	H	T	M	H	O	H
235	L	S	O	H	O	M
236	A	S	O	H	O	M
237	H	S	O	H	O	H
238	L	A	O	H	O	H
239	A	A	O	H	O	H
240	H	A	O	H	O	H
241	L	T	O	H	O	H
242	A	T	O	H	O	H
243	H	T	O	H	O	B
244	L	S	Y	L	OB	L
245	A	S	Y	L	OB	L
246	H	S	Y	L	OB	L
247	L	A	Y	L	OB	L
248	A	A	Y	L	OB	L
249	H	A	Y	L	OB	M
250	L	T	Y	L	OB	M

Rules	Weight	Height	Age	IT	BMI	Calorie Goal
251	A	T	Y	L	OB	M
252	H	T	Y	L	OB	H
253	L	S	M	L	OB	L
254	A	S	M	L	OB	L
255	H	S	M	L	OB	L
256	L	A	M	L	OB	L
257	A	A	M	L	OB	M
258	H	A	M	L	OB	M
259	L	T	M	L	OB	M
260	A	T	M	L	OB	H
261	H	T	M	L	OB	H
262	L	S	O	L	OB	L
263	A	S	O	L	OB	L
264	H	S	O	L	OB	M
265	L	A	O	L	OB	M
266	A	A	O	L	OB	M
267	H	A	O	L	OB	H
268	L	T	O	L	OB	H
269	A	T	O	L	OB	H
270	H	T	O	L	OB	H
271	L	S	Y	M	OB	L
272	A	S	Y	M	OB	L
273	H	S	Y	M	OB	L
274	L	A	Y	M	OB	L
275	A	A	Y	M	OB	M
276	H	A	Y	M	OB	M
277	L	T	Y	M	OB	M
278	A	T	Y	M	OB	M
279	H	T	Y	M	OB	H
280	L	S	M	M	OB	L
281	A	S	M	M	OB	L
282	H	S	M	M	OB	M
283	L	A	M	M	OB	M
284	A	A	M	M	OB	M
285	H	A	M	M	OB	H
286	L	T	M	M	OB	H
287	A	T	M	M	OB	H
288	H	T	M	M	OB	H
289	L	S	O	M	OB	M
290	A	S	O	M	OB	M

Rules	Weight	Height	Age	IT	BMI	Calorie Goal
291	H	S	O	M	OB	H
292	L	A	O	M	OB	H
293	A	A	O	M	OB	H
294	H	A	O	M	OB	H
295	L	T	O	M	OB	H
296	A	T	O	M	OB	H
297	H	T	O	M	OB	H
298	L	S	Y	H	OB	L
299	A	S	Y	H	OB	L
300	H	S	Y	H	OB	M
301	L	A	Y	H	OB	M
302	A	A	Y	H	OB	M
303	H	A	Y	H	OB	H
304	L	T	Y	H	OB	H
305	A	T	Y	H	OB	H
306	H	T	Y	H	OB	H
307	L	S	M	H	OB	M
308	A	S	M	H	OB	M
309	H	S	M	H	OB	H
310	L	A	M	H	OB	H
311	A	A	M	H	OB	H
312	H	A	M	H	OB	H
313	L	T	M	H	OB	H
314	A	T	M	H	OB	H
315	H	T	M	H	OB	H
316	L	S	O	H	OB	M
317	A	S	O	H	OB	M
318	H	S	O	H	OB	H
319	L	A	O	H	OB	H
320	A	A	O	H	OB	H
321	H	A	O	H	OB	H
322	L	T	O	H	OB	H
323	A	T	O	H	OB	H
324	H	T	O	H	OB	B

4.3 Encode the fuzzy sets

Rule 1
IF weight is light
AND height is short
AND age is young
AND intensity training is low
AND BMI is underweight
THEN calorie goal is casual

Rule 2
IF weight is heavy
AND height is short
AND age is young
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is casual

Rule 3
IF weight is light
AND height is average
AND age is young
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is casual

Rule 4
IF weight is average
AND height is average
AND age is young
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 5
IF weight is heavy
AND height is average
AND age is young
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 6
IF weight is heavy
AND height is average
AND age is young
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 7
IF weight is light
AND height is tall
AND age is young
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 8
IF weight is heavy
AND height is tall
AND age is young
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 9
IF weight is light
AND height is short
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is casual

Rule 10
IF weight is average
AND height is short
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is casual

Rule 11
IF weight is heavy
AND height is short
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 12
IF weight is light
AND height is average
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 13
IF weight is average
AND height is average
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 14
IF weight is heavy
AND height is average
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 15
IF weight is light
AND height is tall
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 16
IF weight is average
AND height is tall
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 17
IF weight is heavy
AND height is tall
AND age is middle
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is moderate

Rule 18
IF weight is light
AND height is short
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 19
IF weight is average
AND height is short
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 20
IF weight is heavy
AND height is short
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 21
IF weight is light
AND height is average
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 22
IF weight is average
AND height is average
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 23
IF weight is heavy
AND height is average
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is moderate

Rule 24
IF weight is light
AND height is tall
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is low

Rule 25
IF weight is average
AND height is tall
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is moderate

Rule 26
IF weight is heavy
AND height is tall
AND age is old
AND intensity of training is low
AND BMI is underweight
THEN calorie goal is moderate

Rule 27
IF weight is light
AND height is short
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is casual

Rule 28
IF weight is average
AND height is short
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is casual

Rule 29
IF weight is heavy
AND height is short
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 30
IF weight is light
AND height is average
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 31
IF weight is average
AND height is average
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 32
IF weight is heavy
AND height is average
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 33
IF weight is light
AND height is tall
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 34
IF weight is average
AND height is tall
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 35
IF weight is heavy
AND height is tall
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 36
IF weight is light
AND height is short
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 37
IF weight is average
AND height is short
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 38
IF weight is heavy
AND height is short
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 39
IF weight is light
AND height is short
AND age is young
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is casual

Rule 40
IF weight is light
AND height is average
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 41
IF weight is average
AND height is average
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 42
IF weight is heavy
AND height is average
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 43
IF weight is light
AND height is tall
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 44
IF weight is average
AND height is tall
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 45
IF weight is heavy
AND height is tall
AND age is middle
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is high

Rule 46
IF weight is light
AND height is short
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 47
IF weight is average
AND height is short
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 48
IF weight is heavy
AND height is short
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 49
IF weight is light
AND height is average
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is low

Rule 50
IF weight is average
AND height is average
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 51
IF weight is heavy
AND height is average
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 52
IF weight is light
AND height is tall
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 53
IF weight is average
AND height is tall
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is moderate

Rule 54
IF weight is heavy
AND height is tall
AND age is old
AND intensity of training is moderate
AND BMI is underweight
THEN calorie goal is high

Rule 55
IF weight is light
AND height is short
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 56
IF weight is average
AND height is short
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 57
IF weight is heavy
AND height is short
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 58
IF weight is light
AND height is average
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 59
IF weight is average
AND height is average
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 60
IF weight is heavy
AND height is average
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 61
IF weight is light
AND height is tall
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 62
IF weight is average
AND height is tall
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 63
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 64
IF weight is light
AND height is short
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 65
IF weight is average
AND height is short
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 66
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 67
IF weight is light
AND height is average
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 68
IF weight is average
AND height is average
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 69
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 70
IF weight is light
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 71
IF weight is average
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 72
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is underweight
THEN calorie goal is high

Rule 73
IF weight is light
AND height is short
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 74
IF weight is average
AND height is short
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is low

Rule 75
IF weight is heavy
AND height is short
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 76
IF weight is light
AND height is average
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 77
IF weight is average
AND height is average
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is moderate

Rule 78
IF weight is heavy
AND height is average
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is high

Rule 79
IF weight is light
AND height is tall
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is high

Rule 80
IF weight is average
AND height is tall
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is high

Rule 81
IF weight is heavy
AND height is tall
AND age is old
AND intensity training is high
AND BMI is underweight
THEN calorie goal is high

Rule 82
IF weight is light
AND height is short
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is casual

Rule 83
IF weight is average
AND height is short
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is casual

Rule 84
IF weight is heavy
AND height is short
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 85
IF weight is light
AND height is average
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 86
IF weight is average
AND height is average
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 87
IF weight is heavy
AND height is average
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 88
IF weight is light
AND height is tall
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 89
IF weight is average
AND height is tall
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 90
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 91
IF weight is light
AND height is short
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 92
IF weight is average
AND height is short
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 93
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 94
IF weight is light
AND height is average
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 95
IF weight is average
AND height is average
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 96
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 97
IF weight is light
AND height is tall
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 98
IF weight is average
AND height is tall
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 99
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is low
AND BMI is normal
THEN calorie goal is high

Rule 100
IF weight is light
AND height is short
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 101
IF weight is average
AND height is short
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 102
IF weight is heavy
AND height is short
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 103
IF weight is light
AND height is average
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is low

Rule 104
IF weight is average
AND height is average
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 105
IF weight is heavy
AND height is average
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 106
IF weight is light
AND height is tall
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 107
IF weight is average
AND height is tall
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is moderate

Rule 108
IF weight is heavy
AND height is tall
AND age is old
AND intensity training is low
AND BMI is normal
THEN calorie goal is high

Rule 109
IF weight is light
AND height is short
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 110
IF weight is average
AND height is short
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 111
IF weight is heavy
AND height is short
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 112
IF weight is light
AND height is average
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 113
IF weight is average
AND height is average
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 114
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 115
IF weight is light
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 116
IF weight is average
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 117
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is height

Rule 118
IF weight is light
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 119
IF weight is average
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 120
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 121
IF weight is light
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 122
IF weight is average
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 123
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is high

Rule 124
IF weight is light
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 125
IF weight is average
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is high

Rule 126
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is high

Rule 127
IF weight is light
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 128
IF weight is average
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 129
IF weight is heavy
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 130
IF weight is light
AND height is short
AND age is young
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is low

Rule 131
IF weight is average
AND height is average
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is moderate

Rule 132
IF weight is heavy
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is high

Rule 133
IF weight is light
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is high

Rule 134
IF weight is average
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is high

Rule 135
IF weight is heavy
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is normal
THEN calorie goal is high

Rule 136
IF weight is light
AND height is short
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 137
IF weight is average
AND height is short
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 138
IF weight is heavy
AND height is short
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 139
IF weight is light
AND height is average
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 140
IF weight is average
AND height is average
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 141
IF weight is heavy
AND height is average
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 142
IF weight is light
AND height is tall
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 143
IF weight is average
AND height is tall
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 144
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 145
IF weight is light
AND height is short
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 146
IF weight is average
AND height is short
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 147
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 148
IF weight is light
AND height is average
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 149
IF weight is average
AND height is average
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 150
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 151
IF weight is light
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 152
IF weight is average
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 153
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 154
IF weight is light
AND height is short
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is low

Rule 155
IF weight is average
AND height is short
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 156
IF weight is heavy
AND height is short
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 157
IF weight is light
AND height is average
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is moderate

Rule 158
IF weight is average
AND height is average
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 159
IF weight is heavy
AND height is average
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 160
IF weight is light
AND height is tall
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 161
IF weight is average
AND height is tall
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 162
IF weight is heavy
AND height is tall
AND age is old
AND intensity training is high
AND BMI is normal
THEN calorie goal is high

Rule 163
IF weight is light
AND height is short
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is casual

Rule 164
IF weight is average
AND height is short
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 165
IF weight is heavy
AND height is short
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 166
IF weight is light
AND height is average
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 167
IF weight is average
AND height is average
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 168
IF weight is heavy
AND height is average
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 169
IF weight is light
AND height is tall
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 170
IF weight is average
AND height is tall
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 171
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 172
IF weight is light
AND height is short
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 173
IF weight is average
AND height is short
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 174
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 175
IF weight is light
AND height is average
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 176
IF weight is average
AND height is average
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 177
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 178
IF weight is light
AND height is tall
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 179
IF weight is average
AND height is tall
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 180
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is low
AND BMI is overweight
THEN calorie goal is high

Rule 181
IF weight is light
AND height is short
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 182
IF weight is average
AND height is short
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is low

Rule 183
IF weight is heavy
AND height is short
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 184
IF weight is light
AND height is average
AND age is old
AND intensity training is low
AND BMI is overweight

Rule 185
IF weight is average
AND height is average
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 186
IF weight is high
AND height is average
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is high

Rule 187
IF weight is light
AND height is tall
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is moderate

Rule 188
IF weight is average
AND height is tall
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is high

Rule 189
IF weight is heavy
AND height is tall
AND age is old
AND intensity training is low
AND BMI is overweight
THEN calorie goal is high

Rule 190
IF weight is light
AND height is short
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 191
IF weight is average
AND height is short
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 192
IF weight is heavy
AND height is short
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 193
IF weight is light
AND height is average
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 194
IF weight is average
AND height is average
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 195
IF weight is heavy
AND height is average
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 196
IF weight is light
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 197
IF weight is average
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 198
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 199
IF weight is light
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 200
IF weight is light
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 201
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 202
IF weight is light
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 203
IF weight is average
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 204
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 205
IF weight is light
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 206
IF weight is average
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 207
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 208
IF weight is light
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is low

Rule 209
IF weight is average
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 210
IF weight is heavy
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 211
IF weight is light
AND height is average
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is moderate

Rule 212
IF weight is average
AND height is average
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 213
IF weight is heavy
AND height is average
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 214
IF weight is light
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 215
IF weight is average
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 216
IF weight is heavy
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is overweight
THEN calorie goal is high

Rule 217
IF weight is light
AND height is short
AND age is young
AND intensity training is high
AND BMI is overweight
THEN calorie goal is low

Rule 218
IF weight is average
AND height is short
AND age is young
AND intensity training is high
AND BMI is overweight
THEN calorie goal is low

Rule 219
IF weight is heavy
AND height is short
AND age is young
AND intensity training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 220
IF weight is light
AND height is average
AND age is young
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 221
IF weight is average
AND height is average
AND age is young
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 222
IF weight is heavy
AND height is average
AND age is young
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 223
IF weight is light
AND height is tall
AND age is young
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 224
IF weight is average
AND height is tall
AND age is young
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 225
IF weight is heavy
AND height is tall
AND age is young
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 226
IF weight is light
AND height is short
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is low

Rule 227
IF weight is average
AND height is short
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 228
IF weight is heavy
AND height is short
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 229
IF weight is light
AND height is average
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 230
IF weight is average
AND height is average
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 231
IF weight is heavy
AND height is average
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 232
IF weight is light
AND height is tall
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 233
IF weight is average
AND height is tall
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 234
IF weight is heavy
AND height is tall
AND age is middle
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 235
IF weight is light
AND height is short
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 236
IF weight is average
AND height is short
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is moderate

Rule 237
IF weight is heavy
AND height is short
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 238
IF weight is light
AND height is average
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 239
IF weight is average
AND height is average
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 240
IF weight is heavy
AND height is average
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 241
IF weight is light
AND height is tall
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 242
IF weight is average
AND height is tall
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is high

Rule 243
IF weight is heavy
AND height is tall
AND age is old
AND intensity of training is high
AND BMI is overweight
THEN calorie goal is bulking

Rule 244
IF weight is light
AND height is short
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 245
IF weight is average
AND height is short
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 246
IF weight is heavy
AND height is short
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 247
IF weight is light
AND height is average
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 248
IF weight is average
AND height is average
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 249
IF weight is heavy
AND height is average
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 250
IF weight is light
AND height is tall
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 251
IF weight is average
AND height is tall
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 252
IF weight is heavy
AND height is tall
AND age is young
AND intensity of training is low
AND BMI is obese
THEN calorie goal is high

Rule 253
IF weight is light
AND height is short
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 254
IF weight is average
AND height is short
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 255
IF weight is heavy
AND height is short
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 256
IF weight is light
AND height is average
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 257
IF weight is average
AND height is average
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 258
IF weight is heavy
AND height is average
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 259
IF weight is light
AND height is tall
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 260
IF weight is average
AND height is tall
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is high

Rule 261
IF weight is heavy
AND height is tall
AND age is middle
AND intensity of training is low
AND BMI is obese
THEN calorie goal is high

Rule 262
IF weight is light
AND height is short
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 263
IF weight is average
AND height is short
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is low

Rule 264
IF weight is heavy
AND height is short
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 265
IF weight is light
AND height is average
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 266
IF weight is average
AND height is average
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is moderate

Rule 267
IF weight is heavy
AND height is average
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is high

Rule 268
IF weight is light
AND height is tall
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is high

Rule 269
IF weight is average
AND height is tall
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is high

Rule 270
IF weight is heavy
AND height is tall
AND age is old
AND intensity of training is low
AND BMI is obese
THEN calorie goal is high

Rule 271
IF weight is light
AND height is short
AND age is young
AND intensity of training is moderate
AND BMI is obese
THEN calorie goal is low

Rule 272
IF weight is average
AND height is short
AND age is young
AND intensity of training is moderate
AND BMI is obese
THEN calorie goal is low

Rule 273
IF weight is heavy
AND height is short
AND age is young
AND intensity of training is moderate
AND BMI is obese
THEN calorie goal is low

Rule 274
IF weight is light
AND height is average
AND age is young
AND intensity of training is moderate
AND BMI is obese
THEN calorie goal is low

Rule 275
IF weight is average
AND height is average
AND age is young
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 276
IF weight is heavy
AND height is average
AND age is young
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 277
IF weight is light
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 278
IF weight is average
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 279
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 280
IF weight is light
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is low

Rule 281
IF weight is average
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is low

Rule 282
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 283
IF weight is light
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 284
IF weight is average
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 285
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 286
IF weight is light
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 287
IF weight is average
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 288
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 289
IF weight is light
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 290
IF weight is average
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is moderate

Rule 291
IF weight is heavy
AND height is short
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 292
IF weight is light
AND height is average
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 293
IF weight is average
AND height is average
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 294
IF weight is heavy
AND height is average
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 295
IF weight is light
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 296
IF weight is average
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 297
IF weight is heavy
AND height is tall
AND age is old
AND intensity training is moderate
AND BMI is obese
THEN calorie goal is high

Rule 298
IF weight is light
AND height is short
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is low

Rule 299
IF weight is average
AND height is short
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is low

Rule 300
IF weight is heavy
AND height is short
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is moderate

Rule 301
IF weight is light
AND height is average
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is moderate

Rule 302
IF weight is average
AND height is average
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is moderate

Rule 303
IF weight is heavy
AND height is average
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 304
IF weight is light
AND height is tall
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 305
IF weight is average
AND height is tall
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 306
IF weight is heavy
AND height is tall
AND age is young
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 307
IF weight is light
AND height is short
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is moderate

Rule 308
IF weight is average
AND height is short
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is moderate

Rule 309
IF weight is heavy
AND height is short
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 310
IF weight is light
AND height is average
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 311
IF weight is average
AND height is average
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 312
IF weight is heavy
AND height is average
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 313
IF weight is light
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 314
IF weight is average
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 315
IF weight is heavy
AND height is tall
AND age is middle
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 316
IF weight is light
AND height is short
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is moderate

Rule 317
IF weight is average
AND height is short
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is moderate

Rule 318
IF weight is heavy
AND height is short
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 319
IF weight is light
AND height is average
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 320
IF weight is average
AND height is average
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 321
IF weight is heavy
AND height is average
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 322
IF weight is light
AND height is tall
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 323
IF weight is average
AND height is tall
AND age is old
AND intensity training is high
AND BMI is obese
THEN calorie goal is high

Rule 324

IF	weight is heavy
AND	height is tall
AND	age is old
AND	intensity training is high
AND	BMI is obese
THEN	calorie goal is bulking

5.0 Inference System

5.1 User Interface

For this project, the user interface was developed using Flutter. Flutter is an open-source software development kit developed by Google that enables the creation of web and mobile applications. The user interface or frontend of the system was developed as progressive web app. This system can run both on mobile apps and web.

Below are the screenshots of the User Interface

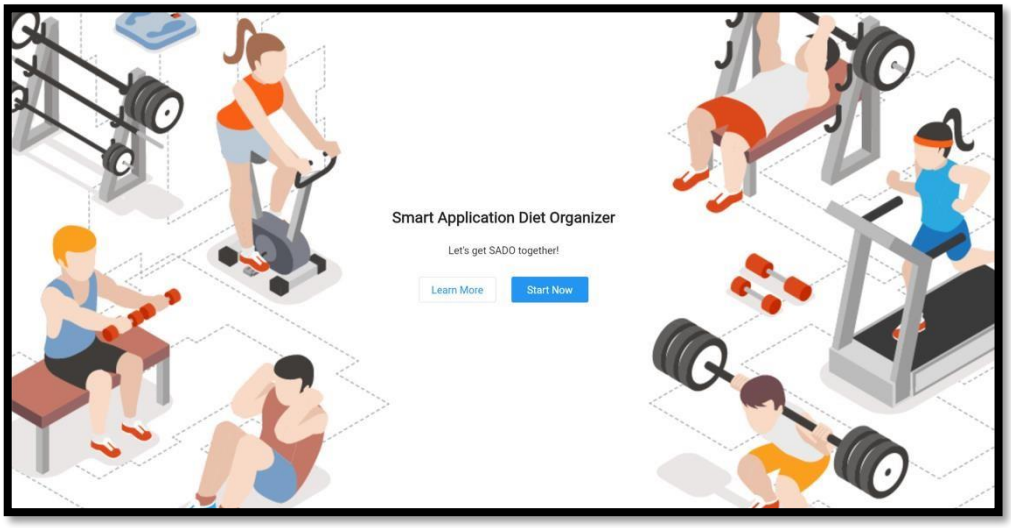
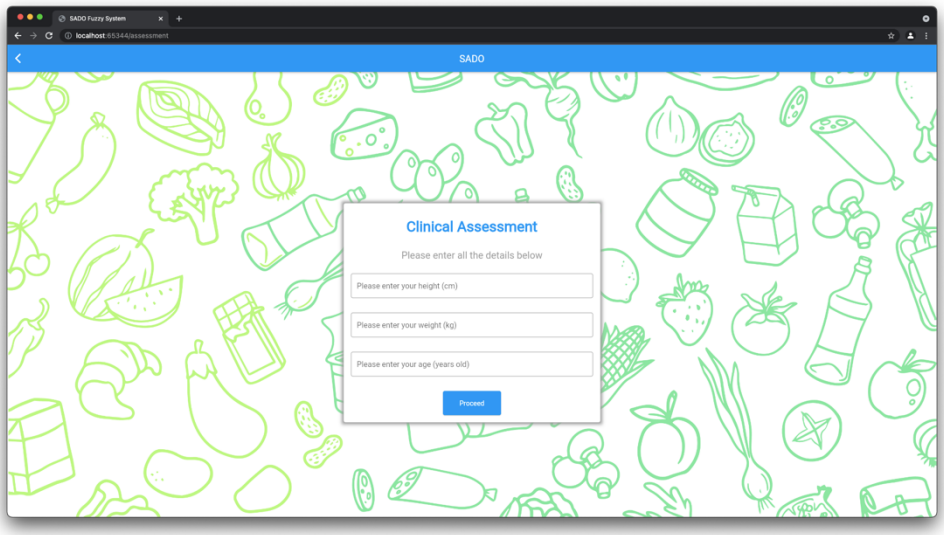
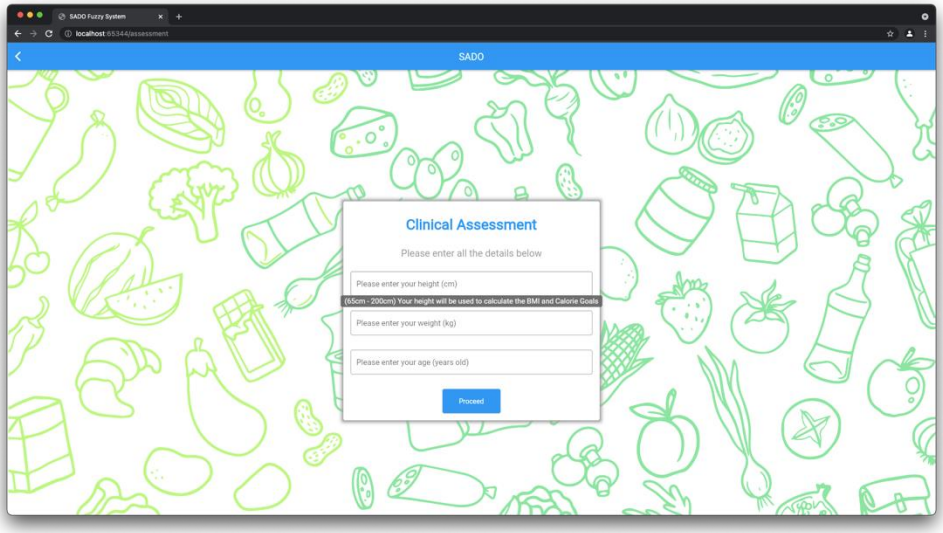


Figure 5.1.1 Landing Page

This is the landing page of the application. Users will need to click the ‘Start Now’ button to begin.





Once the user clicks the start button, users will need to fill up the clinical assessment. During the clinical assessment, the system will calculate BMI and Calorie Goals using SADO Fuzzy Inference Module through Mamdani Approach

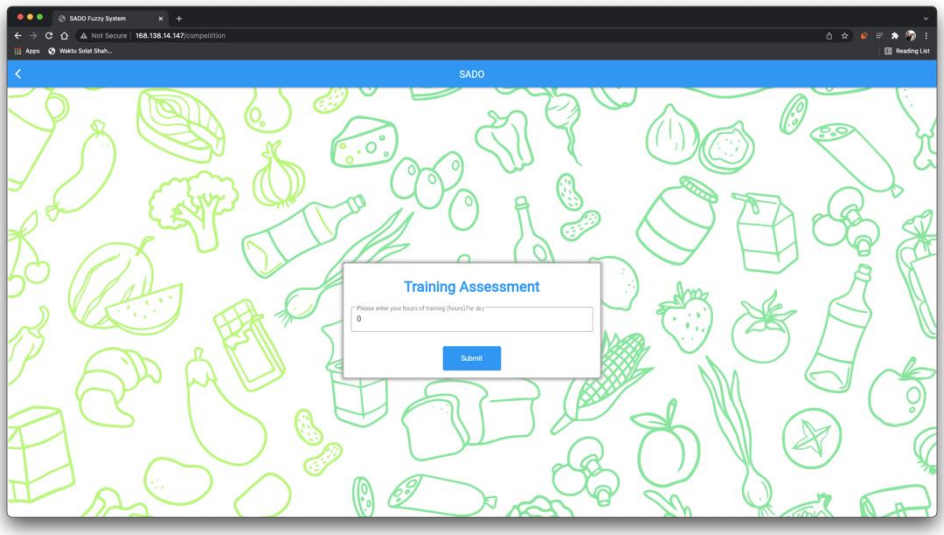


Figure 5.1.3 Training Assessment

Later users will be asked to enter how many hours they train per day. (hours).

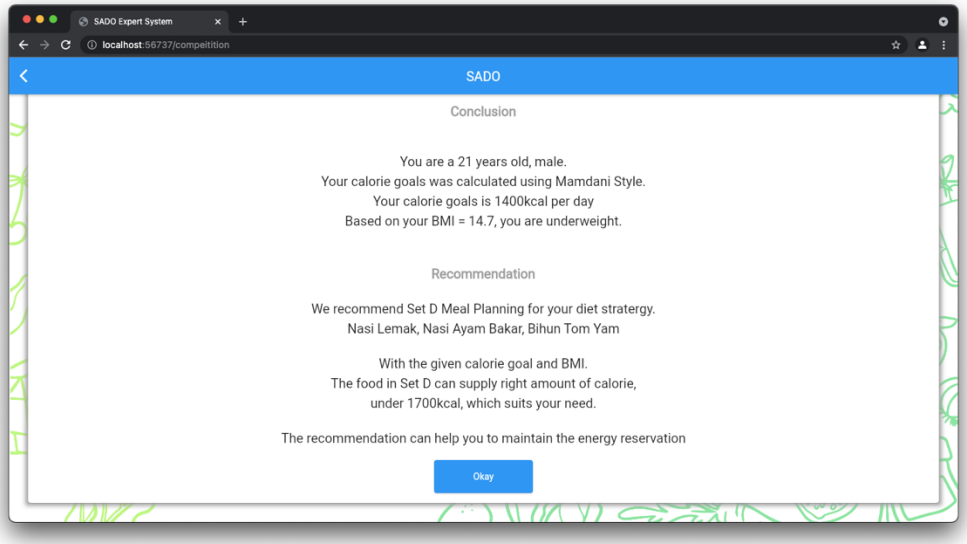


Figure 5.1.4 Recommendation Page

Based on the assessment on the previous page, the user will be presented with the recommendation for diet management. At this page, the system will display the explanation facility and the recommended diet for the athlete.

5.2 Fuzzy Inference

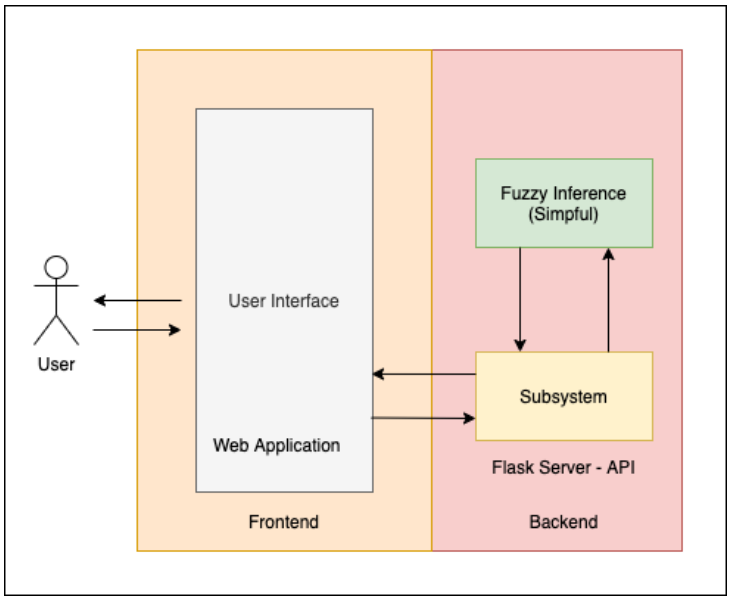


Figure 5.2.1 Technical Stack of SADO System

Based on the technical stack above, we are using Flutter for the Web App (front end) and Flask for the backend. For inference engine development, we use Simpful. Simpful is a Python library for fuzzy logic reasoning, designed to provide a simple and lightweight API, as close as possible to natural language

We found that Simpful is more versatile and suitable for the system. The inference engine was designed on a Jupyter Notebook for the early stage of the development phase. We tested the inference engine thoroughly on the Jupyter notebook to make sure the engine is working properly as expected.

Then, the backend merged the code to subsystem, Flask. Flask is a micro web framework written in Python. This allows us to integrate well with the inference engine that are written in Python. Flask allows us to develop API that connects with the frontend. All the calculations such as BMI are done at the subsystem. Results of the calculation will be passed to Simpful in order to calculate the Calorie Goals using Mamdani Approach.

5.3 Fuzzy Set

```
"""
    Define fuzzy set
"""

# Weight
P1 = FuzzySet(function=Triangular_MF(a=50,b=50,c=68), term="light")
P2 = FuzzySet(function=Triangular_MF(a=55,b=68,c=82), term="average")
P3 = FuzzySet(function=Triangular_MF(a=68,b=110,c=110), term="heavy")
LV1 = LinguisticVariable([P1,P2,P3], concept="Weight", universe_of_discourse=[50,110])
FS.add_linguistic_variable("Weight", LV1)

# Height
P1 = FuzzySet(function=Trapezoidal_MF(a=160,b=160,c=162.5,d=165), term="short")
P2 = FuzzySet(function=Trapezoidal_MF(a=162.5,b=165,c=175,d=177.5), term="average")
P3 = FuzzySet(function=Trapezoidal_MF(a=175,b=177.5,c=180,d=180), term="tall")
LV2 = LinguisticVariable([P1,P2,P3], concept="Height", universe_of_discourse=[160,180])
FS.add_linguistic_variable("Height", LV2)

# Age
P1 = FuzzySet(function=Trapezoidal_MF(a=20,b=20,c=26,d=30), term="young")
P2 = FuzzySet(function=Trapezoidal_MF(a=25,b=30,c=50,d=55), term="middle")
P3 = FuzzySet(function=Trapezoidal_MF(a=50,b=55,c=55,d=55), term="old")
LV3 = LinguisticVariable([P1,P2,P3], concept="Age", universe_of_discourse=[20,60])
FS.add_linguistic_variable("Age", LV3)

# BMI
P1 = FuzzySet(function=Trapezoidal_MF(a=17,b=17,c=17,d=18.5), term="underweight")
P2 = FuzzySet(function=Trapezoidal_MF(a=17,b=18.5,c=24.5,d=26), term="normal")
P3 = FuzzySet(function=Trapezoidal_MF(a=23,b=24.5,c=29,d=30.5), term="overweight")
P4 = FuzzySet(function=Trapezoidal_MF(a=29,b=30.5,c=30.5,d=30.5), term="obese")
LV4 = LinguisticVariable([P1,P2,P3,P4], concept="BMI", universe_of_discourse=[16,31])
FS.add_linguistic_variable("BMI", LV4)

# Intensity
P1 = FuzzySet(function=Trapezoidal_MF(a=3,b=3,c=3,d=4), term="low")
P2 = FuzzySet(function=Trapezoidal_MF(a=3,b=4,c=5,d=6), term="moderate")
P3 = FuzzySet(function=Trapezoidal_MF(a=5,b=6,c=6,d=6), term="high")
LV5 = LinguisticVariable([P1,P2,P3], concept="Intensity", universe_of_discourse=[1,8])
FS.add_linguistic_variable("Intensity", LV5)

# Output
P1 = FuzzySet(function=Triangular_MF(a=500,b=500,c=1300), term="casual")
P2 = FuzzySet(function=Triangular_MF(a=1000,b=1400,c=1800), term="low")
P3 = FuzzySet(function=Triangular_MF(a=1500,b=1900,c=2300), term="moderate")
P4 = FuzzySet(function=Triangular_MF(a=2000,b=2400,c=2900), term="high")
P5 = FuzzySet(function=Triangular_MF(a=2500,b=2900,c=2900), term="bulking")
LV6 = LinguisticVariable([P1,P2,P3,P4,P5], concept="Calorie", universe_of_discourse=[500,3000])
FS.add_linguistic_variable("Calorie", LV6)
```

Figure 5.3.1 Fuzzy Set

The fuzzy set declaration of the system based on the fuzzy variables, type of graph, degree of membership and the universe of discourse.

```
"""
    Define fuzzy rules - Import from text file.
"""
FS.add_rules_from_file(path='list_of_rules.txt')
```

Figure 5.3.2 Fuzzy Rules

The fuzzy rules are stored in the text file, and being imported into SADO Fuzzy Inference Module using the code above.

Figure 5.3.3 Fuzzy Inference

The fuzzy inference is evaluated using Mamdani Style. Output of the inference is the calorie goals.

5.4 Mobile Application

Our inference system is also developed as a mobile application that is published on the Google Play Store for public use. The application is published under open-testing release for public wide testing. The publishing of a mobile application serves as an alternative for the web application in case the user prefers to use the mobile application version of the system. The mobile application has a couple of advantages over the web application, this includes faster initial loading, so the user can use the app in much fewer steps and waiting time. The user interface for the mobile application is much similar to the web application for ease of transition between the web and the mobile applications.

Figure 5.4.1 Mobile Application Home Page

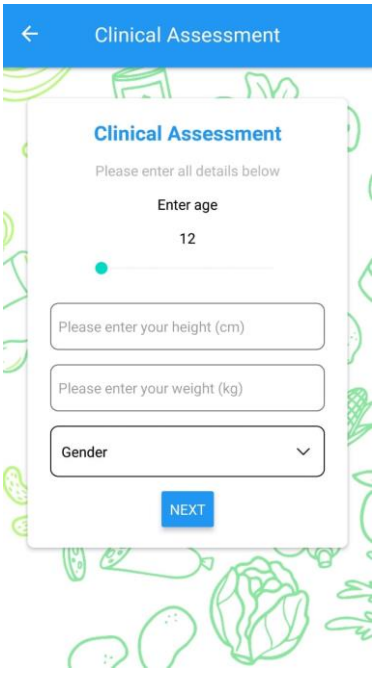


Figure 5.4.2 Clinical Assessment Page

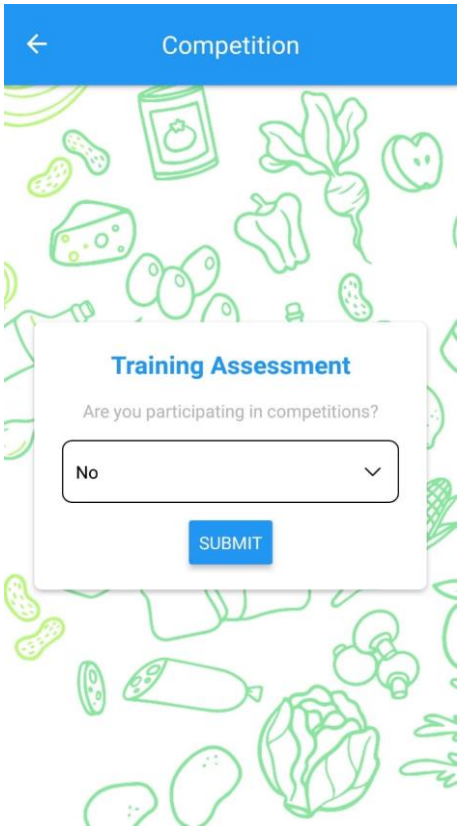


Figure 5.4.3 Training Assessment Page

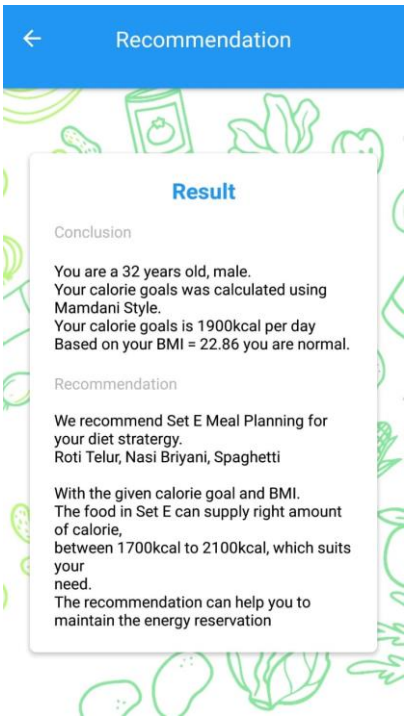


Figure 5.4.4 Training Assessment Page

6.0 Conclusion

To summarize, this systems purpose is to help dietician and athlete. The output shows how many calories should be taken by the athletes. Additional output that displays a menu according to the calory intake will also be shown.

The calories output is based on the athlete's physique which is height and weight which will be calculated as BMI which is also considered as an input. Simple BMI is not enough to determine what's the athlete best diet. On top of that, we consider their intensity training and age. All this input will produce the desired output based on the elicited rules which will fulfil the objectives that has been stated in this report.

As you can see, there are a total of 5 inputs and 1 output. All 5 linguistic variables and 1 output have their table that shows its peak membership value until not peak for each subset of a linguistic variable. This table helps us create the fuzzy sets representation. Most common function of this representation found are triangular and trapezoidal. Here we found each subset of each linguistic variable equation of a straight line. Fuzzy membership function is also displayed. This may assist us in acquiring the membership value that is not available in the tables provided for testing. We also do this to decrease the computation time and helps us represent the knowledge that we acquired.

There are a total of 324 rules because of 5 input variables with their linguistic value which is calculated by 3 * 3 * 3 * 3 * 4. There is no fuzzy associative memory (FAM) representation since we have more than 3 variables.

Mamdani-style inference is used in the project rather than Sugeno-style because it is most common and is suggested. Since all operators for our rule uses AND operator, it will always take the linguistic value the lowest membership value of a fuzzy set if the input were in between 2 (intersection) linguistic values. The defuzzied solution of variable's fuzzy set gives us the calory intake that is proposed. This is easy to be executed because of the numerical range of each linguistic variable which have been normalized

For backend, library used is Simpful, close to human language**.** A python library for fuzzy logic reasoning. Therefore, we also Python as our programming language. As for our frontend we use Flutter, a framework that uses Dart programming language.

Flask, which is a micro web framework written in Python and is not a library but acts as an intermediary between the frontend (interface) and Simpful (knowledge base). Flask assist us in creating the web application a lot easier so we can access it through the frontend (Flutter) which is the interface that gives it a website look. All results are done on Flask and passed to Simpful to fire the rules that they fulfil.

In addition, instead of stopping there, we there is an additional architecture where specific calories fire specific rules so that the system can also suggest menu that contains the suggested calory intake.

In conclusion, we have successfully delivered the requirements and accomplished what had been proposed by following the basic process in developing a fuzzy expert system and also provided an extra component to give the system a smoother look using useful components such as Flutter, Flask, and Simpful as our system architecture. The problem statement is solved by applying the basic process mentioned, and through detailed development and testing, a quality output and system is created. Although it may not go public, we have proven ourselves that we are capable of such task. What we have done is merely the tip of the iceberg of fuzzy, not to mention the entire course of computer science or more specifically Artificial Intelligence.

7.0 References

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