



# Fuzzy Analytic Hierarchy Process to Recommend a Food to a Heart Patient Based on Cholesterol Level

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*Abstract*— Nowadays in a fast moving environment, most of the people are in a need of Food Recommendation System, since they have been suffering from many health related issues like Diabetes, Cholesterol, etc. In existing, the recommendation system is used to suggest an ice cream to a diabetic patient using Analytic Hierarchy Process. But the drawback is, it has very low accuracy value. To achieve a good accuracy rate, this paper proposed a Fuzzy Analytic Hierarchy Process to recommend a food to a heart patient. And also the inability of the Analytic Hierarchy Process to deal with the impression and subjectiveness in the pair-wise comparison process has been improved in the Fuzzy Analytic Hierarchy Process. The method fuzzy analytic hierarchy process adopted here uses Trapezoidal Fuzzy Number to calculate membership function. The major criterion analyzed by this paper is cholesterol since too much of cholesterol in our body is the risk factor for heart diseases. First, the system captures different levels of cholesterol by examining the food and patient datasets. Second, the fuzzy sets are identified to compute the membership function. As a result, the system will recommend a food to a patient by comparing a membership function with user input.

*Keywords*—Fuzzy Analytic Hierarchy Process(FAHP),Recommendation System,Cholesterol,Analytic Hierarchy Process(AHP).

## I. INTRODUCTION

Recommendation systems or recommender systems are a subclass of information filtering systems [4] that seek to predict the 'rating' or 'preference' that a user would give to an item. Recommendation systems have become extremely common in recent years, and are applied in a variety of applications. In existing, there are various recommendation systems related to movie, on-line purchase, restaurant. But in health care perspective only limited numbers of expert systems are devised. For instance, online diet counselling system, food category representative system and expert system for diagnosing a disease. The online diet counselling system [6], generates personalize meal recommendation by identifying which recipe that promotes weight loss and maintenance. The basis for the recommendation is basal metabolic rate (BMR) which determines the calories that he/she must take for the day. The system lacks in item which they taken into consideration. Expert system also utilized for diagnosing a disease.

In existing, recommendation System is also used to suggest an ice cream to a diabetic patient [7]. The technique employed in this system was Analytic Hierarchy Process. The purpose of using AHP is to structure a multiple criterion problem in order to recommend a particular ice cream to a diabetic patient. It suggests an ice cream based on the consistency value obtained by performing a pair wise comparison among the criteria. Though system performs all the mathematic calculation related to Analytic Hierarchy Process the obtained consistency value shows the accuracy of only 44%.

To improve the accuracy of the expert system this paper proposed a Fuzzy Analytic Hierarchy process to suggest a food to a heart patient. The main criterion for this expert system is cholesterol level in both food items and patient. The Fuzzy Analytic Hierarchy Process is the combination of fuzzy logic and analytic hierarchy process. Fuzzy logic is derived from fuzzy set theory dealing with reasoning that is approximate rather than precisely deduced from the classical predicate logic [2]. The accuracy of the final indices value is considerably higher when compare to the analytic hierarchy process.

## II. FUZZY ANALYTIC HIERARCHY PROCESS

In existing, Analytical Hierarchy Process is used as a mathematical tool is to structure a multiple criterion problem in order to recommend a particular ice cream to the patient suffering from diabetes [7]. It can use both prejudiced individual judgments and objective assessment just by Eigen vector and examining the reliability of the assessment by Eigen value. The



procedure for calculating the consistency index in analytic hierarchy process is: constructing the pair wise comparison matrix, calculate the Eigen value for each attribute, compare the Eigen value with the Saaty’s scale to get the consistency value. The criterions considered for ice cream are Sugar, Proteins, Cholesterol and Dietary fiber which are attributes of an ice cream. The first step while developing a AHP model for a particular problem is to arrange its details in hierarchy, level 0 shows objective of this analysis which is to recommend a particular ice cream to a diabetic patient. The next level i.e. level 1 shows different criterions cum attributes of an ice cream which are Sugar, Cholesterol, Dietary fiber and proteins. The last level i.e. level 2 shows different types of ice cream like Breyers Homemade vanilla, Breyers vanilla and Ben and jerry butter pecan are considered.

The limitation of the existing technique is, consistency indices value obtained from AHP is seems to be in less accuracy. The better accuracy value can be achieved by employing Fuzzy logic methods. In this paper, Fuzzy Analytic Hierarchy Process is used as a decision making mechanism. It is the combination of fuzzy logic and AHP. The AHP has a special concern with departure from consistency and the measurement of this departure, and with dependence within, and between, the groups of elements of its structure. In general form, the FAHP is a non-linear framework for carrying out both deductive and inductive thinking without the use of syllogisms.

### III. SYSTEM DESIGN

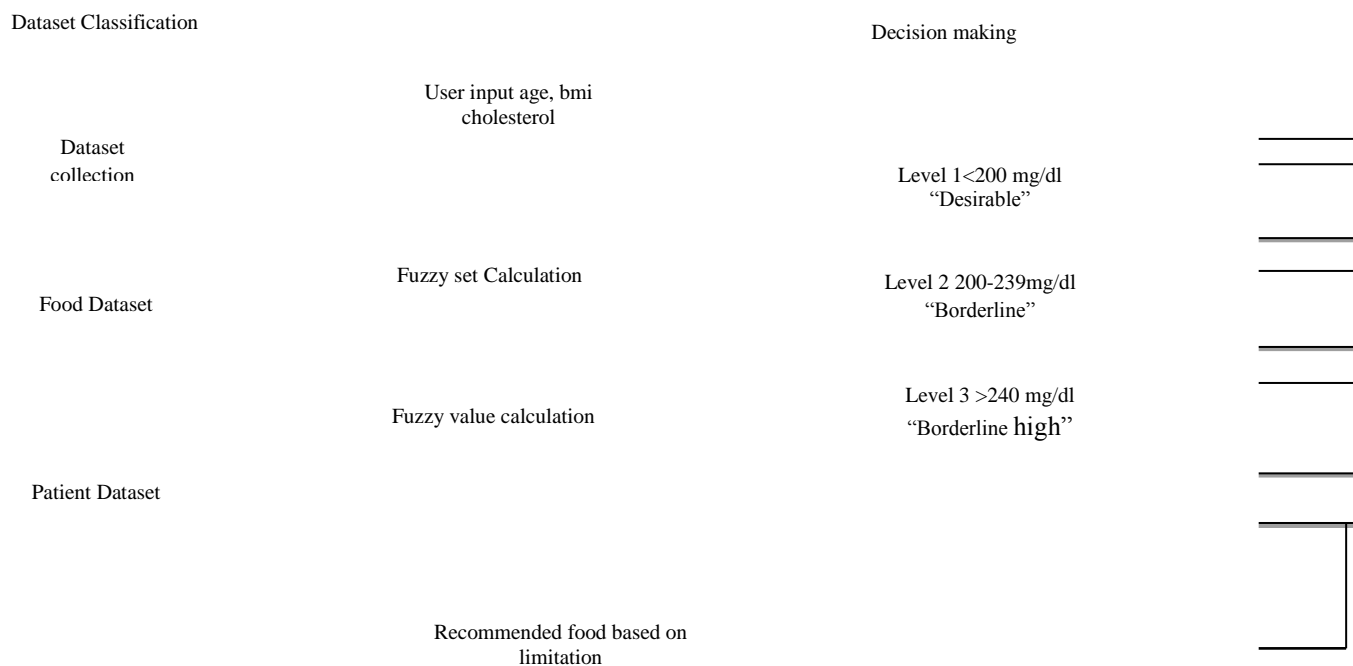


Figure 1.1 shows the system architecture for the proposed recommendation system, the dataset accumulation is the vital part of the system. The proposed framework utilizes two datasets namely food dataset and patient datasets. Food dataset consist of attributes like nutrients in the food items whereas patient dataset consist of details about patient’s medical history. These dataset are collected and processing them to classify the attributes like low, medium, high values. After accumulating these dataset and the input from the user which is his/her age, height, weight, bmi and cholesterol, the system will process the data with the help of Fuzzy Analytic Hierarchy Process. It is the technique used to process the data of both food and patient for recommendation. This paper also utilizes trapezoidal fuzzy number method which is the sub-technique of fuzzy analytic hierarchy process used to



perform the membership function for the computation [2]. Decision making process will take place to recommend a food based on the levels of the cholesterol and the membership function value.

The advantages of the proposed system are, accuracy of the recommendation is high when comparing to the existing system which uses Analytic hierarchy Process, the system is more efficient and good data sensing and also it provides more flexibility on determining the cholesterol range for both food and patient.

**Trapezoidal Fuzzy Number:**

The trapezoidal membership function is calculated using fuzzy set [m, n, o, p] for low, medium, high attribute values[5]. The formula used to calculate the membership function is given below, where x is an input.

$$x = \begin{cases} 0, & x < m \text{ or } x > p \\ \frac{(x - m)}{(n - m)}, & m \leq x < n \\ 1, & n \leq x \leq o \\ \frac{(p - x)}{(p - o)}, & o < x \leq p \end{cases}$$

The membership function is used to identify the range in which the user’s current cholesterol belongs to. The ranges are identified with the help of fuzzy set [m,n,o,p]. Similarly, a fuzzy rule base is constructed to compare the membership function with a given cholesterol level. By utilizing trapezoidal fuzzy number technique, this paper divides the severity of the cholesterol level into four parts: low, low to medium, medium to high, high and recommend a appropriate food to the patient.

**IV. SYSTEM WORKING**

This paper consists of four subunits like classifying the dataset, fuzzy set calculation, fuzzy value calculation and food recommendation. The detailed descriptions about these subunits are given below.

**A. Classifying the dataset**

Food dataset and patient dataset are collected manually by using spreadsheet in order to suggest a food item to a patient. The attributes for the patient dataset will be their medical history like age, id, blood sugar level, blood pressure level, cholesterol level, history of heart disease etc. The attributes for the food dataset will be their nutrient content like calories, cholesterol, protein, fat, sodium, potassium, dietary fiber, sugar.

The food dataset can be broadly classified by using constrains like if cholesterol value less than 200 mg/dl then it will be considered as desirable, if the cholesterol value is in between 200 to 239 mg/dl it will be considered as borderline high, similarly if the cholesterol value above 240 it is considered as high cholesterol food. Thus the major criteria used for analyzing the data set is cholesterol, since it enters our body from food also such as animal based products like egg, meat. The figure 1.3 depicts that various attributes in food dataset which comes under the category of vegetarian, non-vegetarian, cereals & nuts. After analyzing the dataset, it is classified as low level cholesterol food, high level cholesterol food and same procedure is carried out for patient dataset.

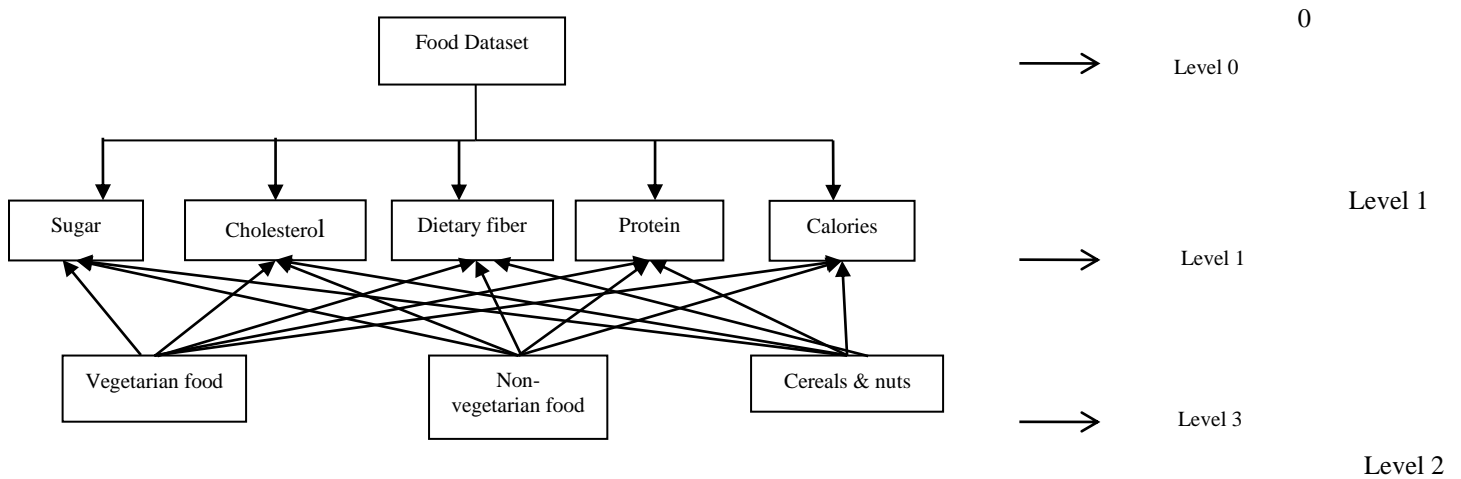


Figure 1.3 Classifying the dataset (food)

**B. Fuzzy set calculation**

Fuzzy set calculation involves applying fuzzy logic in the combination of analytic hierarchy process. The dataset undergoes fuzzification process and the corresponding fuzzy values are stored in the knowledge base. Figure 1.4 explains the steps involved for calculating the fuzzy set. It is obtained for each attributes by calculating minimum, maximum, average and standard deviation for each one. The minimum value of the attribute shows the starting range for the membership function where as the maximum value gives the final range. From the results, [m, n, o, p] sets are calculated for all attributes with fuzzy value like age\_low, age\_med, age\_high, chol\_low, chol\_med, chol\_high etc. The fuzzy set computed in this module is used to calculate the fuzzy value in the upcoming module.

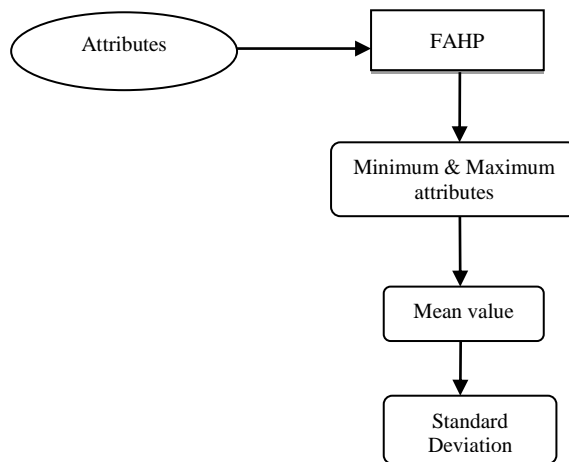


Figure 1.4 Fuzzy set calculation

**C. Fuzzy value calculation**

For calculating the fuzzy value, a trapezoidal membership function uses [m,n,o,p] set for low, medium and high fuzzy values of all attributes in the knowledge base. The trapezoidal fuzzy number method take input the user i.e. patient’s current

cholesterol value. The fuzzy value  $x$  which is calculated is act as a membership function. The membership function is calculated by analyzing the ranges obtained from fuzzy set value. If-then-else rules are constructed using data mining application. These rules are used to evaluate a fuzzy numbers. The membership function is generally used to categorize the dataset on the basis of criteria.

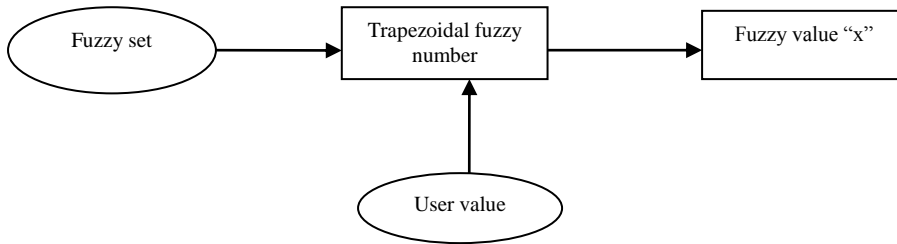


Figure 1.5 Fuzzy value calculation

**D. Recommending food items**

Recommendation Systems are also software tools and techniques providing suggestions for items to be of use to a user. The suggestions relate to various decision-making processes, such as what items to buy, what music to listen to, or what online news to read [3]. Item is the general term used to denote what the system recommends to users. A Recommendation System normally focuses on a specific type of item and accordingly its design, its graphical user interface, and the core recommendation technique used to generate the recommendations are all customized to provide useful and effective suggestions for that specific type of item.

Recommendation Systems typically apply techniques and methodologies from other neighbouring areas such as Human Computer Interaction (HCI) or Information Retrieval (IR) [3]. However, most of these systems bear in their core an algorithm that can be understood as a particular instance of Data Mining technique. There are large numbers of Data Mining techniques accessible to Recommendation System.

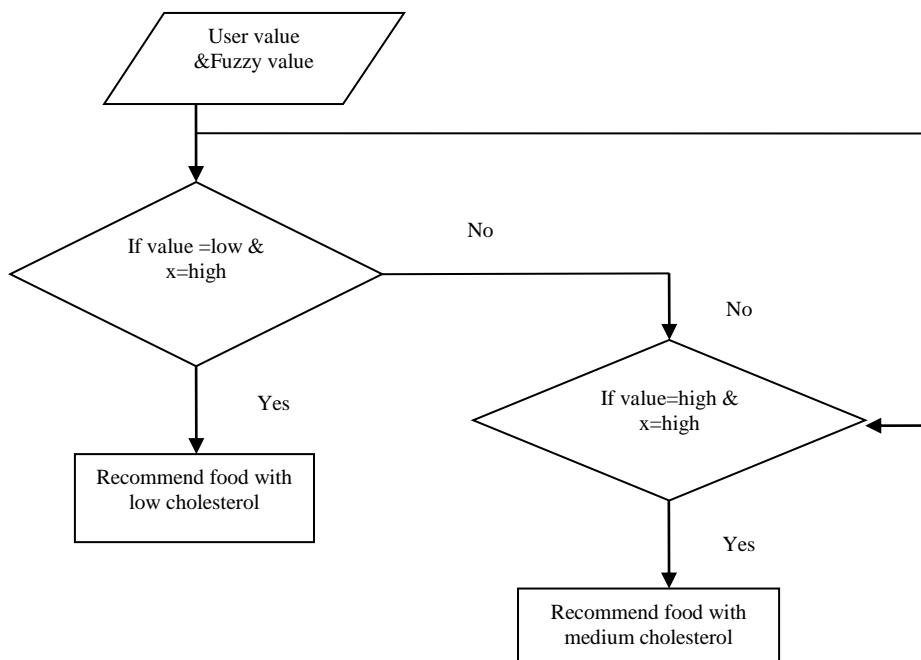


Figure 1.6 Decision making process for recommending food items



The recommendation of a food item is based on the soft computing technique called fuzzy analytic hierarchy process. The suggestions are performed by comparing the membership function obtained by trapezoidal fuzzy number method. Figure 1.6 shows the decision making process in food recommendation. In this module the function is compared with the user input and also attributes in the food dataset. If the user's current cholesterol level is greater than the membership function then the cholesterol content food is not recommended whereas the user's input value is lower than the membership function then the cholesterol content food with different levels are recommended.

## V. CONCLUSION

Recommendation Systems are primarily directed towards individuals who lack sufficient personal experience or competence to evaluate the potentially overwhelming number of alternative items that a Web site, for example, may offer. In existing, ice cream is recommended to a diabetic patient based on the sugar level in the ice cream but the accuracy of the obtained consistency index value is very low. To overcome the inconsistency in multi-criteria decision problem, this expert system utilizes soft computing technique called Fuzzy Analytic Hierarchy Process for recommending a food. In this project, recommending a food to a heart patient is considered as a major task. Various food items were taken and they are recommended by analyzing the cholesterol level in both food and a patient. Recommendations are given by comparing the membership function with the user input. This membership function is also used to identify the food and patient cholesterol range.

Future improvements of the system would include adding more information to the patient database like blood sugar level and fat and the future recommendations may take into consideration of other bases like carbohydrates, sugar, calories in the food rather than cholesterol. It is also suggested that machine learning approach is applied to classify the food and patient dataset.

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