International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 4788–4798

Soft Computing Techniques Based Diet Recommendation System

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Abstract

M*any factors influence an individual's health, such as physical exercise, sleep, nutrition, heredity and pollution. Being nutrition one of the major modifiable factors in our lives, small changes can have a big impact. Due to diversity in food components and large number of dietary sources, it is challenging to perform real-time selection of diet patterns that must fulfill one's nutrition needs. In this project we have implemented a recommender system that helps the user track their calorie goals based on their Body Mass Index and also provide food recommendations based on the user's history and preferences. The user will enter their BMI details and their dietary preferences and allergies and will be recommended a certain daily calorie goal. Using the concepts of Fuzzy Logic and Collaborative Filtering for building a recommender system, we help the users by providing food suggestions based on their personal preferences. The Android based application also features a Step Counter or Pedometer for the users to track their steps as part of an activity or exercise.*

Keywords *- Diet Recommendation, Body Mass Index, Optimal Nutrition, Macros, Adaptive Learning, Fuzzy Logic, Collaborative Filtering*

1. INTRODUCTION

A healthy diet is very important in daily human life. For maintaining health and immunity, one needs to try to keep a well-balanced diet. Every person needs the appropriate amount of carbohydrates, proteins, vitamins, minerals and fats. All the issues related to the health of a person are related to the diet. With proper diet one can maintain the health and be free from these diseases. In this fast-moving generation, it is easy to lose track of one's daily nutrition needs. People tend to ignore the nutritional value of the foods they eat and eventually this leads to low immunity, diseases and possibility of being overweight or underweight.

1.1 Recommender system

A diet recommendation system may help users keep track of their daily food intake and also assist in working towards a personal goal of losing or gaining weight. Due to heavy information overloads triggered by the Internet, extracting/finding valuable information becomes increasingly difficult. In this context, recommender systems became an effective tool to extract useful information and deliver it in an efficient way. A recommender system predicts the preferences of users for unrated items and recommends new items to users.

1.2 Collaborative Filtering technique

The basic idea of CF is to use the wisdom of the crowd for making recommendations. First of all, a user rates some given items in an implicit or explicit fashion. Then, the recommender identifies the nearest neighbors whose tastes are similar to those of a given user and recommends items that the nearest neighbors have liked.

Our recommender system provides takes user BMI information as an input to provide a calorie goal to the user which helps them monitor their daily calorie intake, considering the user's allergies and vegetarian or non-vegetarian preferences. It also uses user food preferences and diet history to recommend certain food products that the user may like using the concepts of Fuzzy Logic and Collaborative Filtering. The system also features a Step Counter (Pedometer) to track the steps taken by the user.

The rest of the paper is organized as follows. Section 2 discusses related work. Section 3

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presents the proposed
work. Section 4 presents the experimental setup and results, and Section 5 concludes the paper.

2. RELATED WORK

Arushi Singh et al. [6] describe an approach for diet prediction based on the user's age group using data sourced from various places. They created a system which predicts nutrition and macros required to be consumed by the user based on age groups. The system uses a Fuzzy Logic approach and the membership functions are based on the respective age groups.

Tousif Osman et al. [1] implemented a system to search and sort a list of food based on the preferences of the users. It takes into consideration the different parameters such as Taste, Environment, Budget, User Reviews and Location. They have used a Fuzzy Engine to sort the parameters into 3 membership levels. The Apache based server fetches the required data and sends it to the Fuzzy Engine which is passed through the fuzzy conditions and the level of preference for each item is calculated. This system is a web-based application and their future scope includes creation of an Android application for the same.

Junghyo Lee et al. [3] have created a system that uses thermal imaging using smartphones to create visual as well as thermal representations of the user's food to detect the type of food being consumed with about 90% accuracy. The applications let the user take visual and thermal pictures of the food being consumed and uploads it to a cloud server which runs the food recognition software and returns the segmented food types to the application. This system is a good example of using artificial intelligence and image recognition in the field of food and nutrition.

Agapito G. et al. [2] provided a diet organizer system that monitors dietary conditions of users and provides adequate recommendations and restrictions based on their diabetic conditions. It accepts multiple factors as inputs such as age, gender, glucose levels, creatinine values, blood pressure and clinical treatment history of users and provides adequate recommendations for the user to follow for better health and keeping diabetic conditions under check.

Badrul Sarwar et al. [11] have provided a detailed study on Recommendation systems based on Collaborative Filtering. They show the use of different Collaborative Filtering algorithms such as Item-Based, Memory-Based and Model Based. The paper mainly focuses on Item-based Collaborative Filtering as an efficient method for recommendation systems.

A lot of existing systems provide efficient nutrition plans and fitness regimes but fail to actively track the progress of a user on a daily real-time basis. In a world of smart devices and smart systems, it is necessary for applications to be more user friendly and portability.

Some Limitations of existing systems are listed below:

1. Lack of real-time analysis and tracking of user nutrition intake.
2. Lack of portability; many diet recommendation systems have not been made available for mobile devices as applications.
3. Most systems do not use recommendation unit as the base of operation of the systems.

This project covers the concept of recommender systems to help users get better food suggestions based on their personal goals and preferences.

1. Recommendations - Using the concepts of Fuzzy Logic and Collaborative Filtering, provide better recommendations along with tracking of daily progress based on the personal goal of the users.

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2. Portability - The Android based mobile application allows users to make their entries any time of the day. The availability of an offline database also helps user keep complete track of their progress.

3. Health Benefits - This project supports the overall enabling of better health and controlled Nutrition levels while recommending food items and also allowing users to track their Step activity using a Pedometer function.

3. PROPOSED METHODOLOGY

On analyzing the limitations of existing systems and objectives, the proposed system is and Android based application for Diet Recommendation that uses the concepts of Fuzzy logic and Collaborative Filtering algorithm in particular to actively analyze and track user food intake and suggest items based on user history and preferences in collaboration with other users.

Phase 1: The user will enter their BMI information with dietary preferences. And will be given a calorie goal suggested by the system which can be customized by the user.

Phase 2: As the user adds their daily food intake in the application, the rank associated with each food item is updated based on the frequency of consumption of the food item.

Phase 3: The rank generated is a value between 0 and 1 fuzzified by the Fuzzy Logic Engine which is then processed by Collaborative Filtering.

Phase 4: Using collaborative filtering, the ranks are now changed based on current user's history and other users' preferences.

Phase 5: The updated ranks are now sorted in order for the food item to be recommended to the user appropriately.

3.1 Modules for Implementation

3.1.1 User BMI Calculation

Body Mass Index of a person is derived from the weight and height of a person.

It is defined as the Body Mass (m) divided by the square of the Height(h), where mass is in kilograms and height is in meters.

BMI= (mass (kg))/ (height (m)) ^2.

The BMI is used to determine if a person is underweight, normal, overweight, or obese.

The categories are defined as:

BMI < 18.5: Underweight

18.5 < BMI < 25: Normal 25 < BMI < 30: Overweight BMI > 30:
Obese
On calculation of the user's BMI, the application suggests a daily calorie goal to be followed.

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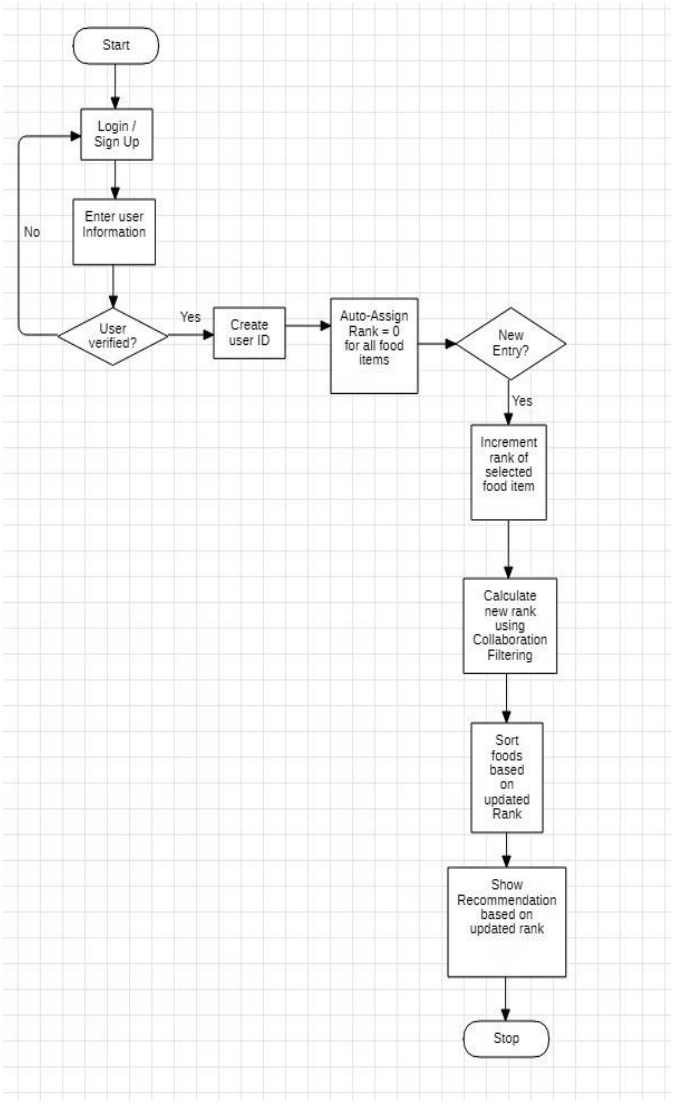

Figure. 1. System flow Diagram

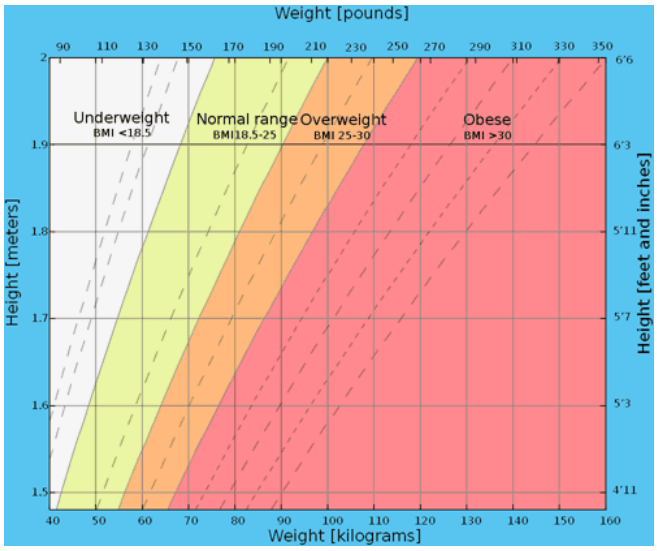

Figure. 2 BMI Chart [15]

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3.1.2 Fuzzy Logic Application

For generation of rank for each food item consumed by the user, Boolean logic does not prove to be efficient in case of recommender systems. Boolean logic only accepts truth variables in the form of 'True' and 'False' or '0' and '1'.

Fuzzy Logic on the other hand is a many-valued form of logic which truth values may be any real number between '0' and '1'.

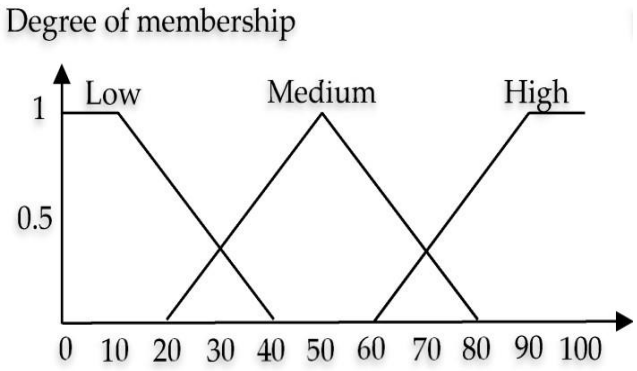

Figure. 3 Fuzzy Logic [14]

In this application, Fuzzy logic helps us determine the degree of recommendation by assigning ranks to the food items as real numbers between '0' and '1' which is determined by the frequency of consumption of the particular food item.

3.1.3 Recommender System

The collaborative filtering technique is a powerful method for generating user recommendations. Collaborative filtering relies only on observed user behavior to make recommendations—no profile data or content access is necessary.

The technique is based on the following observations:

- Users who interact with items in a similar manner (for example, buying the same products or viewing the same articles) share one or more hidden preferences.
- Users with shared preferences are likely to respond in the same way to the same items.

Combining these basic observations allows a recommendation engine to function without needing to determine the precise nature of the shared user preferences. All that's required is that the preferences exist and are meaningful. The basic assumption is that similar user behavior reflects similar fundamental preferences, allowing a recommendation engine to make suggestions accordingly.

For example, suppose User 1 has viewed items A, B, C, D, E, and F. User 2 has viewed items A, B, D, E and F, but not C. Because both users viewed five of the same six items, it's likely that they share some basic preferences. User 1 liked item C, and it's probable that User 2 would also like item C if the user were aware of its existence. This is where the recommendation engine steps in: it informs User 2 about item C, piquing that user's interest. [13]

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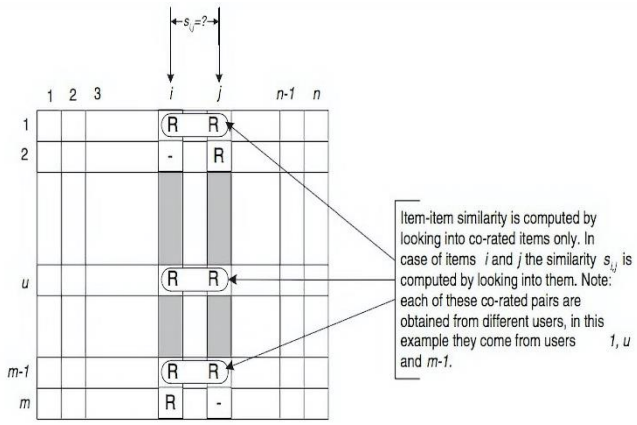

Figure. 4 Collaborative Filtering Algorithm [11]

Correlation-based Similarity

In this case, similarity between two items i and j is measured by computing the Pearson-r correlation $corr_{i;j}$. To make the correlation computation accurate we must isolate the co-rated cases (i.e., cases where the users rated both i and j) as shown in Figure 4. Let the set of users who both rated i and j are denoted by U then the correlation similarity is given by

$$Sim(i, j) = \frac{\Sigma (R_{ip} - R_{iavg}) \quad \Sigma (R_{jp} - R_{javg})}{\sqrt{(\Sigma (R_{ip} - R_{iavg})^2} \sqrt{\Sigma (R_{jp} - R_{javg})^2}}$$

Pedometer (Step Counter)

A pedometer is a device that helps count the number of steps taken by a person.

It is used in different fields such as sports, fitness, rehabilitation etc.

The Step Counter in the system uses various sensors in the mobile device such as:

- Gyro Sensors for detection of steps
- Accelerometer for detection of speed
- Magnetometer for detecting the orientation of the device

It is found that walking 10,000 steps burns approximately 300-600 calories depending on the speed and intensity of walking.

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4. RESULT & DISCUSSIONS

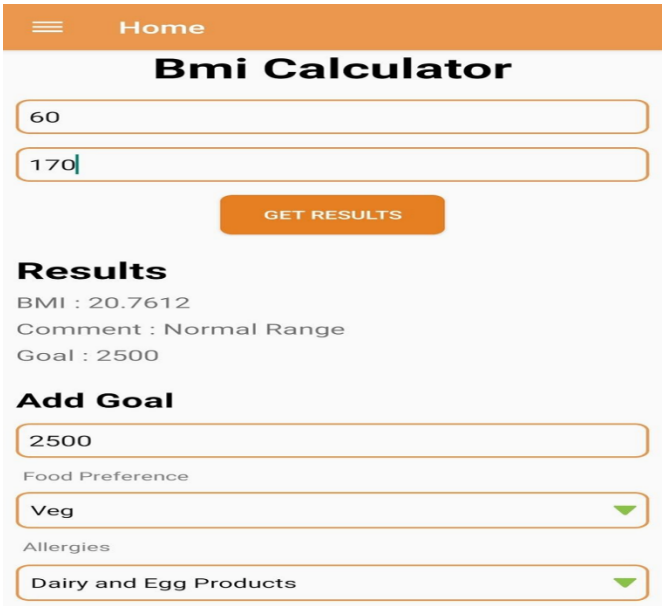

Figure 5 BMI Calculation

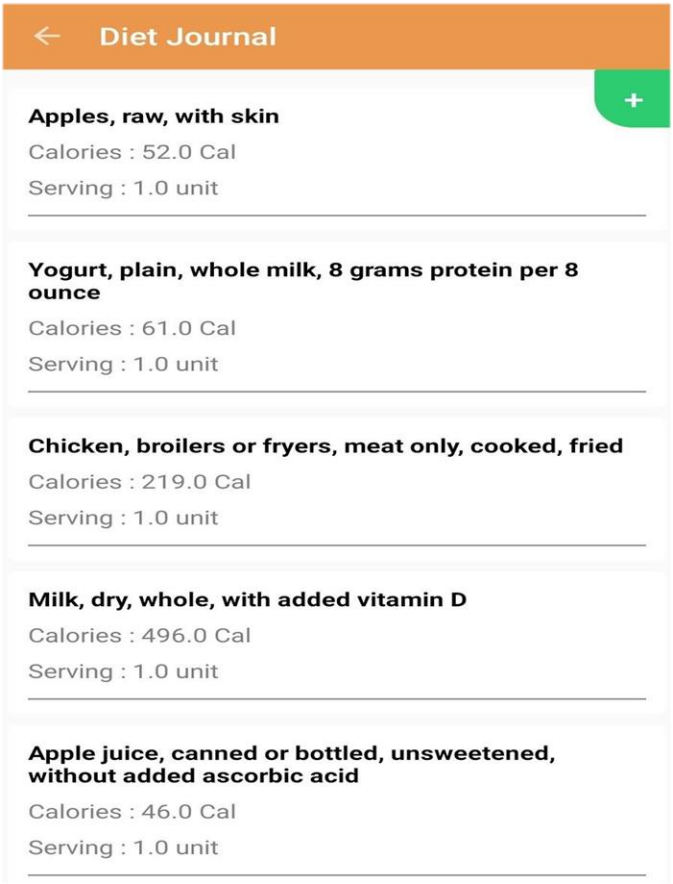

Figure 6 Diet Journal

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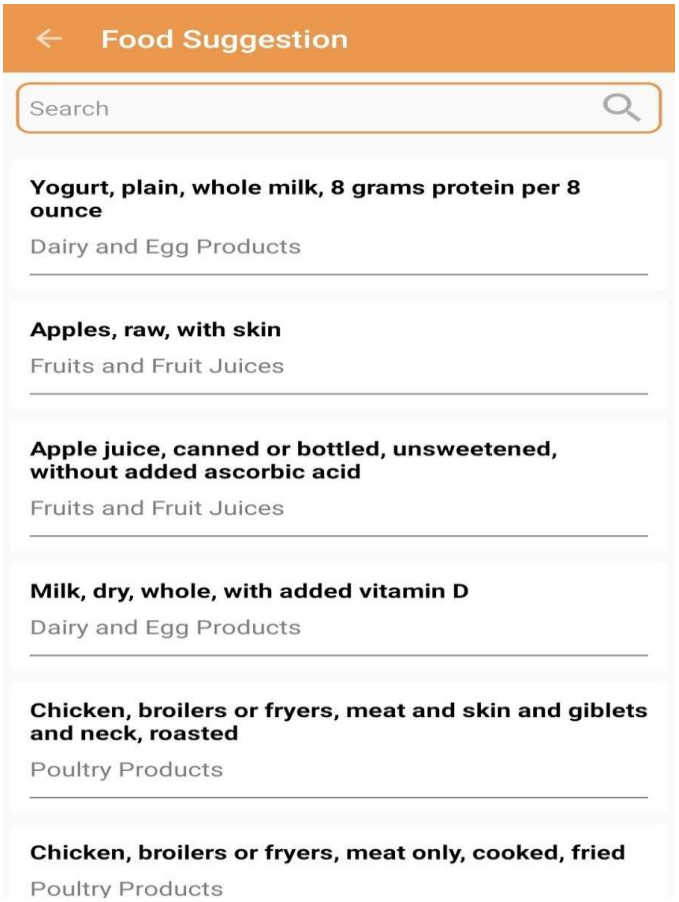

Figure 7 Suggestion Page

We survey a few users that used the application based on their personal preferences to gain insight on how accurately the recommendation system has been implemented. This survey based on Google forms also helped us to understand how much the recommender system depends on the frequency and quantity of usage.

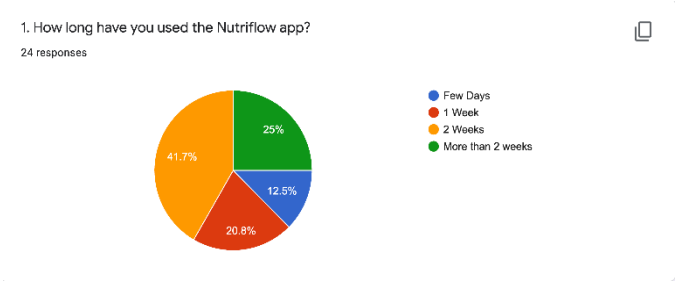

Figure 8

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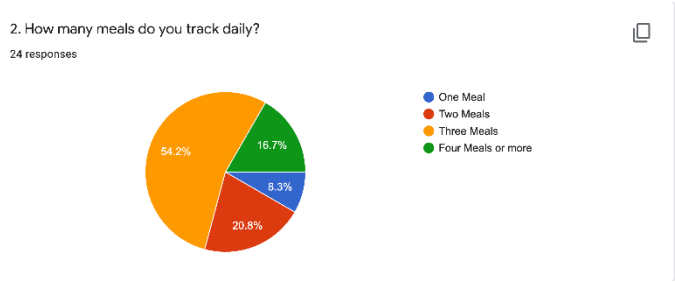

Figure 9

We made different Users operate the application for different time periods and enter varied amount of food items per day which helps us in understanding how this might affect the accuracy of recommendation by the application.

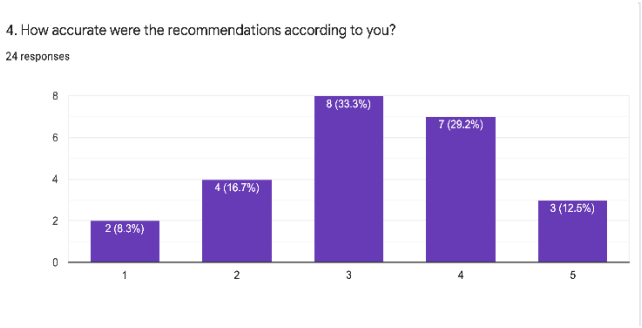

Figure 10

Here we see varied responses from users based on the accuracy of recommendations provided to them by the applications.

On analyzing the data, we can deduct that the accuracy of recommendations depends highly on the time period of usage and number of entries done by the user.

- Users that have used the app for longer time periods seem to have better recommendations as compared to the ones that used the app for shorter periods.
- Users that have higher daily food entries also seem to have better recommendations and vice versa.

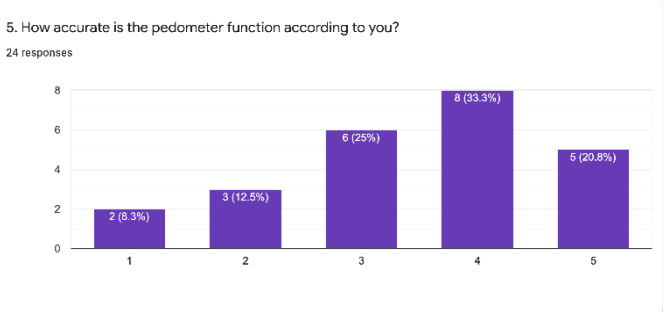

Figure 11

We also surveyed the accuracy of the Pedometer function of the application to get a feedback on the accuracy.

5. CONCLUSION

The concept of Recommender Systems and Fuzzy Logic has been used widely in the fields of Pattern recognition, multi- objective optimizations, biomedical engineering and many more. Here

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we use Fuzzy logic and Collaborative Filtering to implement a Diet Recommendation System which provides nutrition goals and food recommendations. The use of Artificial Intelligence has been widely recognized in the field of Nutrition and Medicine.

The future prospects of this application include Integration of Modules for showing Restaurants based on users Geolocation, provide Workout regimes based on user's fitness aims and also provide complete Diet Plans. Finally, by one-on-one interaction with dietary experts, further training models and the use of Deep Learning to improve recommendations would be a very useful addition to a well- designed Diet Recommendation System.

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