

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

Recommendation System for Personalized Diet Management

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ABSTRACT: The purpose of this project is to develop a diet recommender system for personalized diet management using Fuzzy K means. A recommender system is an intelligent system that can help a user to come across interesting suggestions. The system considers m users in an n -dimensional space (n is the number of user attributes) and then presents an approach based on user clustering to produce a recommendation for the active user. Fuzzy K-means clustering algorithm is used to categorize users based on their age, gender, height, weight etc. Fuzzy K-means is similar to K-means but here an object can belong to more than one cluster using the probability value of objects to clusters. Traditional collaborative filtering approach is used to evaluate and compare users. Our own algorithm is proposed for preparing a diet chart. The diet recommendation algorithm provides food based on the nutritional requirements of the user i.e. (calorie, protein, carbohydrate, fats etc.) Finally, the system is evaluated based on cluster purity, precision and recall of the clustering and diet recommendation algorithm respectively.

I. INTRODUCTION

Balanced nutrition is an important aspect of a healthy lifestyle. Along with regular physical exercise, a balanced diet is extremely crucial for a person's health. However, with the increasing pace of today's professions, nutrition and health is often overlooked. There has been an epidemic of diet-related diseases like Diabetes and Coronary Heart Diseases all over the world especially in Urban Areas. In Indian Urban Areas, around 32 out of every 1000 individuals suffer from coronary heart disease while more than 2 out of every 100 individuals suffer from Diabetes. These diseases are almost always directly related to unhealthy eating habits. Our objective of this project is to build a system that will aim to recommend appropriate nutritional intake to its users based on their nutritional requirements and personal preferences. The system will also consider the user's physical activities throughout the day and suggest appropriate diet plans.

II. LITERATURE SURVEY

C.Nagarajan *et al.* [10][11] identified that it recommends appropriate nutritional intake to its users based on their diet history and personal preferences. The system will also consider the user's physical activity throughout the day and suggest appropriate diet plans for the same. We also provide data on the nutrients and seasonal availability of foods to the users. This system uses ABC algorithm, that can be used to extract the information from the database to provide a suitable diet according to requirements of the user.

C.Nagarajan *et al.* [5] discussed that Predictive Data Mining helps in the prediction of a healthy diet for any individual and nutritionist to recommend a diet plan. The Harris-Benedict equation is used to calculate an individual's Basal Metabolic Rate (BMR). To determine the number of calories to be taken in each meal of the day the system uses simple mathematical equations.

Morning Breakfast:

$$a_1 + a_2 + a_3 + \dots + a_n = \frac{\text{cal}}{5} \quad 1$$

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Snacks:

$$b_1 + b_2 + b_3 + \dots + b_n = \frac{\text{cal}}{10} \quad 2$$

Lunch:

$$c_1 + c_2 + c_3 + \dots + c_n = 4 * \frac{\text{cal}}{10} \quad 3$$

Phongsavanh Phorasimand Lasheng Yu [3] studied the Collaborative filtering, the most successful algorithm in the recommendation system. A recommender system is an intelligent system that can help a user to come across interesting patterns. This paper considers the users m (Number of users), points in n dimensional space (n is the number of items) and presents an approach based on user clustering to produce a recommendation for the user by a new approach. The system uses k -means clustering algorithm to categorize users based on their interests and calorie requirements. The system evaluates the traditional collaborative filtering and this approach to compare them. Results shows that the proposed algorithm is more accurate than the traditional existing one, besides it is less time consuming than the previous existing methods.

Rahul Katarya and Om Prakash Varma[4] applied a hybrid of k -means and cuckoo search to the Movielens dataset to achieve an improved movie recommendations system for the user. The performance of the system is measured using MAE, RMSE, SD, and t -value. The experiment outcomes on the Movielens dataset discussed indicated that the approach provide high performance regarding accuracy and were capable of providing reliable and personalized movie recommendation systems with the specific number of clusters. Evaluation metrics (for a given number of clusters) originated to be lesser than those of other methods.

E Riswanto, B Robi'inand Suparyanto[5] developed a specific recommendation system for culinary tourism destinations in Yogyakarta based on mobile using the KNN (K-nearest neighbor) algorithm. The recommendation system is based on previous user ratings of food taste, environmental atmosphere, price, service and distance between users and location. The weight of each criterion is tailored to the needs of the user. The results showed that the mobile application recommendation system was able to provide recommendations to users to determine culinary tourism destinations in Yogyakarta in accordance with the parameters of user desires.

III. EXISTING SYSTEM

The user creates a user profile which will contain all the basic information like age, gender, height, weight to find the Basal Metabolic Rate (BMR) which is the calorie requirement needed for a day when a person is at rest which is then multiplied with the daily activity level multiplier (refers to the amount of physical work done per day) to find the daily nutritional requirements of the user. The user profiles are grouped or clustered using the k means clustering algorithm based on the users age, gender, height, weight and calorie requirements. With which a user will be provided a diet of a similar user. We have proposed our own algorithm for preparing a diet chart. The diet recommendation algorithm provides food based on the nutritional requirements of the user i.e. (calorie, protein, carbohydrate, fats etc.). The system is evaluated based on the purity of the cluster, Precision and Recall. But the existing system does not take into account the health conditions of a user such as underweight, overweight and blood glucose level of a user.

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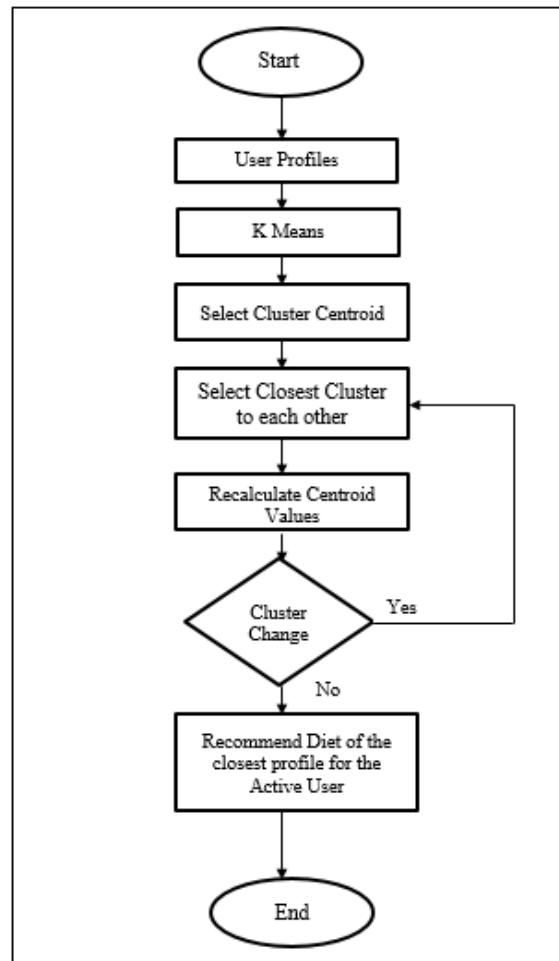


Figure 1 Flow Diagram of Existing System

IV. PROPOSED SYSTEM

The user creates a user profile which will contain all the basic information like age, gender, height, weight and daily activity (refers to the amount of physical work done per day) to find the daily nutritional requirements of the user. The user profiles are grouped or clustered using the Fuzzy K Means clustering algorithm based on the users age, gender, height, weight and calorie requirements. Similar users in a cluster are ranked using the weighted approximate algorithm. With which a user will be provided a diet of a similar user. The diet recommendation algorithm is optimized and provides food based on the nutritional requirements of the user i.e. (calorie, protein, carbohydrate, fats etc.). The system is evaluated based on the purity of the cluster and Root Mean Squared Error (RMSE).

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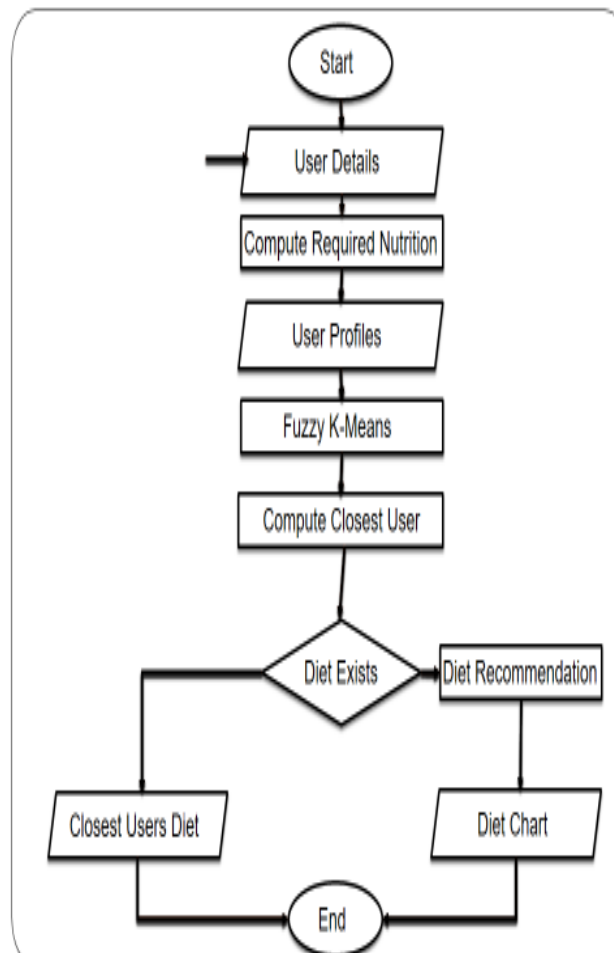


Figure2 Flow Diagram of Proposed System

Each user creates a user profile which consists of all the user information. Some basic information is given by the user like age, gender, height, weight and daily activity. From which the nutritional requirements of a user are calculated using his Basal Metabolic Rate (BMR). BMR is the amount of energy required per unit time that a person needs to keep a body functioning at rest. Then the BMR is added to the amount of energy that a person spends by doing physical work per unit time (in this instance we calculate it for a day). The BMR is calculated based on gender. Equation represents BMR where h is the number of calories burned (Kcal) in 24 hours, w is weight in (kg), s is height in (cm), and 'a' represents age.

$$h(\text{male}) = 66.4730 + (13.7516 \times w) + (5.0033 \times s) - (6.7550 \times a)$$

$$h(\text{Female}) = 65.0955 + (9.5634 \times w) + (1.8496 \times s) - (4.6756 \times a)$$

Then the Required Nutrients (RN) is calculated by multiplying the BMR with the Daily activity level multiplier.

$$RN = BMR \times \text{Daily Activity}$$

The traditional k-means clustering algorithm gives the values of any point lying in some particular cluster to be either as 0 or 1 i.e., either true or false. But the fuzzy logic gives the fuzzy values of any particular data point to be lying in

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either of the clusters. Here, in fuzzy k-means clustering, we find out the centroid of the data points and then calculate the distance of each data point from the given centroids until the clusters formed becomes constant.

The formula to compute the centroid (V) is:

$$V_{ij} = \left(\sum_1^n (\gamma_{ik}^m \times x_k) \right) / \sum_1^n \gamma_{ik}^m$$

Where, μ is fuzzy membership value of the data point, m is the fuzziness parameter (generally taken as 2), and x_k is the data point.

Euclidean distance is calculated for each data point with every cluster.

Updating membership values.

$$\gamma = \sum_1^n \left(\frac{d_{ki}^2}{d_{kj}^2} \right)^{\frac{1}{m-1}} - 1$$

These steps are repeated until there is no change in membership values

Diet Recommendation Algorithm

For the diet recommendation we have devised our own algorithm which splits the foods into categories like cereals, fruits, vegetables, diary products, meat etc. And based on the nutritional requirements needed for a day a balanced diet is provided. The algorithm first divides the nutrition requirement into three as breakfast, lunch and supper in equal ratio. Then each meal of the day will be provided separately on the basis of Kcal, Carbohydrates, Protein, Fats, Fiber and other necessary nutrition's. Each meal has a tolerance rate of +/-10% which will be balanced through the subsequent meals. The system also takes the BMI and the Blood Glucose value under consideration and provides diet plan to maintain them at normal. The diet can be altered based on the user's requirements if a user doesn't prefer a particular food, the user will be shown alternatives for that food which will contain similar nutrition content

V. EVALUATION METRICS

The system or the provided diet is evaluated based on precision and recall.

$$\begin{aligned} \text{Precision} &= \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}} & \text{Recall} \\ &= \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}} \end{aligned}$$

VI. RESULTS AND DISCUSSION

Fuzzy K means provides better efficiency than K means which provided a cluster purity of 0.71. It takes more time than K means because each data point is checked with every cluster.

The diet recommendation algorithm provides diet on a daily basis based on a user's Daily activity, Basal Metabolic Rate and Health conditions such as underweight, overweight and diabetes. The predicted health conditions of a user are evaluated using precision and recall. The system considered 78 user profiles.

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Table 1 Prediction of health condition

	Prediction-No	Prediction-Yes
Actual-No	56(TN)	0(FP)
Actual-Yes	0(FN)	22(TP)

VII. CONCLUSION

The system gets various attributes from the user such as gender, age, height and weight and calculates the calorie requirements based on Daily activity and health conditions then similar users are identified using fuzzy k-means clustering algorithm. The diet plan of similar users is provided else we create a diet plan based on the nutritional requirement of the user.

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