# Diet Recommendation using Predictive Learning Approaches

Anjali Jain
*Department of CSE,*
*Jaypee Institute of Information Technology,*
*Noida, India*
*KIET Group of Institutions, Delhi-NCR Ghaziabad*
jainanjali4u@gmail.com

Alka Singhal
*Department of CSE,*
*Jaypee Institute of Information Technology,*
*Noida, India*
alka.singhal@mail.jiit.ac.in

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*Abstract*— **In the modern world, people's health is one of their top priorities. As a result of inadequate nutrition, many people in the modern world are afflicted with a variety of diseases. It is urgently necessary to make timely and easy recommendations for a balanced diet, which is quite challenging. Time is one of the major restraints in today's world, therefore authors created a system for recommending diets to people based on their unique health needs, whether they are trying to gain weight, lose weight, or get a health checkup. The system is built on machine learning classifiers including Random Forest, Support Vector Machine, Ada Boost, and Gradient, as well as clustering methods like K-means. Boost. After calculating Body Mass Index and the user's desire for diet based on their health state (overweight, underweight, or healthy), the suggested system makes meal recommendations based on the user's age, height, and weight. The proposed paper summarises numerous similar works and evaluates the effectiveness of the suggested strategy. The performance comparison is displayed in terms of recall, recall accuracy, precision, and f1-measure.**

***Keywords— DRS, Predictive Learning, BMI.***

## I. INTRODUCTION

People in the modern world are too busy to take care of their health or eat healthfully. People need someone to give them a healthy diet plan because they frequently skip meals at specific times. Numerous elements, including nutrition, heredity, and sleep, have an impact on a person's health. People used to follow diet advice from many online sites because the internet is so overflowing with information. A balanced diet that promotes activity and a long life is the most important aspect of human existence. A balanced diet is one that contains the right ratio of carbs, lipids, proteins, vitamins, minerals, and sugar, among other things. Diet advice is in high demand right now since so many people are asking for it and so much research is being done on the topic. A person's diet depends on a number of variables, including nutrition, accessibility, disease, and technology. A person's diet has an impact on how their body morphologically changes. To lose weight, people used to fast, skip meals, and practise intermittent fasting. Therefore, it is necessary to offer a suitable and balanced food plan so that one can adhere to it. There is a lot of inquiry and research being done for diet recommendations. Diet advice is in high demand right now since so many people are asking for it and so much research is being done on the topic.

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Organized and efficient machine learning algorithms are utilised to prescribe the right amount of nutrients, calories, fat, and carbohydrates for a diet that will keep you fit and healthy. Numerous other techniques have been the subject of research, such as similar user behaviour, user preferences for item features, hybrid filtering (HF), knowledge-based filtering (KBF), ant colony algorithm, classification, clustering, decision tree, logistic regression, natural language processing (NLP), inductive logic programming (ILP), ontologies, sparse canonical correlation, support vector machines, semantic technologies, multi-criteria decision making, and graph-based recommendation[2]. These are the fundamental recommendation strategies used in the different areas of healthcare. The advantages and disadvantages of various filtering methods have also been covered by authors. To forecast the optimal meal menu for a given health status, the author of the proposed study used machine learning

classifiers such Random Forest, Support Vector Machine, AdaBoost, and gradient boost [3].

## II. RELATED WORK

Having a diet that is well-balanced in nutrients is the key to living a healthy life. Because eating healthfully is a need today. People used to diet to maintain their health, gain weight, or lose weight. However, these kinds of diets, procedures, and restrictions are bad for their physical and mental health. A person should consume in accordance with their desires, nutritional requirements, and ingredient needs. There are many recommendation strategies that have been applied to diet recommendations, such as similar user behavior, which suggests products based on the interests and preferences of other users who are similar to the one in question. Similar user behavior and preferences for item features were reported in (Osadchiy et al., 2018) for user recommendations. The system uses association rules and inverse filtering methods to recommend the results based on user item descriptors and preferences [1]. K- means clustering and collaborative filtering were used by (Yuan et al., 2019) to execute diet advice [2]. The recipes in the cluster with higher ratings are those that best suit the user's nutritional needs. The approach turned out to be 70% more precise and efficient. A recipe recommendation employing ingredients based on user preference for similar foods was proposed by (C. Yuen et al., 2012) [3].

For hypertensive patients, (Sookrah et al., 2019) developed the DASH recommendation engine, which stands for dietary approaches to control hypertension and is based on content-based filtering and machine learning [4]. Hybrid filtering was established to address the issues of comparable user behaviours and user interest in similar goods. To address the cold start and sparsity issues, (Kim et al., 2020) proposed a knowledge-based hybrid decision model that takes into account both physical and mental health. To assist users who made decisions about their diet and nutrition on a health platform, a food recommendation model was proposed [4]. By examining user demands, (Li et al., 2016) suggested a nutritional combination model. As more individuals switch to purchasing food online, the quality and nutrients of the food are being sacrificed. The model eliminates the cold start issue and provides high performance since it is based on the functioning of comparable user behavior and user desire for item features. When a product is brand-new, the rating may be restricted since so many authors have employed knowledge-based filtering [6]. After viewing the user's pathological reports, (Rehman et al., 2017) proposed cloud-based food recommendation, where ant colony optimization, a technique inspired by nature, is used to generate an optimal food list and food recommendation, and accuracy is increased by increasing the number of ants [7]. For youngsters between the ages of 3 and 6 years old, a different authors created a sensor-based smart plate that measures the weight of food both before and after meals.

The suggested approaches are intended to track children's growth indices and dietary deficits. The results and analysis of the necessary amount of nutrition led to the recommendation of the nutrient-dense menus. There are numerous other methods that different authors employ when recommending a cuisine or diet.

Jiang et al. (2020) employed a graph mining method based on random walks that can also be applied to address user health demands. The Food-Nutrition-Recipe Graph (FNRG), which was developed in this study and proved helpful for those with chronic diabetes, is a heterogeneous graph that integrates data from Food Data Central (FDC), recipe websites, and scientific literature. (Chena et al., 2019) introduced the NutRec model, which specifies the healthiest ingredient and its dosage for recipes for nutritious foods. The framework takes into account quantity as well as user-defined elements that are vital for a specific diet. Results from experiments can demonstrate the superior healthfulness of recipes. The author of this paper uses the data sets from Yummly and Allrecipes for improved outcomes [9]. The issue that occurs when conventional methods of recommendation are used to gather data from electronic health records was addressed by (Lore’s et al., 2012).

Therefore, the author developed a novel filtering technique that distinguishes between user and item features individually, and the trial proved to be more helpful for those with special health concerns and applicable to a specific diet with quantity. The strategy was mostly focused on consumers' interest in particular items of relevance to them. The issue of sparsity, latency, and inappropriate handling of persons with various needs and interests is resolved by this unique technique. For recipe recommendation, the author additionally uses a variety of nature-inspired algorithms. (Singh et al., 2019) introduced the use of fuzzy logic and the analytical hierarchy method to prescribe diets for people with diseases. They concentrated on the issue of undernourishment and the condition known as marasmus, which is brought on by a deficiency in nutrients such as carbs, fats, proteins, lipids, glycogen, etc. [8]. (Singh et al., 2019) employed a fuzzy technique to prescribe the right diet, taking into account a variety of human factors based on the age group. The method was employed since the diet data is quite ambiguous and extensive.

In this case, the author used a sizable data set in which age group and nutrition were supplied into a fuzzy ontology as inputs, and food and nutrition were produced as a nutrition %. According to the test results, the advised diet is more

accurate than the diet a dietician has recommended [7]. The expert recommendation method for the optimum nutrition was proposed by (Chen et al., 2018). For the recommendation of a tailored diet, a person's genetic background is occasionally necessary. As it is necessary for a tailored diet, people used to test their tests to obtain precise information about their genes. The author has created a system to correlate a person's genotypic data with data on supermarket items [6]. There are many different systems for making suggestions, therefore it was necessary to use a variety of innovative ways to improve the effectiveness of the systems that represent the foods that patients should eat. Many authors have employed machine learning and deep learning since some specialists have discovered that a balanced diet is an excellent choice to treat patients with various diseases. Proposed IoMT-assisted patient diet recommendation (Iwendi et al., 2020). For this analysis, the author employed LSTM and demonstrated that it had more accuracy. Random forest classifier was also used. In this study, a sizable data set was used, and it was split into training and testing data sets, respectively, with a 70:30 ratio. The health of the community is a vital concern, although dietary requirements of an individual cannot always be taken into consideration [5]. proposed food recommendation system taking user preferences and nutrition into account (Toledo et al., 2019). AHP sort and a decision table were employed by the author. Twenty nutrient food profiles and 600 food items are included in their paper. There is a paucity of consumer food history in this work, which could be exploited to improve the recommendations [6]. A model for diet advice was proposed in 2020 by (V. Nallarasan et al., 2020) that is based on the input parameters and recommends the diet food. The authors' diet recommendation was based on a fuzzy inference-based method [7].

Some publications and research projects deal with making dietary and food recommendations for people based on their work cultures and how sensors record their daily activities. The consumer can receive product and service recommendations from web-based systems based on their preferences [9]. Similar to this, the suggested system follows this methodology when advising users on their diet and food choices. The automated method for providing users with customized meals has been mentioned by George Salloum et al. [2]. The authors covered patient data including dietary preferences, food variety, food-meal compatibility, and inter-food compatibility. Another paper [7] provided further evidence of the work based on the consumption of tea and related beverages and how this affects the user's health. The study [4] illustrates the model to magnify the health problems and the suggested diet.

To support the suggested system, numerous current models and methodologies are discussed in the text above. The proposed system makes improved recommendations and suggestions to the user by utilizing a hybrid paradigm.

## III. PROPOSED FRAMEWORK

Due to the coronavirus, people are now more aware of their nutritional demands and watchful of their health [9]. The necessity of the hour is to maintain a healthy and nourishing diet, and everyone is searching for the nutritional advantages of a specific item and how much of it they need for their own bodies. In this study, the author employed classifiers and machine learning algorithms to prescribe diets based on user needs and requirements.

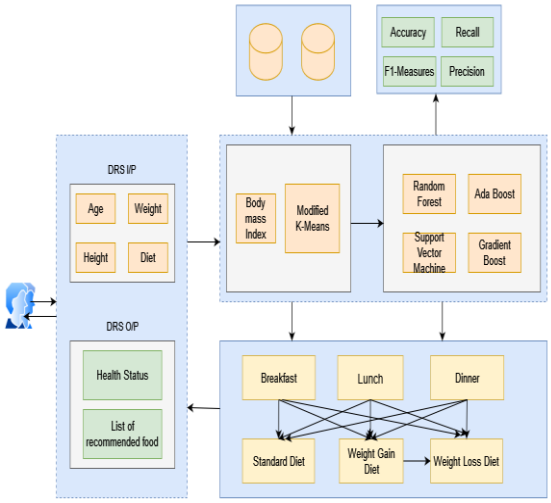


Fig. 1 Proposed framework for nutrition-based diet recommendation

The user will enter their age, height, weight, and preferred diet (vegetarian vs. non-vegetarian). The diet suggestion system examines the foods in each category first, and then makes predictions based on the user's health needs. Depending on the user's needs, the system will suggest the required list of food products, regardless of whether the user is healthy, overweight, or underweight. As seen in fig. 1, the recommended list of foods will be provided for breakfast, lunch, and dinner. The suggested framework demonstrates how the recommendation model operates. Machine learning algorithms for clustering and classification are implemented in Python and used to recommend a user's diet. The user enters the necessary information, including age, weight, height, and vegetarian and non-vegetarian food preferences. A user's body mass index determines whether they are overweight, underweight, or healthy. Food products are grouped into breakfast, lunch, and supper clusters using K-means clustering so that the user can receive more personalized recommendations. Multiple attributes are inputted into the K-means clustering algorithm to create clusters. Based on the user-inputted values that fall into one of the clusters, the

classification method is utilized to forecast the list of food items.

The dietary items are grouped based on the nutrients that are good for healthy, underweight, and overweight people. For the purpose of recommending foods that are suitable for a certain health status, the author used the random forest classifier, support vector machine, AdaBoost, and Gradient Boost. Through the Python-designed Tkinter, the user will enter information. Depending on the user's health status—overweight, underweight, or healthy—a list of food products will be suggested when the user enters his or her information. Figure 2 depicts the workflow for the process.

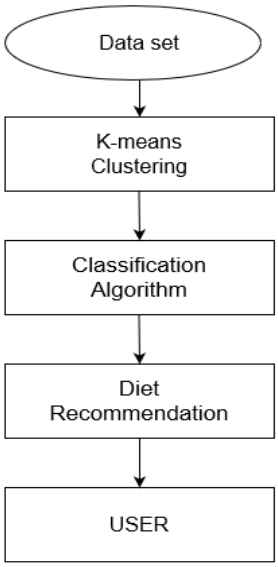


Fig. 2 Process flow diagram

## IV. EXPERIMENTAL SETUP AND RESULT ANALYSIS

Python 3's Scikit-Learn machine learning library is utilized to construct this framework. The GUI interface utilizes Tkinter. The most effective and reliable library for machine learning is Scikit Learn. A variety of machine learning algorithms are offered by Scikit Learn in the supervised and unsupervised categories. Additionally, Scikit learn libraries are used for classifiers. Accuracy, precision, recall, F1-measures, and confusion matrices are some of the performance features used to evaluate classifier performance. The food data set is sourced from Kaggle and includes nutrient values for calories, fat, and carbohydrates, among other things. The values are the input for the suggested framework, and Patient Age is the patient's age. Patient Diet is used to specify the value of the vegetarian and vegan diet, either 0 or 1. The patient's weight in kg. The suggested diet will appear on the screen once the values have been input. In figure 3, the output screen is displayed. The sample data is filled and shown in figure 4. The output of the input values is shown in figure 5.

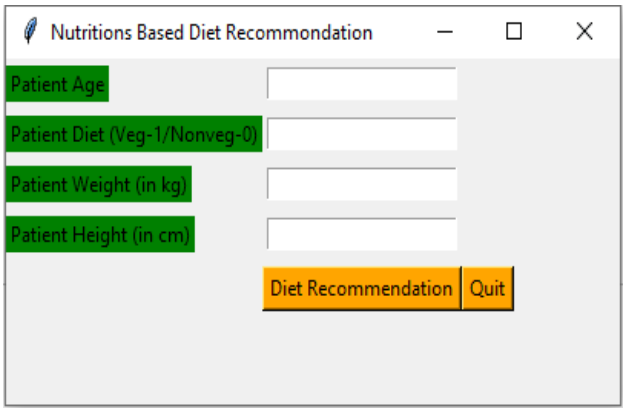


Fig. 3 User Details

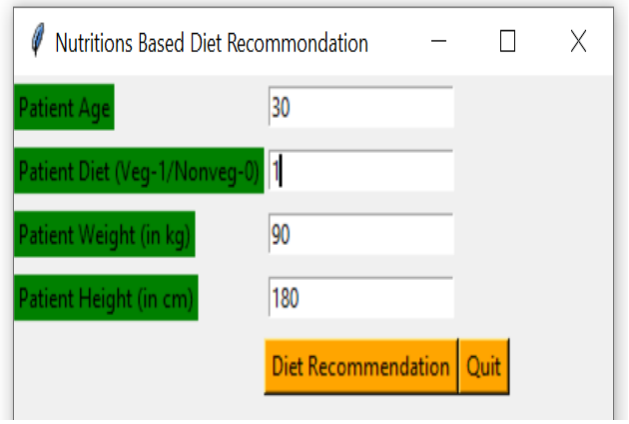


Fig. 4 Diet Recommendation input for Over-Weight Person

```
Age: 30
Veg-NonVeg: 1
Weight: 90 kg
Hight: 180 cm

Your body mass index is:  27.777777777777775
Acoording to your BMI, you are Overweight
####################
SUGGESTED FOOD ITEMS ::
Cauliflower
Corn
Pumpkin
Sugar Doughnuts
Tomato
Brownie

 Thank You for taking our recommendations. :)
```

Figure 5. Diet Recommendation output for Over-Weight Person

Another sample data for the healthy diet plan is filled and shown in figure 6. The output of the input values for the healthy person is shown in figure 7.

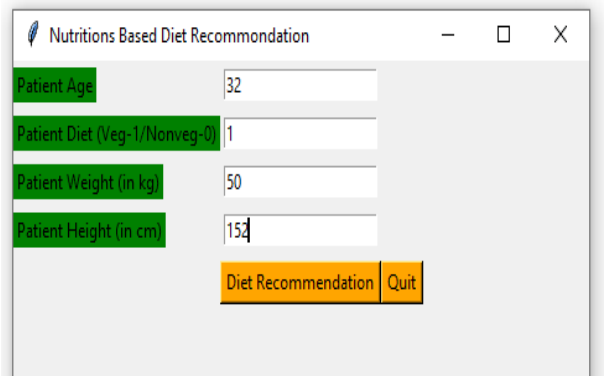


Fig. 6 Diet Recommendation for Healthy Person

```
Age: 32
Veg-NonVeg: 1
Weight: 50 kg
Hight: 152 cm

Your body mass index is:  21.641274238227147
Acoording to your BMI, you are Healthy
####################
SUGGESTED FOOD ITEMS ::
Cauliflower
Corn
Pumpkin
Sugar Doughnuts
Poha
Tomato
Brownie

 Thank You for taking our recommendations. :)
```

Fig. 7 Diet Recommendation for Healthy Person

## Performance Evaluation

The performance of the proposed work is measured on various performance indexes as shown in table 1 terms of, recall and f1-measure.

Table1: Accuracy and precision values of proposed system

| *Performance* / *Classifier* | *Accuracy* | *Precision* | |
|---|---|---|---|
| | | 0 | 1 |
| Random Forest | 0.82 | 0.71 | 0.88 |
| Support Vector Machine | 0.73 | 1 | 0.73 |
| AdaBoost | 0.86 | 0.83 | 0.88 |
| Gradient Boost | 0.82 | 0.71 | 0.88 |

Table1: Recall and F1-measure values of proposed system

| *Performance* / *Classifier* | *Recall* | | *F1-measures* | |
|---|---|---|---|---|
| | 0 | 1 | 0 | 1 |
| Random Forest | 0.71 | 0.88 | 0.71 | .88 |
| Support Vector Machine | 0.14 | 1 | 0.25 | .84 |
| AdaBoost | 0.71 | 0.94 | 0.77 | .91 |
| Gradient Boost | 0.71 | 0.88 | 0.71 | .88 |

## V. CONCLUSION

In the proposed study, a diet advice system based on user input values is demonstrated. Given everyone's hectic schedules in today's world, it might be challenging to plan or follow a diet based on one's health. The study discusses a diet prediction model and strategy for this aim. The author has outlined a framework for diet advice based on the user's needs, their weight status—overweight, underweight, or healthy—and two sample scenarios—a healthy person and an overweight person. K-means clustering and classifiers like Random Forest, Support Vector Machine, AdaBoost, and Gradient Boost are utilised for recommendations. The correctness was checked using the performance measures F-measures, Recall, Accuracy, and Precision.

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