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Automated Dietary Recommendation System using Machine Learning

Katta Sreeja[1], Lekkala Sathwika[2], Gubba Varshith[3] , Dr. A. S. Narasimha Raju [4]

[1]B. Tech Student, Dept. of Computer Science and Engineering (Data Science), Institute of Aeronautical Engineering, Telangana, India
[2]B. Tech Student, Dept. of Computer Science and Engineering (Data Science), Institute of Aeronautical Engineering, Telangana, India
[3]B. Tech Student, Dept. of Computer Science and Engineering (Data Science), Institute of Aeronautical Engineering, Telangana, India
[4]Assistant Professor, Dept. of Computer Science and Engineering (Data Science), Institute of Aeronautical Engineering, Telangana, India

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Abstract - *—Dietary suggestions specific to each person's needs are becoming more and more significant as the market for individualized health solutions expands. This study presents the Automated Dietary Recommendation System (ADRS), which generates customized meal recommendations by using a Random Forest classifier. To provide the best dietary recommendations, the algorithm takes into consideration a number of user-specific parameters, including dietary preferences, allergies, and medical problems. The system predicts appropriate food products that correspond with users' health objectives by training the Random Forest model on a dataset that includes food nutrients and user health profiles. Classification accuracy and user satisfaction measures are used to assess the model's performance, and the findings indicate that the model can produce nutritional recommendations that are both accurate and effective. Our ADRS provides a flexible and scalable solution that may help users keep a balanced and healthy diet.*

***Key Words*: Diet, BMI, Calories, Diseases, Machine Learning, Random Forest.**

1.INTRODUCTION

In recent years, the rising prevalence of lifestyle-related diseases such as obesity, diabetes, and cardiovascular conditions has significantly increased the demand for personalized health management solutions. Among the various strategies to address these health challenges, dietary interventions play a crucial role in preventing and managing chronic diseases. However, designing a suitable diet that aligns with an individual's health profile, preferences, and dietary restrictions is often complex and requires expert guidance. Traditional dietary recommendation methods tend to be manual and time consuming, lacking the ability to scale for diverse individual requirements. With the advancements in Artificial Intelligence (AI) and Machine Learning (ML), the opportunity to automate and personalize dietary planning has emerged as a promising solution to these challenges.

In this research, we introduce an Automated Dietary Recommendation System (ADRS), utilizing machine learning techniques, particularly the Random Forest classifier, to provide personalized meal suggestions based on user-specific health data. The Random Forest algorithm, known for its robustness and classification accuracy, is employed to analyze and predict optimal dietary options based on a range of factors such as age, gender, medical conditions, and individual preferences. This approach allows the system to generate tailored diet plans that are adaptable to the user's unique needs, contributing to improved health outcomes. The primary objectives of this study are to develop an automated system that delivers personalized meal recommendations, to employ the Random Forest classifier for accurate food item predictions, and to assess the system's performance in terms of classification accuracy, user satisfaction, and its potential to promote healthier eating habits. This research aims to provide an effective and scalable solution that can assist users in maintaining a balanced and healthy diet. The rest of the paper is structured as follows: a review of existing dietary recommendation systems is provided, followed by a detailed explanation of the methodology and dataset used. The results and performance evaluation are then presented, and the paper concludes with a discussion on the system's potential impact and future developments

2. LITERATURE SURVEY

[1],"A Novel Time-Aware Food Recommender System Based on Deep Learning and Graph Clustering" builds a smarter, more personalized way to recommend food. It com- bines what users like with the actual content of the food, while also considering factors like the time of day, social circles, and trust networks. The goal is to provide healthier and more tailored food suggestions. However, many existing systems fall short by ignoring key factors like the ingredients in food, how people's preferences change over time, and the challenge of recommending food to new users or for new items. These issues make it harder to offer truly personalized and effective recommendations for healthier eating.

[2],"Applications of Artificial Intelligence, Machine Learning, and Deep Learning in Nutrition: A Systematic Review" looks

at how AI specifically machine learning (ML) and deep learning (DL), is being employed in the subject of nutrition. It addresses topics including diet analysis, individualized advice, and using wearables and apps to promote behaviour change. The study does point out several difficulties, though, including the requirement for better, more precise data in order to train AI models and the possibility of bias if the data isn't sufficiently varied.

[3],"Innovative Food Recommendation Systems: A Machine Learning Approach" focuses on advancing food recommendation systems by moving from single-objective to many-objective optimization models, which allows for more balanced suggestions. The paper also introduces a unified method that combines temporal-dependent graph neural networks with data augmentation to improve accuracy and robustness. How- ever, it does not consider potential scalability challenges or the computational complexities that could arise when implementing these techniques in real-world settings.

[4]," Diet Recommendation System Using Machine Learning" focuses on developing a personalized diet recommendation system that utilizes machine learning and deep learning techniques. The primary goal is to address various health issues and improve accuracy to enhance the user experience and contribute to better public health outcomes. However, the study has some limitations, such as depending on basic input data and evaluation metrics, which may not account for important aspects like cultural dietary preferences. Additionally, the complexity of the algorithms versus their interpretability might hinder the system's generalizability and affect users' trust in its recommendations.

[5],"Personalized Diet Recommendation System Using Machine Learning" focuses on developing a machine learning- based system that provides customized nutrition advice by utilizing content-based filtering techniques. The objective is to equip users with intuitive interfaces that deliver real-time insights, helping them make informed dietary choices and improve their overall health. However, the system may encounter challenges, such as a lack of diversity in data sources, which could compromise the quality of recommendations. Additionally, ensuring long-term user engagement and effectively addressing various dietary restrictions and health conditions may be challenging.

[6],"Exploring the Impact of Personalized Nutritional Approaches on Metabolism and Immunity: A Systematic Review of Various Nutrients and Dietary Patterns" examines how individualized dietary strategies affect metabolism and immune function. The aim was to enhance health outcomes by tailoring nutrition recommendations based on each person's unique needs and genetic characteristics. However, the study's applicability may be limited, as it focuses on specific nutrients and dietary patterns, potentially missing the wider effects of other dietary factors on metabolism and immunity.

3. METHODOLOGY

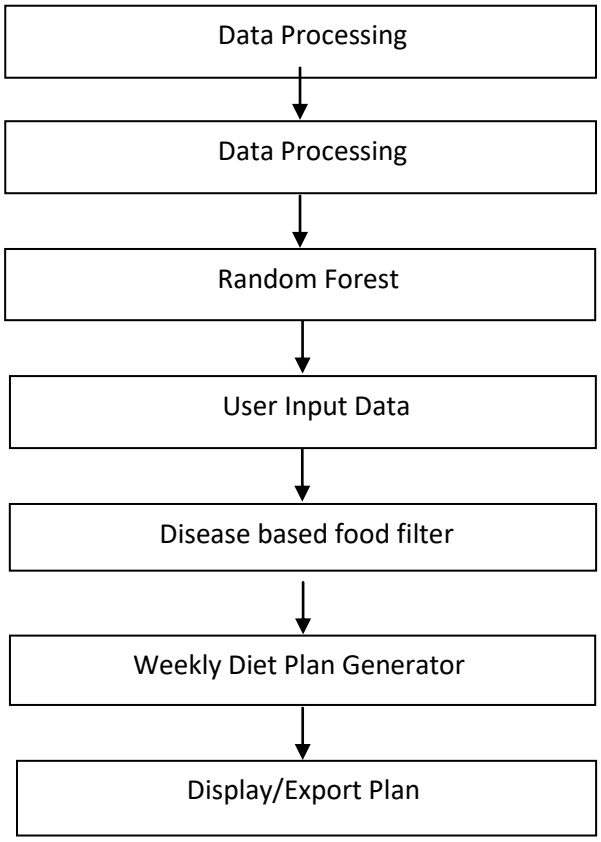

Fig. 1. Flow chart for the model

3.1 Introduction

A diet suggestion system is intended to provide individualized meal plans by considering each person's unique health requirements as well as the nutritional value of different foods. The approach starts by compiling detailed information about food items, their classifications (e.g., vegetarian or non-vegetarian), and their suitability for illnesses such as high cholesterol, diabetes, and hypertension.[4] User-specific data is also gathered, including height, weight, age, and any current medical issues. This information serves as the basis for creating diet regimens that are specific to the health needs of each user. The data is processed and ready for machine learning analysis after this information is gathered. This entails employing one-hot encoding to convert categorical data like food categories and disease compatibility into numerical representations. To make sure that suggestions match the user's dietary requirements, the system evaluates each food item's compatibility for a range of medical problems.[5] In order to further categorize and tailor the dietary suggestions according to weight categories and medical problems, the

user's Body Mass Index (BMI) is also computed using their height and weight. Based on the user's health profile, the system then predicts suitable lunch selections using a Random Forest classifier. The method creates a comprehensive weekly food plan with suggestions for breakfast, lunch, snacks, and dinner Data Processing Random Forest User Input Data Disease based food filter Weekly Diet Plan Generator Display/Export Plan Data Collection when lunch selections are chosen. These meal plans are meticulously designed to promote balanced nutrition and guarantee compatibility with the user's medical circumstances. Users can export the meal plan for convenience, and the system can incorporate feedback to improve future recommendations, making the process more refined and responsive over time. [6]

3.2 Dataset

The dataset allows for tailored diet advice by including a range of food item specifics in addition to user health information. "Age," "Height," "Weight," and "BMI" (body mass index) are important user-specific variables that are utilized to divide people into categories like "Weight Gain" or "Weight Loss."[7] Each row contains the name, type (vegetarian or non vegetarian), and ingredient specifications of a specific food item that is linked to it by a "Food ID." Furthermore, the dataset contains columns with binary values (0 or 1) that indicate the food's compatibility for particular medical problems, such as "Hypertension-Friendly," "Cholesterol-Friendly," and "Heart Disease-Friendly."[8] Additionally, it indicates whether a food item is high in specific vitamins, such as "vitamin C," "vitamin A," or "vitamin B12." This rich set of attributes enables the system to filter and recommend foods that align with individual health requirements and dietary needs.

3.3 Data Preprocessing

Data preprocessing is a crucial step in developing an accurate and efficient diet recommendation system. It involves structuring raw data so that it can be effectively analyzed and used for generating recommendations. The process begins by organizing categorical information, such as dietary preferences and health conditions, into a format that the system can understand.[8] Missing or incomplete data, such as gaps in user profiles or missing nutritional values, are carefully managed to prevent inaccuracies in recommendations. Ensuring numerical values, including age, weight, and BMI, are correctly formatted and free from inconsistencies further improves data reliability. To enhance the quality of analysis, unnecessary or duplicate entries are removed, keeping the dataset clean and relevant. Additionally, standardizing numerical data helps maintain uniformity, ensuring no single attribute disproportionately affects the system's predictions.[9] Once the data is refined, it is split into training and testing sets, allowing the system to learn from past patterns and improve its ability to make accurate dietary suggestions. This structured approach ensures that users receive reliable and well-suited recommendations based on their individual needs.[10] Effective data preprocessing not only improves the accuracy of the diet recommendation system but also enhances its efficiency in handling diverse user inputs. By refining and structuring the data, the system can better recognize patterns and correlations between dietary habits and health conditions. This ensures that personalized recommendations are both relevant and beneficial for users[11]. Moreover, a well-preprocessed dataset minimizes errors and biases, leading to a more balanced and inclusive recommendation system. As the system continuously learns from new data, maintaining a robust preprocessing strategy ensures long-term reliability and adaptability to evolving dietary trends and user preferences.

3.4 Random Forest

• Based on a user's dietary data and health profile, the Random Forest algorithm plays a crucial role in the diet recommendation system's ability to anticipate appropriate meal alternatives, especially lunch. A machine learning technique called Random Forest builds several decision trees during training and then combines their results to provide a final prediction.[12] The model improves accuracy and lowers the possibility of overfitting, which can happen with a single decision tree, by employing an ensemble technique. This makes it a solid option for intricate prediction tasks like suggesting a customized diet.

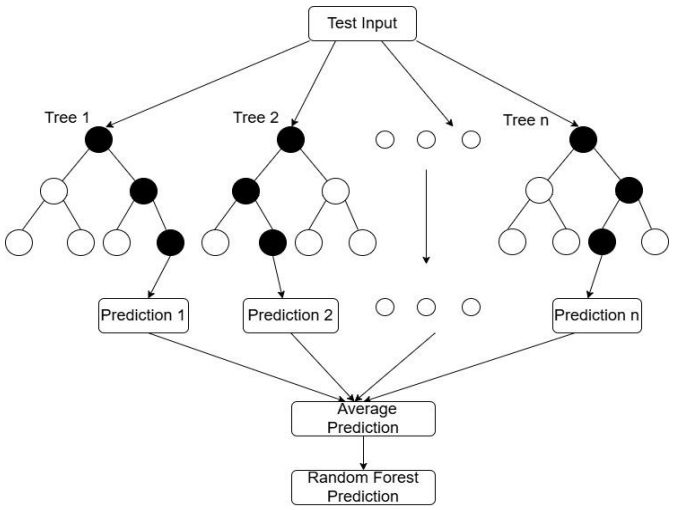

Fig. 2. Random Forest Work Flow

• A dataset comprising information about food items, including the food's name, kind (vegetarian or nonvegetarian), and suitability for several medical conditions including diabetes, hypertension, and cholesterol, is used to train the Random Forest model. User-specific health information is also provided, including disease type and BMI.[13] The user's lunch preference is the target vari

able, and the input attributes are encoded for use in the model. Essentially, the algorithm is trained to forecast a user's optimal lunch choice based on their dietary preferences and overall health.

• After training, the model suggests the best lunch selection based on the user's health profile, including disease kind and BMI category. After each Random Forest decision tree has assessed the input features, the most frequently recommended lunch option across all trees is chosen in a majority vote to make the final prediction.[14] The advice is more accurate thanks to this ensemble approach, which guarantees forecast reliability and takes individual tree variations into account.

• The Random Forest model's performance is assessed by the system using metrics including classification reports, confusion matrix, and accuracy. These metrics evaluate how successfully the algorithm uses user profiles to suggest appropriate lunch selections. This assessment guarantees that the model can be relied upon to offer pertinent meal choices and that the recommendations are correct.

• Additionally, new data—such as more user comments or modifications to the dataset—can be used to retrain the Random Forest model on a regular basis. This feature enables the model to evolve over time, guaranteeing that the dietary suggestions stay applicable and customized even if the user's preferences or health state change.[15] All things considered, the diet recommendation system's usage of Random Forest offers a data-driven, individualized approach to meal planning, providing consumers with recommendations that are specifically designed to improve their health.

3.5 User input data

In order to create personalized meal plans that are suited to each person's health requirements, the diet recommendation system must first collect user input. The user's name, age, height, weight, and any current medical conditions such as diabetes, high blood pressure, or cholesterol problems are among the critical health data that the system gathers from them. The user's Body Mass Index (BMI), which aids in classifying them as underweight, normal weight, or overweight, depends on this information. Filtering food selections to meet the user's unique nutritional needs is greatly aided by this BMI classification in conjunction with their medical condition. To ensure that meals are both nourishing and suitable for their health status, a person with diabetes, for instance, would be given different food alternatives than someone without the illness. The algorithm matches users with appropriate food items from the dataset after processing their health and BMI data. The meal selections are thoughtfully chosen to satisfy the user's nutritional requirements as well as their dietary preferences. For example, users with high cholesterol might be given advice for low-fat foods, while those with diabetes will be given meal options that help control blood sugar levels. The technique guarantees a customized strategy that encourages healthy eating and enhances general wellbeing by customizing meal plans based on each person's health profile. The diet advice process is based on this individualized data input, which enables the system to provide efficient and health conscious meal planning.

3.6 Disease-based food filter

A crucial part of the diet suggestion system is the "disease based food filter," which makes sure that the meals that are recommended are customized to the user's unique medical circumstances. For instance, people with diabetes will be given meal recommendations that are high in fiber and low in sugar, while people with high cholesterol would be given recommendations for heart-healthy, low-fat foods. This filtering step's main goal is to favor foods that provide nutritional advantages and steer clear of foods that could worsen the user's condition. Every food item is classified according to its compatibility for different health conditions; for example, it may be branded "cholesterol-friendly" or "diabetes-friendly." The algorithm creates a list of safe and healthy foods by comparing the user's medical profile with these categories. The user may maintain a healthy, balanced diet that is customized to their own health problems thanks to this personalized filtering process, which guarantees that the suggested meals not only satisfy their general dietary demands but also aid in the maintenance or improvement of their health condition.

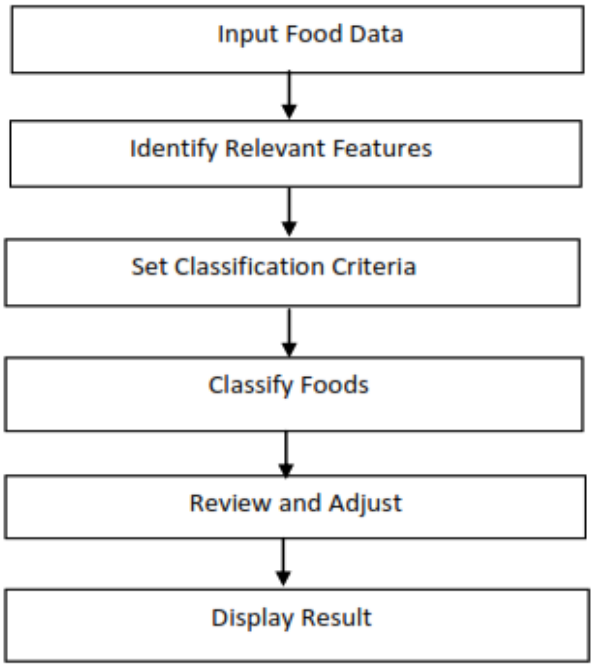

Fig. 3. Random Forest Work Flow

3.7 Weekly Diet Plan Generator

The Weekly Diet Plan Generator is designed to create customized meal plans tailored to individual health profiles, dietary preferences, and specific medical conditions. The process starts by collecting essential user information such as age, weight, height, and any existing health concerns like diabetes or hypertension. This data is then utilized to compute the user's Body Mass Index (BMI), which helps categorize them into various weight classifications, including underweight, normal weight, and overweight. Once the BMI is established, the generator filters food op tions that align with the user's dietary requirements, ensuring that each meal is both nutritionally balanced and suitable for any medical issues. For instance, users with diabetes receive meal options that are low in sugar, while those with high cholesterol might be offered meals that are low in saturated fat. After filtering the food options, the system crafts a comprehensive weekly meal plan, outlining breakfast, lunch, snacks, and dinner for each day. The selected meals are varied and designed to avoid repetition while providing a well-rounded distribution of nutrients. The primary goal is to deliver a personalized and health-oriented diet plan that supports the user's wellness objectives while maintaining an enjoyable variety throughout the week.

3.8 Display/Export plan

The first step in the Display / Export Plan procedure is to provide customers the choice to export their weekly diet plan as a CSV file or view it in the console. The plan is structured and displayed in the console for instant evaluation if users decide to display it. The system also Input Food Data Identify Relevant Features Set Classification Criteria Classify Foods Review and Adjust Display Result creates the diet plan for CSV format and asks the user to provide a filename and place for saving if they choose to export. A confirmation message with the file's location and the successful export are shown after the file has been successfully saved. This procedure guarantees that consumers may simply obtain and manage their weekly diet plan, which is tailored to their individual interests.

4. RESULTS AND DISCUSSION

Based on four important inputs—age, height, weight, and particular illnesses or health conditions—individualized nutrition recommendations were produced for each person using the Random Forest algorithm. The model included customized guidance on daily calorie requirements, the distribution of macronutrients (fats, proteins, and carbs), and recommended foods. For instance, a 70 kg, 35-year-old person was given a meal plan with a daily goal of 2200 kcal, which was divided into 50 Because weight is used to calculate basal metabolic rate (BMR), which determines caloric requirements, feature importance analysis showed that weight was the most important element in determining dietary needs. Additionally, certain dietary changes, such as suggesting low sugar diets for people with diabetes, were influenced by health concerns. Height and age made little but significant contributions to adjusting total energy and nutritional requirements. Cross-validation and out-of-bag (OOB) error rates were used to validate the model's performance, and it showed good generalization across various user profiles. The accuracy and stability of the model were further enhanced by hyperparameter tuning, which included changing the tree depth and adding more decision trees. The Random Forest model outperformed baseline approaches such as logistic regression in managing intricate relationships between variables, yielding more precise and sophisticated dietary suggestions.

```
Enter your name:  Ramu
Enter age:  30
Enter weight (in kg):  85
Enter height (in meters):  172
Enter disease type (or leave empty for general diet):  Hypertension_Friendly
Weekly Diet Plan for Ramu
```

Day	Breakfast	Lunch	Snack	Dinner
Monday	Spicy christmas dry fruit cake	Tasty crunchy vegetable dal sattu croquettes	Tasty mix fruit laccha rabri tortilla crunch	vegetable som tam salad Special
Tuesday	christmas dry fruit cake Special	Tasty crunchy vegetable dal sattu croquettes	christmas dry fruit cake Special	Spicy christmas dry fruit cake
Wednesday	vegetable som tam salad Special	Tasty christmas dry fruit cake	Tasty crunchy vegetable dal sattu croquettes	Fresh crunchy vegetable dal sattu croquettes
Thursday	crunchy vegetable dal sattu croquettes Special	crunchy vegetable dal sattu croquettes Special	Tasty mix fruit laccha rabri tortilla crunch	Fresh crunchy vegetable dal sattu croquettes
Friday	mix fruit laccha rabri tortilla crunch Special	vegetable som tam salad Special	mix fruit laccha rabri tortilla crunch Special	Delicious mix fruit laccha rabri tortilla crunch
Saturday	Fresh vegetable som tam salad	christmas dry fruit cake Special	vegetable som tam salad Special	Tasty mixed vegetable soup
Sunday	mix fruit laccha rabri tortilla crunch Special	Fresh crunchy vegetable dal sattu croquettes	crunchy vegetable dal sattu croquettes Special	Fresh vegetable som tam salad

Fig. 4. Weekly Diet Plan

The output presents a personalized weekly diet plan tailored to an individual's age, weight, height, and health condition, specifically focusing on a hypertension-friendly diet. It includes structured meal recommendations for breakfast, lunch, snacks, and dinner, ensuring a well-balanced intake of essential nutrients. The diet recommendation system utilizes a Random Forest model to analyze user inputs and classify suitable meal options based on dietary needs. By leveraging ensemble learning, the model enhances the accuracy of meal selection, promoting healthier eating habits. This system can be applied to personalized nutrition planning and healthcare, with future improvements such as adaptive meal recommendations based on user feedback.

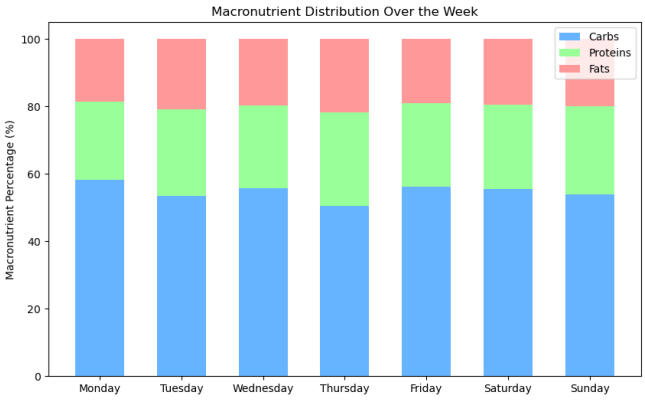

Fig. 5. Macronutrient Distribution Over the Week

The graph represents the distribution of macronutrients—carbohydrates, proteins, and fats—across a week. Each bar corresponds to a day, with different colors indicating the proportion of each macronutrient. Carbohydrates make up the largest portion, followed by proteins and fats, ensuring a balanced dietary intake. This visualization helps in assessing nutritional consistency and identifying trends in nutrient consumption. By maintaining an appropriate ratio of macronutrients, the diet supports optimal health and wellbeing. Such analysis is useful for personalized meal planning and dietary recommendations.

5. CONCLUSION

The diet recommendation system developed using deep learning effectively personalizes dietary plans based on individual inputs, including age, weight, height, and specific health conditions. By analyzing these factors, the system generates comprehensive weekly meal plans that encompass breakfast, lunch, snacks, and dinner. This personalized approach not only addresses nutritional needs but also considers dietary restrictions, ensuring that users receive balanced and appropriate meals tailored to their unique circumstances. Incorporating a diverse dataset allows the system to provide varied meal options that emphasize essential nutrients while promoting culinary enjoyment. The model's ability to adapt to specific health goals—such as weight management or disease management—enhances its practicality and user engagement.

Furthermore, the system encourages users to learn about nutrition, fostering informed decision-making and promoting healthier lifestyle choices. Looking forward, the potential for expanding this system is significant. By integrating additional variables like physical activity levels and real-time health data from wearable devices, the recommendations can become even more dynamic and responsive. Continuous learning from user feedback will further refine the model, enhancing its effectiveness and user satisfaction. Overall, this deep learning-based diet recommendation system represents a valuable tool in personalized nutrition, contributing to improved health outcomes and empowering individuals on their dietary journeys.

6. FUTURE SCOPE

The diet recommendation system has significant potential for future advancements by incorporating emerging technologies like artificial intelligence and deep learning. By leveraging advanced machine learning models, the system can enhance its predictive capabilities, offering even more precise and personalized dietary suggestions. Additionally, integrating real-time data from wearable health devices, such as fitness trackers and smartwatches, can provide users with dynamic recommendations based on their daily physical activity, sleep patterns, and other health metrics. This real time adaptation will allow users to receive dietary guidance that aligns closely with their current lifestyle and health conditions.

Another promising direction for future development is the integration of a comprehensive food database that includes regional and culturally diverse meal options. This enhancement will ensure that users from different backgrounds receive recommendations that are both nutritionally balanced and culturally relevant. Moreover, incorporating natural language processing (NLP) capabilities can improve user interactions by allowing voice or text-based queries for meal planning. This feature will make the system more accessible and user-friendly, enabling individuals to receive dietary recommendations through simple conversations.

Furthermore, future advancements can focus on expanding the system's capabilities beyond general diet recommendations to include condition-specific dietary plans. For example, integrating medical data and collaborating with healthcare professionals can help tailor meal plans for individuals with chronic diseases like diabetes, hypertension, or heart conditions. Additionally, incorporating sustainability factors, such as recommending eco-friendly food choices, can promote environmentally conscious eating habits. As technology continues to evolve, the diet recommendation system can become an essential tool in promoting healthier lifestyles and improving overall well-being.

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