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Machine Learning based Diet Recommendation System

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***Abstract*—Recent studies have shown that food recommendation systems can contribute well enough in the field of food and nutrition. Such systems are based on machine learning models, offer personalized diet and food recommendations depending on a person's dietary preferences, health needs and fitness goals. This review talks about a Diet Recommendation System that produces custom diet plans based on age, gender, height, weight, health conditions, food preferences and specific nutritional needs. For data collection we have used USDA and grocery datasets. Collaborative and content-based filtering methods are used for building recommendation models. Algorithms like decision trees and random forest are used for model training. The recommends a diet plan for the day based on user inputs. This application will help users in planning their everyday meals which may vary due to food choices, nutritional requirements and health conditions.**

***Index Terms*—recommendation system, machine learning, datasets, classification, filtering and data pre-processing.**

I. INTRODUCTION

One of the most pressing global issues is unhealthy eating and lack of awareness of what to eat, based on their health conditions which may lead to chronic diseases. Diet plays a significant part in healthy living. A nutrition recommendation system is an interface that guides people in making right food choices. Diet recommendation systems assess diet preferences and nutritional preferences among other dietary preferences to provide individual recommendations for healthier food intake. A patient-dietician based recommendation system was proposed in [1]. It is an artificial intelligence-based solution that automatically identifies which food items should be given to patients according to their health conditions. Another automated health monitoring and recommendation system [6] was proposed which aimed to manage diseases like diabetes, hypertension and thyroid disorders. In our system we aim to build a recommendation model which fulfils the following requirements: Analysis of various medical datasets and designing an automatic model that decides which food is to be given to which patient based on his/her disease and features like age, gender, height, weight, calories intake, protein, fat, sodium, cholesterol, etc. To develop a recommendation model which provides diet recommendations to individual users on the basis of their unique health data, preferences, and nutritional needs. To utilize machine learning algorithms like decision trees, random forest, K-nearest neighbor for the model training of recommendation systems.

II. LITERATURE REVIEW

In recent years, machine learning techniques have emerged in enhancing recommendations by analyzing large datasets, learning user preferences, and utilizing recommendations based on real-time feedback.

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Some of the existing research works in the field of machine learning and related technologies and their contribution in food/diet recommendation systems are illustrated below.

“Ref. [1]”, Iwendi, Celestine, et al.(2020) developed an innovative recommendation system designed to bridge the gap between patients and dieticians. This system suggests appropriate foods for individuals based on their medical conditions and factors like age, gender, weight, calorie intake, and nutritional components such as protein, fat, sodium, fiber, and cholesterol. The study utilized a dataset comprising 1,000 food products and data from 30 patients collected through IoT and cloud technologies. These products were tested across various medical conditions, and the LSTM deep learning model achieved an impressive accuracy rate of 97.74%.

“Ref. [2]”, Theodore Armand, Tagne Poupi, et al. are invaluable in premising this research on how AI, ML, and DL influence or shape today's world of nutrition sciences. What they achieve explains what these technologies can do, how such capabilities revolutionize nutrition in overcoming some of its major challenges, problems and opportunities to enhance what is possible. The researchers followed a hybrid approach of following guidelines of AI in this domain. The researchers conducted an extensive scientific review of literature from major databases of applications of AI, ML and DL in nutrition. This very detailed study not only outlines the present abilities in the field but also opens up discussions on future possibilities as well as challenges ahead for it.

“Ref. [3]”, Ortiz-Viso, Bartolome, et al. proposed an innovative evolutionary approach to design and recommend complex items specifically tailored for nutritional interventions. Their recommendation system stands out by integrating diverse input sources, including both data-driven and knowledge- based methods, to produce structured and detailed outputs. The researchers utilized an evolutionary framework to combine individual components into a flexible structure, creating an initial set of customizable recommendations. A content-based method was then applied to refine these suggestions based on user preferences, ultimately delivering personalized recommendations. They demonstrated the potential of this approach by applying it to healthy diet planning, highlighting its effectiveness and adaptability in tackling challenges within the field of nutrition.

“Ref. [4]”, a personalized recommendation system aimed at improving nutrition has been created. The system works with two types of data: genetic data and grocery data. The genetic data focuses on how our genes influence our ability to process key nutrients— such as energy, fat, protein, sugar, and salt. On the other hand, the grocery data is continuously updated to reflect new information. To categorize grocery items, they used a DLSTM (Deep Long Short-Term Memory) model, comparing its results with those of Convolutional Neural Networks (CNNs). In the "Personalized Recommendation System" section, the researchers explained how the system makes product suggestions, connected it to broader problems involving randomness, and introduced the idea of Genetic Algorithms (GA). They also discussed ways to improve the system, such as boosting categorization accuracy through advanced word embedding for grocery-related content and refining the underlying deep neural network (DNN) model.

“Ref. [5]”, in their deep dive into healthy food recommender systems, Trang Tran, Thi Ngoc and their team present a fascinating overview of how these systems work today. But they don't just stop at what's current; they highlight the hurdles that lie ahead in further developing these technologies. They delve into several innovative techniques used to provide personalized food recommendations: Each approach brings something unique to the table, helping people make the healthiest food choices tailored to their needs. This thorough examination not only showcases the potential of current technologies but also underscores the importance of ongoing innovation to make our food choices smarter and healthier. It's a testament to the exciting possibilities at the intersection of technology and nutrition.

“Ref. [6]”, a super helpful "E-Health monitoring system" was developed that merges diet and fitness recommendations using the power of machine learning. The system keeps a close eye on users' health and suggests follow-up sessions until everything is back to normal. It further applies decision trees to classify and recommend personalized diet and exercise plans. They tried out two different algorithms: C4.5 and ID3. Turns out, the C4.5 decision tree was a better performer, giving much more reliable and accurate results.

“Ref. [7]”, Min, Weiqing, Shuqiang Jiang, and Ramesh Jain developed a unified framework for food recommendations that tackles key challenges like integrating context, building personalized models and understanding food characteristics. Their approach combines user preferences, rich context and diverse food data to create more accurate recommendations. A standout feature of their system is the use of Knowledge Graphs (KG), which improve the precision and variety of food suggestions. By organizing food data effectively, KG ensures users receive more relevant and diverse food options according to their needs.

“Ref. [8]”, a “Nutrition diet recommendation system” was designed to help people make healthier food choices. This system is super personalized—it looks at the body mass index (BMI) and choice to buy at the grocery store to give the best diet advice. They used two smart techniques to do this: Content- Based Filtering and Collaborative Filtering. Content-Based Filtering figures out what foods you might like by looking at the details

of each food item. Meanwhile, Collaborative Filtering checks out what similar users enjoy and suggests those foods items to the user. To make sure their recommendations are spot-on, they use the USDA nutrient dataset. This means they have detailed nutritional info on tons of food items, so their suggestions are both accurate and tailored.

"Ref. [9]", Amiri, Maryam, Juan Li, and Wordh Hasan have proposed an AI–powered meal planner that's all about making healthy eating easier for people. This meal planner tailors meal plans to each person's specific health conditions. They even built a mobile app to bring this idea to life and tested it out with real users to make sure it works well. The system uses technologies like: Knowledge graphs to organize and utilize data effectively. Rule-based screening to filter out the right food choices. Fuzzy-based nutrition optimization to fine the meal plans for your nutritional needs. For making food recommendations, they use Semantic Rule-Based Filtering to ensure the suggested foods are relevant. Heuristic Search to quickly find the best options.

"Ref. [10]", Agapito, Giuseppe, and their team introduced "DIETOS," an advanced dietary recommender system designed to assist in the monitoring and management of chronic diseases. The system health profile for each user, factoring in key health indicators, and provides individualized nutritional recommendations based on this profile. These suggestions follow the main guidelines set by medical specialists, ensuring they are both relevant and medically appropriate.

Table I. contains brief description about various food recommendation systems which includes proposed solutions, methodology used and gaps in research work.

TABLE I. COMPARATIVE ANALYSIS OF VARIOUS FOOD RECOMMENDATION SYSTEMS

Paper	Author(s)	Proposed Solutions	Methodology	Research Gap
[1]	Iwendi, Celestine, et al.(2020)	Proposed a deep learning and IoT based solution that recommends personalized diet recommendations.	Algorithm like naïve Bayes, MLP, RNN, LSTM, GRU.	Small and limited datasets are used which produced unreliable results.
[2]	Theodore Armand, Tagne Poupi, et al.(2024)	Provided detailed research on how AI applications can help in the field of nutrition.	AI, ML, DL techniques like NLP, RL, Random forest.	Low data quality standards and privacy protocols.
[3]	Ortiz- Viso, Bartolome ,et al.,(2023)	Presented a model that is capable of handling distinct inputs and producing well-structured output.	ML and DL recommendation algorithms.	Small datasets and less optimized evaluation process used for recommendation.
[4]	Chen, Chih-Han, and Christofer Toumazou	Proposed a framework on data collection, processing and categorization.	Support Vector Machine (SVM), Deep Neural Networks (DNNs) and LSTM.	Accuracy can be improved using generalized grocery related articles and correlation of genetics to nutrients data.
[5]	Trang Tran, Thi Ngoc, et al.(2018)	Challenges related to the field of combination of AI and health were discussed.	Collaborative filtering, Content- based and Knowledge- based recommendation systems.	Usage of unfiltered user data and complexity of recommendation algorithms need to be discussed further.
[6]	Divya Mogaveera,Vedant Mathur, Sagar Waghela (2021)	Developed an automated-health monitoring and recommendation system to aid in managing diseases like diabetes, hypertension and thyroid disorders.	ID3 and C4.5 classifiers.	C4.5 model implementation had some issues which can be improved using a combined system of diet and exercise tracking.
[7]	Min, Weiqing, Shuqiang Jiang and Ramesh Jain.	Proposed an unique framework for food recommendation.	Context, Personal & heterogeneous food recommendations were used.	Usage of only one discipline in research work. Multidisciplinary research can give better results.
[8]	Gouthami, Butti and Malige Gangappa.	Proposed a recommendation system using BMI calculation.	Collaborative filtering methods.	Limited dataset diversity and lack of comprehensive health integration.
[9]	Amiri, Maryam, Juan Li and Wordh Hasan.(2023)	Proposed an AI powered meal planner that generates personalized meal plans.	Knowledge- base, semantic rule based filtering, heuristic search methods for searching food items.	Not capable of handling real time changes and usage of smaller and homogeneous samples.
[10]	Agapito, Giuseppe, et al.	Proposed a web based recommender system called DIETOS.	Web-based technologies along with recommendation models.	Not completely reliable in case of CKD patients and real time changes.

II. PROPOSED WORK

In this paper, a recommendation system is proposed which suggests a diet plan to users according to the factors like age, gender, disease/illness, calories intake, and other dietary requirements. The nutrient dataset is taken

from the U.S. Department of Agriculture which incorporates Body Mass Index (BMI) that is calculated using basic physical attributes. Python libraries like pandas, numpy, and scikit learn are used for data pre-processing. Collaborative- filtering and Content-based filtering are used for building recommendation models. For model training algorithms like decision trees, random forests are used. Additionally, it considers medical history to ensure that the recommendations are not only accurate but also safe for your specific health needs. This approach offers a practical and highly personalized solution for anyone looking to have a personalized diet but cannot afford a professional nutritionist.

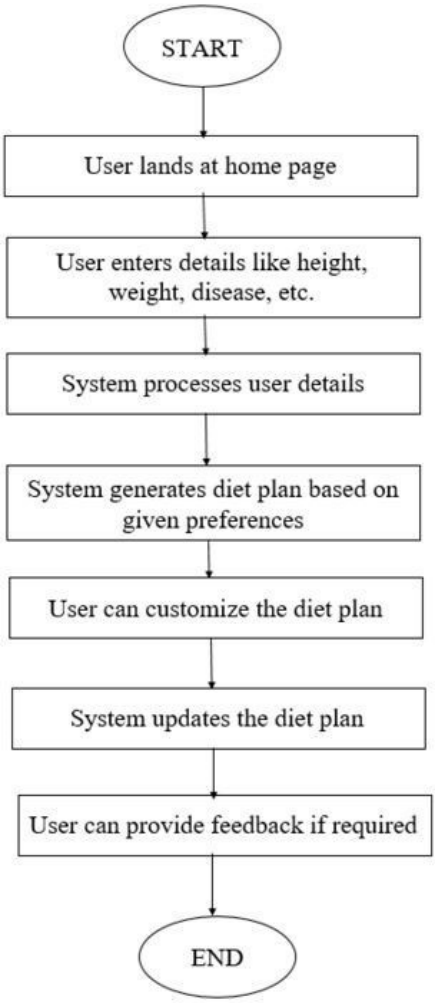

Figure 1. Flowchart representing the various stages of a diet recommendation system

A. Client-side Model

At the client-side, firstly user need to sign in/log in to get started. Once user is logged in they'll be asked to enter some details like their age, height, weight, gender, food choices, health issues and diseases. Body Mass Index (BMI) is calculated using height and weight details provided by the user. Based on all inputs, the recommendation system will give personalized diet suggestions like what food items they can eat in breakfast, lunch and dinner.

B. Server-side Model

At server-side, system runs smoothly on the reactjs framework. Rectjs is a fantastic javascript library that is efficient, flexible and perfect for building user interface components on the server side. NodeJs is an open-source cross-platform javascript environment. This allows the web application to run outside the web browser seamlessly. Alongside nodejs, mongodb is great for handling grocery data whether it's reading, inserting, deleting or updating information. This setup ensures that the recommendation system runs efficiently and can provide accurate and up-to-date diet suggestions.

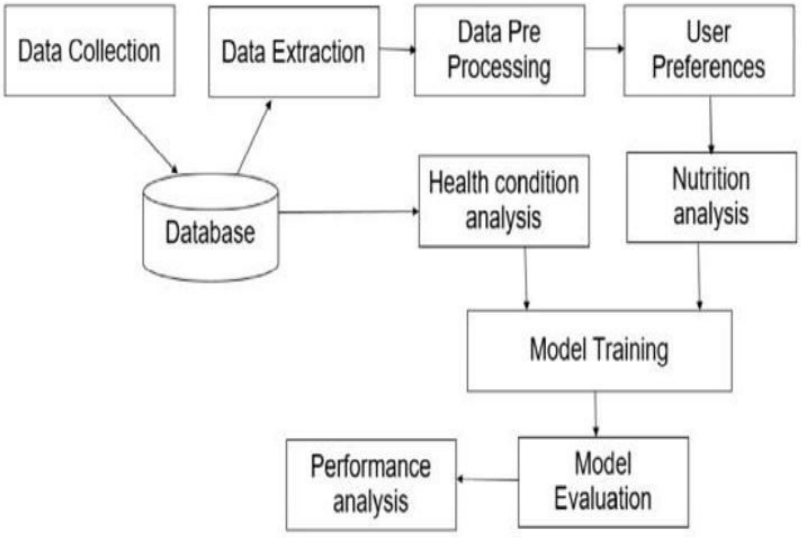

Figure 2. Various processes in the making of a diet recommendation system

C. Methodology & Algorithms

Data Processing

Once the dataset is picked, the next step is to give it a good clean-up. Any sort of irrelevant data needs to be removed and ensure everything is in similar format. Sometimes there are missing values or numbers that don't quite match up, like some being single digit, some being two and some being three. To make sure that our machine learning model works best, we bring all these numbers into a consistent range using min-max normalization.

Model Selection

For model selection, we have used two recommendation models, collaborative filtering and content-based filtering. Collaborative filtering filter out new food items that user might like by using the similar preferences of other people. It looks at patterns in how users rate or choose foods and uses this information to recommend similar items. This algorithm finds patterns in user's behaviour such as rating or selecting food items, to recommend similar items. There are two main filtering ways:

Filtering based on user: This method finds people with tastes similar to that of user and suggests foods they've liked.

Item-based filtering: This method looks at the similarities between different food items and recommends items that are similar to the ones user have enjoyed.

Content-based filtering is a recommendation technique that focuses on analyzing the characteristics of items to match them with a user's specific preferences and needs. In the context of a diet recommendation system, this means evaluating the nutritional properties of meals, such as calorie content, protein, carbohydrates, fat, vitamins, and minerals. The system then compares these attributes with the user's dietary requirements, health conditions, and personal goals (like weight loss or muscle gain).

Model Training

A decision tree is a machine learning algorithm used for classification and regression. It splits the data into subsets based on different conditions at every node, which leads to a decision at the leaf nodes. In the context of a diet recommendation system, a decision tree classifies or recommends diets based on user attributes like BMI, health conditions, and dietary preferences.

Start with User Input: The system collects user details (e.g., age, height, weight, dietary restrictions).

Apply Conditions: The decision tree evaluates these inputs at each node, such as:

"Is BMI > 25?"

"Does the user have hypertension?"

Make Decisions: Based on the conditions, the tree follows specific branches, narrowing down the options.

Provide Output: The leaf node gives a recommendation, like "Low-sodium, vegetarian meal plan" or "High-protein diet."

Random Forest Algorithm is a popular machine learning technique that can sort things into categories (like different types of foods) or predict values (like how many calories user will eat). Random Forest is used because it can handle complex interactions between features, such as the relationship between dietary restrictions and health conditions. It can predict foods or meals that match with the user's dietary preferences, restrictions, or health goals. For example,
Input Features: Dietary preferences, health metrics, and past meal ratings.
Output: A classification (e.g., "recommended" or "not recommended") or ranking of foods based on suitability.

III. Conclusion

Recent studies have shown that following a diet plan given by a dietician helps people live longer, protect against illnesses and increase life quality. In this paper, we discussed a recommendation system which suggests a diet plan to the user according to factors like age, gender, BMI, disease/illness and other dietary requirements. USDA dataset have been used for the same. Algorithms like decision trees and random forest are used for classification. Collaborative and content-based filtering methods are used for building recommendation models. At last, the system generates the diet plan for the users according to their preferences. There are also many challenges involved in making these type of recommendation systems to work more effectively and reliably. Noises in large datasets, accuracy of recommendation algorithms, changing food preferences, personalized diet plans according to complex illness/disease are the some issues that needed to be addressed in future works. AI-powered meal planning and automation, Real-time health monitoring, virtual assistants and chatbots can be added in future for creating more accurate diet plans.

References

[1] Iwendi, Celestine, et al. "Realizing an efficient IoMT-assisted patient diet recommendation system through machine learning model." IEEE access 8: 28462-28474(2020).
[2] Theodore Armand, Tagne Poupi, et al. "Applications of Artificial Intelligence, Machine Learning, and Deep Learning in Nutrition: A Systematic Review." Nutrients 16.7: 1073(2024).
[3] Ortiz-Viso, Bartolome, et al. "Evolutionary approach for building, exploring and recommending complex items with application in nutritional interventions." IEEE Access (2023).
[4] Chen, Chih-Han, and Christofer Toumazou. "Personalized expert recommendation systems for optimized nutrition." Trends in Personalized Nutrition: 309-338(2019).
[5] Trang Tran, Thi Ngoc, et al. "An overview of recommender systems in the healthy food domain." Journal of Intelligent Information Systems 50: 501-526(2018).
[6] Mogaveera, Divya, Vedant Mathur, and Sagar Waghela. "E-Health monitoring system with diet and fitness recommendation using machine learning." 2021 6th International Conference on Inventive Computation Technologies (ICICT). IEEE, 2021.
[7] Min, Weiqing, Shuqiang Jiang, and Ramesh Jain. "Food recommendation: Framework, existing solutions, and challenges." IEEE Transactions on Multimedia 22.10: 26592671(2019).
[8] Gouthami, Butti, and Malige Gangappa. "Nutrition diet recommendation system using user's interest." International Journal of Advanced Research in Engineering and Technology (IJARET) 11 (2020): 2910-2919.
[9] Amiri, Maryam, Juan Li, and Wordh Hasan. "Personalized Flexible Meal Planning for Individuals with Diet-Related Health Concerns: System Design and Feasibility Validation Study." JMIR Formative Research 7: e46434(2023).
[10] Agapito, Giuseppe, et al. "DIETOS: A dietary recommender system for chronic diseases monitoring and management." Computer methods and programs in biomedicine 153: 93104(2018).
[11] Geetha, M., et al. "Human Body Analysis and Diet Recommendation System using Machine Learning Techniques." ICASISET 2020: Proceedings of the First International Conference on Advanced Scientific Innovation in Science, Engineering and Technology, ICASISET 2020, 16-17 May 2020, Chennai, India. European Alliance for Innovation, 2021.
[12] Yue, Wenbin, et al. "An overview of recommendation techniques and their applications in healthcare." IEEE/CAA Journal of Automatica Sinica 8.4: 701-717(2021).
[13] Rostami, Mehrdad, Mourad Oussalah, and Vahid Farrahi. "A novel time-aware food recommender-system based on deep learning and graph clustering." IEEE Access 10: 5250852524(2022).
[14] Ko, Hyeyoung, et al. "A survey of recommendation systems: recommendation models, techniques, and application fields." Electronics 11.1: 141(2022).
[15] De Croon, Robin, et al. "Health recommender systems: systematic review." Journal of Medical Internet Research 23.6: e18035(2021).