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Meal Recommendation System Using Machine Learning and Algorithms

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ABSTRACT

This project introduces a hybrid meal recommendation system designed to enhance the dining experience for hotel guests by tailoring meal suggestions to their daily calorie requirements and nutritional preferences. The system seamlessly combines content-based filtering, which leverages nutritional attributes such as protein, fat, and carbohydrates, with collaborative filtering, tapping into user behavior and feedback. The results of this hybrid system showcase its proficiency in delivering precise meal recommendations, balancing the hotel's offerings with user input and behavior. This project offers a practical and adaptable solution for personalized dining experiences, promoting healthier and more satisfying meal choices for hotel patrons. Through the integration of content-based and collaborative filtering techniques, the system caters to a diverse range of guest preferences, ensuring an elevated culinary journey during their stay.

Keywords : Machine Learning, Content Based Filtering, Collaborative Filtering, Cosine Similarity

I. INTRODUCTION

In the era of digitalization, the culinary world has undergone a paradigm shift. With an abundance of dining options and a growing interest in food diversity, the need for personalized meal recommendations has become increasingly significant. The rapid growth of online food delivery services, coupled with the evolving food preferences of consumers, has prompted the development of advanced recommendation systems to cater to individual tastes and nutritional requirements. In this context, we introduce a comprehensive exploration of a meal recommendation system that harmoniously blends two influential recommendation techniques: Content-Based Filtering and Collaborative Filtering.

The concept of personalized recommendations, popularized by giants like Amazon and Netflix, has transcended into the food industry. This research paper addresses the growing demand for an intelligent meal recommendation system that leverages the fusion

of content-based and collaborative filtering strategies. Content-based filtering analyzes the intrinsic characteristics of meals, such as their nutritional content, ingredients, and cuisine types, while collaborative filtering taps into the collective wisdom of like-minded consumers to offer personalized dining experiences. The meal recommendation system detailed in this paper extends beyond the mere aggregation of user reviews or nutritional attributes. It offers a novel approach that considers individual dietary needs, user profiles, and real-time feedback to refine and optimize the recommendation process. The ultimategoal is to enable users to discover delightful culinary experiences, whether it be a savory meal that aligns with their nutritional goals or an adventurous gastronomic journey through a fusion of cuisines.

As we embark on this journey through the intricacies of content-based and collaborative filtering in the realm of meal recommendations, we aim to provide insights into the practical implementation of these methodologies.

II. PROBLEM STATEMENT

The alarming ubiquity of fast-food consumption has resulted in the widespread intake of nutritionally harmful foods, leading to a significant increase in health-related issues such as obesity, diabetes, high blood pressure, and various other health problems. As a consequence, there is an urgent need for individuals to adopt healthier, well-balanced diets. However, many people in contemporary society face constraints, both in terms of time and finances, which hinder their ability to engage the services of a personal dietitian or nutritionist to manage their health and provide personalized meal plans tailored to their specific dietary needs. This issue highlights a critical gap in the accessibility of professional nutritional guidance, ultimately jeopardizing the overall well-being of a substantial portion of the population.

III. LITERATURE SURVEY

Paper Title	Year	Authors	Methods	Dataset	Abstract
Website on Diet Recommendation Using Machine Learning International Research Journal of Engineering and Technology	2021	Shubham Kardam Pinky Yadav Raj Thakkar Anand Ingle	K-Means clustering Random Forest Classifier	Personalized dataset created in three categories (breakfast, lunch, dinner)	The paper discusses the importance of a balanced diet based on physical aspects and goals, and how it can lead to a healthy life
A Recommender System for Healthy Food Choices: Building a Hybrid Model for Recipe Recommendations using Big DataSets	2020-21	Pallavi Chavan Brian Thoms Jason Isaacs	Content-based, Collaborative filtering, and Hybrid recommendation models	AllRecipes dataset randomly split into a training dataset and a testing dataset.	The paper discusses the design, implementation, and evaluation of three recommender

Literature Survey					systems for recipe recommendations
Recommendation System for Monitoring the Energy Value of Consumer Food Products Based on Machine Learning	NA	Nazar Oleksiv Oleh Veres Andrii Vasyliuk Ihor Rishnyak LyubomyrChyrun	Goal tree analysis Subject area analysis	Clarifai API for dish recognition NutritionxAPI for barcode recognition	The paper discusses the necessity for research on healthy eating and suggests the creation of an intelligent system with characteristics including dish identification, barcode scanning, calorie computation, and energy value monitoring to assist users in maintaining a balanced diet.
Dietary Prediction for Patients with Chronic Kidney Disease (CKD) by considering Blood Potassium Level using Machine Learning Algorithms	2017	M.P.N.M. Wickramasinghe, D.M. Perera, and K.A.D.C.P. Kahandawaarachchi	Multiclass Decision Jungle Multiclass Decision Forest Multiclass Neural Network Multiclass Logistic Regression	The dataset includes attributes related to Chronic Kidney Disease (CKD) patients	The primary goal of this research study is to identify the suitable diet plan for a Chronic Kidney Disease (CKD) patient by applying classification algorithms on the test results obtained from patients' medical records

Diet Recommendation System based on Different Machine Learners	2022	Megh Shah1, Sheshang Degadwala2, Dhairya Vyas3	K-nearest neighbor, Support vector machine, Decision Tree, Navier buyers, Random Forest, and Extra tree classifier	Personalized dataset created Food.csv	This paper presents a diet recommendation system based on different machine learners to predict food items for weight loss, weight gain, and maintaining health, using user inputs such as medical data and dietary preferences.
Diet Recommendation using Machine Learning	2023	Reema Golagana V Sravani T Reddy C Kavitha	Bayesian personalized ranking Matrix factorization techniques Deep learning	Personalized dataset created	The paper proposes a personalized diet recommendation system based on user's physical characteristics and ailments, utilizing machine learning and deep learning techniques, to improve overall health and well-being.
A food recommender system considering nutritional information and user preferences	NA	Raciel Yera Ahmad Alzahrani Luis Martínez	AHPSort as a multi-criteria decision analysis tool	Personalized dataset created	A food recommender system is proposed in this paper that considers both nutritional information and user preferences.
Acceptability, Usability, and Quality of a Personalized Daily Meal Plan Recommender System: The Case of Virtual Dietitian	NA	Manuel Garcia Joel Mangaba Celeste Tanchoco	Statistical analyses The alpha evaluation (Phase 2) involved 397 non-expert users who tested the revised Virtual	Personalized dataset created	The paper evaluates the acceptability, usability, and quality of the Virtual Dietitian (VD) system, a personalized daily meal plan

			Dietitian (VD) system		recommender system, through an alpha evaluation involving 397 non-expert users.

IV. METHODS AND MATERIAL

Data Collection

Gather a dataset of food items and their nutritional information, including calories, protein, carbohydrates, fats, vitamins, and minerals. You can find publicly available datasets or compile your own.

Data Preprocessing

Clean and preprocess the dataset to handle missing values and ensure consistency in the data. You may also need to standardize the portion sizes for each food item.Outlier detection and treatment is an important stage in data preprocessing since they can severely affect statistical analysis and the training process of a machine learning system, resulting in decreased accuracy.

User Input

Design a user interface where the user can input their daily calorie requirement, weight and height. On the basis of this input appropriate calculations are made in the dataset.

Feature Engineering

Extract relevant features from the dataset, such as nutrient content, food categories, and dietary labels (e.g., low-carb, high-protein).we also calculate protein percentage, carbs percentage and fats percentage.

Machine Learning Models

MODEL 1CONTENT BASED FILTERING

Content-based filtering is a popular technique in the field of machine learning and recommendation systems. It is used to recommend items, such as movies, products, or articles, to users based on their past preferences and the characteristics of the items, content-based filtering is particularly useful when there's limited or no data on user interactions, as it relies primarily on item features. It can also recommend niche or personalized items that a user is likely to enjoy. To enhance recommendation systems, content-based filtering is often combined with other techniques, such as collaborative filtering, to provide more diverse and accurate recommendations.Cosine similarity is the cosine of the angle between the vectors; that is, it is the dot product of the vectors divided by the product of their lengths. It follows that the cosine similarity does not depend on the magnitudes of the vectors, but only on their angle.

$$\text{cosinesimilarity} = \cos\theta = \frac{A \cdot B}{\|A\|\|B\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \cdot \sqrt{\sum_{i=1}^{n} B_i^2}}$$

MODEL 2 COLLABORATIVE BASED FILTERING

Collaborative filtering is afundamental technique in machine learning used for recommendation systems. Unlike content-based filtering, which focuses on the characteristics of items, collaborative filtering recommends items based on user interactions and patterns. This approach leverages the collective behavior and preferences of users to make personalized recommendations.

Collaborative filtering can be categorized into two main types: user-based and item-based. User-based collaborative filtering identifies users with similar preferences to the target user and recommends items that those similar users have liked. Item-based collaborative filtering, on the other hand, identifies items that are similar to the ones the user has interacted with in the past and recommends those similar items.

Collaborative filtering is widely used by e-commerce platforms, streaming services, and social media sites to offer users tailored suggestions, enhancing their overall experience and increasing user engagement. However, it does require a substantial amount of user interaction data to be effectiveand can suffer from the "cold start" problem when dealing with new users or items without sufficient data.

K-Nearest Neighbours (KNN) can be used for collaborative filtering, and it is one of the traditional techniques for recommendation systems. Collaborative filtering is a method used in recommendation systems to make automatic predictions (filtering) about user interests by collecting preferences from multiple users (collaboration). KNN can be applied in both user-based and item-based collaborative filtering.

KNN can be effective in collaborative filtering because it leverages the concept of finding similar users or items based on historical interactions. However, it has some limitations, such as scalability issues with a large number of users or items, sparsity in the user-item matrix, and the cold start problem (difficulty recommending to new users or items with limited interaction data).

In practice, more advanced recommendation algorithms, like matrix factorization, singular value decomposition (SVD), and deep learning-based methods, are often used in combination with or as alternatives to KNN for improved recommendation performance.

We have used Euclidean Distance while implementing KNN algorithm.

Euclidean distance (p=2): This is the most commonly used distance measure, and it is limited to real-valued vectors. Using the below formula, it measures a straight line between the query point and the other point being measured.

$$D(x,y) = \sqrt{\sum_{i=1}^{n}(yi - xi)^2}$$

User-Based Collaborative Filtering: The goal of user-based collaborative filtering is to identify users who are comparable to the target user and suggest products that these comparable users have enjoyed.

Make a user-item matrix with rows denoting people, columns denoting items, and cells denoting user evaluations or interactions with items as your data representation.

Calculate the degree to which users are similar to one another. Cosine similarity, Pearson correlation, or Jaccard similarity are examples of common similarity metrics.

Find the K-Nearest Users (Neighbours) for a target user who are most comparable to them based on their prior interactions with goods.

Recommendation: Suggest products that the target user hasn't engaged with but that the k-nearest neighbours enjoy. To make suggestions, you might utilise a weighted average of the ratings provided by the neighbours.

Item-Based Collaborative Filtering: In item-based collaborative filtering, the goal is to identify and

recommend products that are comparable to the items that the user has previously enjoyed.

Training the Model

Train your machine learning model on the preprocessed dataset. You'll need historical data of users' food choices and calorie intakes to build collaborative filtering models.

Recommendation Engine

Implement the recommendation engine that takes user inputs and returns a list of recommended meals or food items based on the model's predictions.

Feedback Loop:

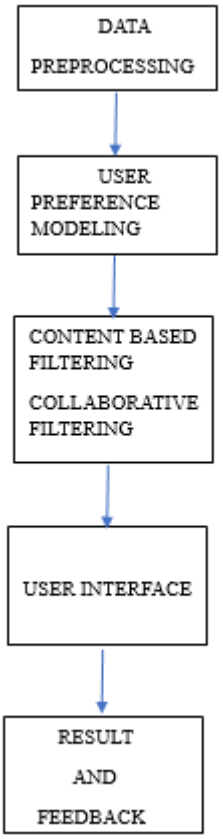
User feedback on recommended meals is collected and used to update user profiles and improve recommendation accuracy.

Continuous feedback and retraining of models help enhance the recommendation engine over time.

User Interface

Create a user-friendly interface (web app, mobile app, or command-line tool) where users can input their calorie requirements and receive meal recommendations. We can create a web app using HTML, CSS and JavaScript and also Streamlit.

V. FLOWCHART



Data Preprocessing : Data preprocessing is a crucial step in machine learning, involving the transformation of raw data into a format that is suitable for machine learning algorithms. It encompasses a wide range of techniques aimed at cleaning, refining, and enhancing the quality of data. Common tasks include handling missing values, dealing with outliers, normalizing and scaling features, encoding categorical variables, and feature engineering.

User Preference Modeling:Convert the user's preferences into a preference vector that matches the format of the meal feature vectors. Ensure that the user's preferences and the meal features are on the same scale for accurate matching.

Content Based Filtering : Content-based filtering is particularly useful when there's limited or no data on user interactions, as it relies primarily on item features.

Collaborative Filtering : Collaborative filtering relies on user-item interaction data to make recommendations, so you'll need to collect and incorporate data related to user preferences and interactions with meals.

User Interface : It will be composed of a web application with a user interface created with certain web development technologies. The user will input their calorie intake, and meals will be presented to them accordingly.

Resul and Feedback : 5 meals are recommended based on calorie requirement & user reviews. We again ask for user feedback after suggesting.

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