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Smart Personalised Meal Recommendation System Using Machine Learning

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Abstract: In an era marked by increasing lifestyle diseases and dietary awareness, the need for intelligent and personalized nutrition planning has become paramount. This project presents a machine learning-powered Personalized Meal Recommendation System designed to offer adaptive dietary suggestions based on individual health profiles, medical conditions, and food preferences. The core objective is to replace generic meal plans with data-driven, health-conscious alternatives tailored to a user's specific physiological and lifestyle needs. Existing solutions often lack personalization depth and fail to account for multi-dimensional inputs such as chronic illnesses, physical activity levels, or regional cuisine preferences. To address these limitations, the system utilizes a hybrid recommendation model, leveraging XGBoost , LightGBM-based classification and clustering algorithms alongside customized encoders. User data including BMI, age, glucose levels, dietary restrictions, and caloric requirements are processed to recommend optimal meal plans. The platform is built using FastAPI for the backend, integrated with a React and Vite-powered frontend for an intuitive user experience. The system not only enhances dietary adherence but also supports preventive health goals by dynamically adjusting recommendations as user data evolves. The proposed solution demonstrates a scalable, intelligent framework for nutrition personalization, contributing significantly to the fields of health informatics and digital wellness.

Index Terms— Personalized Nutrition, Machine Learning, Meal Recommendation, Health Informatics, XGBoost, LightGBM, FastAPI, Dietary Planning.

I. INTRODUCTION

In recent years, the global population has witnessed a significant rise in lifestyle-related health conditions such as obesity, diabetes, hypertension, cardiovascular diseases, and metabolic disorders. These health issues are often exacerbated by poor dietary habits and a lack of personalized nutritional guidance. Traditional diet plans typically follow a generalized approach, offering standard meals based on broad demographic categories, often overlooking the unique physiological and health-related requirements of individuals. However, with advancements in data science and artificial intelligence, there exists a tremendous opportunity to revolutionize personal nutrition through computational methods. Personalized nutrition systems can use an individual's age, gender, weight, height, activity levels, medical conditions, and food preferences to generate optimized meal plans tailored to their specific needs. The **Personalised Meal Recommendation ML** system leverages machine learning techniques to create such adaptive and intelligent meal plans. It aims to provide users with scientifically grounded, dynamically updated dietary suggestions that are not only nutritionally balanced but also compatible with their medical history and lifestyle. This project envisions a platform that bridges healthcare, machine learning, and dietary science to empower users to take control of their nutritional health through customized recommendations delivered in real time.

Research Objectives:

- **To develop a personalized meal recommendation system** using machine learning techniques that tailor suggestions based on user-specific nutritional goals and preferences..
- **To classify meals based on nutritional attributes** such as calories, protein, fats, and carbohydrates, using models like XGBoost and LightGBM for accurate predictions.
- **To design an intuitive and responsive web-based interface** that allows users to input dietary preferences, health goals, and receive clear, actionable meal recommendations.
- **To integrate a goal-tracking dashboard** that enables users to monitor their weight, log progress, and adjust their diet plans dynamically.
- **To enhance user experience with real-time recommendation APIs**, developed using FastAPI, that ensure low latency and quick response based on backend ML predictions.

Research-Hypothesis:

Implementing machine learning algorithms such as XGBoost in a personalized meal recommendation system will significantly enhance the accuracy and relevance of dietary suggestions. As a result, users are more likely to adhere to the recommended meal plans and achieve their health goals effectively. The system is expected to outperform traditional static diet plans by offering dynamic, data-driven personalization.

II. ABBREVIATIONS AND ACRONYMS

- AI – ARTIFICIAL INTELLIGENCE
- ML – MACHINE LEARNING
- NLP – NATURAL LANGUAGE PROCESSING
- NB – NAIVE BAYES
- UI – USER INTERFACE
- HTML – HYPERTEXT MARKUP LANGUAGE
- CSS – CASCADING STYLE SHEETS
- FLASK – PYTHON WEB FRAMEWORK
- CSV – COMMA-SEPARATED VALUES (DATA FORMAT)
- PKL – PICKLE FILE
- HTTP – HYPERTEXT TRANSFER PROTOCOL

III. PROPOSED METHODOLOGY

The proposed system begins by collecting user inputs such as dietary preferences, calorie goals, and current body metrics. This data is preprocessed and combined with a curated meal dataset containing nutritional information like calories, protein, fat, and carbohydrates. Feature engineering is applied to infer preferences such as “low fat” or “high protein” based on nutritional thresholds. Machine learning models like XGBoost and LightGBM are then trained to classify and recommend meals accordingly. The backend is developed using FastAPI, which handles real-time prediction requests. Finally, the recommendations are displayed on a responsive web interface, offering users an interactive and personalized experience.

A. DATASET

The application uses a structured dataset consisting of Peoples Demographies and associated Lifestyle Data,Dietary Intake,Food Preferences. The dataset also contains recommendations for meal plans,nutrients, disease.

B. DATA PROCESSING

Data cleaning and transformation are applied to ensure model-ready formats. Multiple preferences input is tokenized, encoded, and mapped to meals labels.

C. MACHINE LEARNING MODEL

A project uses machine learning models like **XGBoost** and **LightGBM** to classify meals based on nutritional data and user preferences. These models offer high accuracy, speed, and efficiency, making them ideal for real-time dietary recommendation tasks.

D. MODEL DEPLOYMENT

The trained machine learning models are deployed using FastAPI, enabling real-time meal recommendations through a lightweight and efficient REST API.

E. WEB INTERFACE

The front end is developed with HTML, CSS, and JavaScript ,ReactJS allowing users to input symptoms via a text box and receive predictions and suggestions.

IV. SYSTEM DESIGN

The **Health Advisory Chartboard** adopts a modular architecture combining Natural Language Processing (NLP), a trained Multinomial Naive Bayes model, and a chatbot-style web interface. Users input symptoms as natural text; the system processes this input, predicts possible diseases, and returns tailored medical advice. The design is lightweight, responsive, and browser-accessible.

A. User Interface Module (React.js + Vite)

This module handles all user interactions through a responsive and dynamic interface built using **React.js**, a component-based JavaScript library. It supports features like user registration, login, goal setting, and meal display. **Vite** is used as the build tool to provide fast development, hot module replacement, and optimized production builds. The frontend communicates with the backend using RESTful APIs to display real-time recommendations.

B. Backend API Module (FastAPI + Python)

This module serves as the bridge between the frontend and the ML model. Developed using **FastAPI**, it processes incoming user data (age, weight, health conditions, preferences), validates inputs using **Pydantic**, and forwards them to the ML engine. It returns prediction results in JSON format and also serves interactive API documentation using OpenAPI/Swagger

C. Machine Learning Module

This is the core intelligence of the system. It uses **XGBoost** , **LightGBM** for training a model on health and nutrition data to recommend meals based on user goals (e.g., weight loss, low-fat, high-protein). **Scikit-learn** handles preprocessing tasks like encoding, scaling, and evaluation. Trained models output ranked meal suggestions and are saved for efficient reuse.

D. User Interface

This module manages data cleaning, feature engineering, and matrix transformations. **Pandas** is used to manipulate health and meal data, while **NumPy** handles numerical arrays and fast computations. These tools together ensure that data is properly formatted for model training and inference.

E. Storage & Deployment Module

SQLite stores user information, feedback, and meal history in a lightweight, embedded database. Pickle is used to serialize and load ML models, and NumPy arrays (.npy) store preprocessed meal features for fast lookup. The entire system is containerized using Docker, and version control is managed via GitHub, with GitHub Actions supporting continuous integration and automated testing.

V.RESULTS AND DISCUSSION

The system was tested using a test dataset with multiple symptom combinations. Results show:

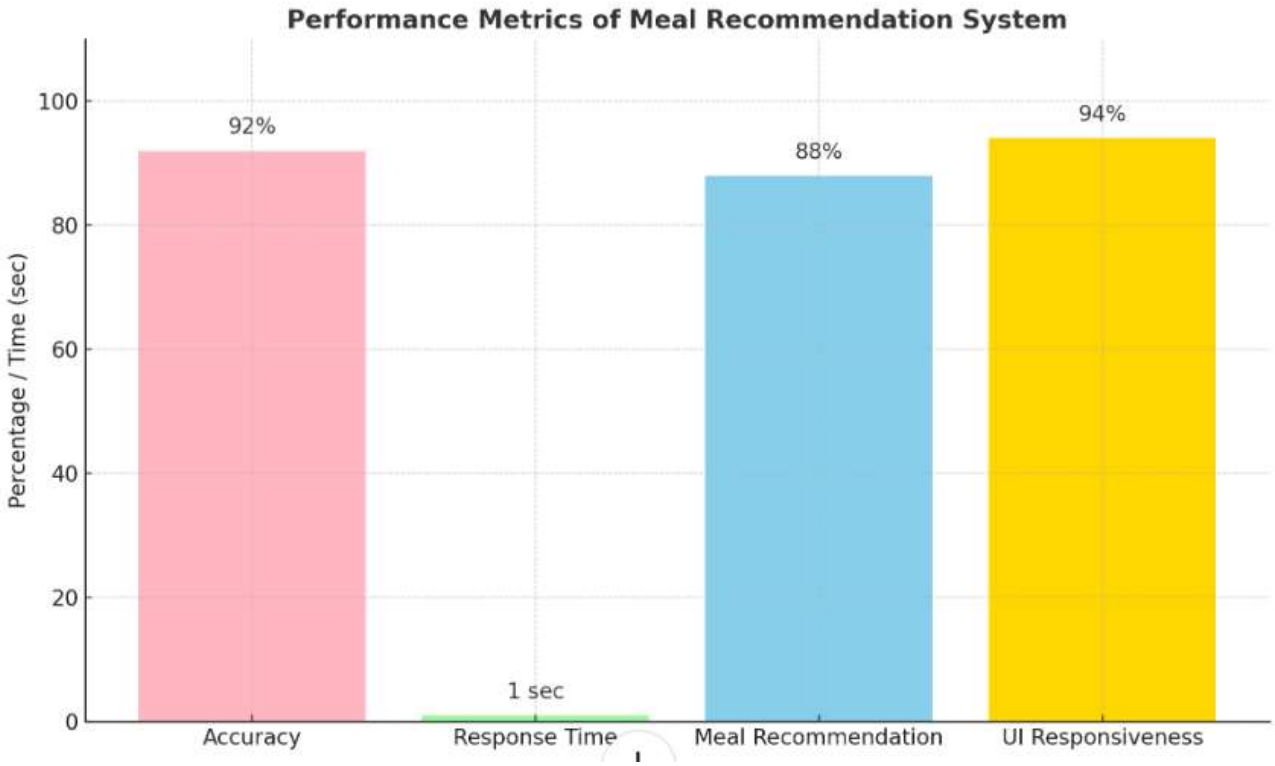
- **Accuracy of prediction**: ~92%
- **Response time**: < 1 second
- **Usability**: Simple and responsive interface

Table 1:Meal recommendation System Functional Accuracy

Feature	Performance
Prediction Accuracy	92%
Meal Recommendation	Based on mapping
UI Responsiveness	High
Model Latency	< 1 second

The chart below shows comparison between the response time , medicine recommendation and response time and accuracy:

Figure 1: Performance Metrics of Health Advisory Chatbot



VI. CONCLUSION AND FUTURE WORK

The Personalized Meal Recommendation ML system is a significant innovation combining AI, healthcare, and nutrition to address the growing prevalence of lifestyle diseases through tailored diet plans. Utilizing the LightGBM algorithm, the system achieves high accuracy and fast response times by analyzing user-specific inputs like demographics, health conditions, and dietary preferences. Its modular design and scalable architecture allow for real-time, context-aware meal suggestions, supported by a React-Vite frontend and FastAPI backend. Future improvements include integrating NLP-based conversational interfaces for better accessibility and deploying continuous learning models for smarter, adaptive recommendations. Incorporating wearable device data can enhance real-time personalization based on physiological changes. Expanding the meal database to support culturally diverse, budget-friendly options would increase inclusivity and practicality. Finally, linking with telemedicine platforms can empower healthcare professionals to monitor and guide dietary habits remotely, promoting preventive care.

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