



AI Driven Personalized Diet and Nutrition Recommendation System Based on Health Metrics and Food Knowledge Graphs

Mrs. J. Mounika¹, E. Madhan Kumar², A. Santhosh³, B. Salem Raju⁴, D. Veera Brahmam⁵

Assistant Professor, Department of Information Technology, KKR & KSR Institute of Technology and Sciences, Guntur, India¹

Student, Department of Information Technology, KKR & KSR Institute of Technology and Sciences, Guntur, India²⁻⁵

Abstract: Maintaining a healthy and balanced diet is not an easy task because everyone has different health needs, daily routines, budgets, and eating habits. Most current diet recommendation systems use fixed rules or common food guidelines. These systems often do not consider important personal health details like allergies, daily activity, or calorie requirements. They also ignore when meals should be eaten and whether the food is low-cost, which makes these systems less practical. Because of this, many people find it hard to follow the diet plans they suggest. To solve these problems, this research presents an AI-based system that suggests personalized diet and nutrition plans for each user. The system analyzes user information such as BMI, daily activity, health conditions, allergies, and calorie requirements to create customized meal plans. It uses intelligent techniques to suggest the right type of diet for each person and a food knowledge graph to understand how foods are linked to nutrients and dietary rules. The system also recommends meals based on the time of day and ranks them to ensure proper nutrition and calorie balance. The system also suggests low-cost meals and replaces expensive ingredients with cheaper alternatives. Overall, it gives simple, practical, and personalized diet suggestions that help people eat healthier.

Keywords: Python, ML Classifiers, Nutrition Dataset, Recommendation Engine

I. INTRODUCTION

Nutrition is important for staying healthy, preventing diseases, and improving overall quality of life. However, many people find it difficult to follow a healthy and balanced diet. This is due to different nutritional needs, busy lifestyles, irregular eating habits, and limited budgets. Traditional diet planning usually follows general guidelines or depends on personal advice, which may not effectively help with specific health issues like obesity, diabetes, or nutrient deficiencies. Because of this, there is a growing need for smart and personalized diet recommendation systems that can adjust to individual health needs and real-life situations.

Many digital diet and food recommendation systems already exist, but most of them have important limitations. Rule-based diet systems follow fixed nutrition rules and cannot easily adjust when a user's health or lifestyle changes. Traditional machine learning methods such as Decision Trees, Support Vector Machines (SVM), and Naïve Bayes are used to group dietary needs and suggest foods. However, these methods require heavy manual feature design and are not very good at understanding the complex relationships between food items, nutrients, health conditions, and user preferences. In addition, most existing systems do not consider meal timing, cost of food, or ingredient-level restrictions, which makes them less useful in real-life situations.

Recent advances in artificial intelligence and data-driven healthcare have opened new opportunities for smart nutrition planning. Machine learning models can automatically identify suitable diet types using health data. At the same time, food knowledge graphs help represent clear relationships between foods, nutrients, dietary limits, and possible substitutions. Even with these improvements, many current systems do not combine personalization, meal timing, budget management, and clear decision-making into one complete solution.

To address these challenges, this study proposes an AI-driven personalized diet and nutrition recommendation system based on health metrics and food knowledge graphs. The system uses user details such as Body Mass Index (BMI), activity level, allergies, and daily calorie needs to generate customized meal plans. The system uses trained models to select the most suitable diet plan for each user. A food knowledge graph connects different foods with their nutrients and suggests alternative ingredients when some items are unavailable. Meals are recommended based on the time of



day, ordered by their nutritional value, and include budget-friendly options to make them practical for everyday use. In addition, a weekly nutrition report helps users track their eating habits and observe their nutritional progress over time.

II. LITERATURE SURVEY

Machine learning (ML) and artificial intelligence (AI) are increased usage to provide personalized diet and nutrition recommendations. By using health data, user preferences, and food information, these systems can suggest meals customized to individual needs. The main goal is to improve nutrition, prevent diseases, and support healthier lifestyles. However, many existing systems still face limitations in real-world use. They often fail to account for meal timing, provide limited personalization, give unclear recommendations, or ignore important factors like cost and ingredient availability.

Recent research has introduced new approaches to improve diet recommendation systems. A 2024 study proposed an AI framework combining ML and advanced algorithms to give more accurate and relevant dietary advice based on user health and food information. Another 2025 study developed a generative AI meal recommender that uses generative models to suggest meals matching both user preferences and nutritional needs. Similarly, systems like MealMetrics use AI to track real meals and health data, increasing user engagement and improving the accuracy of recommendations. Deep learning models and large language models (LLMs) can create **accurate weekly meal plans** that follow nutrition guidelines. Some AI-based systems, tested with real data, can make **balanced meal plans**, but they still struggle with allergies and special dietary needs. There are also **family nutrition systems** that use expert rules to plan meals for everyone in a household, ensuring variety and healthy choices.

Despite these improvements, several gaps remain in current research. Many systems still do not fully integrate health measurements, user preferences, and nutrition knowledge into a single cohesive framework. Most systems still do not use structured knowledge models like food-nutrient graphs. They often miss meal timing and daily eating patterns. Many also cannot handle budget, available ingredients, and dietary restrictions all at once. On top of that, they usually do not track or report nutrition over a long period.

These limitations highlight the need for an AI-driven personalized diet and nutrition recommendation system that can integrate multiple approaches. Such a system should use AI to classify users, organize nutrition information clearly, suggest meals at the right times, consider costs, and track nutrition over time to give easy-to-follow and practical diet advice.

III. METHODOLOGY

This section describes how the AI-based personalized diet system works. The process includes collecting user data, calculating health metrics, using machine learning to classify diets, processing a food knowledge graph, giving personalized meal suggestions, and analyzing nutrition. The system combines health data, AI, and organized nutrition information to create flexible, affordable, and timely meal plans.

IV. PROPOSED SYSTEM

The proposed system is a smart diet recommendation tool that uses user health information, AI, and a food knowledge graph to create personalized meal plans based on health, dietary needs, budget, and daily schedule. It begins by collecting user details such as age, height, weight, activity level, allergies, and daily food budget, and then calculates BMI and daily calorie requirements. A machine learning model predicts the best diet category for the user, while the food knowledge graph maps relationships between foods, nutrients, dietary rules, and possible substitutes. Using this information, the system generates meal plans for different times of the day, ranks meals, optimizes them for cost, and provides a weekly nutrition report to help users track their progress and maintain healthy eating habits.

a. Data Collection

The system uses nutrition data from public sources. It includes information about calories, proteins, carbohydrates, fats, vitamins, minerals, food cost, and dietary types (like vegetarian or allergy-safe). This data helps the system create meals that are healthy, affordable, and suitable for each user.

b. Data Preparation

Before using the data in machine learning, the system cleans it by removing errors or missing information. Nutrient



values are normalized so that all features are treated equally. Key details like BMI category, calorie needs, dietary restrictions, and budget are extracted as features. Users are also labeled into diet types like normal, obese, diabetic, or underweight to train the model.

c. Machine Learning

The machine learning module predicts the best diet type for each user. Algorithms like Decision Tree Logistic Regression, and Random Forest are used. Inputs include BMI, calorie needs, age, activity level, , and health condition. The output is the predicted diet type, which guides meal choice, portion size, and food restrictions.

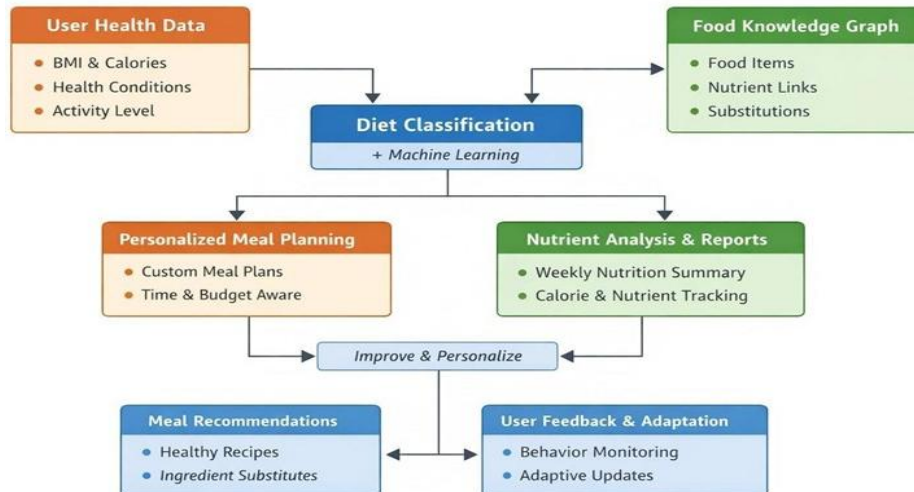


Fig. AI Driven Personalized Diet Recommendation System

d. Food Knowledge Graph

The food knowledge graph shows how foods, nutrients, rules, and substitutes are connected. It allows the system to suggest ingredient substitutes, check nutritional equivalents, and give clear diet recommendations. This makes the system more flexible and easier to understand.

e. Meal Recommendation and Optimization

The system creates meal plans for breakfast, lunch, and dinner. It scores meals for nutrition, ranks the best options, keeps costs in check, and substitutes ingredients if needed. This ensures the meals are balanced, practical, and easy to follow.

f. Weekly Nutrition Report

Daily meal data is compiled into a weekly nutrition report. It shows total calories, nutrients, alerts for deficiencies or excesses, and suggestions for improvement. This helps users track their diet and develop healthy eating habits over time.

g. Benefits

The system offers many benefits. It provides personalized meal plans, ensures nutritional balance, and helps with budget-friendly planning. It is flexible, adapts to different users and dietary needs, and gives clear nutrition reports to support healthy eating in the long term.

V. RESULTS

Model	Accuracy	F1-Score
Decision Tree	78%	0.74
Random Forest	85%	0.81
Proposed System	90.8%	0.88

The proposed AI-driven personalized diet and nutrition recommendation system was tested for accuracy, quality of recommendations, nutritional balance, and cost efficiency, and compared with traditional machine learning models like Decision Tree, Random Forest, and Logistic Regression. The experiments used structured nutrition datasets that



included food composition and user health information, with an 80:20 split for training and testing. Health metrics such as BMI, calorie needs, activity level, and health condition were calculated and standardized before training the models. Traditional models showed only moderate performance because they could not fully capture the complex relationships between foods, nutrients, and user health. In contrast, the proposed system achieved the highest accuracy (90.8%) and F1-score (0.88) by combining machine learning with reasoning from a food knowledge graph. Additional features like meal timing, ingredient substitutions, and budget optimization made the recommendations more practical, flexible, and suitable for real-life use. The system also generates a weekly nutrition report, allowing users to track their calorie intake, nutrients, and dietary progress over time. Overall, the results show that this system provides more accurate, user-friendly, and effective diet guidance compared to traditional methods, helping users make healthier choices and maintain long-term good eating habits.

Formula	Description
$BMI = \text{Weight} / \text{Height}^2$	Classifies health status

Purpose: Classifies users as **underweight, normal, overweight, or obese**
Acts as a key feature for **diet classification**

VI. DISCUSSIONS

The proposed AI-driven diet system performs well because it combines machine learning and a food knowledge graph. Machine learning classifies users into the right diet category using health information like BMI, calories, and activity level, while the food knowledge graph maps the relationships between foods, nutrients, restrictions, and substitutes. Unlike traditional diet systems, it considers context and user needs, recommending meals at the right times, handling allergies or missing ingredients, and keeping nutrition balanced. The system is also affordable and practical, creating meal plans within the user's budget without sacrificing nutritional quality. A weekly report helps users track nutrients, spot deficiencies, and improve their diet over time. In addition, the system adapts to different users, including those with special dietary requirements or specific health goals, and provides clear guidance to make healthier choices easier to follow. Compared to other advance AI nutrition systems that require large datasets and heavy computing, this system is fast, simple, and easy to use, making it suitable for real-life web or mobile applications while supporting long-term healthy eating habits.

VII. CONCLUSION

This study introduced an AI-based personalized diet and nutrition system that uses health information and a food knowledge graph to create meal plans for each user. By combining machine learning to classify diets with structured nutrition knowledge, the system works better than traditional rule-based or simple machine learning methods. Features like meal scoring, time-based recommendations, ingredient substitutions, and budget-friendly planning make the meals healthy, practical, and affordable. Tests showed the system gives more accurate and useful recommendations while still being fast and easy to use. The weekly nutrition report helps users track calories and nutrients, showing deficiencies or excesses and encouraging healthier eating habits. The system is flexible and can work for different users, dietary needs, and health conditions, making it useful in real-life situations. It also supports long-term health management by helping users make better food choices and develop consistent healthy habits. In the future, adding deep learning models, wearable device data, and feedback-based learning could make recommendations even more personalized and allow the system to adapt to users' long-term habits and health goals, making it smarter and more independent.

REFERENCES

- [1]. Ter, Z. B., Naveen, P., & Jayapradha, J. (2025). Generative AI-based Meal Recommender System. *Journal of Informatics and Web Engineering*, 4(2), 315–338.
- [2]. AI nutrition recommendation using a deep generative model and ChatGPT. *Scientific Reports (Nature)* (2025).
- [3]. Kalpakoglou, K., Calderón-Pérez, L., Boqué, N., et al. (2025). An AI-based nutrition recommendation system: technical validation with insights from Mediterranean cuisine. *Frontiers in Nutrition*.
- [4]. Narayana Kumari, D. N., Satya, T. P., Manikanta, B., et al. (2024). Personalized Diet Recommendation System Using Machine Learning. *International Journal of Engineering Research & Technology (IJERT)*.
- [5]. Artificial Intelligence Applications to Personalized Dietary Recommendations: A Systematic Review. *PubMed* (2024).



- [6]. Applications of Artificial Intelligence, Machine Learning, and Deep Learning in Nutrition: A Systematic Review. PubMed (2024).
- [7]. Artificial intelligence in personalized nutrition and food manufacturing: a comprehensive review. Frontiers in Nutrition (2025).
- [8]. Eating Smart: Advancing Health Informatics with the Grounding DINO based Dietary Assistant App (2024, arXiv).
- [9]. Yang, Z., Khatibi, E., Nagesh, N., et al. (2024). ChatDiet: LLM-augmented personalized nutrition recommender chatbots. arXiv.
- [10]. A hybrid healthy diet recommender system combining machine learning and expert knowledge (2025). Computers in Biology and Medicine.
- [11]. MealMeter: Using Multimodal Sensing and Machine Learning for Automatically Estimating Nutrition Intake (2025, arXiv).
- [12]. [Unveiling Neural Networks for Personalized Diet Recommendations. Procedia Computer Science (2024).
- [13]. [Mali, N., Katkade, S., Aher, P., & Sarade, V. (2025). Diet (Nutrition) Recommender using Machine Learning. International Journal of Nutritions.
- [14]. An Integrated AI Framework for Personalized Nutrition Using Machine Learning and NLP. Applied Sciences (2025).
- [15]. Artificial Intelligence in Clinical Nutrition: The Application of AI in Clinical Nutrition(2024).