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VedAahar: An AI-Based Personalized Ayurvedic Food Recommendation System

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Abstract: In Ayurveda, personalized nutrition is based on an individual's constitution (Prakriti), seasonal variations (Ritu), and digestive strength (Agni), which play a crucial role in maintaining health and preventing diseases. However, existing Artificial Intelligence (AI)-based Ayurvedic systems mainly focus on diagnostic analysis and lack effective implementation of constitution-specific dietary recommendations. This research proposes **VedAahar**, a machine learning-based Ayurvedic meal recommendation system that integrates Random Forest multi-class classification with rule-based filtering derived from Ahara Vidhi principles. The system utilizes structured datasets, including vegetarian, non-vegetarian, and fasting meal categories, and considers features such as prakriti, ritu, health goals, and meal slots to generate personalized recommendations. Additionally, Top-K probabilistic ranking and history-based de-duplication techniques are applied to ensure diverse and relevant meal suggestions. Experimental results show that the model achieves an accuracy of 69.14%, demonstrating its effectiveness in providing constitution-aware dietary guidance. Overall, the proposed system bridges traditional Ayurvedic knowledge with modern AI techniques, contributing to the development of intelligent and personalized preventive healthcare solutions.

Keywords: Ayurveda, Prakriti, Personalized Nutrition, Random Forest, Multi- Class Classification, Hybrid Recommendation System, Dosha Balancing, AI in Healthcare.

I.INTRODUCTION

Personalized medicine is increasingly transforming modern healthcare by emphasizing individualized treatment strategies over generalized approaches. Among various factors influencing health, dietary regulation plays a critical role in maintaining physiological balance and preventing chronic diseases. Traditional Ayurvedic science provides a well-established framework for personalized nutrition through the concept of **Prakriti** (body constitution), which classifies individuals into Vata, Pitta, and Kapha types. This framework is further supported by principle such as **Ritu** (seasonal adaptation), which collectively guide food selection and dietary habits [3], [4]. Unlike conventional calorie-based dietary systems, Ayurveda focuses on achieving internal balance and long-term well-being through constitution-specific dietary planning.

In recent years, advancements in Artificial Intelligence (AI) and Machine Learning (ML) have enabled the computational modeling of traditional healthcare knowledge. AI applications in Ayurveda have shown promising results in areas such as Prakriti classification, diagnostic support, Ayurgenomics, and predictive health analytics [1], [5]. Various ML techniques, including Decision Trees, Support Vector Machines, and ensemble methods, have been successfully applied to classify dosha types and analyze health patterns, demonstrating the feasibility of translating qualitative Ayurvedic principles into structured predictive systems.

Despite these developments, most AI-driven Ayurvedic systems primarily focus on diagnosis and classification tasks rather than actionable dietary recommendation. Dietary recommendation involves a more complex problem space, as it must consider multiple interacting factors such as constitution, seasonal variation, individual health goals, and meal timing. Additionally, food preferences and lifestyle variations introduce further complexity, making it difficult for purely data-driven models to generate reliable and context-aware suggestions. This highlights the need for hybrid systems that combine Machine Learning with domain-specific knowledge to ensure both accuracy and practical relevance.

To address this gap, this paper proposes **VedAahar**, an AI-based personalized Ayurvedic food recommendation system that integrates Machine Learning with domain-specific Ayurvedic knowledge. The system employs a Random Forest multi-class classification model combined with rule-based filtering derived from **Ahara Vidhi** principles to generate constitution-aware and season-sensitive meal recommendations. By incorporating structured attributes such as prakriti, ritu, health goals, and meal slots, VedAahar aims to provide practical, scalable, and intelligent dietary guidance suitable for real-world applications.

In conclusion, the integration of Ayurvedic dietetics, Machine Learning, and rule-based intelligence represents a promising direction for personalized healthcare systems. Ayurvedic principles provide a scientifically grounded framework for individualized nutrition, Machine Learning enables predictive and scalable decision-making, and rule-based filtering ensures adherence to traditional dietary guidelines. Together, these approaches create a reliable, interpretable, and constitution-aware dietary recommendation system. This research aims to bridge the gap between traditional Ayurvedic knowledge and modern AI-driven applications by delivering an effective and practical personalized nutrition framework.

II.LITERATURE REVIEW

Recent advancements in Artificial Intelligence (AI) have significantly influenced research in traditional healthcare systems, including Ayurveda. A major focus of AI-driven Ayurveda research has been on **Prakriti (constitution) classification**, where Machine Learning models such as Decision Trees, Support Vector Machines, Random Forest, and ensemble techniques have been widely applied. These models have demonstrated strong predictive performance in identifying dosha types, with several studies reporting high classification accuracy, thereby validating the feasibility of computationally modeling Ayurvedic concepts [6], [7].

In addition to constitution analysis, AI applications in Ayurveda extend to areas such as diagnostic support systems, pulse signal digitization, tongue image analysis, symptom-based clustering, and Ayurgenomics integration. Ayurgenomics, in particular, explores the relationship between genetic markers and Ayurvedic constitutional types, providing a scientific foundation for personalized healthcare approaches [1], [5]. These developments highlight the ability of AI to transform traditionally qualitative Ayurvedic knowledge into structured and data-driven systems.

However, most existing research primarily focuses on diagnosis and prediction rather than practical dietary recommendation. Constitution-specific dietary planning presents a more complex challenge compared to classification tasks, as it involves multiple interacting factors such as seasonal variation (Ritu), individual health goals, meal timing, and lifestyle preferences. This increased complexity leads to a larger output space, making accurate and context-aware recommendations more difficult to achieve using conventional Machine Learning approaches.

Moreover, contemporary diet recommendation systems are largely based on calorie tracking, macronutrient optimization, or collaborative filtering techniques. Such systems rarely incorporate Ayurvedic principles like dosha balance, Ahara Vidhi, and Ritucharya, resulting in a lack of constitution-sensitive personalization. As a result, they fail to provide holistic dietary guidance aligned with traditional Ayurvedic science.

Furthermore, while hybrid recommender systems have been explored in healthcare, the integration of rule-based Ayurvedic knowledge with Machine Learning models remains limited. Purely data-driven approaches may overlook domain-specific dietary constraints, leading to recommendations that are not fully aligned with Ayurvedic guidelines. This highlights the need for a hybrid framework that combines predictive modeling with knowledge-based filtering to ensure both accuracy and adherence to traditional principles.

III.PROBLEM STATEMENT

Despite the growing adoption of Artificial Intelligence (AI) in healthcare and Ayurveda, existing systems primarily focus on diagnostic tasks such as Prakriti classification and disease prediction, with limited emphasis on practical dietary recommendation. Traditional Ayurvedic dietetics emphasizes constitution-based nutrition, where food selection depends on factors such as **Prakriti (Vata, Pitta, Kapha)** and **Ritu (seasonal variation)**. However, these principles are largely qualitative and challenging to implement in scalable, data-driven systems.

Current digital diet and nutrition platforms predominantly rely on calorie counting, macronutrient balancing, or collaborative filtering approaches, which do not incorporate Ayurvedic concepts such as dosha balance, Ahara Vidhi, and seasonal adaptation. As a result, they fail to provide personalized, constitution-aware dietary recommendations aligned with traditional Ayurvedic knowledge.

Moreover, dietary recommendation is inherently a complex multi-class problem involving a large number of possible meal options influenced by multiple interacting parameters such as health goals, meal timing, and individual preferences. Purely Machine Learning-based approaches often struggle to capture domain-specific constraints, while purely rule-based systems lack adaptability and scalability.

Therefore, there is a need for a hybrid computational framework that integrates Machine Learning techniques with Ayurvedic dietary principles to generate accurate, scalable, and constitution-specific meal recommendations. The system should consider key attributes such as prakriti, ritu, health goals, and meal slots to ensure personalized, diverse, and context-aware dietary suggestions suitable for real-world applications.

IV.PROPOSED METHODOLOGY

The proposed system, **VedAahar**, integrates Machine Learning with Ayurvedic dietary principles to generate personalized meal recommendations. The methodology follows a structured pipeline consisting of data preprocessing, feature encoding, model training, prediction, and rule-based filtering to ensure constitution-aware and context-sensitive outputs.

The system utilizes a supervised learning approach where the input feature vector is defined as :

X={Prakriti,Ritu,Goal,MealSlot}

And the target variable as :

y = Meal_ID

A. Data Preprocessing

The dataset consists of categorical attributes derived from Ayurvedic dietary principles. Preprocessing is performed to ensure data consistency and quality. The steps include:

- Removal of duplicate and inconsistent records
- Conversion of all textual values to lowercase
- Standardization of categorical entries
- Merging of vegetarian, non-vegetarian, and fasting datasets

These steps ensure a clean and structured dataset suitable for machine learning.

B. Feature Encoding

Since all input attributes are categorical, **Label Encoding** is applied to convert them into numerical values. Each category (e.g., Vata, Pitta, Kapha) is assigned a unique integer representation.
This transforms the dataset into a numerical feature matrix, enabling compatibility with tree-based algorithms such as Random Forest.

C. Random Forest Model

The system employs a **Random Forest multi-class classification model** due to its robustness and effectiveness in handling categorical data. The model constructs multiple decision trees and aggregates their outputs using majority voting:

$\hat{y} = \text{mode}(T_1(x), T_2(x), \ldots, T_n(x))$

where $T_i(x)$ represents the prediction of the i-th tree.
Node splitting is performed using the **Gini Index**, defined as:

$\text{Gini} = 1 - \Sigma p_i^2$

where p_i represents the probability of class i.
The model is configured with the following parameters:

- n_estimators = 70
- max_depth = 10
- random_state = 42
- class_weight = balanced

D. Training and Evaluation

The dataset is divided into training and testing sets using an **80:20 split**. The model is trained on the training data and evaluated on unseen test data.
The system achieved an accuracy of **69.14%**, demonstrating its ability to predict constitution-aware meal recommendations. A confusion matrix is used to analyze class-wise performance and identify misclassification patterns.

E. Recommendation Strategy

To enhance usability, the system implements **Top-K probabilistic ranking** using the predict_proba() function. Instead of returning a single prediction, multiple high-probability meal options are provided.
Additionally, a **history-based de-duplication mechanism** is applied to avoid repetitive recommendations and ensure diversity in meal suggestions.

F. Rule-Based Filtering

A rule-based filtering layer is integrated based on **Ahara Vidhi principles** to ensure that recommendations remain consistent with Ayurvedic dietary guidelines. This layer validates:

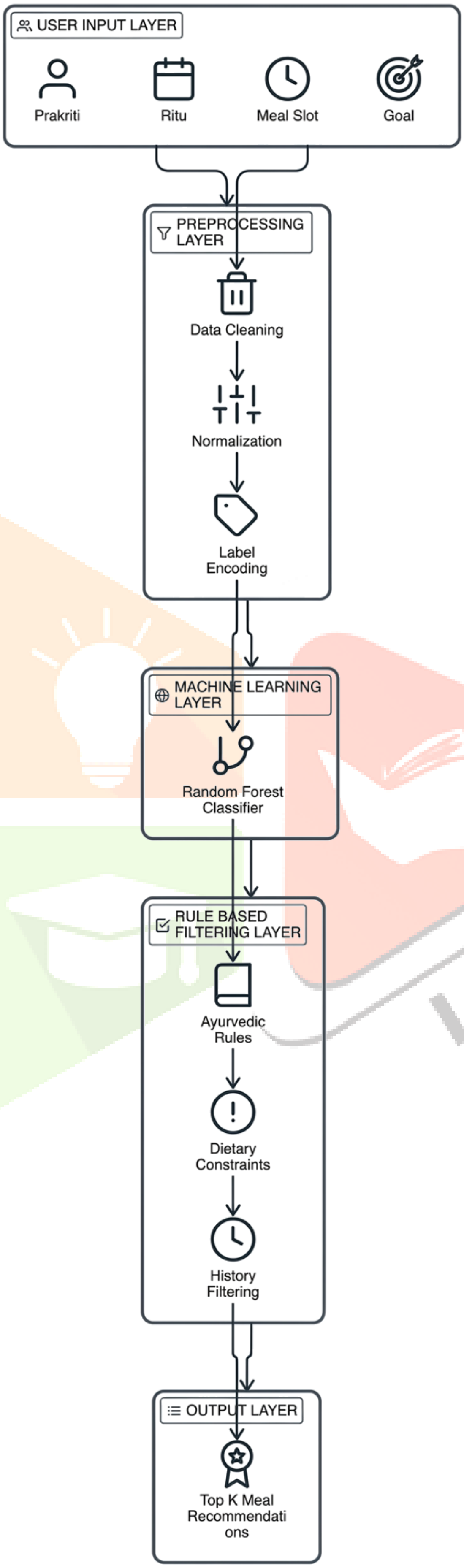
- Constitution compatibility (Prakriti-based filtering)
- Seasonal alignment (Ritu-based filtering)
- Dietary category constraints (veg, non-veg, fasting)

This hybrid approach improves reliability by combining data-driven prediction with domain-specific knowledge.

G. Deployment

The system is deployed using **Flask REST APIs**, enabling real-time interaction. Users provide input parameters, which are processed through the trained model and filtering layers to generate personalized meal recommendations.

V.SYSTEM ARCHITECTURE



VI.RESULTS

The performance of the VedAahar system was evaluated using a Random Forest multi-class classification model trained on structured datasets comprising vegetarian, non-vegetarian, and fasting meal categories. The dataset was divided into training and testing sets using an 80:20 split to ensure reliable evaluation on unseen data. The model achieved an overall accuracy of **69.14%**, indicating its capability to generate constitution-aware meal recommendations based on input attributes such as Prakriti, Ritu, Goal, and Meal Slot.

Further analysis using a confusion matrix revealed that the model performs effectively across major classes, with higher accuracy observed for frequently occurring meal combinations. However, certain misclassifications were identified in cases where multiple meal options are equally suitable for similar input conditions, reflecting the inherent complexity of Ayurvedic dietary recommendation systems.
The system was further validated through functional implementation and user interface testing to demonstrate its practical usability. The workflow begins with the **login interface**, which allows users to securely access the system and initiate the recommendation process.

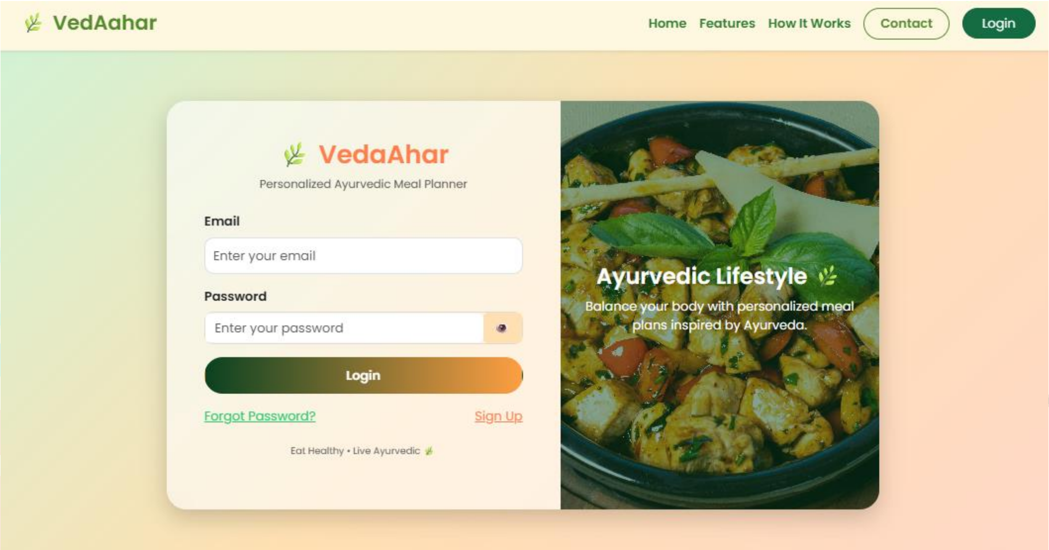


Fig. 1. Login Page of VedAahar System
The system then presents a **quiz interface** that collects user-specific inputs such as Prakriti-related responses, seasonal conditions (Ritu), dietary goals, and meal preferences. These inputs are used as feature variables for the machine learning model.

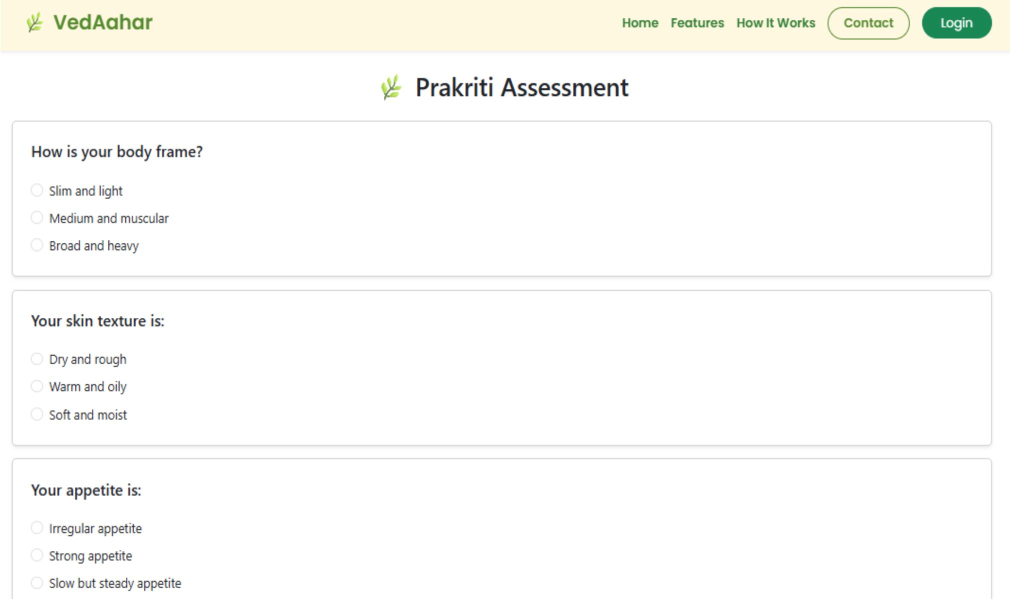


Fig. 2. User Quiz Interface for Data Collection

Based on the collected inputs, the system determines the individual's **Prakriti (Vata, Pitta, Kapha)** and displays the classification result.

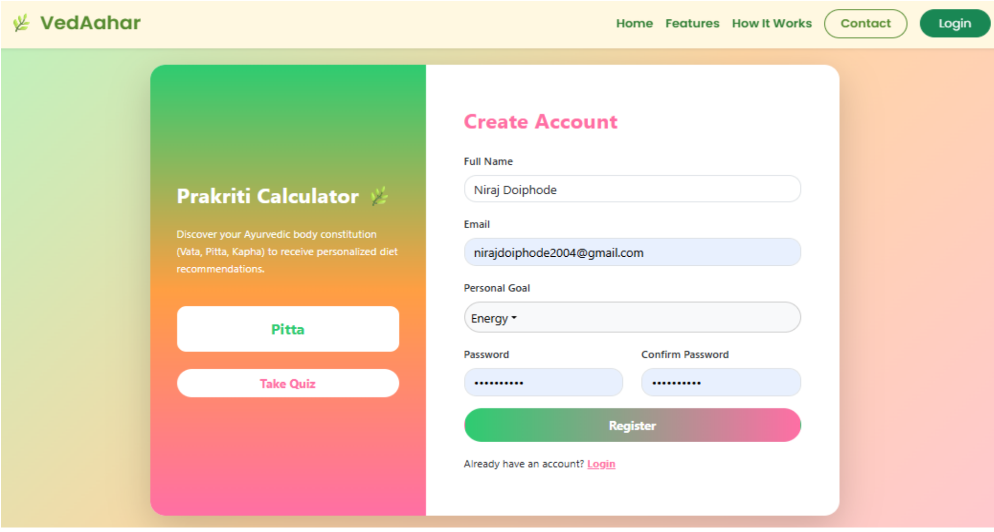


Fig. 3. Prakriti Prediction Result Page

Following this, the trained model generates **personalized meal recommendations** by combining probabilistic predictions with rule-based filtering derived from Ayurvedic principles.

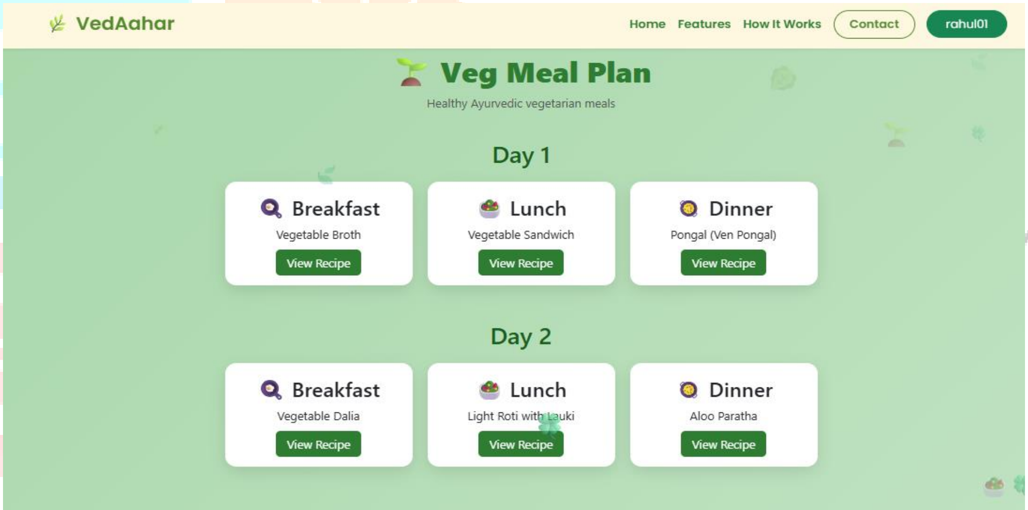


Fig. 4. Generated Meal Recommendations

To enhance usability and real-world applicability, the system also provides an option to download the generated meal plan in a structured format. A **PDF report** is created containing the recommended meals and relevant dietary information.

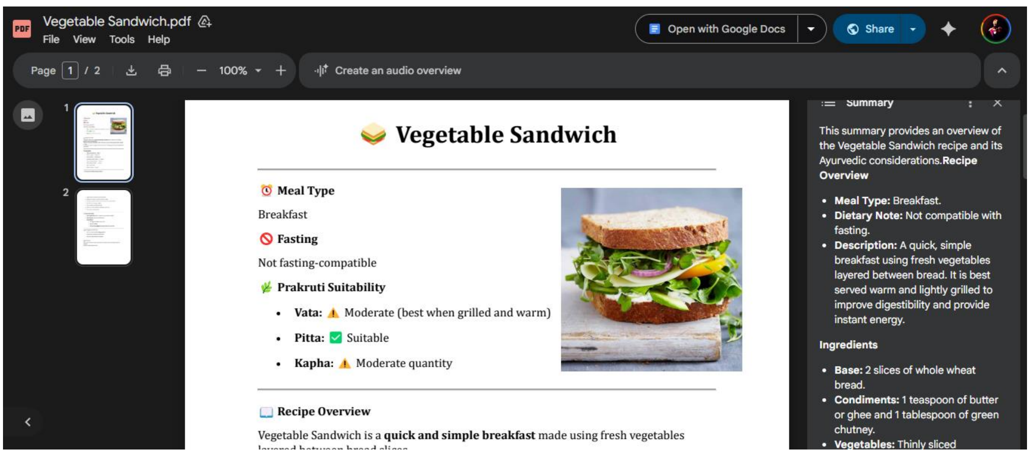


Fig. 5. Generated Meal Plan PDF

Additionally, the implementation of **Top-K probabilistic ranking** allows the system to suggest multiple high-probability meal options instead of a single output, improving flexibility and user satisfaction. The integration of rule-based filtering ensures that all recommendations remain consistent with Ayurvedic dietary guidelines. Overall, the results demonstrate that the VedAahar system effectively combines Machine Learning and traditional knowledge to deliver personalized, diverse, and constitution-aware meal recommendations suitable for real-world applications.

CONCLUSION AND FUTURE SCOPE

VedAahar demonstrates the effective integration of traditional Ayurvedic dietary principles with modern Machine Learning techniques to develop a personalized meal recommendation system. By utilizing key attributes such as Prakriti, Ritu, Goal, and Meal Slot, the system generates constitution-aware and context-sensitive dietary suggestions. The use of a Random Forest multi-class classification model enables the system to learn meaningful patterns from structured datasets and provide reliable meal recommendations.

The achieved accuracy of 69.14% indicates that machine learning can be successfully applied to model Ayurvedic dietary personalization, despite the inherent complexity of multi-class food recommendation problems. Furthermore, the hybrid approach combining data-driven prediction with rule-based filtering derived from Ahara Vidhi principles ensures that the recommendations remain aligned with traditional Ayurvedic guidelines. The incorporation of Top-K probabilistic ranking and history-based filtering enhances usability by providing diverse and non-repetitive meal suggestions, making the system practical for real-world applications.

Future enhancements of the VedAahar system can focus on improving model performance and expanding personalization capabilities. The implementation of advanced machine learning algorithms such as XGBoost, LightGBM, or CatBoost can improve predictive accuracy, while hyperparameter optimization and k-fold cross-validation can enhance model generalization. Incorporating additional user-specific attributes such as age, BMI, lifestyle habits, and medical conditions can further refine personalized recommendations. The integration of real-time user feedback mechanisms can enable continuous system improvement, while the development of a mobile or web-based application can enhance accessibility and usability. Additionally, future research may explore the integration of Ayurgenomics to establish deeper connections between genetic factors and dietary recommendations, thereby advancing the scope of AI-driven personalized healthcare systems.

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