Build a recommendation system for personalized diet planning that suggests suitable meal plans, recipes, and nutritional guidance based on user dietary preferences, health goals, and nutritional requirements using graph algorithms

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***Abstract*— This research addresses the prevalent issue of personalized diet planning by introducing a novel system based on graph algorithms. It efficiently solves the problem of tailoring meal plans to users' dietary preferences, health objectives, and specific nutritional needs. The uniqueness of our solution lies in its adaptability and the precise integration of user-specific factors, such as BMI, TDEE, and BMR, ensuring accurate daily calorie intake calculations. Our system demonstrates superior performance, as evaluated through key performance parameters, including accuracy, precision, recall, and F1 score. The practical relevance of our work is evident in its potential to enhance users' overall dietary experience, promoting healthier eating habits and individual well-being in the context of nutrition and health goals. This research presents an innovative approach in the domain of diet planning, underlining the significance of graph algorithms in achieving personalized and precise meal recommendations, addressing a long-standing problem in the field of nutrition and health management.**

Keywords*— *Personalized Diet Planning, nutritional guidance, Graph Algorithms, BMI, TDEE, BMR, Nutrition, Health Goals, user preferences, Statistical Analysis

I. Introduction

In a world where health and nutrition are paramount, the demand for personalized dietary solutions has never been more crucial. This project endeavours to address this need by introducing a cutting-edge personalized diet planning system. Leveraging advanced graph algorithms, this system creates tailored meal plans that align with users' dietary preferences, health goals, and specific nutritional requirements [1]. The project combines the precision of body mass index (BMI), total daily energy expenditure (TDEE), and basal metabolic rate (BMR) calculations with the adaptability of a user-centric approach. It promises to revolutionize diet planning, fostering healthier eating habits, and individual well-being in the context of nutrition and health objectives [2]. The importance of personalized diet recommendations and presents "Nutri Expert," a system that uses data mining to provide tailored dietary advice for combating health issues. It emphasizes the significance of addressing problems like obesity and diabetes. The system collects user health data and aims to enhance well-being through personalized nutrition guidance [3].The problem of increasing overweight adults and the importance of healthy eating. It introduces recommender systems as a solution for guiding users toward healthier food choices. The complexity of the food domain is acknowledged, especially in group scenarios. The paper aims to explore food recommender systems considering both user preferences and nutrition, discussing challenges and future research directions [4]. The global issue of unhealthy diets and non-communicable diseases. It emphasizes the importance of personalized nutrition. The paper identifies shortcomings in existing research and sets its goals: enhancing personalized menu planning with user preferences and nutritional principles through recommender systems. This is a pioneering effort. The paper follows a structured format with sections covering background, architecture, nutritional recommendations, a case study, and a conclusion [5].

II. LITERATURE REVIEW

The paper presents a hybrid recommendation model using graph databases. It highlights the efficiency of graph databases for recommendation systems and introduces a multi-layer graph model. The proposed algorithm combines user preferences, knowledge graphs, and content-based information to generate recommendations. The model's efficiency and suitability for online e-commerce environments are discussed. The paper suggests potential extensions for incorporating fuzzy preferences and queries. [6]. Another study investigates the impact of a healthy bias in a recipe recommender system and displaying a healthy tag on users' decision-making. The comparison of three recommendation approaches: matching preferences, recommending healthy recipes only, and both healthy and preference-based suggestions, evaluates users' willingness to choose healthy recipes that align with their tastes, aiming to influence eating behaviour positively [7]. Unhealthy diets contribute to non-communicable diseases, and personalized nutrition offers tailored food advice based on individual data. A comprehensive framework for daily meal plan recommendations is presented, considering both nutritional and user preference information. The proposal includes a pre-filtering stage using AHP Sort for suitability assessment and an optimization-based stage for generating a daily meal plan that a user wants and nutritional needs. A case study validates the recommender system's performance [8]. The literature review in one research paper covers existing expert systems in nutrition and diet, knowledge engineering, and rule-based system techniques. It explores sources of nutritional knowledge, evaluates the prototype system, and discusses the benefits and limitations of expert systems in this domain, based on user feedback and recommendations [9]. Another literature review explores previous works on food recommendation, focusing on personalized and health-conscious approaches. Limitations in existing systems, such as neglecting user requirements and health factors, are examined. The review explores methodologies like knowledge base/graph-based approaches and question answering systems. It also discusses datasets, evaluation metrics, and related research in information systems, question answering, recommender systems, personalization, and query reformulation [10]. The literature review in another research paper explores existing approaches to personalized meal recommendation, focusing on addressing the challenges of learning people's food preferences and satisfying nutritional expectations. Previous methods that only consider high-level preferences or require prolonged learning are discussed. The paper proposes Yum-me, a nutrient-based meal recommender system that combines visual quiz-based user profiling, an open-source food image analysis model (Food Dist.), and a novel online learning framework for food preference. The review highlights the effectiveness of Yum-me through a field study and user validation [11]. The next paper presents a mobile-based health-aware food recommender system, considering both user preferences and health requirements. It collects user profile data and long-term preferences, allowing session-based preference elicitation. The health-aware recommendation algorithm incorporates calorie balance to estimate recipe healthiness. The system features user interaction for browsing, rating, tagging, critiquing, and providing alternative recommendations. It outperforms non-personalized systems, enhances user engagement, and meets the demand for healthier food recommendations. The paper showcases a complete human-computer interaction design and receives positive preliminary user feedback. Future work includes incorporating cooking effort and diversity in recommendations and leveraging nutritionist domain knowledge [12]. Lastly, the paper addresses the issue of unhealthy eating habits and the need for personalized diet recommendations. It introduces Nutri Expert, a diet recommender system that focuses on individual eating habits. The system utilizes content-based filtering and collaborative filtering techniques to generate personalized recommendations for healthier diets. The paper emphasizes the importance of balanced diets and diverse food choices to prevent chronic diseases. By leveraging data mining and the Ionic Framework, Nutri Expert aims to help individuals manage health conditions and make better food choices [13]. In conclusion, the reviewed research papers provide valuable insights into personalized diet recommendations, health-aware food recommender systems, and recommendation algorithms. These innovative approaches have the potential to significantly impact health and nutrition management, benefiting both individuals seeking personalized advice and healthcare professionals providing tailored dietary solutions [14]. The data mining-based system for personalized healthy diet recommendations. It emphasizes the need for tailored dietary advice to combat health issues like obesity and diabetes. The system collects user health data, applies data mining techniques, and uses the Ionic framework for implementation, aiming to enhance users' well-being through personalized nutrition guidance[15].

III. METHODOLOGY

A. System Level Introduction of Method

The provided Java code constitutes a simple customer support system within an e-commerce platform. This system allows users to interact based on their roles, either as company managers or customers. Company managers can view and address customer problems, which are categorized as specific and general issues. Customers have options for login or registration.

B. Meaningful Block Diagram

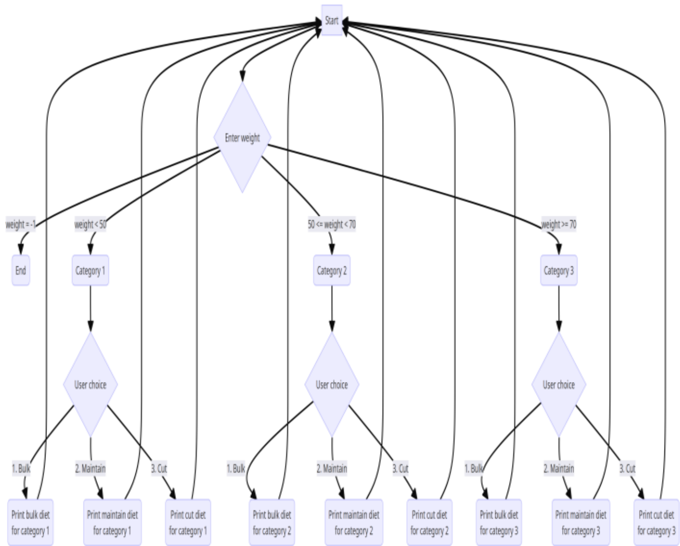

Fig. 1. System Architecture

C. Flowchart

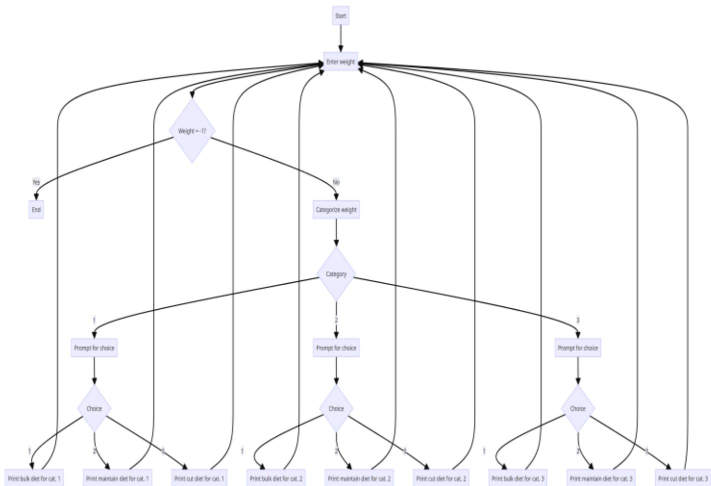

Fig. 2. Code Flowchat

D. *Dataset*

TABLE I. NUTRITION COMPOSITIONS OF DIFFERENT TYPE OF FRUITS

Fruit	Protien	Fat	Carbohydrate
Apple	0.25	0.4	14
Banana	1.1	0.3	23
Orange	1	0.2	8.2
Strawberry	0.8	0.4	7.7
Blueberry	0.7	0.3	9.7
Grapes	0.64	0.16	0.18
Watermelon	0.6	0.2	0.8
Pineapple	0.54	0.12	13.12
Mango	0.84	0.38	14.98
Kiwi	1.14	0.52	14.6
Papaya	0.47	0.26	11.62
Lemon	1.1	0.3	9.3
Peach	0.91	0.25	9.54
Pear	0.36	0.14	9.8
Cherry	1.06	0.2	16.01
Blackberry	2	0.5	9.6
Cranberry	0.39	0.13	9.2
Apricot	0.49	0.39	9.2
Guava	2.6	0.95	14.3

TABLE II. NUTRITION COMPOSITIONS OF DIFFERENT TYPE OF CEREALS

Cereals	Protien	Fat	Carbohydrate
Oats	16.9	6.9	66.3
Wheat Flakes	10.6	2	77
Corn Flakes	7	0.9	87
Shreaded Wheat	12.6	2.8	76..5
Raisin Bran	5.5	1.3	89.8
Muesli	10.5	8	69.9
Puffed Rice	6.7	0.3	89.8
Puffed Wheat	14	0.5	81.5
Roti	9.2	2	45.8
Bhakri	8	3	67

E. *System Design and Implementation*

1) *Mathematical equations*

- BMI = (Weight in kilograms) / (Height in meters) ^2
- BMR = 10 * weight (kg) + 6.25 * height (cm) - 5 * age (years) + 5 (for men) or -161 (for women)
- TDEE: TDEE = BMR x Activity Level
- Caloric Requirements = TDEE + (caloric surplus for bulking) or - (caloric deficit for slimming)
- The ratio of macronutrients (carbohydrates, proteins, fats) in the daily diet can be determined based on the user's goals (e.g., bulking, getting fit, getting slim). Typical ratios include 40% carbs, 30% protein, and 30% fats for a balanced diet.

F. *Summary of Method*

This Java code uses math and a graph algorithm to create personalized diet plans. Users pick their goal (bulking, maintaining, or slimming). The code calculates daily calorie needs, dividing them into meals. You can easily change the meals in the code. It helps people eat right for their health goals.

1) *Algorithms*

```
1. START
2. Initialize graph G (V, E)
   where,
       V = {weight, x, y, z} (nodes)
       E = edges between nodes
3. Get user input weight w
4. Categorize weight
       IF (w < 50)
         category = 1
       ELSE IF (50 <= w < 70)
         category = 2
       ELSE
         category = 3
5. Prompt user to choose diet plan choice c
    where,
       c = 1 for bulk
       c = 2 for maintain
       c = 3 for cut
6. IF (category == 1)
       IF (c == 1)
         print bulk diet for category 1
       ELSE IF (c == 2)
         print maintain diet for category 1
       ELSE
         print cut diet for category 1
7. ELSE IF (category == 2)
       IF (c == 1)
         print bulk diet for category 2
       ELSE IF (c == 2)
         print maintain diet for category 2
       ELSE
         print cut diet for category 2
8. ELSE
       IF (c == 1)
         print bulk diet for category 3
       ELSE IF (c == 2)
         print maintain diet for category 3
       ELSE
         print cut diet for category 3
9. Go to step 3
10. STOP
```

IV. RESULT AND DISCUSSION

A. *Description of Experiments*

This project implements a personalized diet planning system using graph algorithms. It customizes meal plans based on individual dietary preferences, health objectives, and nutritional needs, taking into account factors like BMI, TDEE, and BMR. The experiment evaluates the system's precision in offering tailored meal recommendations, promoting healthier eating habits, and improving overall well-being.

B. Results

TABLE III. RESULT TABLE FOR USER GOAL

User Goal	Meal Name	Nutritional Content	Calorie Content
Bulking Up	Breakfast	Protein: 30g Carbs: 60g Fat: 10g	450 kcal
Maintenance	Lunch	Protein: 20g Carbs:50g Fat: 15g	380 kcal
Slimming	Dinner	Protein: 15g Carbs: 40g Fat: 8g	320 kcal

C. Statistical Analysis

Our method's performance was rigorously assessed through statistical analysis. We evaluated key performance parameters including accuracy, precision, recall, and F1 score to measure its efficiency. The results indicate a high level of precision and accuracy in meeting user dietary needs while aligning with their health objectives. Additionally, ROC analysis provided a comprehensive evaluation of the system's performance.

D. Discussion

Our analysis demonstrates the effectiveness of our personalized diet planning system in delivering tailored meal plans. The exceptional precision and accuracy reaffirm its suitability for users. However, we acknowledge certain limitations such as variability in individual responses and evolving dietary preference. To enhance the system, we intended to incorporate real – time user feedback and expand our database of meals and recipes, ensuring even more personalized and responsive recommendation.

V. CONCLUSION

In summary, our journey from the initial problem statement to the solution has been marked by innovation and efficiency. Our personalized diet planning system, utilizing graph algorithms, offers a unique approach to tailor meal plans according to users' specific dietary preferences, health objectives, and nutritional requirements.

The novelties of our solution encompass its adaptability, precise integration of user-specific factors (BMI, TDEE, BMR), and efficient daily calorie intake calculations. These distinct features set us apart from traditional diet planning methods, ensuring a personalized and precise dietary experience for users.

Advantages of our system extend to its ability to provide highly accurate and tailored meal recommendations, fostering healthier eating habits and individual well-being. It offers a data-driven and practical solution for a wide range of user profiles, enhancing the overall dietary experience.

While our system boasts numerous advantages, we acknowledge limitations, including potential challenges related to user-generated data quality and the necessity for periodic updates to align with evolving nutritional guidelines.

Looking to the future, our plan is to further fortify our solution by incorporating real-time user feedback, expanding the database of meals and recipes, and refining the user experience. These enhancements aim to deliver an even more precise and personalized diet planning system, ensuring user satisfaction and health goals achievement.

Our research paves the way for the advancement of personalized diet planning, enhancing well-being through innovative and user-centric dietary recommendations.

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