International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

Diet Recommendation System Using Machine Learning

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ABSTRACT - This paper presents a personalized diet recommendation system that leverages machine learning algorithms to provide customized diet plans based on personal health data, dietary habits, and food preferences. The aim of this system is to provide users with the necessary tools to make informed dietary decisions, improve overall well-being, and reduce the risk of lifestyle-related diseases, such as obesity, diabetes, and cardiovascular disease. Personal health data, dietary habits, and food preferences were collected from a large user population, which underwent preprocessing to extract relevant features. Machine learning models were developed to generate personalized diet recommendations based on the user's information. The nearest-neighbour algorithm provided real-time feedback and guidance on eating habits, and the system also provided access to various recipes and meal ideas. The effectiveness of the system was assessed by measuring changes in Body Mass Index (BMI) following adherence to the personalized diet plan, which produced a significant improvement in users' dietary habits and a substantial reduction in BMI. This research demonstrates the potential of machine learning in creating personalized healthcare applications that offer more accurate and effective healthcare services, and the proposed system could have a significant impact on public health by promoting healthy dietary habits and lowering the risk of lifestyle-related diseases.

***Key Words*:** Personalized diet recommendation, Machine Learning, Nearest-Neighbor Algorithm, Body Mass Index, User preferences, Public Health

1.INTRODUCTION

In today's fast-paced world, where people are always on the go, personalized food recommendation services provide a simple and easy-to-use solution to help users make informed dietary choices. Despite the challenges associated with providing personalized recommendations, such services have a potentially huge user base, making them essential in meeting the diverse needs of users in terms of basic nutrition, calories, taste, health, and social occasions. By exploring the opportunities and challenges in providing such services, this research paper aims to contribute to the development of more effective and user-friendly personalized food recommendation systems.

2. OBJECTIVE

The objective of this reference paper is to propose a diet recommendation system that takes into consideration an individual's past medical history to provide personalized food recommendations. The system aims to improve overall nutritional intake, provide education and guidance on healthy eating habits, portion sizes, and food choices, and increase adherence to dietary recommendations. By exploring the potential benefits of such a system, this reference paper aims to contribute to the development of more effective and personalized diet recommendation systems.

3. EXISTING SYSTEM

Various diet and food recommendation systems have been developed, including those for food recommendations, menu suggestions, diet plans, health recommendations for specific diseases, and recipe recommendations. These systems gather information on user preferences from various sources such as user ratings. However, existing techniques for recommending diets often overlook the severity of a patient's ailment, which can vary between individuals and negatively impact their health. Similarly, while some systems aim to balance a user's diet according to their needs, they may disregard important nutritional aspects that are critical to making food recommendations and creating a well-balanced diet.

For instance, one Food Recommendation System (FRS) proposes using K-means clustering and Self-Organizing Maps for food clustering analysis to suggest suitable replacements for diabetic patients. However, FRS does not address the issue of varying degrees of diabetes or the dynamic changes that can occur hourly based on a patient's circumstances, which can affect meal recommendations. Another example is an Android-based food recommendation system that suggests customized recipes based on tags and ratings entered in the user's preferences. While this system uses matrix factorization and latent feature vectors to improve prediction accuracy, it does not consider nutritional needs when balancing the user's diet.

To overcome these limitations, there is a need to develop a more personalized food recommendation system that considers individual needs, health conditions, and nutritional requirements. This can be achieved through machine learning algorithms that analyze data on a person's health, medical history, food preferences, and nutritional intake to provide tailored recommendations. The system can also serve as a source of education and guidance on healthy eating habits, portion sizes, and food choices, helping individuals improve their overall nutritional intake and reduce the risk of nutrient deficiencies. By providing personalized recommendations that are tailored to an individual's preferences and goals, a diet recommendation system can increase adherence to dietary guidelines and reduce the likelihood of falling off track.

4. METHODOLOGY

4.1. HARDWARE REQUIREMENTS

Operating System: The system can run on any operating system, including Windows, Mac OS, and Linux.
Processor: A minimum of Intel Core i3 processors is required for efficient functioning of the system. However, an Intel Core i5 processor or higher is recommended for better performance.
RAM: The recommended minimum RAM for the system is 8 GB. However, for optimum performance, 16 GB or higher RAM is recommended.
Storage: The system requires at least 20 GB of free hard disk space to store the necessary software packages and datasets. Additionally, it is recommended to use a solid-state drive (SSD) for faster data access and retrieval.
Graphics Card: A dedicated graphics card is not required for the system. However, if the system is used for training machine learning models, a graphics card with a minimum of 2 GB of video memory is recommended.
Network: A stable internet connection is required for accessing external APIs and cloud services that may be used in the system.

4.2. SOFTWARE REQUIREMENTS

The software requirements for the diet recommendation system include an operating system such as Linux or Windows, as well as Python programming language and several Python libraries like NumPy, Pandas, and Scikit-Learn. Additionally, the system needs to have Streamlit and FastAPI web frameworks installed to provide the user interface and API endpoint functionalities, respectively. Other required dependencies should also be installed to ensure the system's proper functionality.

4.3. ALGORITHMS USED

4.3.1 CONTENT BASED RECOMMENDER SYSTEM

A content-based recommender system is a type of recommendation system that provides personalized recommendations to users based on their past interactions and preferences with content. Such systems are effective for generating recommendations for users with niche preferences or when there is limited user data available. In the context of a diet, a content-based diet recommender system can provide personalized recommendations to users based on their dietary preferences, restrictions, and nutritional needs.
To build a content-based diet recommender system, the first step is to identify the features or characteristics of the foods and recipes that are most relevant to the user's dietary needs. These features can include macronutrient and micronutrient content, calorie count, dietary

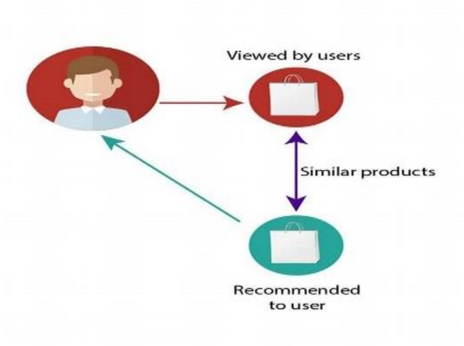

Fig -1: Content Based Recommendation

restrictions, and food allergies. The system then analyzes these features of foods and recipes in a database to generate recommendations for meals and snacks that meet the user's dietary requirements.
Figure 2 depicts the working of a content-based recommendation system for diet. The system operates by analyzing the characteristics of foods and recipes in a database and using these characteristics to generate personalized recommendations for meals and snacks that meet the user's dietary requirements. The recommendations can be further refined based on the user's feedback and interactions with the system.
Overall, content-based diet recommender systems can provide valuable support for individuals who want to maintain a healthy and balanced diet. By leveraging the features of foods and recipes, such systems can provide personalized recommendations that meet the user's dietary requirements, preferences, and restrictions.

4.3.2 NEAREST NEIGHBOR ALGORITHM

The nearest neighbor algorithm is a widely used recommendation algorithm in content-based diet recommender systems. This algorithm leverages the

International Journal of Scientific Research in Engineering and Management (IJSREM)
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similarity between items in a database to generate recommendations for the user. In the context of a diet, the algorithm calculates the similarity between the nutrient content of foods and recipes to provide personalized recommendations to the user.

The nearest neighbor algorithm identifies the closest neighbors to a user's preferences based on their past interactions with the system. It then recommends similar foods and recipes to the user, considering their dietary preferences, restrictions, and nutritional needs. This algorithm is particularly useful for providing personalized recommendations to users with limited data available, such as those with niche dietary preferences or new users with limited interactions.

To improve the accuracy of the recommendations, the nearest neighbor algorithm can incorporate user feedback and interactions. For example, if the user indicates a preference for a certain food, the algorithm can adjust its recommendations to include similar items. Similarly, if the user finds a recommended item unappealing or unsuitable, the algorithm can remove similar items from future recommendations.

Overall, the nearest neighbor algorithm is a powerful tool for generating personalized recommendations in content-based diet recommender systems. It provides accurate and relevant recommendations based on the user's dietary preferences, restrictions, and nutritional needs, and can be adjusted based on user feedback and interactions.

5. SYSTEM ANALYSIS

5.1. ARCHITECTURE OF PROPOSED SYSTEM

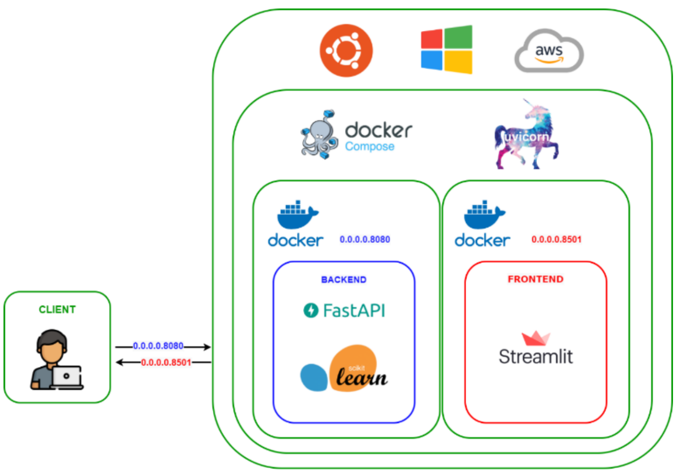


Fig -2: System Architecture

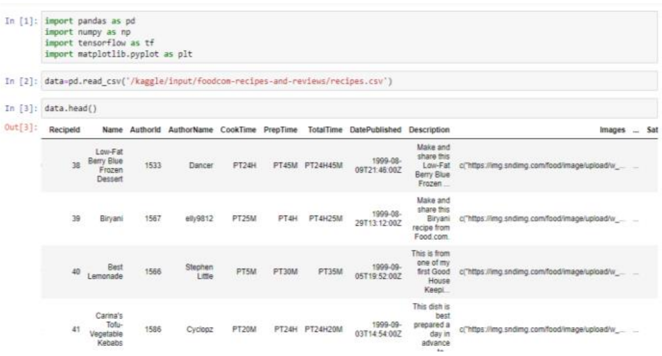
Figure 2 presents the system architecture of the diet recommendation system. The system functions as follows:

- Users enter relevant information, including age, gender, weight, and activity level, on the website.
- The input data is processed through a machine learning (ML) model that utilizes Nearest Neighbor to group meals based on calorie content.
- The system calculates the user's Body Mass Index (BMI) and current state (overweight, underweight, or healthy) based on the processed data.
- The system suggests a personalized diet plan to the user based on their dietary goals, preferences, and nutritional needs for breakfast, lunch, and dinner.
- Users have the option to modify the recommended plan or create their own by selecting from a variety of suggested foods.
- After selecting food items, the system computes the calorie count and displays a comparison between the user's selected calorie intake and the recommended daily intake.
- The user can then create a personalized diet plan based on the information provided.

Overall, the diet recommendation system uses a combination of user data and an ML model to suggest a personalized diet plan that caters to the individual's nutritional needs, dietary preferences, and goals. The system provides users with the flexibility to modify or create their own diet plan while ensuring that they meet their recommended calorie intake.

5.2. IMPLEMENTATION:

Data collection:



```
In [1]: import pandas as pd
        import numpy as np
        import tensorflow as tf
        import matplotlib.pyplot as plt

In [2]: data=pd.read_csv('/kaggle/input/foodcom-recipes-and-reviews/recipes.csv')

In [3]: data.head()
Out[3]:
```

	RecipeId	Name	AuthorId	AuthorName	CookTime	PrepTime	TotalTime	DatePublished	Description	Images	...	Sat
	38	Low-Fat Berry Blue Frozen Dessert	1533	Dancer	PT24H	PT45M	PT24H45M	1999-08-09T21:46:00Z	Make and share this Low-Fat Berry Blue Frozen ...	c("https://img.sndimg.com/food/image/upload/w_...	...	
	39	Biryani	1567	elly9812	PT25M	PT4H	PT4H25M	1999-08-29T13:12:00Z	Make and share this Biryani recipe from Food.com.	c("https://img.sndimg.com/food/image/upload/w_...	...	
	40	Best Lemonade	1566	Stephen Little	PT5M	PT30M	PT35M	1999-09-05T19:52:00Z	This is from one of my first Good House Keepi...	c("https://img.sndimg.com/food/image/upload/w_...	...	
	41	Carina's Tofu-Vegetable Kebabs	1586	Cyclopz	PT20M	PT24H	PT24H20M	1999-09-03T14:54:00Z	This dish is best prepared a day in advance to...	c("https://img.sndimg.com/food/image/upload/w_...	...	

Fig -3: Data collection code

Collect data on food items, nutritional content, and user dietary preferences. Figure 3 shows code for data collection phase.

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Data preprocessing:

```
In [7]: dataset=data.copy()
        columns=['RecipeId','Name','CookTime','PrepTime','TotalTime','RecipeIngredientParts','Calories','FatContent','SaturatedFatContent
        dataset=dataset[columns]

In [8]: max_Calories=2000
        max_daily_fat=100
        max_daily_Saturatedfat=13
        max_daily_Cholesterol=300
        max_daily_Sodium=2300
        max_daily_Carbohydrate=325
        max_daily_Fiber=40
        max_daily_Sugar=40
        max_daily_Protein=200
        max_list=[max_Calories,max_daily_fat,max_daily_Saturatedfat,max_daily_Cholesterol,max_daily_Sodium,max_daily_Carbohydrate,max_dai

In [9]: extracted_data=dataset.copy()
        for column,maximum in zip(extracted_data.columns[6:15],max_list):
            extracted_data=extracted_data[extracted_data[column]<maximum]
```

Fig -4: Data preprocessing code

Figure 4 depicts code for data preprocessing. Preprocess the data by encoding the food items and user dietary preferences into numerical features that can be used in the machine learning model.

Feature selection:

```
In [12]: from sklearn.preprocessing import StandardScaler
         scaler=StandardScaler()
         prep_data=scaler.fit_transform(extracted_data.iloc[:,6:15].to_numpy())

In [13]: prep_data

Out[13]: array([[-0.55093359, -0.91281917, -0.77924852, ...,  0.15672078,
                  2.35502102, -0.68338127],
                [ 1.47428542,  1.13139595, -0.0647135 , ...,  3.91055068,
                  2.56324444,  1.25158691],
                [-0.92414618, -1.11248669, -1.12222533, ...,  0.4855234 ,
                  0.98513013, -0.60183088],
                ...,
                [ 0.49162165,  0.73206091,  1.85024037, ..., -0.61048534,
                  1.76322815, -0.56476253],
                [ 0.25704672,  0.03797856,  1.02137974, ..., -0.61048534,
                  1.54404561, -0.63148557],
                [-1.40937801, -1.09347074, -1.12222533, ..., -0.82968708,
                 -0.94367625, -0.74269064]])
```

Fig -5: Feature selection code

Select relevant features for the machine learning model, such as nutritional content, ingredients, user dietary restrictions, etc.

Model selection:

```
In [14]: from sklearn.neighbors import NearestNeighbors
         neigh = NearestNeighbors(metric='cosine',algorithm='brute')
         neigh.fit(prep_data)

Out[14]: NearestNeighbors(algorithm='brute', metric='cosine')
```

Fig -6: Model selection code

Figure 6 highlights the code for selecting the model. Select a machine learning algorithm, such as a content-based recommendation algorithm, that is appropriate for the problem and data.

Model training:

```
In [15]: from sklearn.pipeline import Pipeline
         from sklearn.preprocessing import FunctionTransformer
         transformer = FunctionTransformer(neigh.kneighbors,kw_args={'return_distance':False})
         pipeline=Pipeline([('std_scaler',scaler),('NN',transformer)])

In [16]: params={'n_neighbors':10,'return_distance':False}
         pipeline.get_params()
         pipeline.set_params(NN__kw_args=params)
```

Fig -7: Model training code

Train the machine learning model on the preprocessed data to learn the relationships between the features and user preferences. Figure 7 depicts the code for training the model selected.

Model evaluation: Evaluate the performance of the model using metrics such as accuracy, precision, recall, and F1 score.

Hyperparameter tuning: Tune the hyperparameters of the model to optimize its performance.

Deployment: Deploy the model in a production environment and integrate it into a diet recommendation system.

Testing:

```
In [18]: extracted_data.iloc[pipeline.transform(extracted_data.iloc[0:1,6:15].to_numpy())[0]]
```

Out[18]:

	RecipeId	Name	CookTime	PrepTime	TotalTime	RecipeIngredientParts	Calories	FatContent	SaturatedFatContent	CholesterolContent	SodiumCo
0	38	Low-Fat Berry Blue Frozen Dessert	PT24H	PT45M	PT24H45M	c("blueberries", "granulated sugar", "vanilla ...	170.9	2.5	1.3	8.0	
463750	480841	Mango Salsa	PT5M	PT10M	PT15M	c("fresh mango", "tomatoes", "sweet onion", "f...	152.5	0.8	0.2	0.0	
485171	503065	Glazed Pineapple With Cinnamon Creme Fraiche	PT10M	PT10M	PT20M	c("lime", "honey", "ground cinnamon", "ground ...	172.5	2.2	1.2	5.0	
158110	165636	Lemon Float Punch	PT120H	PT5M	PT120H5M	c("lemons", "sugar", "water", "ginger ale", "l...	158.4	1.7	0.9	0.4	
28595	32172	L & B's Concoction	PT5M	PT5M	PT10M	c("strawberry", "strawberry", "milk", "blueber...	167.3	2.0	1.0	5.7	
224062	233508	Blueberry Mango Smoothie	NaN	PT5M	PT5M	c("vanilla-flavored soymilk", "frozen blueberr...	147.5	0.4	0.1	0.0	
206883	215824	Blueberry Orange Smoothie	NaN	PT5M	PT5M	c("blueberries", "fresh blueberries")	179.4	2.6	1.3	0.7	

Fig -8: Testing data code

Test the recommendation system with real user data and evaluate its performance. Figure 8 highlights the code for testing the data.

Maintenance: Continuously update and maintain the recommendation system to ensure it stays up to date with new food items, nutritional information, and user preferences.

5. OUTPUT/RESULTS

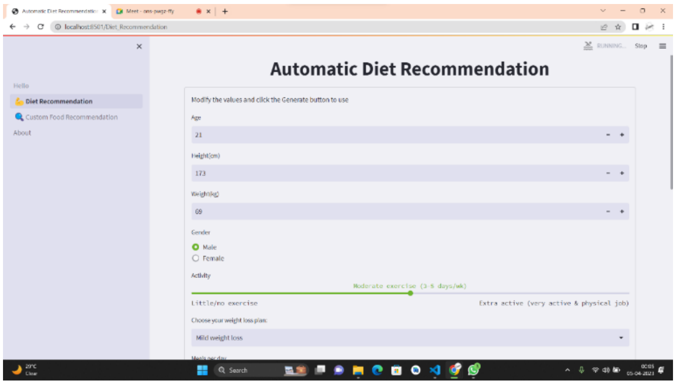

Fig -9: Automatic diet recommendation page

On the Automated Diet Recommendation page shown in figure 9, we need to provide information about our age, height, weight, gender, and daily activities, and then select our weight goal - whether we want to maintain or reduce it. After entering all the necessary fields, we can generate a response by clicking on the 'Generate' button**.**

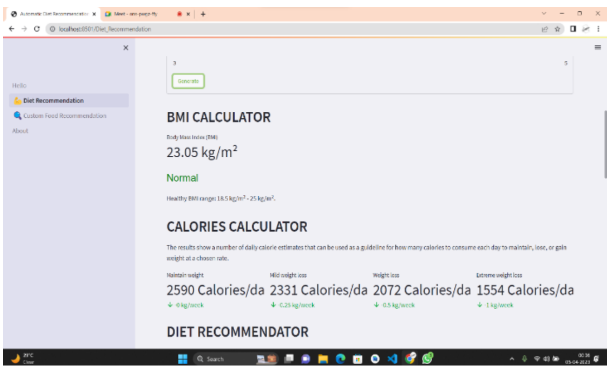

Fig -10: BMI Calculator

After clicking on the 'Generate' button, the system will calculate our BMI level as well as the number of calories we need to consume to either maintain or reduce our weight as shown in figure 10.

Formula for Calculating BMI:

$$\text{weight (kg)} / [\text{height (m)}]2$$

The formula for BMI is weight in kilograms divided by height in meters squared.

Formula for Calculating Calories (BMR):

For women:

$$BMR = 655 + (9.6 \times \text{body weight in kg}) + (1.8 \times \text{body height in cm}) - (4.7 \times \text{age in years});$$

For men:

$$BMR = 66 + (13.7 \times \text{weight in kg}) + (5 \times \text{height in cm}) - (6.8 \times \text{age in years})$$

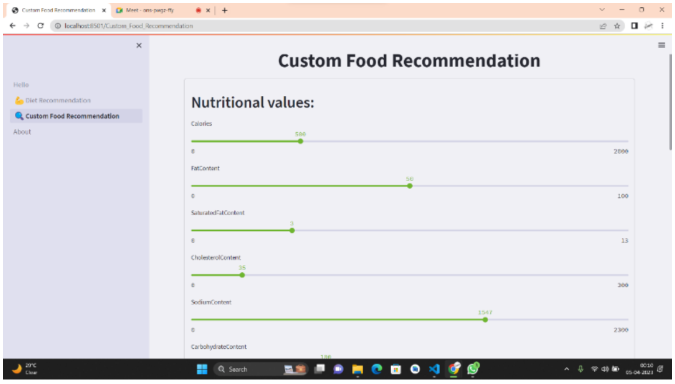

Fig -11: Custom Food Recommendation

The 'Custom Food Recommendation' page is the next page of our WebApp. As shown in figure 11, users can input their own preferred nutritional intake measures on this page. For example, if someone has health issues related to the fat content in their meals, they can adjust the amount of fat they want to consume in their meal. The system then recommends meals based on the user's customized nutritional intake. Our recommendation system includes the following nutritional values: calories, fat content, cholesterol content, sodium content, carbohydrate content, fiber content, sugar content, and protein content.

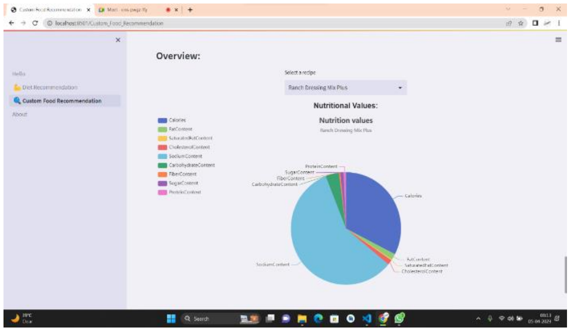

Fig -12: Overview of nutritional values

If we want to visualize the nutrient intake of a particular meal or recipe, we first need to select that meal from the dropdown list, which will generate a pie chart showing a proper view and measurement of each nutrient's value as depicted in figure 12.

6. CONCLUSIONS

To improve dietary habits, a personalized diet recommendation system using machine learning can offer efficient and customized dietary recommendations considering individual preferences and restrictions. By analyzing vast food and nutritional data, machine learning algorithms can predict which foods are most likely to be preferred by a particular user accurately.

Content-based filtering is one of the popular strategies for diet recommendation, where the system suggests food items based on similarity to previously consumed foods. This approach can be more effective when combined with other recommendation methods, such as collaborative filtering or hybrid methods.

However, developing a diet recommendation system using machine learning faces challenges, such as data quality and privacy concerns, limited diversity in food recommendations, and the potential risk of reinforcing unhealthy eating habits. Addressing these challenges is crucial to ensure the system's effectiveness and long-term success.

In conclusion, a personalized diet recommendation system based on machine learning has the potential to revolutionize the approach to diet and nutrition, providing individuals with tailored and effective recommendations to achieve their health and wellness objectives.

ACKNOWLEDGEMENT

Prof. A.D.Wankhade, Department of Information Technology, Government College of Engineering, Amravati, has been a tremendous source of support and guidance to the authors throughout this project. Their moxie and experience have been inestimable in suiting this work. fortuitous to have had such a surprising

companion who invariably handed with the necessary coffers and helped to beat the expostulations that came along the expressway.

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