Optimizing Health: A Personalized Diet Recommendation System Based on Machine Learning

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Abstract:

Today, if you are suffering from a chronic disease, you need not only good medicine, but also a proper diet. A recommender system only predicts which products a user can purchase. Traditionally, there have been two types of recommendation techniques. Content-based collaborative filtering techniques are used accordingly. This type of filtering technique is called hybrid filtering. Using the techniques described above, we use your personal information such as your age, height, weight, diet type, nutrients, and related medical conditions. It finds similarities between users and uses the KNN algorithm to recommend types of foods to include in your diet. There are basically two types of data sets that are mainly used to get a better knowledge of the data. The first is about user profiles that contain personal information, and the second is about specifically recommended food types and ingredients gleaned from various web scraping sites. There are plenty of vegetarian and non-vegetarian styles, so you can choose your favorite from the recommended menu. This recommendation process can be used to personalize content such as groceries to users, specifically telling them what to eat based on their interests. If groceries aren't available, you can also order groceries whose purchase history is also saved in your profile. This way, you can cook for yourself without going to a specific nutritionist, saving you money and time. It has to do with building a dating system.

Keywords: *Recommendation Systems, Machine Learning, Web Scrapping, Collaborative filtering, Content-based filtering, KNN*

Introduction:

"HEALTH IS WEALTH" is the most famous saying we know. Today, people tend to eat unhealthy foods, and careless behavior can lead to serious illnesses. On the other hand, hectic schedules prevent people from better managing their health. People are often unaware of what to eat and how to stay active and healthy. According to one study, more than 70% of people suffer from diseases caused by malnutrition. Most people avoid going to a dietician or nutritionist because hiring a nutritionist can be costly review.

People's lifestyles have evolved with smartphones, giving them instant access to all the information they need. This is how the idea was born to create a nutritionist who acts like a real nutritionist. Artificial intelligence is a technology that enables natural language interaction between humans and machines. It requests all the user's data and processes them to deliver the diet plan to the user. As a result, users no longer need to consult a nutritionist, saving time. Proper coaching can help ordinary people stay healthier. The AI section helps you create healthy meal plans. Adjusting your diet plan on a regular basis requires familiarity with foods and is a time-consuming process. Some of his IoT systems have problems with not updating information about users when they are far away. Meal plans vary from person to person, and this has been overlooked in the development of most systems and AI applications. This program is primarily important for monitoring the user's health. You don't need a professional nutritionist or spend money on self-examinations. This online application will help you with that. Smartphones and the Internet have transformed communication and changed people's lifestyles. Increasing numbers of smartphones and personal digital assistants (PDAs) available.

A personal diet recommender is a human diet-related artificial intelligence application. It functions as a nutrition adviser, much like a professional dietician. This system functions similarly to that of a nutritionist. To learn about his or her diet plans, a person must provide certain information to the dietitian data such as body type, weight, height, and working hours. Similarly, this technology generates a diet plan based on the information given by the user.

The system collects all of the user's data and processes it to deliver the diet plan to the user. As a result, the user does not need to see a nutritionist, which saves time, and the user may obtain the necessary diet plan with a single click. The project also includes a login page where the user must create an account before using the app. Because this project requires Internet connectivity, there is a risk of server failure. The system produces more accurate results since it receives the user's data and processes it based on some metrics previously known to the program, based on which a diet plan is developed, and then asks the user if the diet plan is acceptable. If the diet is not approved, the system may suggest an alternate diet plan.

Related Work:

This paper proposes a strategy that provides generic suggestions to every user based on movie popularity and/or genre, and it has exhibited the modeling of a movie recommendation.

system using content-based filtering. The KNN method is used in this model, along with the idea of cosine similarity, because it is more accurate than other distance metrics and has a lower complexity. In the world of the internet, recommendation systems have become the most important source of relevant and reliable source of information, and this suggested system is capable of storing a vast quantity of data and producing efficient results. This recommendation system searches for the finest movies based on the genre that is comparable to the movie we just saw and returns the results. This paper also provides insight into difficulties that may arise are encountered in content-based recommendation systems, and we have made efforts to address them. Simple ones examine one or a few characteristics, whereas more complicated ones consider several parameters extra parameters are used to refine the results and make them more user friendly With sophisticated deep learning and additional filtering algorithms included. A good movie recommendation system may be constructed using techniques such as collaborative filtering and hybrid filtering. This can be a significant step forward in the development of this model since it will not only become more efficient to use but will also boost its commercial value.[1] The author of this research developed a revolutionary recommender system called DIETOS (DIET Organizer System) to profile health. Users' status and to offer usual foods in adaptable technique to improve the quality of life of both healthy and sick people and persons suffering from chronic dietary illnesses. The suggested system can assemble a user's health. profile, and in particular, it may profile persons impacted by CKD, hypertension, and diabetes, in addition to healthy users As a result, a completely automated system capable of modulating the dietary prescription in real time based on the clinical and laboratory data of the patient is desirable. In this regard, we want to expand current DIETOS functions in the future by advising customers on diets and/or dishes that are compatible with their health state. Although DIETOS was initially intended to advise solely Calabrian traditional meals, we want to create a set of functions that will make it easy for professionals to add more traditional foods or/and recipes, as well as to track users' progress and motivate/ communicate with them. As a result, it will be feasible to expand contact between users and medical doctors, resulting in a richer user experience. Finally, by introducing additional questionaries capable of profiling new diseases as well as new events such as pregnancy, athlete, and so on, more users will be able to be advised with recipes and foods appropriate for their health state.[2] In this paper a disease Mauritius, hypertension is one of the leading causes of death. Proper eating habits and diets can assist to improve the country's predicament. As a result, the research suggests a DASH diet recommendation system for recommending healthy meals and

dishes. The recommended recipes seek to assist not only a hypertensive person to maintain his diet but also a typical user avoid health concerns. The system uses machine learning and content-based filtering algorithms to produce appropriate suggestions based on allergies, blood pressure, age, weight, smoking/alcohol use, nutritional intake, and food preferences. The system employs a mobile application that is convenient and quick to use, and it has been tested with a group of hypertension patients and found to be adequate. Relevant charts are projected to show the user's various blood pressure measurements throughout a specific period. In future works, the technology will be utilized to recognize and analyze the user's eating habits. As a result, the user's progress may be tracked.[3]. The author of this study developed a recommender system that assists users in monitoring their calorie objectives based on their BMI and delivers meal recommendations based on the user's history and preferences. A daily calorie target will be suggested after the consumer enters their BMI, dietary habits, and allergies. Providing food recommendations based on user preferences using Collaborative Filtering and Fuzzy logic to create a recommender framework. Users may use the Android-based application's Step Counter or Pedometer to track their steps as part of an operation or workout. A recent evaluation of similar activities indicates that, while much research focuses on developing computer-assisted food counting tools, many of them indirectly address dietary and data relevant to healthy living. In these circumstances, this article describes the conventional structure of food recommendations, which includes a data collecting layer, a user, a user profile database, a smart system layer, and a user-friendly interface. It has also offered a worldwide solution that may be utilized as a smart system layer. They construct a Diet Recommendation System that gives nutrition objectives and meal suggestions using Fuzzy logic and Collaborative Filtering. So, when we compared fuzzy logic and collaborative filtering to other techniques and parameters, we discovered that our strategy is more efficient and accurate. This application's future possibilities include the integration of modules for presenting Restaurants based on the user's geo-location, providing Workout regimens depending on the user's fitness goals, and providing comprehensive Diet Plans.[4]. This study introduces the notion of Nutrigenomics and how it relates to a person's nutrition. Nutrigenomics is the study of the effects of nutrition on a person's DNA. Protein genes make up a genome (a collection of DNAS). These genes oversee a person's overall health. Any infected gene can affect a person's health. Various methods may be applied to deliver dietary facts to a person by studying gene variation. Generic algorithms will examine DNA sequences. The application will also generate a nutrition assessment based on lifestyle and other factors. A smartphone application is being developed that will.

collect a person's genetic information and then recommend a meal to that individual based on that information. The dietary products mentioned may be scrutinized in terms of weight, nutritional content, and other considerations. There are also recipes for various foods that may be used to create an effective diet. The research just discussed the relationship between a person's food and his or her genes, with no mention of constructing any algorithms that may be employed for the same. Furthermore, the method utilized in the produced application may have been clarified for better comprehension. It did not, however, weigh up a person's age, height, weight, and other aspects that are equally crucial for a diet.[5]. In this paper, a Healthcare recommendation system for food and exercise was built. The most efficiently used algorithm decision tree is used to collect information from the datasets provided. Out of the machine learning algorithms used Random Forest has given more accuracy. Here machine learning algorithms are used for data analysis and deep learning for health monitoring. From UCI Chronic kidney, the system extracts the features which were responsible for kidney diseases. After that, Machine Learning automated the classification of CKD with respect to its severity. Using USDA Food Composition Database, they proposed a diet recommendation which recommends suitable diet to patients for those are hypertensive. A web-based diet recommendation system using Health Calabria Food Database improves the health of people who were affected by chronic diseases. Finally, a Recommendation system was built which recommends users with their diet and workout that suits them, based on the inputs provided on the system.[6]. This paper is about content aware recommendation. Because of lack of communication infrastructures and citizenship collaboration, circumstances aware recommendation has some limitations. Though we have web 2.0 we still use recommendation systems. Collaborative filtering comprises of a large family of methods. It recommends a set of items based on preferences of user. To make it work worthy it relies on smart city sensors and databases. The CARS is incarnated in a computer program that runs in a server. It recommends routes to citizens. The routes are selected by using collaborative filtering and by considering the user preferences, their health condition and the real-time information obtained from city sensors.[7]. In this paper author discussed about the machine learning algorithms and on the other hand data mining techniques. Machine Learning, in computer research plays a vital role in classification and predictive analysis systems. Machine learning models are proposed to address the problems in the specific measures to make the predictive model successful. Efficient cloud-based cluster model deals with huge amount of data. While Neural Networks can be used for mining the secrets, genetic algorithms work efficient with patterns. Data mining is a technique to retrieve information in databases and visualize data.

In addition, text diagnostic evidence. Data mining is a tool used to discover information in databases.[8]

Proposed System:

In our project, the user must have to create their profiles which is a questionnaire that includes Age, Height, Weight, Nutrients, Type of disease and Preference of diet. For a particular user, their profiles will be created. By using Hybrid filtering technique, the food items will be suggested based on the user preferences. The Similarities of the users are identified based on the KNN algorithm. Our proposed system is basically a web page which is used to store the history (orders) of the particular user. So, the user doesn't need to come back to check their diet when they lost track of following their diet.

Methodology:

Our Project is mainly divided into following modules 1. Data collection and processing 2. Feature selection 3. Hybrid Filtering 4. KNN Recommendation 5. Deployment

1. **Data collection and processing**

Data collection is one of the crucial parts of the project. First of all, we need to collect information about the food items. In this project we need to know about the food items like what type of ingredients they made up etc. Using the python library beautiful soup. And the technique is known as web-scrapping. Here, we are going to collect the information about the food items from the web pages and as it is unstructured we use beautiful soup to bring the definite structure. Beautiful Soup: Beautiful Soup is a Python package for parsing HTML and XML documents. It creates parse trees that are helpful to extract the data easily.

Web scraping helps to collect these unstructured data and store it in a structured form. There are different ways to scrape websites such as online Services, APIs, or writing your own code.

To extract data using web scraping with python, you need to follow these basic steps :

1. Find the URL that you want to scrape.
2. Inspecting the page.
3. Find the data you want to extract.
4. Write the code.
5. Run the code and extract the data.
6. Store the data in the required format .

Now that scrapped data will be processed to create a perfect dataset as shown in fig.1.
In processing the data Basic cleaning, Adding a columns like veg/nonveg, review, Nutrient, Disease, Diet, Price, User, Meal id, such that complete data set will be created.

Fig.1 Flow for Web Scrapping

2. Feature Selection

Feature selection in machine learning is the key aspect where important features to input are selected. In feature selection, we eliminate the irrelevant and redundant features and process only the important features to reduce the input variables. This is important because the irrelevant data can pollute the algorithms which impacts on the performance of the model. We can choose a feature selection is of Categorical input, categorical output. More widely used feature selection methods are Filter methods.

In our project, firstly we performed feature selection for whole dataset and calculated the mean occurrence(MO).After we are done with that, the main features we got are nutrients, disease, and diet. Again, we have done feature selection for the obtained features; Nutrients to get the highly recommended or highly used nutrients. Of all the nutrients, we have taken only calcium, magnesium, selenium, and fiber.

We have done feature selection by using the process that is described in fig.2 for disease to know which diseases are commonly seen in people. We can see obesity, goiter, kidney disease, heart disease, hypertension, and anemia.

Finally, we have done feature selection for the diet to know which diet is commonly used by the people. And the result is high fiber diet, low fat diet, ketogenic diet, high protein diet, vegan diet.

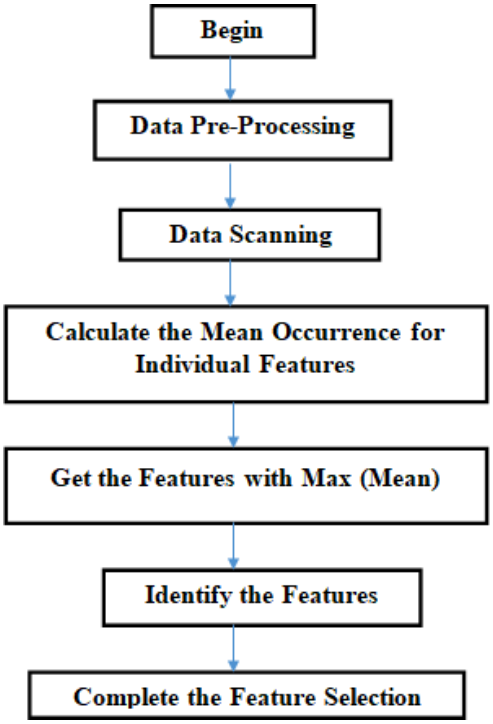

Fig.2 Flow for Feature selection

3. Hybrid Filtering

A hybrid recommendation system is a special type of recommendation system which can be considered as the combination of the content and collaborative filtering method. Content-based and Collaborative filtering. These methods face the issue when there is not enough data to learn the relation between users and items. In such cases, the third type of approach is used to build the recommendation system named Hybrid Recommendation System.

Fig.3 Structure of Hybrid Filtering

This approach overcomes the limitations of both content-based and collaborative filtering methods. Hybrid recommender system approaches can be implemented in various ways like

by using content and collaborative-based methods to generate predictions separately and then combining the prediction or we can just add the capabilities of collaborative-based methods to a content-based approach (and vice versa). Recommendation based on recent activities by using the process fig. 4 for the items like clicked, Watched, purchased, liked, and rated.

For this we are going to consider Recent search history, recently liked, Recently rated, and Timestamp of activity. Another way for making the recommendations is based on user-user similarity by using the process fig. 5, In which we will compare the similarity between the two user profiles.

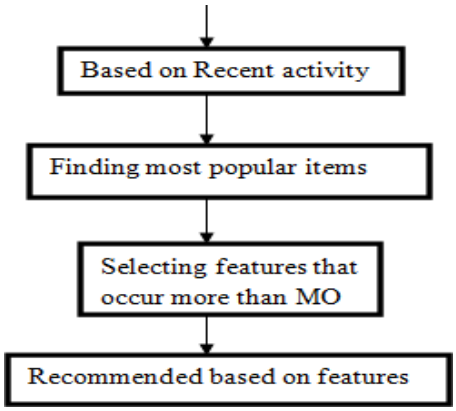

Fig.4 Flow chart for recent Activity

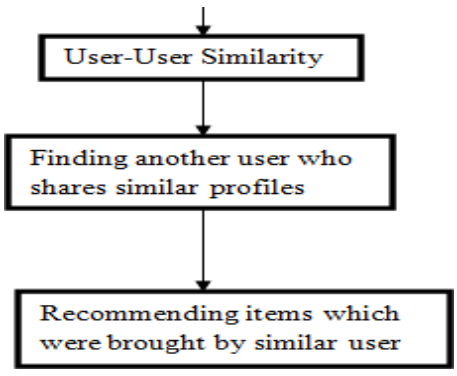

Fig.5 Flowchart for User-User similarity

4. KNN Recommendation

KNN stands for K-Nearest Neighbors where k means number. It is a supervised algorithm which is used for both classification and regression models in machine learning. Here neighbors are checked to determine the classification.

Number of neighbors are totally based on k. Defining k is a balancing act as different values which leads to overfitting or underfitting. Choice of k is dependent on the input as there exists outliers and noise. So the higher values of k performs better on them.

KNN uses distance metrics to determine which datapoint is close to a query point. Distance between query point and other points are calculated.

Here we are using Minkowski distance metric for finding the nearest neighbors. In our project, we have used ball tree algorithm in KNN to find the nearest neighbors. Based on the features we got the recommendations. We have taken recommendations based on user-user preferences and recommendations based on recent activities. And finally, we concatenated both the recommendations and displayed the final recommendations.

5. Deployment

Django is a high-level Python web framework that enables rapid development of secure and maintainable websites. Django can be used to build almost any type of website — from content management systems and wikis, through to social networks and news sites. It can work with any client-side framework and can deliver content in almost any format (including HTML, RSS feeds, JSON, and XML). Internally, while it provides choices for almost any functionality you might want (e.g. several popular databases, templating engines, etc.), it can also be extended to use other components if needed. The complete activation of the web pages can be done based on the process of Fig.6.

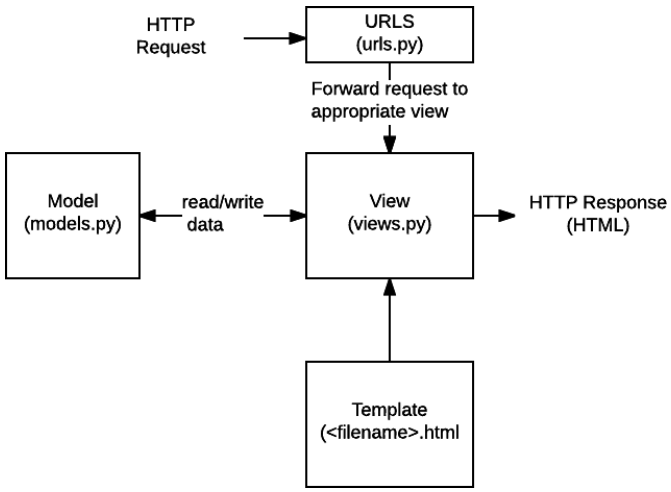

Fig.6 Steps for converting the group of code into separate files.

Django helps developers avoid many common security mistakes by providing a framework that has been engineered to "do the right things" to protect the website automatically. Django is well-supported by many web hosting providers, who often provide specific infrastructure and documentation for hosting Django sites. A URL mapper is typically stored in a file named urls.py. In the example below, the mapper (URL patterns) defines a list of mappings between routes (specific URL patterns) and corresponding view functions. If an HTTP Request is received that has a URL matching a specified pattern, then the associated view function will be called and passed the request. Views are the heart of the web application, receiving HTTP requests from web clients and returning HTTP responses. In between, they marshal the other resources of the framework to access databases, render templates, etc. Django web applications manage and query data through Python objects referred to as models. Models define the structure of stored data, including the field types and possibly also their maximum size, default values, selection list options, help text for documentation, label text for forms, etc. The definition of the model is independent of the underlying database — you can choose one of several as part of your project settings.

The Django model provides a simple query API for searching the associated database. This can match against a number of fields at a time using different criteria (e.g. exact, case-insensitive, greater than, etc.), and can support complex statements.

Results and Discussions:

Personalized health diet recommendation systems using machine learning techniques are becoming increasingly popular due to the growing awareness of the importance of maintaining a healthy diet. The proposed system is designed to provide users with recommendations for their diet based on their health and food preferences. By taking into account various factors such as age, gender, body mass index (BMI), and medical conditions, the system can generate personalized diet plans tailored to each individual's needs.

The system operates by using a hybrid filtering technique in conjunction with the KNN (k-nearest neighbors) algorithm to recommend food items based on the user's profile information and dynamic context information. The user's profile information includes data such as height, weight, and medical history, while dynamic context information includes data such as the user's current location and time of day. By utilizing both static and dynamic data, the system can provide accurate and relevant recommendations to the user.

The system also takes into account various dietary requirements and preferences such as vegetarianism, lactose intolerance, and gluten-free diets. This is achieved by incorporating a large database of food items with their nutritional information and categorizing them according to dietary requirements. The system can then recommend food items that are appropriate for the user's dietary needs and preferences.

The system’s accuracy is evaluated through case studies and human-expert evaluations, which have demonstrated an accuracy rate of 96.1%. The system is implemented using Python and Django, which are portable and interactive languages for web development, including

dynamic semantics potential. The use of Python and Django also allows for the incorporation of powerful text processing capabilities, making it easier to fetch data from the web.

In conclusion, the proposed personalized health diet recommendation system effectively provides users with tailored diet plans based on their individual needs and preferences. By utilizing machine learning techniques and incorporating various dietary requirements and preferences, the system is able to provide accurate and relevant recommendations to the user. The use of Python and Django makes the system easy to implement and maintain, while the incorporation of powerful text processing capabilities enables data to be fetched from the web efficiently.

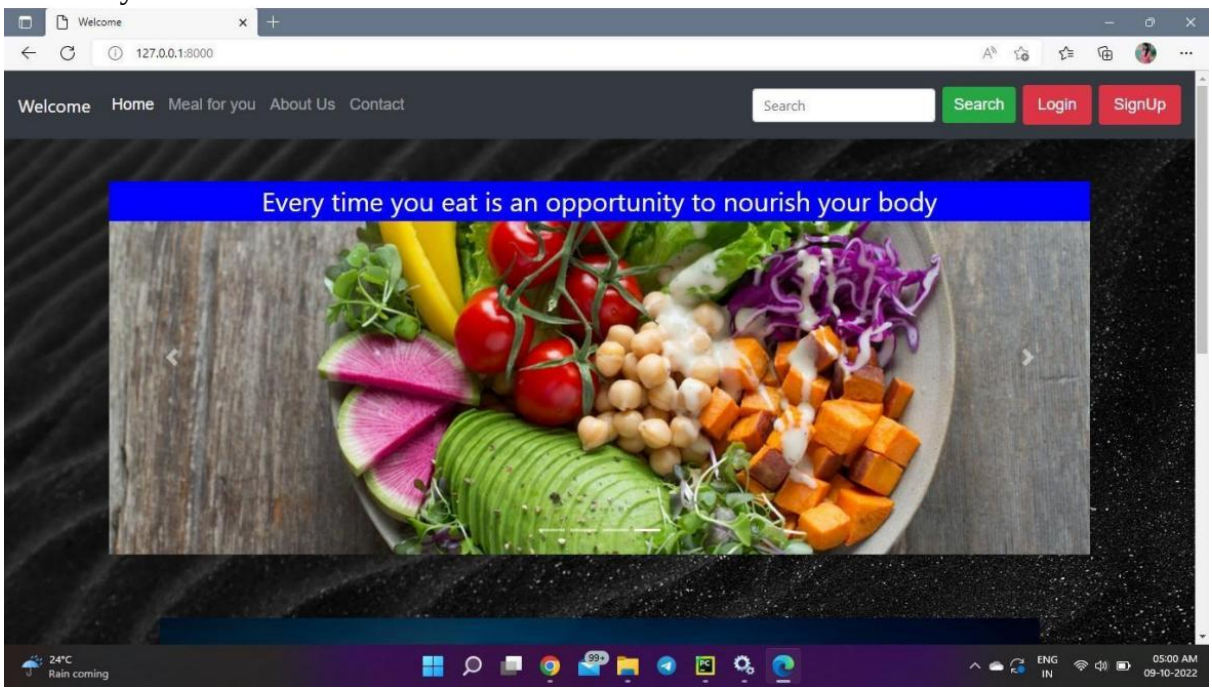

Fig-1: User Interface of Home Page

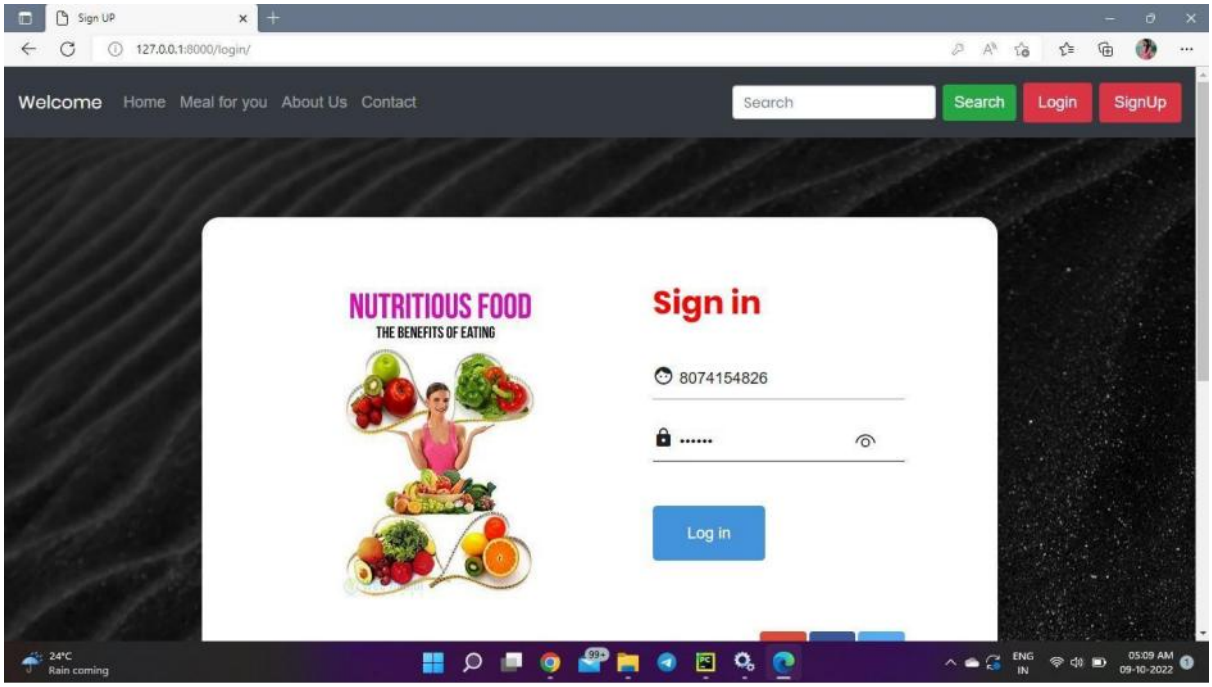

Fig-2: User Interface of Sign-in Page

We have evaluated the functionality of the personalized recommendation system by use case studies and human-expert evaluation. The two case studies discussed below were used to highlight the utility of the proposed system and to test our proof-of-concept personalized recommendation system. In the first case, Users will give their basic details whereas in second case food and health details will be given depending on that user profiles will be generated by questionnaire manner. Based on his profile information and dynamic context information, the system can provide various health recommendations diet food items will be displayed.

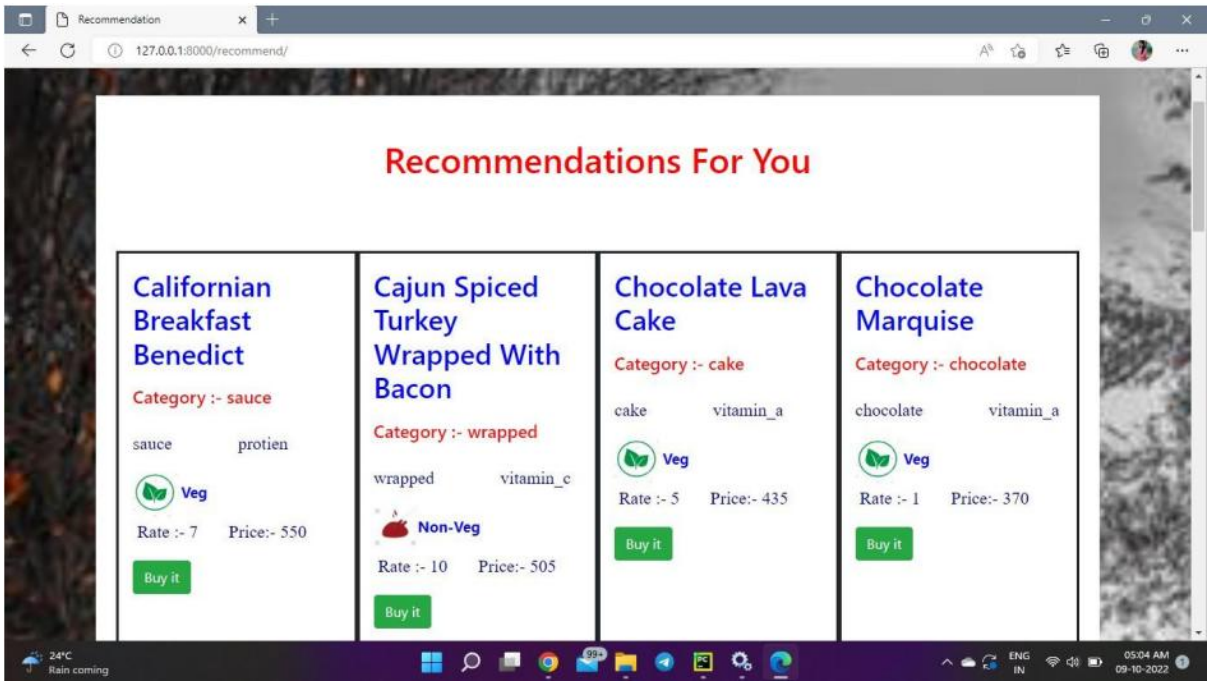

Fig-3: User Interface of Recommendation Page

Conclusion:

The work presented here is present in the field of Machine Learning in personalized health diet Recommendation. We designed a system which helps the users with recommendation of their diet. It deals with the health monitoring of diseases like hypertension, diabetes etc., and

also deals with nutrients and type of diet it recommends the food items accordingly. We got the Accuracy of 96.1% by using the following technique and algorithm. The information provided by the user while registering is taken as input and uses hybrid filtering technique with KNN algorithm to recommend food items and displays as an output to the users.

References:

[1] Yue, W., Wang, Z., Zhang, J., & Liu, X. (2021). "An overview of recommendation techniques and their applications in healthcare". IEEE/CAA Journal of Automatica Sinica, 8(4), 701-717.

[2] Toledo, R. Y., Alzahrani, A. A., & Martinez, L. (2019). "A food recommender system considering nutritional information and user preferences". IEEE Access, 7, 96695-96711.

[3] Chen, S. W., Chiang, D. L., Chen, T. S., Lin, H. Y., Chung, Y. F., & Lai, F. (2018). "An implementation of interactive healthy eating index and healthcare system on mobile platform in college student samples". IEEE Access, 6, 71651-71661.

[4] Gao, X., Feng, F., He, X., Huang, H., Guan, X., Feng, C., ... & Chua, T. S. (2019). "Hierarchical attention network for visually-aware food recommendation". IEEE Transactions on Multimedia, 22(6), 1647-1659.

[5] Alian, S., Li, J., & Pandey, V. (2018). "A personalized recommendation system to support diabetes self-management for American Indians". IEEE Access, 6, 73041-73051.

[6] Afolabi, A. O., & Toivanen, P. (2019). "Integration of recommendation systems into connected health for effective management of chronic diseases". IEEE Access, 7, 49201-49211.

[7] Agapito, G., Calabrese, B., Guzzi, P. H., Cannataro, M., Simeoni, M., Caré, I., ...& Pujia, A. (2016, October). DIETOS: A recommender system for adaptive diet monitoring and personalized food suggestion. In 2016 IEEE 12th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob) (pp. 1-8). IEEE.

[8].Sookrah, R., Dhowtal, J. D., & Nagowah, S. D. (2019, July). A DASH diet recommendation system for hypertensive patients using machine learning. In 2019 7th International Conference on Information and Communication Technology (ICoICT) (pp. 1-6). IEEE.

[9].Shrimal, M., Khavnekar, M., Thorat, S., & Deone, J. (2021). Nutriflow: A Diet Recommendation System. Available at SSRN 3866863.

[10].Singh, R. H., Maurya, S., Tripathi, T., Narula, T., & Srivastav, G. (2020). Movie recommendation system using cosine similarity and KNN. International Journal of Engineering and Advanced Technology, 9(5), 556-559.

[11].Yang, J. (2019, July). Personalized Nutrition Solution Based on Nutrigenomics. In 2019 19th International Conference on Computational Science and Its Applications (ICCSA) (pp. 102-107). IEEE.

[12].Mogaveera, D., Mathur, V., & Waghela, S. (2021, January). e-Health Monitoring System with Diet and Fitness Recommendation using Machine Learning. In 2021 6th International Conference on Inventive Computation Technologies (ICICT) (pp. 694-700). IEEE.

[13].Casino, F., Patsakis, C., Batista, E., Postolache, O., Martínez-Ballesté, A., & Solanas, A. (2018, September). Smart healthcare in the IoT era: A context-aware recommendation example. In 2018 international symposium in sensing and instrumentation in IoT era (ISSI) (pp. 1-4). IEEE.

[14].J. Castro, R. Yera, and L. Martínez, ‘‘A fuzzy approach for natural noise management in group recommender systems,’’ Expert Syst. Appl., vol. 94, pp. 237–249, Mar. 2018.

[15].Hsiao, J. H., & Chang, H. (2019, July).Preference-driven personalized recommendation by k-comparative annotation and reasoning. In Proceedings of 2019 IEEE International Conference on Service Operations and Logistics, and Informatics (pp. 7-19). IEEE.

[16] NOOR, M. (2018). “Web-based decision support system for dietary meal plan recommendation”. Journal of Theoretical and Applied Information Technology, 96(23).

[17] Dayang, P., Petsou, C. S., & Sambo, D. W. (2021). “Combining fuzzy logic and k-Nearest neighbor algorithm for recommendation systems”. Int. J. Inf. Technol. Comput. Sci.(IJITCS), 13(4), 1-16

[18] Baral, R., Iyengar, S. S., Zhu, X., Li, T., & Sniatala, P. (2019). “HiRecS: A hierarchical contextual location recommendation system”. IEEE Transactions on Computational Social Systems, 6(5), 1020-1037.

[19] Cena, F., Rapp, A., Musto, C., & Semeraro, G. (2020). "Generating recommendations from multiple data sources: A methodological framework for system design and its application". IEEE Access, 8, 183430-183447.

[20] Iwendi, C., Khan, S., Anajemba, J. H., Bashir, A. K., & Noor, F. (2020). Realizing an efficient IoMT-assisted patient diet recommendation system through machine learning model. IEEE Access, 8, 28462-28474.