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A Comparative Study of Methods for Restaurant Recommendation System

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***Abstract*—Today, exploiting sentiment analysis has become popular in designing recommender systems in various fields, including the restaurant and food area. The analysis of users' opinions and the extraction of their food preferences lead to the provision of personalized recommendations. The semantic approach is used to cluster the name of foods extracted from users' comments and analyze their sentiments about them. Finally, nearby open restaurants are recommended based on their similarity to user preferences. Restaurant Recommendation System is an online system to search for restaurants. The system allows visitors to browse information about the restaurants, including searching for restaurants, viewing/giving recommendations, and viewing/rating restaurants. Visitors can only view recommendations and view rating results. If the user would like to give recommendations or rate restaurants, he or she has to login or sign up. Additionally, the user can check the history of previous recommendations. In addition to customer functions, the system also provides functions to the administrator that allows to manage the contents of the site, including editing customer info, restaurants, recommendations and ratings, etc.**

Keywords - Machine Learning, Recommendation system, Clustering, Sentiment Analysis.

I. Introduction

The purpose of this system is to let people get ideas about which restaurant will be great for them. This system can give people some suggestions; also, you can get other opinions from this site. Furthermore, you can find the best restaurants by viewing the ratings page, which gathers many members, their experience and response. For instance, you can search by price range or by location. Besides viewing other opinions, user can give suggestions to others by rating restaurants, using collaborative filtering. In this site, there are many ways to search restaurants and rate include by zip code, by type, by keyword, by distance, by price, and by recommendation search. If the user would like to give recommendations or rate restaurants, he or she has to login or sign up. Additionally, the user can check their history of previous recommendations. In addition to customer functions, the system also provides functions to the administrator that allows he or she to manage the contents of the site, including editing customer info, restaurants, recommendations, ratings, etc. This will be easier for people to use.

The project aims to develop a restaurant recommendation system using clustering and sentiment analysis. The objective of the recommendation system is to provide recommendations based on recorded information on the user's preferences. These systems use information filtering techniques to process information and provide the user with potentially more relevant items.

II. Literature Survey

A. Restaurant recommender system based on sentiment analysis[2]

Recommender systems help users make informed decisions by collecting information about their preferences in a variety of areas, including products and services. These systems make it possible for users to choose the best of many options. The choice of restaurant among numerous and unknown selections is one of the important uses of the recommender systems, especially for tourists and travellers. However, extracting user preferences is a challenging issue in these systems. Traditional approaches such as using questionnaires or user provided ratings to restaurants cannot dynamically extract their preferences. Nowadays, online comments on websites and social networks are considered a rich source of implicit information. In this regard, the user's preferences of food can be derived from the processing of these comments and the analysis of their underlying sentiments.

B. Restaurant Recommendation System Using Customer's Data Analysis[4]

Recommendation system filters and recommends only relevant data to the user using different filtering techniques. The study of user behavior is increasingly becoming a topic of research because of innovations in technologies. Restaurant recommendation is done on the basis of user behavior and restaurants ranking using Zomato API. It helps the user to search for restaurants in unknown cities. Considered features

are :1. Cost 2. Distance 3. Rating. The customer's feedback beyond the ratings can be used to improve the application. Restaurant recommendation system is a very popular service whose accuracy and sophistication keeps increasing every day.

C. A Restaurant Recommendation System by Analyzing Ratings and Aspects in Reviews[6]

This approach of restaurant recommender system is based on a novel model that captures correlations between hidden aspects in reviews and numeric ratings. There are two major approaches to produce recommendations: content-based filtering (CBF) and collaborative filtering (CF). CBF systems tend to make overspecialized recommendations. CBF systems tend to make overspecialized recommendations. CF models users' past behaviour and preferences from similar users. The input to this system is a review corpus and a target user . The output is a list of top-k restaurants recommended for users. This system consists of two main components: profile generator and rating predictor. The rating prediction model is build on linear/logistic regression to model the relationship between ratings .

D. Location Based Personalized Restaurant Recommendation System for Mobile Environments[7]

Mobile has become the most common means of introducing new and developing technologies to the masses. Restaurant recommendation system is a very popular service whose accuracy and sophistication keeps increasing every day. With the increased use of smartphones and internet services recommendation system is accessible by many consumers. In this paper, they presented a personalized location-based restaurant recommendation system integrated into mobile technology. They studied the user's behavioural pattern of visiting restaurants using a Machine Learning algorithm.

E. Restaurant Recommendation System Using Clustering Techniques[9]

People from different world like to visit different eateries. The restaurant recommendation system is the most needful recommender system now in the modern world where all the families try different eateries. In this system, they propose a propelled Eatery Audit framework that identifies concealed conclusions in input of the client and rates the eatery as needs be. The framework utilizes feeling mining procedure with the end goal to accomplish wanted usefulness.

III. TECHNIQUES

These are some of the techniques or algorithms we come across while doing the survey. We found it important to mention them in accordance to built restaurant recommendation system.

A. Clustering : K-means Clustering

K-means clustering is a popular unsupervised machine learning algorithm used for clustering or grouping data points into distinct clusters based on their similarity in a multi-dimensional feature space. It is an iterative algorithm that aims to minimize the variance or distance between data points within the same cluster while maximizing the distance between different clusters.

K-means clustering has several advantages, such as simplicity, scalability, and efficiency. It can be used for a wide range of applications, such as image segmentation, customer segmentation, anomaly detection, and recommendation systems. However, it also has some limitations, such as sensitivity to initial centroid placement, the need to specify the number of clusters (k), and the possibility of getting stuck in local optima.

K Means Clustering will help us group locations based on the amenities located around them.

For example, a location with a high amount of shops nearby will be labeled "Amenity Rich" while a location with less amenities will be labeled "Amenity Poor". Similar locations will be grouped (clustered) together.

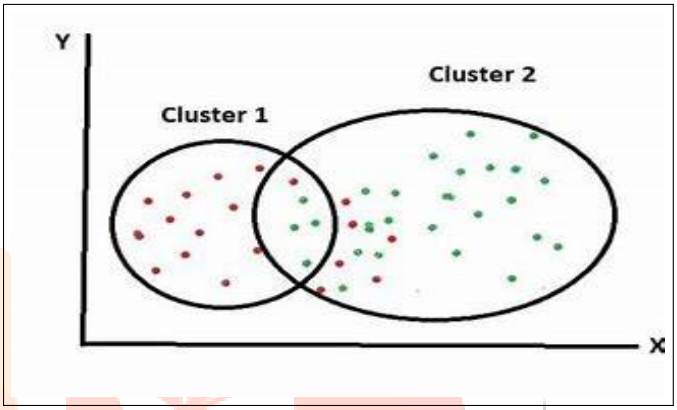

Fig. 1. K-means Clustering

B. Recommendation System

Recommendation systems are algorithms or techniques used to suggest items or content to users based on their preferences, behaviour, or other relevant factors.

Here are some types of recommendation systems:

1) ***Collaborative Filtering****:* This method recommends items based on the behaviour or preferences of similar users. It can be either user-based, where recommendations are made based on similar users' past behaviour, or item-based, where recommendations are made based on similar item profiles. Collaborative filtering can work well when there is a large amount of user data available.

2) ***Content-Based Filtering****:* This method recommends items based on their content features, such as genre, keywords, or metadata. It focuses on the characteristics of the items themselves, rather than user behaviour. For example, if a user has shown a preference for action movies in the past, a content-based filtering system might recommend other action movies with similar content features.

3) ***Hybrid Methods****:* These recommendation systems combine multiple techniques, such as collaborative filtering and content-based filtering, to leverage the strengths of different approaches. Hybrid methods can often result in more accurate

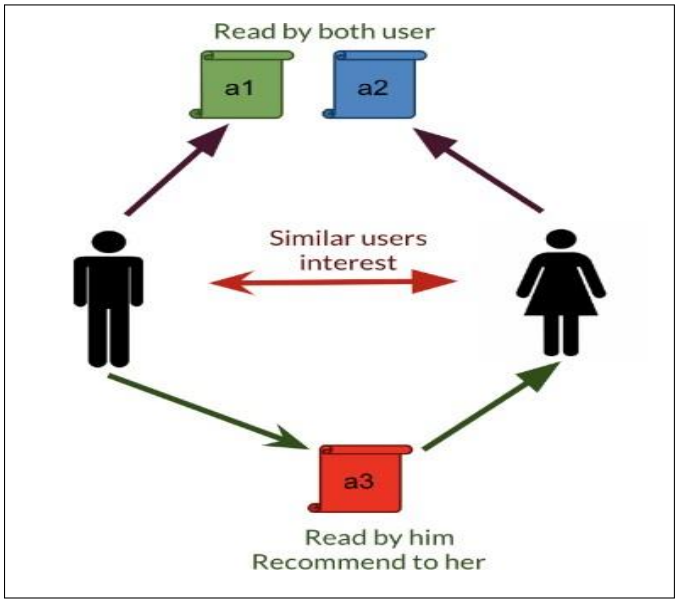

Fig. 2. Collaborative Filtering

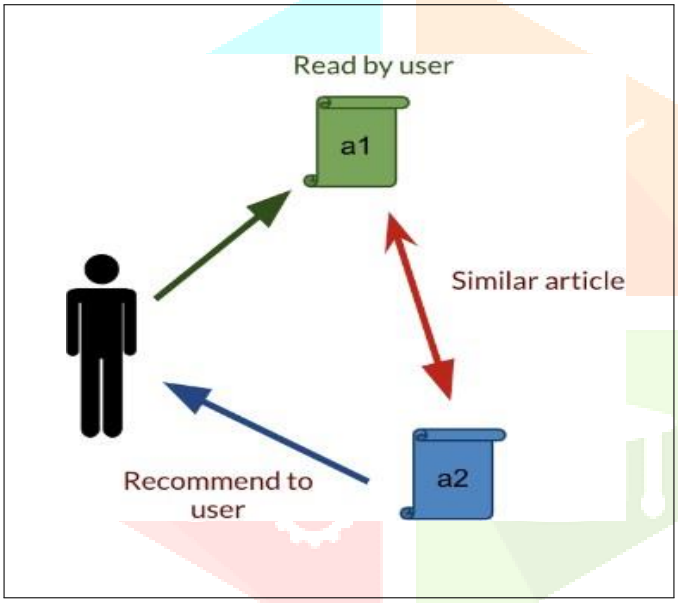

Fig. 3. Content-Based Filtering

and diverse recommendations, as they can compensate for the limitations of individual methods.

4) ***Context-Aware Recommendation****:* These recommendation systems take into account contextual information, such as time, location, or device, in addition to user preferences and behavior. For example, a context-aware recommendation system for a travel app might consider the user's location, travel history, and preferences to recommend relevant hotels or activities.

5) ***Item-based recommendation****:* Item-based recommendation systems are a type of collaborative filtering technique used to make recommendations based on similarity between items. In item-based recommendation systems, recommendations are generated by identifying similar items to those that a user has shown interest in or interacted with, and then recommending other items that are similar to those items.

C. Sentiment Analysis

Sentiment analysis is the process of using natural language processing, text analysis, and computational linguistics to identify and extract subjective information from text or speech. This technique involves determining the emotional tone of a piece of content, whether it be positive, negative, or neutral, and is often used to gain insights into customer opinions, product reviews, social media sentiment, and more.

There are several sentiment analysis techniques that can be used, including:

1) ***Rule-based approach****:* This approach involves using a predefined set of rules to identify sentiment in text. The rules may be based on certain keywords, phrases, or grammatical structures that are associated with positive, negative, or neutral sentiment.

2) ***Machine learning approach****:* This approach involves training a machine learning model on a large dataset of labeled data, such as movie reviews or social media posts, to identify patterns in the text that are associated with different sentiment categories.

3) ***Lexicon-based approach****:* This approach involves using a sentiment lexicon, which is a collection of words and phrases that are associated with different sentiment categories. Each word in the text is then assigned a sentiment score based on its presence in the lexicon.

4) ***Hybrid approach****:* This approach combines multiple techniques, such as rule-based and machine learning, to achieve better accuracy and performance.

The choice of technique depends on the specific use case and the available resources, as each technique has its own advantages and disadvantages.

D. Accuracy measurements

1) ***Vectorization and Cosine Similarity****:* Vectorization and cosine similarity are two key concepts often used in recommendation systems, including item-based recommendation systems.

Vectorization refers to the process of representing items or users as vectors in a multi-dimensional space. Vectors are mathematical representations that capture the attributes or features of items or users in a structured format.

Cosine similarity is a measure of similarity between two non-zero vectors defined in an inner product space. Cosine similarity is the cosine of the angle between the vectors; that is, it is the dot product of the vectors divided by the product of their lengths. Cosine similarity ranges from -1 to 1, with 1 indicating perfect similarity (i.e., the vectors are pointing in the same direction), -1 indicating perfect dissimilarity (i.e., the vectors are pointing in opposite directions), and 0 indicating no similarity (i.e., the vectors are orthogonal to each other).

$$similarity = \cos\theta = \frac{A.B}{\| A \| . \| B \|} = \frac{\sum_{i=1}^{n} A_i.B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}}$$

It follows that the cosine similarity does not depend on the magnitudes of the vectors, but only on their angle.

In the context of item-based recommendation systems, vectorization and cosine similarity are used to calculate similarity between items based on their vector representations. Items are represented as vectors using their attributes or features, and cosine similarity is used to measure the similarity between these vectors.

2) ***Error metric****:* Here as we pose this as a regression problem, therefore the best metric that we can use is Root Mean Square Error (RMSE) which falls between (0-4). Root mean square is exactly as named, here x_i is a true value whereas $\hat{x}_i$ is predicted value or model output and N here is the total number of rows in the data set.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \hat{x}_i)^2}{n}}$$

IV. Proposed System

This section outlines the standard procedure for bringing recommendation system into operation. The figure illustrates the suggested method's schematic depiction. Below is a short discussion of the flow.

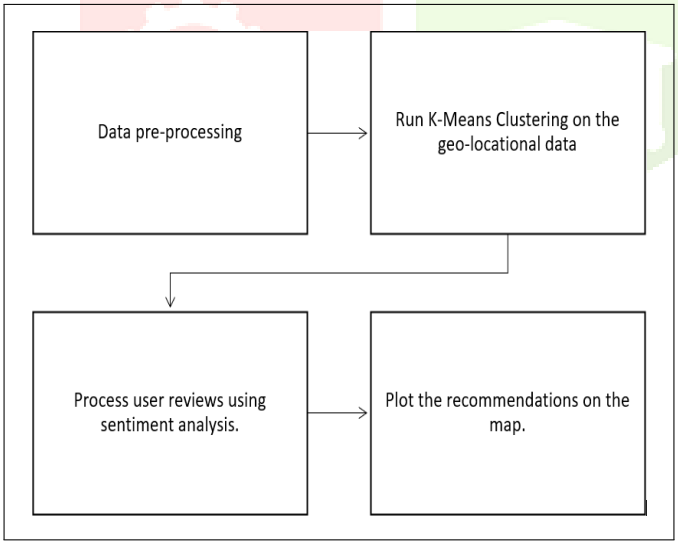

Fig. 4. Data Flow Diagram

The recommendation is a combined result of pre-processing, clustering and sentiment analysis. The first process is to use K-Means algorithm for filtering out the nearest restaurants. The next step is to pre-processing the restaurant reviews. The resultant data is then processed by clustering to prepare a list of items, and then sentiment analysis is carried out, and cluster with the highest score i.e. restaurant best matching to the user is recommended.

V. Comparison Table

Sr. No.	References	Description
1.	[2]	1) Algorithms : Hierarchical and partitioning clustering, content based filtering. 2) Context-aware recommender system is proposed. 3) TripAdvisor website is used for evaluation. 4) Wu-Palmer method has shown highest precision.
2.	[4]	1) Algorithms : Collaborative and Content-based filtering. 2) Location tracking of user. 3) Consideration of ratings from Zomato's API.
3.	[6]	1) Algorithms : Latent Dirichilet Allocations[LDA], Linear Regression, Logistic Regression. 2) Web portals such as Yelp and Dianping are used for collecting reviews. 3) System provides browsing toolthat is capable of efficient access to representative restaurant reviews.
4.	[7]	1) Algorithms : Content-based and Knowledge-based recommendation system. 2) Foursquare is used to extract all data. My Eat! app is hosted on the cloud server which uses the user Foursquare credentials to store his data on the cloud. 3) Study has proposed a model which combines localization, content-based recommendation and personalization in a dynamic environment suitable for mobile app.
5.	[9]	1) Algorithms : Simple Kmeans, Conopy, Hierarchical clustering, farthest first, filtered cluster. 2) Dataset in WEKA is used for technique application 3) Graphical representation of algorithms used. 4) The similar color so is best algorithm and mixed color so is not best algorithm.

VI. Conclusion

In this proposed system we are going to implement K-means clustering to find the geographical location. With the help of REST APIs, we will build a system where the user can review the type of food that he/she requires.

To enhance the system we use collaborative filtering and sentiment analysis algorithms. The sentiment analysis is used to analyze the existing reviews, analyze the best possible options of food and restaurants and provide the best recommendation to the user.

This recommendation to user will be done by UI of a website. In future, android app can be developed for more customer reach and feasibility.

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