Restaurant reco

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A HYBRID RECOMMENDATION SYSTEM FOR RESTAURANTS

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Abstract: Managing a restaurant can be a competitive and an arduous business. According to the Business Insider, as many as 60% of restaurants close within the 1st year of opening[1]. This competitive nature of the restaurant business makes it imperative for owners and managers to understand their customers at a more personal level. Predicting user preferences and recommending food items and restaurants are starting to become a popular advantage. Apart from driving up sales and creating a more personalised experience for the user, it drastically speeds up searches making it very convenient for the customer. In this project, we wish to propose a hybrid recommendation engine that bridges the gap between customers and restaurant owners by aiming to ameliorate user experience and increase restaurant sales.We have built a recommendation engine that enables restaurants to enhance foot-fall and give personalized recommendations to users by focusing on reviews, psychographic factors, lifestyle patterns and user location. By making use ofmethods like content-based filtering, collaborative filtering and using user's Google check-in data to identify locations, we have created a hybrid recommendation system.We present a hybrid recommendation engine, that aims to alleviate problems present in each of the methods and create a fool-proof robust system.

Keywords: Restaurant Recommendation,Hybrid System, Content-based filtering, Collaborative filtering, Location-based.

1. INTRODUCTION

The restaurant industry has always shown a steady growth. In the U.S., the industry has grown at a 2.1% CAGR over the last 20 years (accounting for inflation) [2]. Even though it is a risky business with a high failure rate, the market size and the growth opportunity it provides is very tempting. To differentiate oneself, it is crucial to come up with ways where one can provide a better user experience. The cut-throat competition involved in this industry has led to the creation of various analytical and recommendation systems.

A recommendation system's main goal is to identify customer preferences. Most popularly used recommendation techniques include collaborative filtering, content-based recommendation methods and utilizing historical check-in data of the users [3].Collaborative filtering gives recommendations based on the interests of users. Users can indicate interests by rating the restaurant and by giving a review [9]. A users' interests can also be identified by analyzing past orders, check-in histories, identifying food trends, etc. Restaurants that are positively reviewed or rated by consumers with similar preferences can also be used as recommendations for target customers.User similarity can be quantified through correlations in ratings given to the same products. Further demographic analysis can be done to identify trends in gender, age, occupation, etc[4]. Content based Filtering is used to identify similarities between the

restaurants based onfeatures like view from restaurant, ambiance, food origin, location, etc. Restaurants similar to those are used as suggestions.Thus collaborative and content-based filtering systems are highly dependent on user feedback and history.

A Collaborative filtering or a Content-based filtering system can be beneficial only when user-profile or restaurant data is copious. A paucity of relevant data can lead to inaccurate results and hence we have proposed a hybrid system shown in Fig1.that will generate recommendations using content-based filtering and collaborative filtering. Apart from that we will usegeospatial location and historical check-in data of the users [12].

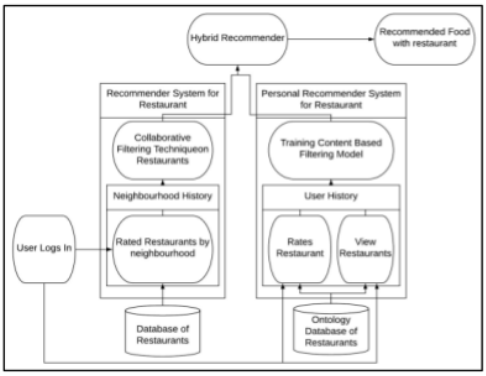

Fig 1. Architecture Diagram for proposed solution

2. LITERATURE SURVEY

Many platforms exist which try to bridge the gap between the restaurants and customers who wish to try new food and services by these restaurants. There are many factors which drive the decision of the customer to select a particular

restaurant. These decision driving factors mainly include dietary options, psychographic factors,lifestyle patterns, events or occasions, the type of service that restaurant provides and location of the restaurant. Research is still going on in this area to include all these factors in one recommendation engine, but accurate results have not been obtained as the number of independent factors and their dynamic nature makes this task more challenging. There exists been Recommendation systems developed by considering various combinations of the above mentioned factors and have achieved novel results.

The primary step is to map user's current geo-location and use that to suggest nearby good restaurants to him. Using this data we can also keep a track of user' previous visited restaurants and its rating and estimate how far the user is willing to go for a fine dine experience.These factors solve approximately 30% of our problem[3].In the hotel recommendation based on surrounding environments paper, calculation of the preferences of the users using their hotel reviews was done to quantify the similarity between the environment of each hotel and user's interests to select the top-k hotel to recommend to the user [11]. One of the novel methods of recommending which was implemented used pairwise association rules, but because of privacy issues this method couldn't gain acceptance[7]. Another architecture which was implemented was used Lambda Architecture and Apache Mesos which helped in fault- tolerance and reduced the chances of failures when a lot of people in the same location who are trying to order the same thing[8].Other recommender systems used psychographic and lifestyle factors which helped to personalise the recommendations to a greater extent[4]. Considering the growth of health issues, people have started to be more aware and diet conscious. Following this trend , it was important for recommendations to upgrade to the next level and consider the nutrition value of the recommended restaurants or food items it recommended, keeping a track of the customers health and food habits[6].All these efforts are appreciated in the food recommendation domain. Our project aims to combine all these factors in our recommendation engine for better results.

3. SYSTEM DESIGN

The Project is an android application. But the project isdivided into three modules Front-End

Module, Back-End Module and the Database. These modules integrated together help in recommending restaurants to the users. The requirements for each of the modules are mentioned as follows.

3.1 Front-End Requirement

3.1.1 Android Studio

Android studio is Android's IDE. It offers tools to make an android application which has an intuitive UI. It helps in making an interactive application which shows users top three restaurants recommended by our model.

3.1.2 Google Maps

Google maps is a Web based service which helps to identify different geographical regions and landmarks. In this project google maps is used to locate different restaurants in the user's region. It also tells us the distance and time to the restaurant from the user's location.

3.2 Back-End Requirement

3.2.1 Jupyter Notebook

Jupyter notebooks are open source web applications which are used to run codes sequentially and the output is produced simultaneously. It is used to run the Collaborative filtering algorithm, Content based filtering algorithm and NLP algorithm and to check the working of algorithms.

3.2.2 Git

Git is a distributed version control system which is used to track the number of changes done in the project. It helped to keep track of changes done in the project with date and time which helped to go back to previous versions if there were some errors.

3.2.3 Google Client API

Google client API is a collection of APIs of different Google Applications like search, map, translate etc. It helped to connect to Google Maps API to show the map, it also helped in getting Google search API for searching restaurants to view reviews and ratings of that particular restaurant.

3.3 Database

3.3.1 Cloud Firestore

It is a database with built-in features. It directly checks for Google sign-in's if we enable that. It is used to store user and restaurant data. It stores the reviews of restaurants when it is retrieved by Google Client API. It has nine attributes in the user table that includeuserID, emailID, Preferences (ratings, distances, Locations, previous reviews), previous ratings, friends, groups and favourites. It also consists of a restaurant table which has 5 attributes, namelyrestaurantID, businessID, location, reviews and ratings.

3.3.2 Yelp Dataset

Yelp dataset consists of a user table and restaurant table. It is used to train the collaborative filtering recommendation system, which after training is planted in the application code which helps in recommending restaurants using collaborative filtering.

3.3.3 Google reviews and ratings

This is retrieved directly from Google Client API and is stored in the Cloud Firestore. It takes a particular user's reviews and ratings of the restaurants and stores it in the user database. It also takes reviews for the restaurants by different users and stores it in the restaurant table.

4. METHODOLOGY

As mentioned prior, in this project we are trying to consider many factors which drive the decision of a customer as possible. For this purpose we have divided our project into modules.

In reference to the architecture diagram of the proposed system previously shown in Fig 1, when a new customer signs up for our application, the primary permission asked would be for GPS or location tracer as these will help us track the user and suggest the best restaurants in the radius acceptable to the user.Since the user is new to the system, he/she doesn't have historic data to identify personal liking and preferences. To overcome this road-block we map the user to our existing users and recommend using Collaborative Filtering.

In collaborative filtering also we use latent factor collaborative filtering. Latent factor Collaborative filtering is a simple yet efficient technique in which the recommendation engine stores the final output as a product of two matrices on which the final rating or output depends.First the users are mapped according to their location,age and gender.After we have mapped similar users with our new user, we try and recommend restaurants based on existing users ratings and reviews.

For measuring the liking of a restaurant from a review we use, Natural Language Processing.To understand a review, we use NLTK libraries. We clean the data by removing stop words and also remove the punctuations.For training and testing purposes we have used the Yelp dataset. Yelp beinga crowd-sourced review platform, possesses reliable information for training and testing our model. We use the TFIDF Vectorizer to extract features from the text and maintain our matrix [5].

$$f(x) = \min_{\binom{P}{Q}} \sum_{(i,x)\in R} (r_{x,i} - q_i \cdot p_x^t)^2$$

Given P is the users-features matrix and Q is the business-features matrix. We use the above mentioned formula to determine error.

To calculate this Least Square Error(LSE) we subtract the real ratings(r) with the predicted ratings(P.Q) and then square the difference.We need to add regularization to our LSE formula to avoid model over-fitting.We have used the below mentioned formula and gradient descent to reduce the errors.

$$\min_{\binom{P}{Q}} \sum_{(i,x)\in R} (r_{x,i} - q_i \cdot p_x^t)^2 + \lambda \left[\sum_x |p_x|^2 + \sum_i |q_i|^2 \right]$$

The next step in this procedure would be to use matrix factorization.Once we apply matrix factorization our data will be stored in two matrices. One will include the user and liking of that user to a particular restaurant.The other will include the cumulative rating of a restaurant for the dishes that they serve.Finally when we multiply the two matrices, we get results which have restaurants that a user might prefer according to the food items or cuisines that restaurant serves.This type of recommendation will be followed for the next two weeks until the system gathers users' liking and lifestyle patterns for content based recommendation.

A location-based recommendation is implemented through an Android application that makes use of Global Positioning System (GPS) [10]. It also provides the convenience to our users to select a particular radius to search restaurants.

The execution process of the application is as follows.The user will login in to the application and a dialog box will appear that asksuser's preferences in terms ofsearch radius, rating and pricing.Then the application generates a list about the restaurants that match these user preferences. Our application asks the user to sign in through a Google account which is authenticated by a firebase and then checks with the Google API for review and rating given by the user of restaurants.It thenapplies content based filtering and also takes into consideration users favourites. if marked any on our application.

After that it takes collaborative filtering, i.e., review of the restaurants in the list.It takes thecoordinates of the restaurants and plots them on the map to enhance user experience. Thus showing restaurants according to user's preference. After multiple considerations, the application selects three restaurants in the radius preferred by the user.It shows the name of the restaurant with its overall rating and shows how expensive it is.

When you click on any restaurant, the application redirects you to Google Maps which shows the direction to be followed from user's location to the restaurant.

5. EXPERIMENTAL RESULTS

In this experimental project, we have tested our collaborative filtering recommendation engine on Yelp dataset. Yelp dataset consists of two tables, one with userID, reviews and ratings of different restaurants, second table consists of restaurantID, businessID, reviews and ratings. After applying the engine on the input, "A dinner place with a nice view" we get the following output shown in Fig 2.

```
Orange Sky
Seafood, Steakhouses, American (New), Restaurants
4.0 562

Steak 44
Restaurants, Steakhouses, Bars, Nightlife, Wine Bars, Seafood
4.5 950

Top of the Rock Restaurant
Restaurants, American (New), Hotels & Travel, Event Planning & Services, Hotels
3.5 325
```

Fig 2. Recommendation on Yelp dataset

We have made an android application which makes a list of restaurants near the GPS location of the user shown in Fig 3. It applies collaborative filtering engine on Google reviews of the restaurants in the list and content based filtering engine on Google reviews given by the user. It finally gets the recommended options down to three and suggests those. The application locates all the restaurants in the list on the map. The user can choose preferences also based on radius, minimum rating and how expensive it is.

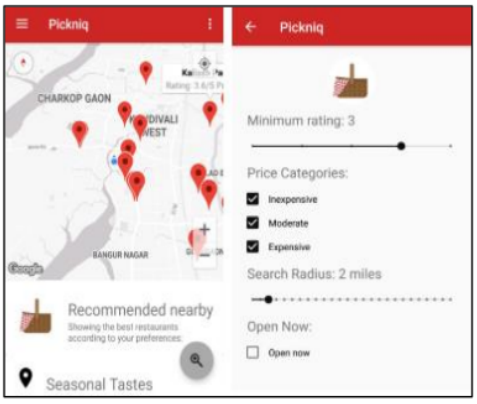

Fig 3. Location based Android Recommendation app.

6. FUTURE WORK

Nowadays there arenumerousapplications in the weight and diet management industry. Further research is required to understand the effectiveness of apps for calorie management. Moreover, there are few examples of food recommender systems that recommend the users nutritional facts about suitable food choices and take into account individual physiological status [6]. Recommending healthy diet alternatives by calculating optimum calorie requirements based on BMI data can improve user involvement.

Using graph databases can improve the target audience and connect with customers even more by taking their health into consideration. The model's efficiency and storage capacity can be improved if we use the Graph Database. We can efficiently store the relationships between a user, the restaurants he has visited and the particular dishes he liked or disliked there. This could be used to specialise a restaurant serving a particular dish. The storage capacity could also be improved using a graph database. It would be interesting to see the query run time in different algorithms mentioned above using graph databases.

CONCLUSION

In this paper, we proposed a hybrid recommender system, named 'Pickniq'' to recommend different restaurants and food items to customers in an adaptive way to improve user experience. The proposed system is able to build a user profile based on the previous orders of the user. Initially, the system maps the users to its other users/customers based on their location, age, gender and if they have a special liking for a particular cuisine or restaurant. For the first two weeks, the system collects the preference for content-based recommendation. During the initial two weeks, the system recommends using the collaborative algorithms as mentioned above. As and when the user visits or calls in for food from a particular restaurant from the app, the system asks him for his reviews and ratings. From the detailed review that the user gives, use of NLP helps to improve or give more personalized recommendations to the user.

One issue that arises in content based recommendations involve excessive specialization (user X is only interested in categories L, M, and N, and the system is not able to recommend items outside those categories, even though they could be interesting to them). Thus to overcome this problem we used a collaborative filtering technique and a location based recommendation technique.A common problem in collaborative based filtering is the cold start problem, which we overcame by making the user fill a form while signing up. Thus we propose a robust system that overcomes all problems in individual methods by creating an aggregated hybrid system.

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