National College of Ireland

Suggesting New Restaurants To Visit Using Content Based Recommender System

MSc Research Project
Data Analytics

Harshit Parihar
Student ID: X21111022

School of Computing
National College of Ireland

Supervisor: Dr. Christian Horn

National College of Ireland
Project Submission Sheet
School of Computing

Student Name:	Harshit Parihar
Student ID:	X21111022
Programme:	Data Analytics
Year:	2023
Module:	MSc Research Project
Supervisor:	Dr. Christian Horn
Submission Due Date:	01/02/2023
Project Title:	Suggesting New Restaurants To Visit Using Content Based Recommender System
Word Count:	5661
Page Count:	15

I hereby certify that the information contained in this (my submission) is information pertaining to research I conducted for this project. All information other than my own contribution will be fully referenced and listed in the relevant bibliography section at the rear of the project.

ALL internet material must be referenced in the bibliography section. Students are required to use the Referencing Standard specified in the report template. To use other author's written or electronic work is illegal (plagiarism) and may result in disciplinary action.

Signature:	
Date:	1st February 2023

PLEASE READ THE FOLLOWING INSTRUCTIONS AND CHECKLIST:

Attach a completed copy of this sheet to each project (including multiple copies).	☐
Attach a Moodle submission receipt of the online project submission, to each project (including multiple copies).	☐
You must ensure that you retain a HARD COPY of the project, both for your own reference and in case a project is lost or mislaid. It is not sufficient to keep a copy on computer.	☐

Assignments that are submitted to the Programme Coordinator office must be placed into the assignment box located outside the office.

Office Use Only	
Signature:	
Date:	
Penalty Applied (if applicable):	

Suggesting New Restaurants To Visit Using Content Based Recommender System

Harshit Parihar
X21111022

Abstract

In this new day and age data analytics has become a part of our daily life. We come across recommendations which range from search engines to advertisements of products on different e-commerce websites. One such area of recommendations include restaurants and food. The pre-existing applications do work quite well but may force upon recommendation based on profit of the organization itself. They do not ask for input from the user by asking them what they might like or not like.A new look can be provide by creating new models of recommending places in a more accurate and quicker way providing help to people in need of suggestions along with asking them for input which may vary from the restaurant they previously visited or a particularly good review of a place that they imagine is the best for them.
To create a good recommendation system this research will use pre-existing Machine Learning algorithms. The data used in this research is scraped from a very famous food application used in India and consist of data of restaurants including there reviews. This data is freely available for educational purposes. No personal information about anybody or owners of any place is consisted in these datasets. This research aims to help businesses and people together by promoting new places and positivity in peoples lives.
In the end of this research multiple recommendation models are created. One uses reviews of places and matches most similar places together, One uses input of a review that an ideal place should have according to the user, and the last one uses restaurant that the user might have previously visited along with location preference to give recommendations.

1 Introduction

1.1 Overview

Many pre-existing applications are available for recommending of restaurants and many new startups are coming up with that aim.People are looking for new places to visit for food and ambience every holiday or after a long day of work. The pre-existing ones do not ask for input from user and sponsored recommendations are always in the face of the user if if that place is good or not. A user deserves a recommendation system that works perfectly according to their needs and requirements. Many users are not well versed with how recommendation models work and sometimes have the misconcenption that some of their private data is being used. This paper also aims to relieve people of such misconceptions if they read it. The authors of this research aim to provide

option to the user for their input not just their visit history. A user may have varying moods. They may want to visit a particular location and search for recommendations there. They may want to find a place that has a particular dish reviewed as good in the review section of the restaurant or a particular feature of such places like good music, cleanliness etc. Investing in new and creative models will also help organizations that deal in hospitality and food according to the author's opinion. For this recommender system data of restaurants was used. One dataset consisted of data from restaurants based in Bengaluru which is the Information Technology capital of India and a very famous hub for higher education. Most frequent visitors of restaurants is the working class and the students. Another dataset used consisted of information of restaurants from around the world but mostly from the true capital of India which is New Delhi. So the data only from the capital state was extracted for use in the model which will be discussed more in the methodology section. Then recommendation functions were created which consisted of machine learning techniques to give accurate recommendations. This function was created as a combination of text vectorization(for easier understanding of text by the machine)and similarity score calculator to give out most similar recommendations. The main vectors for the review base recommendation model were the reviews themselves and the main vectors for the location based model were location, cuisine of the restaurant and it's aggregate rating.

1.2 Motivation

The impact of recommendation models in our daily life was the motivation for this research. It can be noticed that there is a big shortage of good recommendation systems in the area of food and restaurants. The few that are available are not up to the mark in the authors personal experience. Most of the recommendations are mostly not fruitful and do not ask the user what he or she might be looking for. With new techniques of data analytics and machine learning there is a need of a new look at the food and hospitality industry as good food and a good experience brings a lot of positivity in ones life. This research aims to give a understanding on recommendation systems and create one that is better that those that are readily available.

1.3 Objective

The aim of this research is creating recommendation model that uses history of user, location preference and input from the user. The recommendation model created will use the last restaurant that the user has visited, use the reviews of that restaurant and find the restaurant that has the most similar reviews. Another model in the same codebase will ask for input of a review that an ideal restaurant has must have according to the user and then match that review to the reviews of restaurants that are already available and give recommendations. Another model will use history of user, their location preference to find the most similar restaurants according to vectors of previous restaurant visited like cuisine and aggregate rating.

1.4 Research Question

How can we create a recommendation models for restaurants that uses their history, location and input to give accurate and useful recommendation by using content based collaborative techniques?

1.5 Structure of Report

The report will follow the folowing structure :Section 2 discuses the research that was done on previous recommendation model.Section 3 discusses the methodologies used in the completion of the recommendation model. Section 4 discussed the design of the research and how it came about. Section 5 discusses how the project was implemented in code. Section 6 discusses how the model works to give results and what tasks it completes.Section 7 concludes the research and gives what more could be done in the future.

2 Related Work

2.1 Introduction

We know that there are many recommender systems in the world of Information Technology. They are used in industries like e-commerce, entertainment, tourism, health. To construct a good recommender model for this research a study of already available research on recommendation systems needed to be done. This section lays down the researches that were taken as inspiration for this one.
Different researches use different vectors for input data for recommendation model. Like a recommendation system created gives recommendations based on the mood of a location (Meehan et al.; 2013). To predict the mood of that location the model uses real-time tweets about that area and matches it with the time of the user of the model. Another research also states a problem of recommendation model which is that models that depend too much data from social media do not give accurate results because some places have very high budget for marketing their business on social platforms(Abbasi-Moud et al.; 2021). So this research creates a model that uses data of reviews of customer, their location and the time they visited that location to give recommendations. Many drawback of recommendation system were also found conducting the research like high sparsity and cold start. Cold start means that when a new user having no history on a application he/she does not get any meaningful recommendations. The author will try to tackle this problem in this research. High sparsity means that when a user looks for recommendation in one location for a very long time then the recommendations given to him/her become scarce. These problems were seen in very famous tourism applications like TripAdvisor and Yelp(Logesh and Subramaniyaswamy; 2019).
In another research KNN is used to group places together and Euclidean distance to group people together and then produce the recommendation (Parikh et al.; 2018). Nowadays even deep learning techniques like Neural Networks are being used in creation of recommendation models like it was done in this particular research. While doing research for recommendation model it was found that there are three main techniques used for creation of recommendation models. These techniques will be discussed further in this section but those are hybrid model (content based collaborative models), content based models, collaborative based model.

2.2 Hybrid Model Approach

This type of approach was found to be best for recommendation model. This approach uses content from the history of places and runs it through collaborative models. As it uses both of the other approaches together in the best way it gives the best results.

A model for a context-aware information system was developed as a result of research on recommendation systems. The best recommendations were produced using the user's requirements and their context information(Pashtan et al.; 2003). In a study, a recommendation system was developed that employs the hybrid model to design a whole tour for tourists to enjoy while visiting in the lovely areas of the Portuguese city of Oporto. According to each user's preferences and data, this model developed a custom tour for them [Joel P. Lucas]. A prior study developed a recommendation model specifically for skiers, giving them information on routes in snowy conditions and assisting them in choosing the safest route for their experience (Avesani et al.; 2005). In a previous study, a system for making hotel recommendations was developed, in which travelers who had previously stayed at similar hotels were grouped together to make one recommendation and their histories of hotels were used to make another recommendation. These two recommendations were then combined to make the one that fit the user's preferences the best (Ebadi and Krzyzak; 2016). In a previous study, an e-tourism advisor was developed to replace the requirement for a guide, which the majority of users needed while visiting a new region. By fusing data from their prior experiences, GPS position, and preferences, it serves as a guidance (García-Crespo et al.; 2009). Although the hybrid model method is best for this project, other approaches were thoroughly considered as well. The approaches that were looked at are listed below.

2.3 Content-Based Model Approach

Content based techniques use only the content and give out simple recommendations. Thew match the content together straightaway without any analysis of the content that they are putting together. It is also a very old approach and not seen much in the new recommendation models that are coming up. However many researches that used content based approach were studied to get to understand how a simple model can be made more accurate by selecting the right vectors. A study used an intriguing content-based method that included user-to-user conversation. Users give each other ratings, which are subsequently used to recommend certain users to other users(Yang and Hwang; 2013). An application called SMARTYMEUSEUM, which utilizes a different content-based strategy, has been developed. It employs this strategy to the advantage of both the user and the museum that the user may be visiting by recommending information about things in it while they are walking past it (Kuusik et al.; 2009). In a prior study, a mobile application was developed with a content-based model that suggests locations on a three-dimensional map. Data is gathered through computer vision and maps (Noguera et al.; 2012). Two content-based techniques were used in the same study that is in the past but not as much compared to other content based appproaches. The first method asks the user directly for information, whereas the second method uses the model itself to acquire information, saving the user's time (Kesorn et al.; 2017).

2.4 Collaborative-Based Model Approach

The collaborative approach to building recommendations models may not be as effective as the hybrid strategy, but it performs better than the content-based approach. In a prior study, participants' personality data were matched with one another to provide the best recommendation (Tkalcic et al.; 2009). When employing a collaborative model to construct a recommendation system for restaurants, similarities between the ratings supplied by users and the users themselves were discovered (Fakhri et al.; 2019). But

no sign of location or any input from the user was seen. Uses the Pearsons and Cosine relations models to detect similarities between users and locales utilizing models of both in a prior study in which collaborative models were employed (Farokhi et al.; 2016).

3 Methodology

The aim of this research was to create a recommender system to suggest restaurants. Two recommendation models were created for this research. One model uses reviews given by other people to give recommendations and the other uses location and rating. Both the recommendation models were content-based. Both the models require input from the user to get the recommendations. The location based model requires restaurant name and location while review based model requires the name in one part and can also give the restaurants based on an input review given by the user to give recommendations. The location model was created and implemented on data of restaurants in the capital city of India i.e. New Delhi. The review based model was created and implemented on the data of restaurants from Bangalore. The approach taken to complete the project was the CRISP-DM i.e. Cross Industry Standard Process For Data Mining approach.

3.1 Stake Holder / Business Approach

Recommender systems have become advanced over time, they are becoming more and more accurate. Restaurant recommendations are given out by mostly food delivery or travel apps and many big and famous applications use these recommender systems. But while using these applications it can be clearly seen that restaurants that pay extra for advertising their business pop up again and again hiding the user from recommendation that might actually be a good experience from them. To make a connection between these users and good restaurants by using already available data analytics techniques is the aim of this research project. Both models take into consideration any place the user has visited already or might have heard to be good to give them recommendations similar to that.

3.2 Data Extraction

The datasets used as input in the recommendation model contains data that has been scraped from the most famous food delivery, takeaway and dine in application used in India. It is very famous in the capital New Delhi and the place called as the IT capital of India which is Bangalore. The capital is very famous for it's food but not everybody who visits restaurants don't always put a detailed review. Whereas Bangalore it is famous for its Information Technology industry with all the main offices for companies like Microsoft ,Google and a big hub for college education. So mostly all working class and students like to go out and put up reviews for new places that they visit. But New Delhi being an old city famous for food has a lot of restaurants in all areas whereas in Bangalore there are only a few hubs with high number of restaurants. Next we analyse and pre-process the data.

3.3 Data Analysis and Pre-Processing

3.3.1 Review Based Model

In this model along with the data the text also has to be pre-processed. But first we will pre-process the data which involves removal of null values. Then we drop the columns in the dataset that we know are not going to be used in the future steps of creation of the recommender model. In the Bangalore dataset we remove the columns like URL of restaurant, dishes liked and phone number before starting the pre-processing of the text. Now we start processing the text in the code. The ratings column in the dataset has '/5' in all entries so we go ahead and remove it so it can be easily processed by the model which is created. As one restaurant has multiple reviews we create a new column called 'mean rating' which is the average rating of each restaurant.

Next we pre-process the text of the reviews which we are going to use as input for our recommendation model. The cleaning of the text involves multiple steps which are lower casing all the text, removing the punctuations, removing the stop words, removing any urls posted by people, correcting spellings that might be wrong. The review column has to be used as type string to go through transformations. *Zomato Dataset 1*; n.d.

Table 1: Description of Bengaluru Dataset

Attributes	Description	Values
Name	Name of the restaurant	Every Restaurant has a different name
online order	If online orders are available	Data available in true and false
book table	If tables can be booked	Data available in true and false
rate	Rating of the restaurant	It is rating out of five
location	Location of the restaurant	Full address of the restaurant
rest type	Type of restaurant	Casual dining, Café etc
. heightapprox cost	The cost of eating at the place	In the hundreds in INR(Rupees)
review list	The reviews for the restaurant	Reviews are in sentences

3.3.2 Location Based Model

In this model we use the dataset which contains data of restaurants from around the world. The aim of this model is to give recommendation according to the area in which the user is looking for a restaurant. As we are only focusing on the capital state of India i.e. New Delhi, we extract data of New Delhi in a data frame. We drop columns that are not needed and check for null values. The columns that are used are restaurant names, cuisines, locality and aggregate rating. We also do a text pre-processing which involves removing blank spaces and commas from the cuisine columns. Then we remove stop words and empty spaces to make it easy for the model to process data.*Zomato Dataset 2*; n.d.

3.4 Recommender System Methodologies

Multiple methodologies have been used for creation of the recommendation model. All these techniques are natural language processing techniques. These methodologies will be explained below. .

Table 2: Description of Location Model Dataset

Restaurant Name	Name of restaurant	Unique name for everyone
Cuisine	Cuisines of restaurant	Single restaurants can have multiple cuisines
Locality	Location of restaurant	This is the major area in city where the restaurant is
Aggregate Rating	Rating of restaurant	The rating out of 5

3.4.1 Term Frequency(TF)- Inverse Document Frequency(IDF)

TF-IDF is being used in both location based and review based model in the project. This methodology can be in two parts. First Term Frequency which works in in such a way that it checks the number of times a word is repeated in the data frame and recognize important words that might be available. These words weightage would be checked by dividing their count by the count of total words that appear there or mark the word 1 if it appears and 0 if it does not appear. Idf checks for number of times the word appears across multiple data frames but it checks words that are not that important. It decreases the weight of unimportant words so that the important words are highlighted even more.

3.4.2 Cosine Similarity

Cosine Similarity is a measurement of similarity between different data. It measures similarity as a distance or change between two vectors. More the change between the vectors more dissimilar they are from each other. Cosine similarity has been used in both the models as this algorithm is especially used when a group of words or letters are involved. The vectors that will be used to check similarity between two restaurants will be provided by TF-IDF in both the cases.

3.4.3 KNN (K Nearest Neighbour)

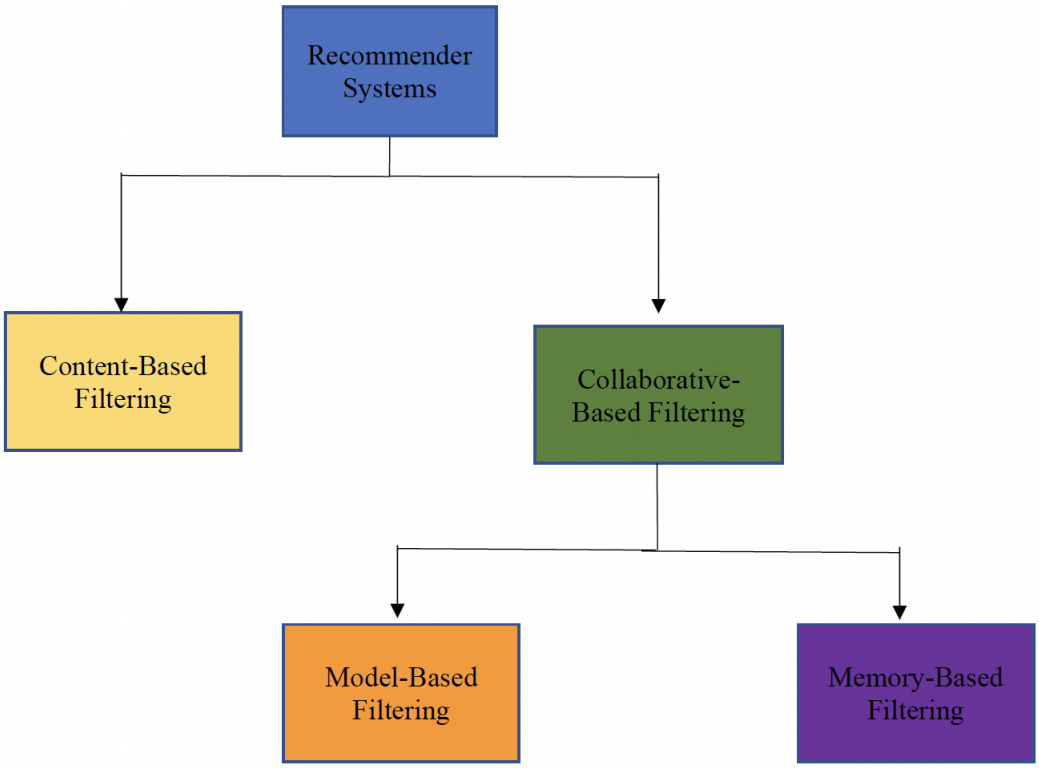
KNN is a algorithm that finds the nearest similar data to the object that is provided to it. In this research it will find most similarly reviewed restaurant by using cosine similarity.

3.4.4 Feature Extraction

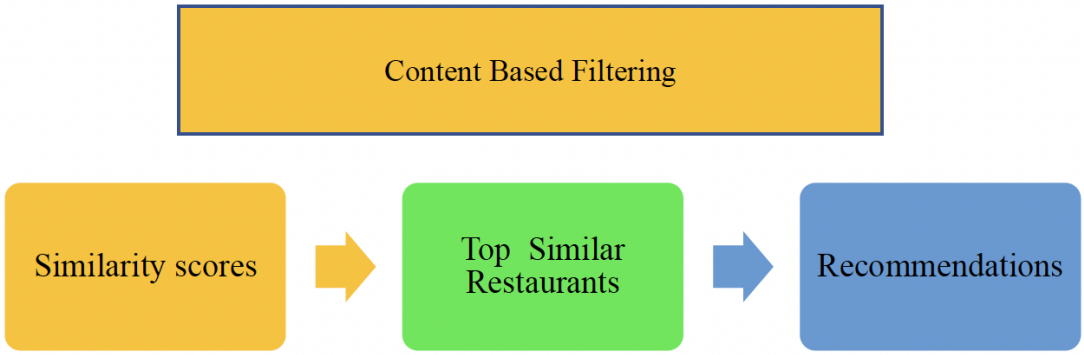
Feature extraction is a technique used in data science that is used to create new features in the already available data. The a feature called mean rating is created in the data that is used in the review based recommendation model and in location based model we use it later to make our final product more accurate which will be discussed further.

4 Design Specification

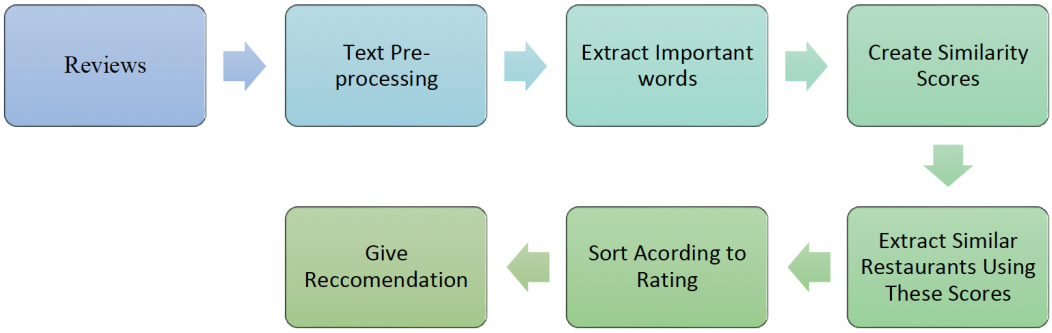
The figure below showcases types of recommender systems. We will be using memory based filtering.



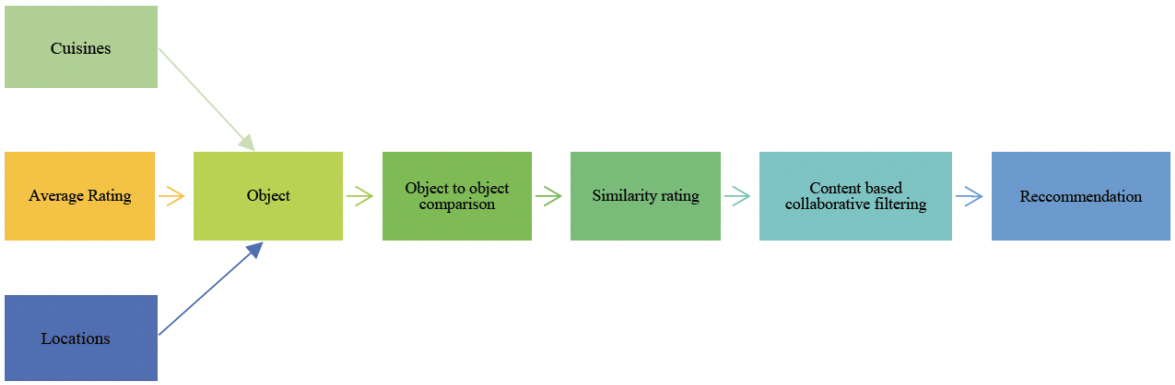
The figure below shows how basic filtering in the models that we create is going to occur. We are going to use the content that we already have to get recommendations. This content that we are using is historical data of the restaurants that we want to recommend.



The figure below is the designed plan for the review based model which will use the reviews given by people to recommend restaurants.



The figure below helps us understand the flow of the location based model that we are going to create which will also use the type of cuisine, rating of the restaurant given by customers and the location the restaurant is already available. This model will use content based collaborative filtering to create similarity scores. Both these models will be using cosine similarity to create similarity scores.



5 Implementation

This project was created by the use of python language. It was implemented in Jupyter Notebook. The project was save as .ipynb file also called as python notebook. The project plan was implemented using capabilities of the python language. The whole implementation will be discussed in this section without discussing the pre-processing of data as it was already discussed in the previous section. Both models will be discussed separately as they are using similar methodologies but these have been used in different ways in both the models.

5.1 Review Based Model

- The dataset containing multiple reviews of restaurants all around Bangaluru is extracted The data is pre-processed and the text of the reviews is pre-processed.

- In the data the null values are removed, columns are renamed, duplicate values are dropped, empty data is removed. Some transformations like removing '/5' from the ratings column. Replacing 'Yes' and 'No' to 'True' and 'False' so that the data type turns to bool and easier for recommendation model to process it. Create a new column called 'Mean Rating' using MinMaxScaler.

- The text was pre-processed in the reviews column. All text was converted into lower casing. URLs were removed. Stopwords and punctuations were removed.

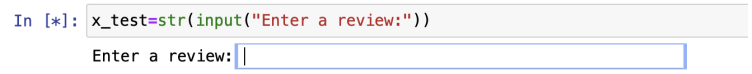
- Next we use TF-IDF vectorizer to create matrices. TF-IDF has been explained in the methodologies section. TF-IDF vectorizer is used to create vectors of words. The matrix that will be provided will consist of columns that will showcase a restaurant and the rows will showcase an overview of the vocabulary i.e. words that appear at least once throughout that dataset consisting of reviews.

- Next we calculate similarity scores. We use the cosine similarity to calculate the scores. To calculate these scores the input is used as the matrices created by TF-IDF vectorizer.

- Then we create a function called recommend in which a restaurant name is entered which the user might have visited before. The recommend function finds out the restaurants with the highest similarity to the restaurant name entered and arranges them in the order of highest mean rating to lowest mean rating. The recommend function then returns the top 10 of those.

- In the second model created in this code is for the purpose of recommending restaurants but in a different way. Instead of a restaurant the user has visited he or she can enter a review of their ideal restaurant to get the recommendations similar to their wish.

- For this we use cosine similarity on the reviews to get similarity scores. We have discussed it above. In the recommend function we give user the option to enter a review.



- The recommend function matches the review written by the user to reviews to create a similarity score matrix and then uses the KNN to match it with its three most similar restaurants to give out the recommendations.

- Both the recommendation models can be used as per the preference of the user and one gives out 10 and the other give out 3 recommendations. These numbers can be tweaked but writing a sentence and matching it with other reviews is going to

work perfectly only until a smaller number of recommendations.

5.2 Location Based Model

In this model we are going to recommend restaurants based on similarity and locality that the user wants the restaurant to be in. The data consisted restaurants from around the world but we extract the data only from the state of new delhi. The preliminary data analysis proves that most of the data in the dataset is of the state of new delhi and areas inside it.

- The recommend function in this model uses TF-IDF vectorizer to pre-process text with processes including removing blank spaces, removing commas from 'cuisine' column, and remove stopwords.

- Cosine similarity is used to create similarity scores between restaurants. These were created using the matrices from TF-IDF vectorizer.

- The similarity score used to get recommendations is created by adding the cosine similarity scores to the aggregate rating of the restaurant inside the recommend function.

- For recommendations the input required is the restaurant name and location where the user wants to go out to eat and the top five similar restaurants are shown. The recommendations shown are from highest cosine similarity score to the lowest.

6 Evaluation

All the recommendation models built in the research were created by the use of data analytics technologies. The recommendation models are created are content based models but the technique used to get recommendation is content based collaborative technique. This technique uses content which is historical content of the restaurant. The technique used is similar in all the models but the vectors have changed. These vectors depend on the preference of an individual. Now we will discuss the results of these models and why some techniques were used over others.

6.1 Review based Model

In this model we use TF-IDF to convert words in reviews to vectors. Count Vectorizer could have been used to complete this process. Count Vectorizer can be used to convert words to vectors by seeing there weightage in the document but it does not reduce the weightage of words that are repeated too frequently like 'a' or 'the' so when similarity scores are deduced they are not that accurate. Whereas TF-IDF uses IDF to read the document back to reduce such numbers. Cosine similarity is used to deduce similarity scores and the these scores have been created and mentioned below.

```
In [39]: cosine_similarities = linear_kernel(tfidf_matrix, tfidf_matrix)
         cosine_similarities

Out[39]: array([[1.        , 0.02464753, 0.02009721, ..., 0.02377917, 0.01316553,
                 0.00871952],
                [0.02464753, 1.        , 0.03023618, ..., 0.02236893, 0.00967281,
                 0.01438304],
                [0.02009721, 0.03023618, 1.        , ..., 0.02226668, 0.02043194,
                 0.07087344],
                ...,
                [0.02377917, 0.02236893, 0.02226668, ..., 1.        , 0.00746073,
                 0.00880157],
                [0.01316553, 0.00967281, 0.02043194, ..., 0.00746073, 1.        ,
                 0.00823143],
                [0.00871952, 0.01438304, 0.07087344, ..., 0.00880157, 0.00823143,
                 1.        ]])
```

Below there are results for a restaurant called Café Alladin and results sorted according to mean rating of reviews given by people who have already visited those.

```
In [41]: recommend('Cafe Aladdin')

         TOP 7 RESTAURANTS LIKE Cafe Aladdin WITH SIMILAR REVIEWS:
```

Out[41]:

	cuisines	Mean Rating	cost
Hammered	North Indian, South Indian, Continental, Asian	4.65	1.2
Float	North Indian, Japanese	4.35	1.5
Hungry Hippie	Cafe, Continental, Italian, Burger	4.23	800.0
Three Dots & A Dash	European, Continental	4.13	1.5
Donne Biriyani Angadi Mane	Biryani, Chinese	3.47	250.0
Bamboo Heights	Chinese, Fast Food, Continental	3.45	500.0
Trippy Paradise	Cafe	2.03	900.0

In the next model a review is asked as an string input. The top three restaurants with similar reviews is shown. Below we put the input as 'tasty paneer'. Paneer is a very famous dish in India and restaurants with reviews that have tasty paneer in their reviews are shown.

```
In [54]: x_test=str(input("Enter a review:"))

         Enter a review:tasty paneer

In [55]: y_pred= fit1(x_train,y_train,x_test)

In [57]: print("The top 3 restaurants that we recommend would be:")
         for i in range(len(y_pred)):
             print(i+1,".",y_pred[i])

         The top 3 restaurants that we recommend would be:
         1 . Kanti Sweets
         2 . Cupcake Bliss
         3 . Ambur Hot Dum Biriyani
```

6.2 Location based Model

This model uses the TF-IDF and cosine similarity in the same way as the location based model but the vectors that we use for the calculation for similarity score are Aggregate Rating, Cuisines and Locality of the restaurant. Only the restaurant name and location where the similar restaurants are being looked in.

```
data_show('Connaught Place','Barbeque Nation')
```

Out[142]:

	Restaurant Name	Aggregate rating	Cosine Similarity
96	Longhorn Steakhouse	3.5	1.00
5	Din Tai Fung	4.4	1.00
101	3 Squares Diner	3.4	0.84
30	Sandubas Cafí©	0.0	0.84
23	Cafí© Daniel Briand	3.8	0.77
64	Gopala Hari	3.1	0.77

6.3 Discussion and Result

These recommendation models can be implemented on any location and give the right recommendations. Only the data of restaurants from that place is needed to be provided. But the problem with recommendation systems is cold start and high sparsity. High sparsity can be solved if the data available is in large quantity. Cold start is a problem is tough to be solved as if a brand new restaurant is opened and it has zero amount of reviews it will not be similar to any of the restaurants available in the dataset. A Hybrid Based recommender system will be more accurate and it can be created if more meaningful features are available in the datasets for the model. This is the future scope of these recommendation model.

7 Conclusion and Future Work

The recommendation model can help people that are looking for things to do when they travel or moving to a new place. Review based model does not show problem of cold start if example review is put in by the user. It won't have a bias that sometimes already available applications give to it's users. This model and paper also gives a look into how these recommendation models work. People who think or imagine that there private data is being used by information technology organizations can look into this paper to understand how these recommendation models work. But the problem of high data sparsity is going to need a lot more research and practical work on this topic needs to be done as future scope of this research. Implementing this model as a mobile application or website it can be made readily available for people to use. Using Cloud technology

like Big Data can also help the model to process the data quicker and handle much more large amount of data.

8 Acknowledgement

I would like to thank god first and foremost. I would like to thank my parents for supporting me along the research. I would like to that my mentor Dr. Christian Horn for help and advice provided along the research and formulate the idea for it. I would like to thank Dr. Catherine Mulwa helping me formulate my idea during my proposal.

References

Abbasi-Moud, Z., Vahdat-Nejad, H. and Sadri, J. (2021). Tourism recommendation system based on semantic clustering and sentiment analysis, *Expert Systems with Applications* **167**: 114324.

Avesani, P., Massa, P. and Tiella, R. (2005). Moleskiing. it: a trust-aware recommender system for ski mountaineering, *International Journal for Infonomics* **20**(35): 1–10.

Ebadi, A. and Krzyzak, A. (2016). A hybrid multi-criteria hotel recommender system using explicit and implicit feedbacks, *International Journal of Computer and Information Engineering* **10**(8): 1450–1458.

Fakhri, A. A., Baizal, Z. and Setiawan, E. B. (2019). Restaurant recommender system using user-based collaborative filtering approach: a case study at bandung raya region, *Journal of Physics: Conference Series*, Vol. 1192, IOP Publishing, p. 012023.

Farokhi, N., Vahid, M., Nilashi, M. and Ibrahim, O. (2016). A multi-criteria recommender system for tourism using fuzzy approach, *Journal of Soft Computing and Decision Support Systems* **3**(4): 19–29.

García-Crespo, A., Chamizo, J., Rivera, I., Mencke, M., Colomo-Palacios, R. and Gómez-Berbís, J. M. (2009). Speta: Social pervasive e-tourism advisor, *Telematics and informatics* **26**(3): 306–315.

Kesorn, K., Juraphanthong, W. and Salaiwarakul, A. (2017). Personalized attraction recommendation system for tourists through check-in data, *IEEE access* **5**: 26703–26721.

Kuusik, A., Roche, S. and Weis, F. (2009). Smartmuseum: Cultural content recommendation system for mobile users, *2009 Fourth International Conference on Computer Sciences and Convergence Information Technology*, IEEE, pp. 477–482.

Logesh, R. and Subramaniyaswamy, V. (2019). Exploring hybrid recommender systems for personalized travel applications, *Cognitive informatics and soft computing*, Springer, pp. 535–544.

Meehan, K., Lunney, T., Curran, K. and McCaughey, A. (2013). Context-aware intelligent recommendation system for tourism, *2013 IEEE international conference on pervasive computing and communications workshops (PERCOM workshops)*, IEEE, pp. 328–331.

Noguera, J. M., Barranco, M. J., Segura, R. J. and Martínez, L. (2012). A mobile 3d-gis hybrid recommender system for tourism, *Information Sciences* **215**: 37–52.

Parikh, V., Keskar, M., Dharia, D. and Gotmare, P. (2018). A tourist place recommendation and recognition system, *2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT)*, IEEE, pp. 218–222.

Pashtan, A., Blattler, R., Andi, A. H. and Scheuermann, P. (2003). Catis: a context-aware tourist information system.

Tkalcic, M., Kunaver, M., Tasic, J. and Košir, A. (2009). Personality based user similarity measure for a collaborative recommender system, *Proceedings of the 5th Workshop on Emotion in Human-Computer Interaction-Real world challenges*, pp. 30–37.

Yang, W.-S. and Hwang, S.-Y. (2013). itravel: A recommender system in mobile peer-to-peer environment, *Journal of Systems and Software* **86**(1): 12–20.

Zomato Dataset 1 (n.d.). `http:https://www.kaggle.com/datasets/himanshupoddar/zomato-bangalore-restaurants`.

Zomato Dataset 2 (n.d.). `http:https://www.kaggle.com/datasets/shrutimehta/zomato-restaurants-data?select=zomato.csv`.