

Restaurant Recommendation System in Dhaka City Based on Machine Learning Approach

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APPROVAL

This Project/internship titled “**Restaurant Recommendation System in Dhaka City Based on Machine Learning Approach**”, submitted by **Taufiq Ahmed**, ID No: 181-15-11129, **Fazle Rabby Talukder**, ID No: 181-15-11022, **Hasibur Rahman**, ID No: 181-15-11134 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 2, January 2022.

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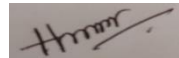
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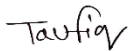
We hereby declare that, this thesis has been done by us under the supervision of **Abdus Sattar, Assistant Professor and Program Coordinator of MSc., Department of CSE** Daffodil International University. We also declare that neither this thesis nor any part of this thesis has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Due to the huge explanation of artificial intelligence, machine learning technology is being used in various areas of our day-to-day life. In Dhaka city, there are lots of Restaurants. Sometimes many of us face a scenario where we go to a restaurant and order some food but the food is not that good or the price of the food is very high as compared to other restaurants. Apart from this, another major problem is the location of the restaurant. We cannot find the best restaurants around us based on our preferences. That is why we want to build a model by using a machine learning algorithm that will be able to suggest a suitable restaurant based on the user's criteria. We have collected Dhaka city's restaurant's data from various websites, then we have used Weight-based score calculation and cosine similarity matrix to build our machine learning model. This model will also suggest similar restaurants based on the user's selected restaurants. By using this algorithm, we can build web applications or mobile applications that help users to find our restaurant.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

A recommendation system is a model which can predict user interest and suggests the desired item according to the user's preference [1]. Due to the rapid increase of internet users, the recommendation is being used on many platforms nowadays. Many e-commerce websites and other well-known platforms like Netflix, LinkedIn, Facebook, Instagram, and YouTube are using recommendation systems to give better results to their users [2]. Because of rapid development in Bangladesh's economy, as the capital of the country, Dhaka city is developing rapidly. Due to this progress, lots of restaurants have opened their business in Dhaka city. Now there is a situation where there are 8 -10 restaurants in one building. However, the problem is among these restaurants very few are providing good services so it's become a dilemma for food lovers to choose quality restaurants [3]. This research is to try to encounter this problem with a machine learning model to recommend restaurants for the users based on their criteria.

Our main intention is to give users their desired restaurant according to their preferences like Location, Cuisine type, price range etc. This machine learning model works in two different phases. In the first stage, the model will take user input for user preferences then calculate it as a score for every restaurant that is stored in our database. After getting the score it will sort the restaurants based on the score and give the best 10 restaurants that match with the preference. When users choose any restaurant we started to work on our second stage of the model in the background. We take the restaurants that users have chosen and use another machine learning algorithm cosine similarity to figure out the most similar restaurant which user chooses by using content-based filtering [4].

This recommendation system will play an important role in terms of user satisfaction because according to the experts Dhaka city has over 10000 restaurants in different locations and every restaurant has its different environment, food culture so it will help users to find out their suitable restaurant without going to the restaurant. Due to the huge expansion of the internet, there are more than 45 million internet users in Bangladesh. Hence, it will be helpful for the users to give their

preferences from home on the internet and the model will suggest the best restaurant nearby the user.

In this research, a new model is proposed where the model deals with two different approaches and merges the best result. Firstly, it takes user input like location, price range, rating, cuisine type. Secondly, it calculates the score based on weight where 90 percent consist of user ratings and 10 percent consists of the price range. After getting the score the model will sort the restaurants based on the score in non-decreasing order and suggest the user top 10 restaurants. Lastly, by taking users chosen restaurants the model uses another machine learning approach content-based filtering, and suggests similar restaurants that users have chosen. So it will give a great overview to the users of which restaurants are best among these huge numbers of restaurants in Dhaka city.

1.2 Motivation

Food is a part of a culture. Whenever we try different types of food we simply try to understand different culture. In Dhaka city there are lots of restaurants with various types of food. But the problem is most of the restaurants focus on the profit so they do not consider about food quality or price. Sometimes many of us face a scenario that we go to a restaurant and order some food but the food is not that good or the price of the food is very high as compare to other restaurants. Apart from this, another major problem is the environment of the restaurant. Sometimes we see that the environment of the restaurant is noisy but we want a calm environment instead. So it is a matter of concern for individual to find out a perfect and suitable restaurant. That is why we want to build a model by using a machine learning algorithm that will be able to suggest us suitable restaurant based on the user's criteria.

1.3 Problem Definition

In this modern age recommendation system is a game-changer for any kind of business. We can see every IT company is adapting recommendation system to attract their customer. To increase business, it is necessary for the Bangladeshi restaurant's owner to reach the customer by using modern technology. However, the problem is whenever I customer wants to find out suitable restaurants he or she just use various social media platform to get the restaurant's review.

Sometimes these reviews are vulnerable. Hence, it is important to make a bridge between restaurants and customers to improve the restaurant's business.

1.4 Research Questions

Some of the main questions that are encountered in this research paper is given below:

- What is the current scenario of the Dhaka's restaurants?
- How people find out better restaurants among a huge number of restaurants in Dhaka.
- Is there any digital solution to help people to figure out best restaurant nearby?
- How to make a better recommendation system that makes food lover life easy?

1.5 Research Methodology

In this section we discuss about the whole working procedure of our system. We have explained about data collection, data preprocessing, feature selection, data scaling and algorithm building. Lastly, we have also discussed about performance of the model and compare our algorithm with others algorithm as well.

1.6 Research Objectives

There are some benefits of using recommendation system of restaurants. Some of the technical objectives are given below:

- Recommend suitable restaurant.
- The model will be able to say which food item of a restaurant is good.
- The model will be able to suggest the restaurant based on your desire ambiance.
- The model will be able to recommend the best restaurant based on your price range.
- If anyone wants to open a new restaurant in a particular area he/she can get an overview about the best food item, price, and interior type that most of the user wants in that

1.7 Research Layout

Chapter 1: will discuss about introduction, motivation, Problem Definition, Research Question, Research Methodology and the expected outcome of our project.

Chapter 2: will discuss about the previous work on recommendation system and outcome of restaurant's recommendation system in Bangladesh point of view.

Chapter 3: Will discuss about the working methodology and the steps to build the recommendation system.

Chapter 4: will discuss about the result and analyze the result that we have built.

Chapter 5: will discuss about the conclusion and future work of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Many works have been done in the recommendation system [5-8]. However, none of them are specifically based on Dhaka city's restaurant. Our paper is mainly based on the city of Dhaka, to do so we have to review some previous work on the recommendation system. Some of them are given below and described shortly.

2.2 Related Works

A paper published in March 2020 has been published by the author that works in three phases: learning, analyzing, and recommendation. There were about 10000 data collected from the yelp website. They have used collaborative filtering to find similar users based on user preference and then recommend those restaurants that similar users like. So whenever a user searches on that system it shows the right rating restaurants [5].

Another paper published in 2016. In this paper, the authors proposed a location-based restaurant recommendation system for users that asked for data from the user like his preferences (area, restaurant type, etc.) and user location. Then by using Cosine Similarity they figure out restaurants that match with user preference and calculate the distance between the user and all the restaurants. After that, make a weight-based score that recommends the best restaurant [6].

$$Score = A * Similarity + B * Distance \dots \dots \dots (i)$$

In 2015 a paper was published. The authors of this paper addressed some interesting techniques to build a hybrid recommendation system. The system will take some psychographic information from the user such as the number of calls per day, mobile phone use per day, internet user per day, and calculate a psychological score to determine how social the user is. They call it a collaborative score. After this, the system also takes some demographic information as well like, income, age, gender, and calculates a demographic score. After this, they figure out the net score considering these two parameters and recommend restaurants based on this score [7].

$$Net\ score = (x * collaborative\ score) + ((1-x) * demographic\ score) \dots\dots\dots(ii)$$

Some authors published a conference paper in 2013 with the titled Location-based personalized restaurant recommendation system for mobile environments. In this paper, they have proposed a restaurant recommendation system for web applications. They used the foursquare web to retrieve users past visits to restaurants. If the user does not visit any restaurant, then the system tries to retrieve the user's friend's last visit to the restaurant. In the backend, the model calculates a score of every restaurant by using a naive biased algorithm and recommends it to the users in the frontend. So when the user moves from one place to another the model constantly shows different restaurants based on score. [8].

Apart from that restaurant recommendation system, there are some other famous recommendation systems that we have gone through to get a better understanding of how to build a recommendation system. A paper was published where the author has made a recommendation system by using the k-means clustering algorithm and k nearest neighbor to recommend a movie to the user. First of all, the system takes input from users like name, gender, age, occupation and tries to put this information on a cluster through utility metrics. After applying the k nearest neighbor algorithm they recommend a movie that matching cluster's people watch, like, and given a good rating [9].

2.3 Bangladesh Perspective

In The city of Dhaka, day by day population is increasing, that's why restaurants are also increasing drastically. But the problem is most of the restaurants focus on quantity rather than quality. So it is challenging for the restaurant owner to attract more customers. Sometimes restaurant owners cannot maintain the quality of food and price range as compared to their competitors. As a result, lots of restaurants shut down their business after a few years. Overall, both restaurant owners and customers face trouble because of lack of knowledge about good restaurants. If there is a medium between owner and buyer it would be convenient form both of them to get better profit and quality respectively. This recommendation system will increase the restaurant's quality because, if they can maintain a good quality, their restaurant's rating will increase and appear first in the recommendation system. In Dhaka city, most families are middle class. If they want to spend their

valuable money on a restaurant for their family, this recommendation system will suggest good quality restaurants easily. Hence it will be convenient for a person to save money. Overall, we can say in Bangladesh's point of view it is quite helpful to introduce new technologies in restaurant's sector.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In this section, we will briefly discuss the whole process that we did to build this restaurant recommendation system. From data collection to building the actual model, we had to come through lots of stages. In this section, we will elaborate on data collection, data processing, feature selection, algorithm building phases.

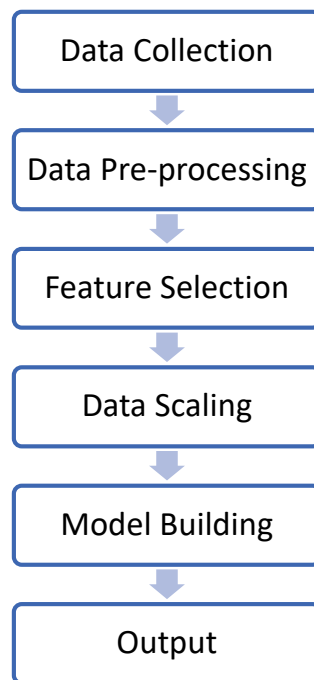


Figure 3.1: Steps of Research Methodology

3.2 Data Collection

There are over 10000 restaurants in the city of Dhaka. Hence, it was quite impossible to go to every restaurant and collect data from the users. We took an alternative approach. We use various websites like Google Maps, Facebook, and Food panda to collect data. At the initial stage, there were about 3000 restaurants data. But due to collecting from various sites, there were lots of issues

with the dataset. We used various data processing techniques to shape our data and make it usable for our model.

3.3 Data Pre-Processing

After getting the raw data from the data collection step we had to process the whole dataset and make it perfect for our model to train. First of all, we have to eliminate irrelevant data. Secondly, we deleted the missing and duplicate data, to do so we had to use various python tools like pandas, Matplotlib etc. After cleaning the dataset, we got almost 1600 restaurants data to work with our model.

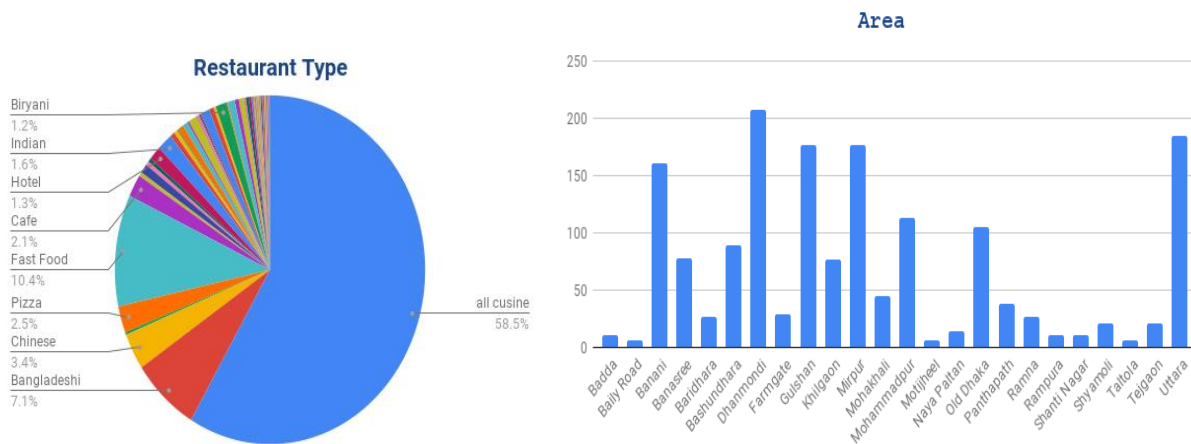


Figure 3.2: Percentage of food type and number of restaurants in an area

3.4 Feature selection

Feature selection is one of the most important parts of making a machine learning model because if we choose our features wisely our model will suggest restaurants accurately [10]. Our target level is the restaurant's name but we need to select the input level carefully. Our input features are location, cuisine type, price range, ratings, and number of ratings. We also consider the number of ratings as a level because a restaurant might have good ratings but the problem is very few people give those ratings so we cannot say that that restaurant is good or bad so that's the reason we consider several ratings as an input level.

Table 3.1: Features that used to build restaurant recommendation system.

Feature Name	Types	Domain
Restaurant Name	String	<Name>
Restaurant Address	String	Banani, Dhanmondi etc.
Ratings	Float	(0-5.0)
Restaurant Type	String	Fast food, Chinese etc.
Number of Ratings	Integer	(>=0)
Price Range	Integer	(1,2,3)

3.5 Data Scaling

We know that our computer does not understand anything except numbers. Hence, we have to convert a string value into a number. For this, we used a level encoder from the python Sklearn package. After converting the data, we used another Sklearn package MinMax scaler to scalar our data so our data's value was in the range of 0 to 1. We used this tool because when we used mathematical calculation it might cause miscalculations if we do not scale every feature on the same scale. So, to play safe we scaled it with a min-max scaler.

3.6 Model Building

After preparing the dataset now the most important come to build the actual recommendation model for our user. In recent time most of the recommendation system or model is being building by using Hybrid recommendation system [11]. We divided our model into two parts, one is a weight-based score and the other is content-based selection.

3.6.1 Weighted based score calculation

A weighted-based recommendation system is the simplest yet a good way to recommend the best restaurant, it easily calculates a score for every restaurant based on their weighted [12]. The main aim of this method is to calculate an indexing score for every restaurant and sort it in non-decreasing order. Whichever restaurant gets the highest score that means that the restaurant has a

good reputation. To calculate the average score we need to consider some features so we choose every restaurant's ratings and several ratings to calculate the average rating scores.

$$\text{average rating} = \frac{(R*NR)+(RM*NRQ)}{(NR+NRQ)} \dots\dots\dots(iii)$$

Where,

R = ratings of a restaurant.

NR = number of people who give ratings

RM = means of rating column.

NRQ = 60% quantile of several ratings.

$$\text{average price} = \frac{3}{P} \dots\dots\dots(iv)$$

Where,

P = price of that restaurant where 1 = cheap,

2 = medium, 3 = expensive.

After calculating the average ratings and average weight for every restaurant we are good to go to calculate the score for every restaurant. We have considered 90% of the average ratings and 10% of the price to calculate our score.

The equation is:

$$\text{score} = \text{average rating} * 0.90 + \text{average price} * 0.10 \dots\dots\dots(v)$$

After getting the score for every restaurant we can now suggest the best restaurant according to the score. All we need to do is take the user preferences as user input and search them into our database. All the restaurants that will come we index them according to their score and we will get the best restaurant at the top.

3.6.2 Content-based similarity calculation

After showing the users top restaurants according to their preference, if the user selects any restaurant the model will start to implement its second recommendation system which is content-based filtering. Content-Based filtering is one of the most popular recommendation systems that many well-known companies use to recommend their product to customers. Content-based filtering finds out similarities among the restaurants and which restaurant matches more with the user's chosen restaurant that will recommend first [13]. An example of content-based recommendation is given below for better understanding

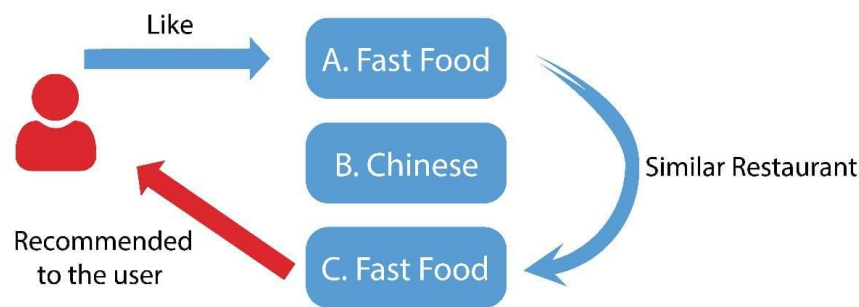


Figure 3.3: demonstration of content based filtering

Here we can see a user has liked a restaurant which main cuisine is Fast food and there are two other restaurants one is Chinese and another one is Fast Food. Hence, restaurant C (Fast food) is more similar to restaurant one as compared to restaurant B (Chinese). That's the reason restaurant one will be recommended to the user in content-based filtering.

3.6.2.1 Algorithm building

There are lots of ways to calculate similarities of two products among them cosine similarity and Euclidean distance is vastly used [14]. In our system, we have used cosine similarity to calculate the similarity of all restaurants with every restaurant. We have used area, cuisine type, ratings, price range, and number of ratings as our variables to compare with.

$$\cos \theta = \frac{p \cdot q}{\|p\| \|q\|} = \frac{\sum_{i=1}^n p_i \cdot q_i}{\sqrt{\sum_{i=1}^n p_i^2} \sqrt{\sum_{i=1}^n q_i^2}} \dots \dots (vi)$$

Here,

p and q are the features of the restaurant. Such as location, restaurant type, price etc.

The cosine similarity function will generate a similarity metric that has the similarity value of every restaurant with each other [15]. The value of all cells in this metric lies between zeros to one. We know that cos 0 degree is equal to 1 so if the value of restaurant[A][B] is close to 1 that means restaurant A is similar to restaurant B so we can suggest restaurant B who chooses restaurant A. So if a restaurant matrix value is close to 1 that means the restaurants are similar and if the value is close to 0 that means restaurants are not similar.

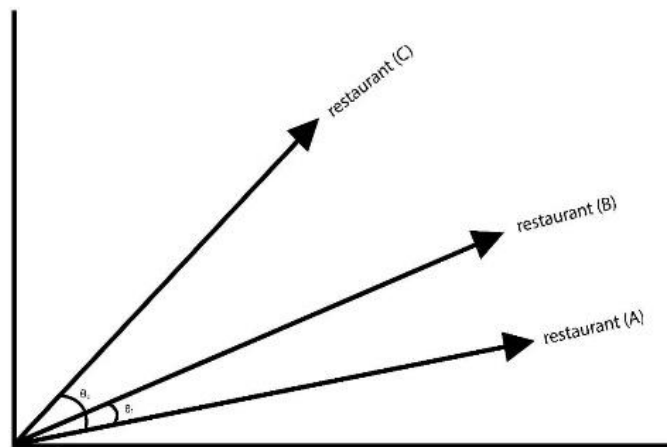


Figure 3.4: Similarity between three restaurants.

So when a restaurant has been selected by the user the system will go to the similarity matrix and extract the top 10 restaurants of that particular restaurant. Hence, those 10 restaurants will be recommended to the user. And that's the all working methodology of our restaurant's recommendation system.

CHAPTER 4

RESULT AND ANALYSIS

Now, our system is ready to recommend restaurants. We can implement this model in any web application or mobile application to achieve better results. There are lots of food delivery apps in Bangladesh like Pathao, food panda, and so on those run businesses in Dhaka city. This model will increase their suggestion and performance to sell more items. First of all, the user will give this preference such as location, price range, food type, ratings then our model will filter the dataset based on score and give the user the best recommendation when the user choose one restaurant among them the model will work again and apply content-based filtering to find out similar restaurants and recommend it to the users.

An overview of our recommendation system is given below to working procedure and outcome of the system:

Step1: Take input of user's preference

```
enter restaurant area: Banani
enter restaurant type: Fast Food
cheap = 1
medium = 2
expensive = 3
enter restaurant price: 2
```

Figure 4.1: Taking User input

Step2: find out top restaurants based on user preference

Out[19]:

	index	Restaurant Name	Area	Restaurant type	price	Ratings	score	Number of ratings
0	156	Takeout Banani	Banani	Fast Food	2	4.4	4.095863	5232
1	88	Madchef Banani, Dhaka.	Banani	Fast Food	2	4.3	4.001048	2750
2	87	Herfy Banani	Banani	Fast Food	2	4.2	3.912272	1786
3	143	BFC	Banani	Fast Food	2	4.1	3.833087	1941
4	90	Urban Spoon	Banani	Fast Food	2	4.1	3.820665	546
5	47	KFC Banani	Banani	Fast Food	2	4.0	3.753862	1252

Figure 4.2: Suggest top restaurants based on preferences

Step3: After chosen any restaurant from input one recommend similar types of restaurant:

Out[21]:

	Restaurant Name	Area	Restaurant type	price	Ratings	Number of ratings
87	Herfy Banani	Banani	Fast Food	2	4.2	1786
143	BFC	Banani	Fast Food	2	4.1	1941
121	KFD Express	Banani	Chinese	2	4.3	1475
47	KFC Banani	Banani	Fast Food	2	4.0	1252
21	Fools Diner	Banani	Chinese	2	4.4	1399
146	Sajna Restaurant	Banani	Indian	2	4.1	1709
249	KFC Banasree	Banasree	Fast Food	2	3.9	1650
124	Soi 71	Banani	Chinese	2	4.2	895
90	Urban Spoon	Banani	Fast Food	2	4.1	546
156	Takeout Banani	Banani	Fast Food	2	4.4	5232

Figure 4.3: Suggest similar type restaurants

From the above demonstration we can see that first of all the user give his preferences to the system to find best restaurants as per his need. After getting the user preferences the model finds out best restaurants as per user's desire and suggest to the user. When the user chooses any restaurants the model then recommends best restaurants that match with previously selected restaurants. That's the model of our recommendation system.

We have used Cosine similarity and Euclidian distance and Manhattan distance to calculate content based filtering. We have found that in cosine similarity gives us less mean square error as compare to Euclidian distance and Manhattan distance.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 Conclusion

Due to the huge development of Dhaka city, many restaurants have been opened all over the city and the number of mobile phone users is increasing day by day. In this case study, we try to find out the best solution for users to find out his/her desirable restaurants with the help of this mobile phone. Despite having some limitations such as we don't have a similar type of user's data to build a recommendation system that suggests restaurants based on user behavior we tried to build a system where the system suggests restaurants based on user's review and restaurant similarities. If we implement it in our mobile sets through the web or apps, it would give us desired results before going to an unknown restaurant. It is very convenient for the users because there are lots of middle-class families in Dhaka city who can afford restaurants' money once or twice a month. Hence, it is very important to have prior knowledge about the restaurant before entering. Therefore, we have built this system with Dhaka city's restaurant's database where users can apply the filter to find out desire restaurants and our system will show them top restaurants based on score. Apart from this, the system is able to suggest the top similar type of restaurants that a user choose.

5.2 Future Work

In the near future, we have plans to extend this project furthermore. We want to implement this model into a web app by using the Django framework. So that anyone can use this recommendation system through his or her devices. Apart from this we also want to collect user's review data who used this system and classify them based on their age, behavior. Hence, we want to implement collaborative filtering. In this data set, there is only restaurants information so here we have applied content-based filtering. However, we can collect users' information and what type of restaurant a particular user likes then we can easily apply collaborative filtering in our system and suggest those restaurants which similar types of user likes.

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