# Intelligent Recommend System Of Restaurant

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**Abstract.** With the development of mobile phone and internet, our society is becoming more and more convenient. Today, many people choose their favorite restaurant on mobile phone which can provide many useful information such as review, distance , payment way etc. In this work, a location-based social network recommendation algorithm was designed, to intelligently analyze multiple users in different locations and recommend suitable places for dining together. we decide to design this system enable multiple people obtaining a list of restaurants which keeping customers satisfied as many as possible. According to some factors, such as distance, review, the types of dishes and other influential factors, the system will choose the appropriate restaurants . In addition, we also match people who are similar to each other based on certain characteristic(favorite dishes, smoking or not, drinking levels, distance and so on).

1. **Introduction**

Nowadays, many people prefer to choose restaurants on mobile phone, because it can provide many useful information , just like price, address, distance, reviews.

So, what will we do? Here is the answer.

We are going to make a project which can provide people the best restaurant that satisfy most of them. Except above, it also has the function of personal matching. Based on people’s characteristic, it assess the similarity of people, and return a list of people who are similar to each other.

Based on the given data set, we firstly search people who are similar to each other in many hands(prefer dishes, smoking or not, drinking levels, age etc.), but we give priority to the distance between them. If someone is too far from other people, we won’t think this one would be disposed to go follow others.



Figure1 : Recommended restaurants

1. **Detail**

Assuming that here is a user denoted with u(*u∈U={u1u2u3...un}*), we employ D(*D={u(user-ID)，s(smoker)，dl(drink-level),am(ambience), bu(budget),ma(marital\_status),hi(hijos),re(religion),pe(personality)},* as the feature data , and the similarity is represented by D. We can get the similarity among a user and other users, so on, with the similarity, the interaction matrix can be calculated based on formula (1).

Like（user-ID，D）=  （1）

User similarity diagram:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | U1 | U2 | U3 | ... | U138 |
| U1 | 0 | 5 | 4 |  | 6 |
| U2 | 5 | 0 | 6 |  | 3 |
| U3 | 4 | 6 | 0 |  | 4 |
| ... |  |  |  | 0 |  |
| U138 | 6 | 3 | 4 |  | 0 |

Figure2 :the interaction matrix of users

Since the interaction matrix is very sparse in practical application, when the traditional matrix decomposition method is used to predict the user's interest, its prediction results are vulnerable to data sparseness. A deep learning framework NCF is introduced here to predict the user's interest. Its model algorithm is shown in Formula (2) :

（2）

The NCF deep learning model can be used to obtain the similarity between each user and other users in set U, and according to the similarity, top 10 choices, named i, are selected to obtain the final candidate point set S.It generates recommendation list through NCF , shown in figure3 :

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | U1 | U2 | U3 | ... | U138 |
| U1 | 0 | 5 | 4 |  | 6 |
| U2 | 5 | 0 | 6 |  | 3 |
| U3 | 4 | 6 | 0 |  | 4 |
| ... |  |  |  | 0 |  |
| U138 | 6 | 3 | 4 |  | 0 |

|  |  |
| --- | --- |
|  | U1 |
| Top-0 | U23 |
| Top-1 | U111 |
| Top-2 | U42 |
| Top-3 | U58 |
| Top-4 | U38 |
| Top-5 | U2 |
| Top-6 | U99 |
| ... | ... |
| Top10 | U3 |

NCF模型

Figure3: Generate recommendation list through NCF

After the candidate set S is obtained, it is filtered according to the coordinate information. When the linear distance between two people is greater than or equal to 1km, the candidate is removed from the set S, and the candidate is complemented in turn.

We match the candidates according to the constraint set Y(*Y = {c(cuisine), p(payment),* ) of the current user u, sort them according to their similarity, and finally get the maximum similarity set 's'. According to the wishes of the current user, we can provide "interested people" for the user to send the invitation. After the invitee agrees, we can recommend the restaurant according to the information of all participants. In order to make the distance between all participants and the restaurant appropriate, we connect the coordinates of all participants to form a polygon, and calculate its center of gravity according to formula (3):

*Cx,y* = （3）

*AI* is the area divided into multiple triangles，*ΣAi*为Polygon area，*Ci* is the center of gravity of the triangle divided into multiple triangles，the calculation formula is：

*x,y=*（4）

After getting the longitude and latitude of the center of gravity, we take the center of gravity as the center point, select all restaurants within the radius range of 500 / 1000 / 1500 / 2000 / m as candidate restaurant set h, and construct a combined recommendation system for restaurant recommendation.

User 1

Recommendation engine

Recommendation engine

Recommendation engine

User 2

User k

filter

sort

merge

Figure4 :Framework of combined recommendation system

About the algorithm of recommendation engine, we match the information between restaurant and user (such as food preference, transportation, payment method and score) within the selected radius. According to the matching results, the evaluation score of each restaurant is obtained, and then the closed restaurants will be filtered out according to the business hours. Finally, the final recommendation result is returned based on the ranking of scores.

Verification consists of two parts:

1. For those who are interested, for a user U in the test set, we calculate the prediction accuracy according to RootMeanSquareError (RMSE) and MeanAbsoluteError (MAE), and let r be the actual similarity between the user and the presenter, and r 'is the prediction similarity predicted by the model, then it can be defined as:

RMSE =  (5)

MAE =  (6)

The smaller the mean square error and absolute error is, the more accurate the prediction result is.

1. For the restaurant forecast, we used the fitness SYD of each person and the restaurant as the rating criteria:

SYD = (7)

Where, R (u) is the number of recommended restaurants, T is the number of interested users, represents the number of recommended restaurants in which participants are interested, and SYD can be used to measure the accuracy of restaurant recommendation.