

A Mobile Recommendation Algorithm based on Location Information and Collaborative Filtering

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Abstract. Aiming to the problems of information overload and low recommendation quality for O2O electricity field, this paper has put forward to a mobile recommendation algorithm based on location information and collaborative filter, which introduces the location information in mobile recommendation algorithm, and also improved the traditional collaborative filter. The algorithm can reduce the recommended amount of calculation in accordance with selecting the recommendation item, so as to optimize the recommendation effect and improve shopping experience of the mobile users. The experiment results show that the algorithm has better advantages than the traditional recommendation algorithm in improvement recommendation quality.

Keywords: Location Information, Mobile Recommendation, Collaborative Filtering.

1. Introduction

According to the 41st statistical report on the development of internet in China, the number of mobile internet users in China was 753million in December 2017, and the mobile internet users is account for 97.5% [1]. The relevant data shows that mobile transactions accounted for 60.8% of China's online retail market in 2017 [2]. With the entry of traditional e-commerce enterprises and emerging e-commerce enterprises, the amount of information content of mobile e-commerce will increase sharply, and exceed the range of information acceptance ability of users. At the same time, due to the limited capacity of mobile devices in data operation and display [3-4], the mobile information overload problem has been produced. By screening and optimizing the recommendation products, the mobile recommendation system can alleviate the problem of mobile information overload and effectively improve the online shopping experience of users.

The O2O e-commerce is called as the mobile of online ordering and offline consumption, which is an important mode of mobile commerce. In the early stage, the O2O e-commerce was dominated by the group purchase, and now it has been extended to local consumption, taxi sharing and other fields. The O2O e-commerce has a strong location information attribute, which needs to consider the location of users and platform products at the same time. In addition, according to the location of users and platform products, the O2O e-commerce has recommended the products in a reasonable order in accordance with the distance. It is a great significance for optimizing the shopping process of O2O e-commerce and improving the flow conversion rate to integrate the location information into the recommendation algorithm.

This paper puts forward to a recommendation algorithm based on the location information and collaborative filtering. The algorithm mainly solves some recommendation problems. Firstly, according to the distance between users and recommendation item, it needs implement pre-filter of recommendation item, so as to narrow the recommendation range and reduce the amount of calculation. Secondly, the algorithm also combines the user's similarity and item similarity, so as to optimize the collaborative filtering algorithm and the recommendation effect.

2. The Relevant Calculation Formula

2.1 The Collaborative Filtering

At present, the recommendation algorithm based on collaborative filtering mainly includes UserCF and ItemCF. The UserCF is algorithm based on users' similarity, while the ItemCF is algorithm based

on Items' similarity. This paper combines the UserCF with the ItemCF, which considers both the users' similarity and Items' similarity, so as to recommend the most items to users. This paper calculates the similarity by using the Person correlation coefficient.

The similarity calculation formula between user u and user v is as shown in the formula (1):

$$sim(u, v) = \frac{\sum_{i \in i_{uv}} (R_{ui} - \bar{R}_u)(R_{vi} - \bar{R}_v)}{\sqrt{\sum_{i \in i_{uv}} (R_{ui} - \bar{R}_u)^2 \sum_{i \in i_{uv}} (R_{vi} - \bar{R}_v)^2}} \quad (1)$$

Where i_{uv} refers to the item intersection of between the user u and the user v , R_{ui} represents that the user u gives rating of the item i , R_{vi} represents that the user v gives rating of the item i . The \bar{R}_u and the \bar{R}_v respectively represents the user u and the user v gives the rating average value of all past items. The $sim(u, v)$ refers to the similarity values between the user u and the user v . Higher values indicate a higher similarity, otherwise lower values indicate a lower similarity.

The similarity calculation formula between item i and item j is as shown in the formula (2):

$$sim(i, j) = \frac{\sum_{u \in U_{ij}} (R_{ui} - \bar{R}_i)(R_{uj} - \bar{R}_j)}{\sqrt{\sum_{u \in U_{ij}} (R_{ui} - \bar{R}_i)^2 \sum_{u \in U_{ij}} (R_{uj} - \bar{R}_j)^2}} \quad (2)$$

Where R_{uj} represents that the user u gives rating of the item j , U_{ij} refers to the user intersection of between the items i and the item j . The \bar{R}_i and the \bar{R}_j represents all user gives the rating average value of the item i and the item j . The $sim(i, j)$ refers to the similarity values between the item i and the item j .

2.2 Predicting the Ratings

The preliminary predicting rating of the user u give item i can be calculated by the formula (3):

$$\hat{R}_{ui} = \bar{R}_i + \left[\frac{\sum_{i \in i_{list}} sim(u, v)(R_{ij} - \bar{R}_i)}{\sum_{u \in i_{list}} |sim(u, v)|} + \frac{\sum_{j \in j_{list}} sim(u, v)(R_{ij} - \bar{R}_j)}{\sum_{v \in j_{list}} |sim(u, v)|} \right] / 2 \quad (3)$$

Where \hat{R}_{ui} that represents that the user u gives the preliminary predicting rating of item i . The \bar{R}_i represents the average value of item i historical rating. The i_{list} refers to users' intersection of item i . The U_{list} refers to item's intersection of user u rating. The R_{ij} refers that user v give the rating of item j .

2.3 Modifying the Ratings

Because the item distance has certain influence on user's consumption decision, the item distance needs be introduced into the rating calculation formula. The preliminary predicting rating can be modified by the formula (4).

$$R_{ui} = \left(\hat{R}_{ui} + 1 - \frac{d_{ui}}{D} \right) \beta \quad (4)$$

Where R_{ui} refers to the modified rating, the \hat{R}_{ui} refers to the preliminary predicting rating. The d_{ui} refers to the distance between user u and item I , the D refers to effective recommendation distance.

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3.1 The Relevant Concept

Definition1-the effective recommendation distance. In the calculation of the users' effective recommendation area and the delineation of the target item, the effective distance should be formed with a radius around the user's location, so as to implement recommendation.

3.2 The Design Idea

In the O2O e-commerce consumption scenario, the probability of the users purchasing the item is relatively high when the distance of items is relatively close. Therefore, firstly, the items are screened in accordance with the effective recommendation distance D , so as to form the recommendation set. Secondly, in the recommendation set, if the item i doesn't rated, the item i need to be predicted by using the combination of the recommendation algorithm based on user's similarity and based on items similarity. Thirdly, the distance between the user and items need to be modified, so that the distance is near the high rating item. Finally, the Top_N recommendation will be implemented in accordance with rating grades of the recommendation item.

Compared with the general collaborative filtering recommendation algorithm, this recommendation algorithm screen items in accordance with distance between items and users, so as to reduce the recommendation range and the calculation amount, improve the recommendation result.

3.3 The Recommendation Algorithm

The specific recommendation process of the mobile recommendation algorithm based on location information and collaborative filter is as follows:

Input: users set U , users location information, items set I , item location information, historical rating set R , effective recommendation distance D .

Output: The top_N recommendation list is arrayed from high to low, which users give rating of nearby items in the current location.

- (1) Getting the location information of all user u and items, filtering the items beyond the effective recommendation distance, and obtaining the pre-recommendation set P .
- (2) Getting the historic rating list u_{list} of the user u in the historic rating set.
- (3) Selecting the i th item of the historic rating set, if the user u has rated the item i , the followed process will move on step 7, otherwise move on the followed step.
- (4) Getting the user list i_{list} rating of item i in the historical rating set. For every user u_i of the user list i_{list} , getting the historical rating list $u_{i_{list}}$ from the historical rating set R , and calculating the similarity between user u and user u_i by the formula (1).
- (5) For every item i_u of $u_{i_{list}}$ Getting the rating record i_{list} , and calculating the similarity $sim(i, i_u)$ of the item i . Calculating the predicted rating \hat{R}_{ui} of item i by using the formula (3).
- (6) Looping the steps from setup 3 to setup 5, so as to make all items of pre-recommendation set get the rating.
- (7) Modifying the predicted rating in accordance with formula (4), so that the nearest items can get a higher rating.
- (8) Sorting the items according to the rating from high to low, and selecting the Top_N item to recommend.

4. The Data Set and Experimental Result

The experimental data comes from part of the order data of an e-commerce platform from august 2015 to September 2016, which are carried out the processes of selection [5].

The experimental data is divided into training set and test set according to the ratio of 8:2. The training set is trained by the user algorithm, and the test set is used for verification. The recommendation results are evaluated by calculating the mean absolute error. Taking UserCF and DARS algorithms as the comparison experiment, the experiment is tested. The effective recommendation distance D values in DARS and LBCE are set to 1000m. the comparative experimental results is shown in Fig 1.

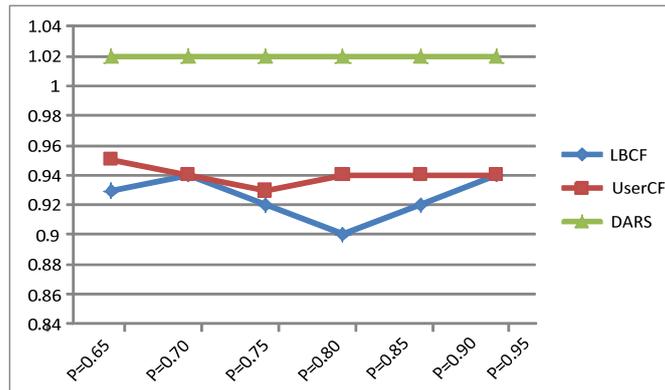


Fig.1 The comparative experimental results

5. Summary

Aiming to requirement of O2O e-commerce in the mobile recommendation, this paper combines the UserCF and ItemCF algorithm, and improves the existing collaborative filtering recommendation algorithms. In addition, the algorithm also adds the location information into recommendation algorithm and considers the influence of distance on shopping decision, so as to optimize the recommendation effect and improve the user experience. This algorithm can reduce the amount of recommendation calculation and improve the quality of recommendation.

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