E-commerce Product Recommendation Method based on Collaborative Filtering Technology

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Abstract—**This paper concentrates on the problem of E-commerce product recommendation, and E-commerce market has attracted more and more attentions. Collaborative filtering algorithm supposes that when two users have similar ratings on products, they may have similar preferences. To combine the user preference information and the collaborative filtering model together, we suppose that if there are two users who share the similar interest, it is very possible for them to select similar products. Afterwards, we design an E-commerce product recommendation algorithm based on collaborative filtering model to compute the recommendation score. Finally, experimental results prove that the proposed method can recommend more relevant products for users with high accuracy.**

Keywords- E-commerce, Product Recommendation, Collaborative Filtering Technology, Neighbor

I. INTRODUCTION

With the rapid development of information technology and the Internet, E-commerce based on virtual economy has been attracted more and more attentions, and gradually developed into the backbone of the emerging industry all over the world [1][2]. Particularly, in recent years, network infrastructure construction is widely utilized, and the E-commerce development speed has been greatly improved. On the other hand, when E-commerce market scale expanding gradually, more and more manufacturers want to join the E-commerce market [3][4]. Thus, fierce competition between businesses increasingly develops. How to enhance profit rate in the intense market competition is a key issue we should face [5].

From the above analysis, it can be observed that it is of great importance to provide rich suitable products for customers. That is to say, E-commerce platform must quickly and accurately recommend the goods to customers in terms of their requirements [6]. Therefore, E-commerce personalized product recommender system is designed to provide the service of personalized recommendation on products to various users [7]. E-commerce product recommendation system focuses on user preferences, and allows users to quickly and accurately choose the products they require. Excellent E-commerce product recommendation may greatly reduce the time cost for user to choose products according to their interests [8].

In Collaborative Filtering algorithm, customer's activity is saved in a user-item rating matrix, which contains users' interests in items [9][10]. The aim of Collaborative Filtering algorithm is to recommend the most relevant items for a specific user [11][12]. In recommendation systems, the users only rate a small number of items, therefore, the rating matrix is very sparse, and we should estimate the missing rates to seek proper recommendation results for users [13]. It can be observed that the task of Collaborative Filtering is to evaluate the unknown ratings based on known entries with lowest accumulative error [14].

The rest of the paper is organized as follows. Section 2 describes the E-commerce product recommendation system. In section 3, the E-commerce product recommendation method is given. Section 4 conducts a series of experiments to demonstrate the effectiveness of our method. Finally, this paper is concluded in section 5.

II. DESCRIPTION OF THE E-COMMERCE PRODUCT RECOMMENDATION SYSTEM

Recommender system can be classified into three categories: content-based filtering, collaborative filtering, and hybrid filtering. In this paper we exploit collaborative filtering algorithm to recommend products for users.

Definition 1 (Product recommendation problem) Suppose that there are a set of users $U=\{u_1,u_2,\cdots,u_n\}$ and a set of products $P=\{p_1,p_2,\cdots,p_m\}$. User's interests for products are represented as a product rating matrix $M=(R_1,R_2,\cdots,R_n)^T$. Each user u can rate a set of products $P_u=\{p_{j1},p_{j2},\cdots,p_{jn}\}$.

Next, to integrate the user preference information with the collaborative filtering model, we assume that if there are two users who share the similar interest, they are possible to choose similar products as well. Collaborative filtering algorithm supposes the fact that when two users have similar ratings on products, they could have similar preference. Therefore, the product recommendation results are extracted from neighbors of the target user. Neighbors of a target user u are defined as follows.

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$$Neighbor(u)=\left\{u_i \in U \left| sim(u,u_i) \geq \underset{j\in[0,m],i\neq j}{sim}(u,u_i)\right.\right\} \quad (1)$$

where $sim(u,u_i)$ refers to the similarity between target user u and u_i. Afterwards, similarity between user u_i and u_j is calculated as follows.

$$sim(u_i,u_j)=\frac{\sum_{\alpha\in Cu_iu_j}\left(r_{u_j\alpha}-\overline{r_{u_j}}\right)\cdot\left(r_{u_i\alpha}-\overline{r_{u_i}}\right)}{\sqrt{\sum_{\alpha\in Cu_iu_j}\left(r_{u_j\alpha}-\overline{r_{u_j}}\right)}\cdot\sqrt{\sum_{\alpha\in Cu_iu_j}\left(r_{u_i\alpha}-\overline{r_{u_i}}\right)}} \quad (2)$$

where $C_{u_iu_j}$ means the set of common products for both user u_i and u_j, and parameter $\overline{r_{ui}},\overline{r_{u_j}}$ means the average of ratings score provided by user u_i and u_j respectively.

III. E-COMMERCE PRODUCT RECOMMENDATION BASED ON COLLABORATIVE FILTERING ALGORITHM

In this section, we discuss how to design the collaborative filtering algorithm based E-commerce product recommendation. The recommendation results of E-commerce product recommendation are calculated as follows.

$$\phi_{u,x,p}^{a,v}=\phi_u^{a,v}+\gamma\cdot\sum_{j=1}^{m}Sim(u_i,u_j)\cdot(\phi_{u_j,x,p}-\phi_{u_j}^{a,v}) \quad (3)$$

where p and u mean the product recommended results and users. $v=g(x,a)$ and γ are exploited as a normalizing factor which is computed as follows.

$$\gamma=\left(\sum_{j=1}^{m}Sim(u_i,u_j)\right)^{-1} \quad (4)$$

where parameter $\phi_{u_i}^{a,v}$ is calculated as follows.

$$\phi_{u_i}^{a,v}=\frac{\sum_{k\in I_{u_i}^{a,v}}^{t}\phi_{u_i,x,k}}{\left|I_{u_i}^{a,v}\right|} \quad (5)$$

s.t.

$$I_{u_i}^{a,v}=\{k\in I\left|\phi_{u_i,x,k}\neq\varnothing \ and\ g(x,a)=v\right.\} \quad (6)$$

Then, the recommendation level of the product p for the user u is computed as follows.

$$\phi(p)_{u_i,x,k}=\frac{\sum_{\psi\in A_k}\beta_a\cdot\phi_{u_i,x,k}^{a,v}}{\sum_{\psi\in A_k}\beta_a} \quad (7)$$

where β_a refers to the weight of the k^{th} attribute of the target user for a given product.

IV. EXPERIMENT

To test the performance of our proposed algorithm, we choose three popular datasets in the study of recommender systems. Dataset 1 is MovieLens 1M (ML-1M), which is made up of 1,000,209 ratings provided by 6040 users for 3952 movies. Dataset 2 refers to MovieLens 100k (ML-100k), which includes 100,000 ratings collected from 943 users in 1664 movies. Dataset 3 is named Epinions, which contains 664,824 ratings from 49,290 users on 139,738 items (such as movies, music, electronic products, books, and so on). Particularly, Epinions is collected from the Epinions website [15][16].

Mean Absolute Error (MAE) is often used to evaluate the accuracy of recommender systems [17]. Suppose that there N actual and predicted rating pairs $\left(r_{u,i},p_{u,i}\right)$, where u means a user and i refers to an item. Then, Mean Absolute Error is defined as follows.

$$MAE=\frac{1}{N}\left|\sum_{i=1}^{N}\left(r_{u,i}-p_{u,i}\right)\right| \quad (8)$$

To make the performance comparison, three methods are chosen: 1) incremental user-based CF (denoted as IUCF) [18], incremental item-based CF (denoted as IICF) [19], and

incremental CF based on co-clustering COCLUST [20]. Experimental results are listed as follows.

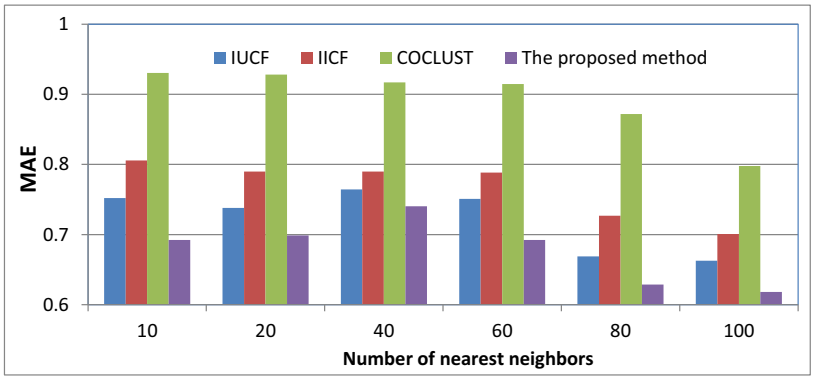

Figure 1. Mean Absolute Error for different methods using MovieLens 1M

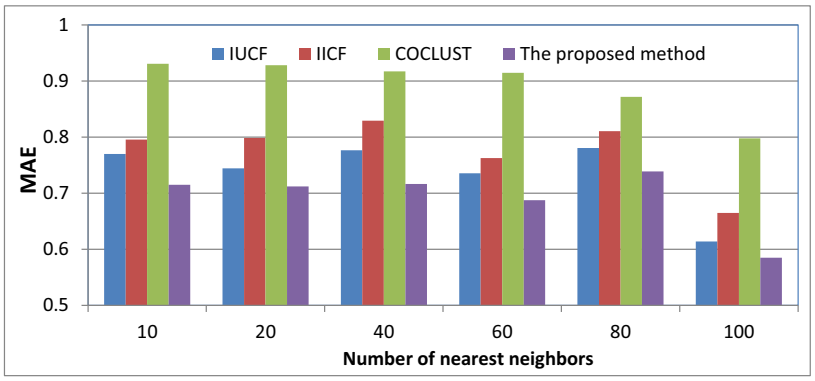

Figure 2. Mean Absolute Error for different methods using MovieLens 100k

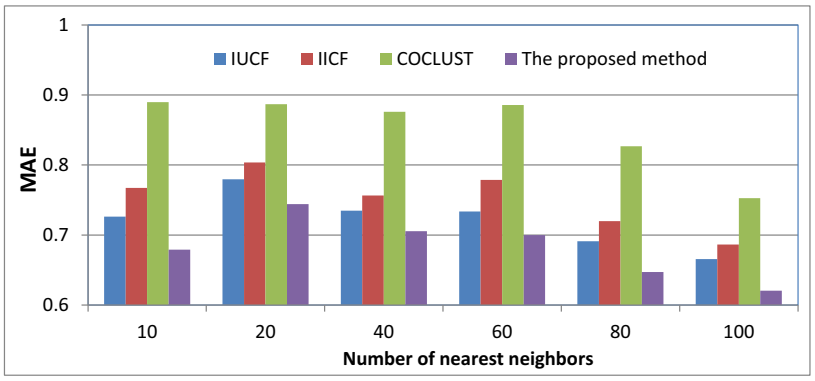

Figure 3. Mean Absolute Error for different methods using Epinions

From the above experiment, it can be seen that compared with other methods, the proposed algorithm performs much more better for all datasets.

V. CONCLUSION

In this paper, we focus on the problem of E-commerce product recommendation. Collaborative filtering algorithm assumes that if two users have similar ratings on products,

they may have similar preferences. Next, we integrate the user preference information and the collaborative filtering model together. Moreover, we suppose that if there are two users who share the similar interest, they may want to buy the same products. Furthermore, a novel E-commerce product recommendation method using based on collaborative filtering algorithm is given.

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