Multi-Category Item Recommendation Using Neighborhood Associations in Trust Networks

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ABSTRACT
This paper proposes a novel recommendation method called RecDI. In the multi-category item recommendation domain, RecDI is designed to combine user ratings with information involving user’s direct and indirect neighborhood associations. Through relevant benchmarking experiments on two real-world datasets, we show that RecDI achieves better performance than other traditional recommendation methods, which demonstrates the effectiveness of RecDI.

Categories and Subject Descriptors
H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval - Information filtering

Keywords
Recommendation, Neighborhood Relations, Trust Networks

1. INTRODUCTION
The trust between users in social networks can be used to improve recommendation performance. The common concept of trust-based recommender systems (RSs) is that users’ interests can be influenced by their trusted friends in social networks. However, users behave differently across different domains. This means that users often express different trust relations in different domains. For example, a user u may trust user v in terms of books but the same user u may not trust user v in terms of movies. Traditional trust-based recommendation methods use trust information on all categories, which is not consistent due to the fact that trust isn’t applicable in different domains. It is therefore important to develop appropriate methods that utilize trust relations of users for recommendation in different domains.

In this work, we propose a novel recommendation method called RecDI, which combines users’ ratings with the information about direct and indirect neighborhood associations in trust networks for multi-category item recommendation. According to items’ categories, we first partition users and items into different subsets and obtain rating and trust relation sets on each category. We then use direct neighborhood association degrees to compute indirect neighborhood association degrees by exploiting trust propagation. Finally, we fuse these association degrees into a traditional matrix factorization model for item recommendation on each category.

2. PROPOSED SCHEME
2.1 Partition Rating and Trust Relation Sets
As mentioned above, users often behave differently across multiple domains of interest. A simple way to obtain these domains is to partition items into different sets according to their categories. Users are also grouped into a relevant category according to whether they have rated items pertaining to that category. Direct neighborhood associations related to each category are easily extracted from original trust networks by removing users who do not belong to the category. Indirect neighborhood associations are obtained through the process of trust propagation. Consequently, a trust network on each category is generated, as shown in Figure 1.

2.2 Build Unified Objective Function
Matrix Factorization (MF) is a model-based collaborative filtering method. In recommender systems there are a set of users $U = \{u_1, ..., u_N\}$ and a set of items $I = \{i_1, ..., i_M\}$. The ratings expressed by users on items are given in a rating matrix $R = [R_{ui}]_{N \times M}$. In this matrix $R_{ui}$ denotes the rating of user $u$ on item $i$. $R_{ui}$ can be any real number, but the ratings are integers in the range (1-5). The objective function of MF method on each category is denoted as:

$$L_c^i(P^c, Q^c) = \sum_{u \in U, i \in I} W_{u,i}^c (R_{ui} - P_u^c Q_i^c)^2 + \lambda (\|P_u^c\|_F^2 + \|Q_i^c\|_F^2)$$

Figure 1: (a) Original trust network on all categories; (b) Generated trust network on category $c_1$.
Root Mean Square Error (RMSE) and the Mean Absolute Error (MAE) are employed as the performance measures to evaluate the prediction quality.

Tables 3 and 4 summarize the performance comparisons of the above recommendation methods on Epinions and Ciao. From the experimental results, it can be observed that RecD outperforms RecT and RecDI outperforms RecD. The first observation reveals that direct neighborhood associations can generate positive effects on prediction accuracy while the second reveals that indirect neighborhood associations can also generate positive effects in terms of prediction accuracy. This is due to the fact that trust relations express the similarities between users’ interests and indirect trust relations complement the use of trust information which helps to accurately determine the similarities of users.

4. CONCLUDING REMARKS

The theory behind our method RecDI is that the tastes of users who make direct expressions on trust are similar and the tastes of users who make indirect expressions on trust are also similar. In future work, we will test this theory and the proposed method extensively.

5. REFERENCES