

## Research on Recommender System based on Social Trust

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**Abstract.** Recommender system has become an effective tool to solve information overload and helps users to make decisions. In order to better improve the quality of personalized recommendation, this paper studies the recommendation algorithms based on social information, such as trust and distrust, then analyses the differences and advantages of the recommender systems which are based on social trust and the traditional. Finally, the future development trend of recommender systems based on social trust is prospected.

### Introduction

With the development of information technology and the Internet, people gradually enter the era of information overload from the age of information scarcity. For information consumers, it is a very difficult thing to find information interested from a large scale data. For information producers, it is the same difficult thing for the majority of users to get the information. The recommender system is an important tool to solve this contradiction. It has become a hot topic in the academic and industry and is applied in many fields, such as e-commerce and social media, and the recommender system can bring great business benefits.

In recent years, when studying personalized recommendation algorithms, many scholars integrate social features (tags, trust, contextual information, etc.) to improve recommendation accuracy. The experiment shows that the recommendation algorithm based on social trust has obtained some research results in the recommender systems, and can solve the cold-start problem more effectively. Although the new users and new items have no rating data, they can also learn the latent features of the user through the trust relationship. In real life, a movie or a song is more likely to choose friends' recommendation than anonymous one. Therefore, trust relationship has played a great role in improving the traditional personalized recommendation. Several trust-aware recommendation algorithms have been proposed in documents [1,2,3].

### Traditional Recommender Systems

In the 90s of last century, collaborative filtering technology in [4] firstly was proposed, indicating the recommender system has become an independent discipline and has attracted wide attention. The core of the recommender systems is the recommendation algorithms, which is based on the binary relation between the user and the item, excavates the potential consumption tendency of each user according to the user's historical behaviors record or their similarity relations, and makes personalized recommendation for each user. The traditional recommendation algorithms are as follows: content-based recommendation [5], collaborative filtering recommendation [6] and hybrid recommendation [7].

**Content-based Recommendation.** Content-based recommendation is mainly based on items that have been selected or rated by users, and similar items are recommended to users. Firstly, by displaying feedback (such as: rating, like, dislike) or implicit feedback (such as: click, search) to obtain user interactive items, then obtain the user's latent features from these items, calculate the similarity between the item and the user, and finally approach the prediction item according to the similarity and select the front ranking items recommended to users. The content-based recommendation method depends on the

user's preference and the features of the items. It is not sensitive to the amount of data, so there is no problem of data sparsity, but it is difficult to extract the features of the item.

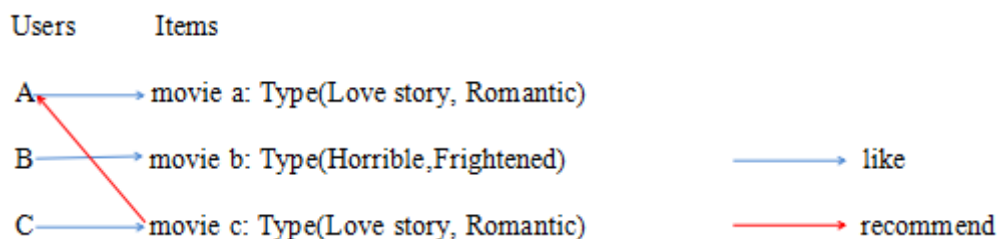


Figure 1. Content-based recommendation

**Collaborative Filtering Recommendation.** Collaborative filtering is mainly divided into three types: User-based Collaborative Filtering (UserCF), Item-based Collaborative Filtering (ItemCF), and model-based collaborative filtering. The UserCF takes into account the similarity between users and users, finds out the items which users prefer, predicts the rating of the target users, and finds the highest rating item set recommended to the user. ItemCF is similar to user-based collaborative filtering, figuring the similarity between items, and recommending the highest rating item set to the user. The model-based approach predicts the latent features of users by constructing a user preference model. Collaborative filtering only needs to use user's historical rating data, so it is simple and effective, and is currently the most successful recommendation method. However, the number of users' rating data is very small compared with the number of items, so there is data sparsity in collaborative filtering algorithm. Moreover, for new users and new items, since no recommendation is available without rating data, there is a cold-start problem.

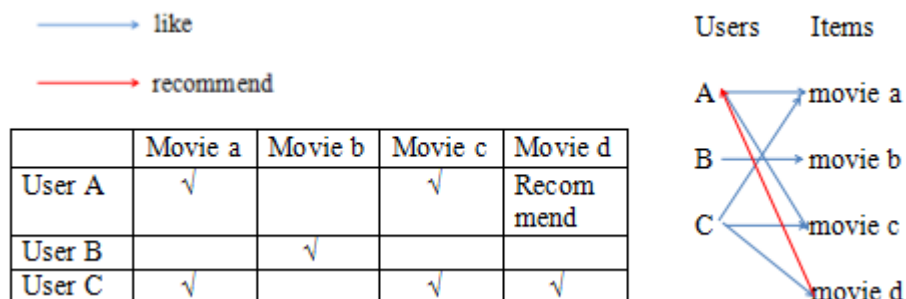


Figure 2. User-based Collaborative Filtering

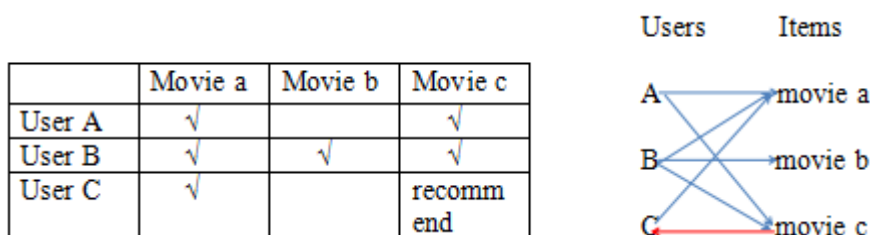


Figure 3. Item-based Collaborative Filtering

**Hybrid-Recommendation.** Considering the shortcomings of the single recommendation method, the hybrid-recommendation [8] can often produce better performance by combining different recommendation algorithms. Common combined strategy includes post integration, fusion and convergence. Post fusion refers to the recommendation results generated by two or more than two recommendation algorithms. The final results are produced by voting mechanism, linear combination or reliability selection combination, which is essentially a mixed decision level. The basic framework of fusion is based on a recommendation algorithm, while merging another recommendation algorithm. The forward fusion is to integrate a variety of recommendation algorithms directly into a unified model, and

then the features extracted from all kinds of data are used as the input of the model, and the recommended results are produced by a unified model.

With the development of social media, the content of recommender system is more varied, including commodities, friends, labels, music, news and so on. Therefore, a large number of new recommendation methods have been generated, such as recommendation algorithm based on social trust and affective perception. It can be seen that the recommender systems is developing towards a more diversified way in the recommendation method. Next, we will focus on recommendation based on social trust.

## Social Trust Recommender Systems

With the exponential growth of online social networking, it is becoming more and more important to integrate social trust information into recommender systems. Hao Ma et al. [1] has proposed a new recommendation model, "Recommendation with Social Trust Ensemble (RSTE)", which combines the preferences of users' preferences and trust. The traditional collaborative filtering recommendation stores users' ratings of items in matrix  $R$ . In which  $R_{ij}$  represents the user  $i$ 's score on the item  $j$ . In document [1], a new understanding is given to all ratings in user-item matrix  $R$ .  $R_{ij}$  indicates the rating of user  $i$  and its trusted friends on item  $j$ , which uses user-item matrix and user's social trust network to recommend. Firstly, in terms of user preferences, the user-item matrix is decomposed to learn two low dimensional matrices of user latent features and item latent features. Then, a probabilistic factor analysis framework is adopted to fuse the preferences of users and their trusted friends through one parameter. Finally, we perform gradient descent objective function, learn low dimensional user specific matrix and item specific matrix, and predict users' preferences for different items.

Compared with social trust, some researchers have found that distrust relations play an important role in recommender systems. M.Mahdavi [9] and others put forward to the integration of social trust and distrust in a model-based recommender system. The basic idea of the algorithm is to find the appropriate latent features for the user, making each user closer to the user he trusted, separate from the users he distrusted and the users with different interactions. In addition, in order to improve the quality of the recommender systems, Rana Forsati et al. [10] combines the method based social regularization idea with the matrix factorization algorithm to propose a new recommendation model, "Collaboration Social Ranking", called "PushTrust" algorithm. The model is based on social relations in social networks and extracts the latent features of users from the rating matrix. Compared with the existing social regularization model, the model uses the trust, the distrust and the neutrality relationship between the users. From the user's point of view, the aim is to find the latent features of the neighbors of the user  $u$ , and then sort them based on the similarity of the latent features of the user  $u$ . The user  $u$ 's trusted user, the distrust and the neutral of the user is divided into a distinct boundary, and the trusted user  $N^+(u)$  is placed at the top of the list, the user  $N^-(u)$  is not trusted to be placed at the lower end of the list, and the neutral user  $N^0(u)$  is placed in the middle of the list. As shown in Figure 4 [10].

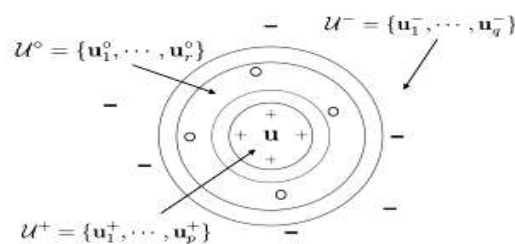


Figure 4. PushTrust Algorithm

The advantages and major difficulties of the recommendation algorithms are shown in Table 1.

Table 1 Comparison of the Recommendation Algorithms

Recommendation Algorithms	Main advantages	Main disadvantages
Content-based recommendation	1 A good model for user interest. 2 The increase in items property can improve the precision of recommendation.	1 Cold-start problems of new users and new items. 2 The items property is limited and it is difficult to get more data.
Collaborative Filtering Recommendation	1 Support users to find latent interest preferences. 2 There is no need for rigorous modeling of items or users.	1 Cold-start problems of new users and new items. 2 Data sparsity problem.
Recommend based on Social Trust	1 Relieving cold start problem. 2 Alleviating the problem of data sparsity.	1 How to integrate real-time factors in social networking. 2 Explore more social trust models to effectively model social trust relationships.

### The Trend of Recommender Systems based on Social Trust

The application of the recommender systems based on social trust has become a hot topic in recent years. However, it can be seen from the above analysis that it is still in the continuous stage, and there will be more and more extensive attempts in the future. The following two possible research directions are summarized.

**Social Trust Combined with existing Traditional Recommendations.** The traditional recommendation algorithm has the advantages of simplicity and strong interpretability, but it is difficult to learn the implicit representation of the deep user-item by using the artificial extraction features and using the shallow model to predict. Integrating into social trust relationships, we can learn more deeply and more dense hidden representations of users and items. Therefore, integrating the advantages of both sides can improve the quality of recommender systems.

**New Model of Social Trust Recommendation.** For recommender systems, recommended items and scenarios are always changing, such as movie recommendation, video recommendation and commodity recommendation. It is unrealistic to construct a social trust model for all recommended items. A friend who is trusted by a user in the movie scene does not mean that he will trust the same friends in the commodity recommendation scenario. This requires different social trust models to be recommended for users in different scenarios. In addition, the user's preference may be influenced by the change in time series, such as the user likes to listen to quiet light music for a certain period of time. Over a period of time the user may like to listen to classical music, and the user will change the trust of the user at this time. Therefore, it is one of the research directions to study a new social trust recommendation model with multiple elements.

### Summary

As the Web users personalized demand increasing, the problem of "information overload" is brought into focus year by year, and the recommender system plays a more important role in various fields. Compared with the traditional recommender systems, which based on social trust can integrate social trust into the recommender systems, build a new recommendation model by learning the latent features of users and items from the mass data, and recommend an effective list of items to users, which can reflect the different preferences of the users and further enhance the user's preference. Further improves the accuracy of the recommendation. On the basis of the analysis of the problems existing in the traditional recommendation algorithm, this paper analyzes the research status and progress of the recommender systems based on social trust, and puts forward the development direction in the future.

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