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Social recommendation via multi-view user preference learning

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ABSTRACT

Recommender system (RS) has become an active research area driven by the enormous industrial demands. Meanwhile, with the rapid development of microblogging system, various kinds of social data are available, which provide opportunities as well as challenges for traditional RSs. In this paper, we introduce the social recommendation (SR) problem utilizing microblogging data. We study this problem via multi-view user preference learning. Specifically, we first model user preference by learning a low-dimensional common representation of multi-view information including rating information, social relations, item side information, tagging information, and then recommend items based on the learnt user preference. We also develop an efficient alternating direction method of multipliers (ADMM) scheme to solve the proposed model. We empirically evaluate our approach using two real world datasets to demonstrate the significant improvement of our proposed approach against the state-of-the-art algorithms.

1. Introduction

With the rapid growth of available information on the Internet, users are getting into trouble with the information overload problem. Recommender systems (RS) [1] intend to help user select interesting information by mining user preference, which has been widely applied to many areas such as e-commerce, online reading, review websites, and so on. Meanwhile, microblogging system is witnessing a dramatic change in the recent years. Social information from microblogging system provides diverse sources for recommendation beyond explicit rating information, which provides opportunities as well as challenges for traditional RSs.

Social recommendation (SR) has attracted increasing attention in recent years. Under the broad definition, any recommender systems that target social media domains could be considered as SR [2]. Current SR could be divided into two categories, *content-based* SR [3–5] and *collaborative filtering (CF) -based* SR [6,7]. Content-based SR incorporates textual information to help the recommendation procedure, and most of them focus on recommending items with textual information. By contrast, CF-based SR integrates social information in traditional CF frameworks. Currently, most of the existing CF-based SRs add social regularization terms on rating regression objectives to improve recommendation performance [8]. Besides, there are some hybrid models that combine content-based SR with CF-based SR [9,10]. For example, MR3 [10] intends to incorporate social relations and item reviews together with rating information to improve the recommendation performance.

In this paper, we introduce a new SR problem utilizing microblogging data. As is known to all, microblogging system such as Sina Weibo[1] contains a large number of personal information that can reflect user's preference. However, in the past, it is really hard to bridge the information from microblogging system and review site. As a consequence, few work has been done to incorporate microblogging data into recommender system. Fortunately, the rapid development of Internet provides the possibility of utilizing these information to enhance the SR performance. For example, we observe that many users on review site such as Douban[2] have a microblogging system accounts, which enable us to obtain their social relations and tagging information from microblogging system, and then integrate these information into our SR framework. We study this problem from the perspective of multi-view user preference learning, where *multi-view* means various description of a user's preference. We define the following two views in SR problem: $\mathcal{V}1$. **social view**, i.e., the microblogging system; $\mathcal{V}2$. **recommend view**, i.e., the review site. The multi-view learning process is to learn the common representation of the social view information and recommend view information. Previous works have shown that tagging information reflects user's

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[1] http://www.sinaweibo.com
[2] http://www.douban.com

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preference in social view [3,11,12]. However, the free-form of tags results in tag redundancy and ambiguity, and thus the tagging matrix can be considered as a low-rank matrix. Therefore, user preference in social view can be regarded as a low-dimensional representation of tagging information. Similarly, user preference in recommendation view can be regarded as a low-dimensional representation of rating information. There is strong evidence proving that information from both two views have a strong correlation [13,12,3]. For example, a user with a personal tag 'Geek' may be interested in technology. As a result, he may like movie 'Interstellar'. Therefore, we assume these two views share the same low-dimensional representation, i.e. user preference. We model user preference by learning a common low-dimensional representation of information from both views. We employ a multi-view learning style method [14–16] in our SR framework to bridge tagging information and rating information. As shown in Fig. 1, the user preference matrix is learnt by factorizing the rating matrix from recommend view and the tag matrix from social view simultaneously. Particularly, we utilize item side information from recommend view to accelerate the learning process. That is, we extract item textual description, and then represent it using bag-of-words model [17,18], which can be regarded as side information of user preference. Then we perform the matrix completion with side information (MCWSI) [19,20,8] to complete the rating matrix, which can significantly reduce the computing complexity of low-rank matrix completion.

Furthermore, social relations from social view between two users provide a strong evidence for them to have similar preference, which can be used as another regularization term named graph regularizer [8,7]. We employ it in our framework to user preference modeling process.

It is worthwhile to highlight the main contributions of this paper as follows:

- We introduce a new social recommendation problem by utilizing microblogging data.
- We propose a novel SR model termed multi-view user preference learning (MVUPL), which utilizes rating information, item side information, user social relations, and tagging information.
- We present an efficient alternating direction method of multipliers (ADMMs) scheme to solve the introduced model.
- We evaluate the proposed model extensively on two real-world datasets, showing that the proposed model outperforms several state-of-the-art SR approaches.

The remainder of this paper is organized as follows. Section 2 gives a brief review on related work. Section 3 describes the learning process of the new social recommendation problem, and then introduces the MVUPL model. The solution of our proposed model is also given in Section 3. Section 4 presents experiments and results. Finally, conclusions are given in Section 5.

2. Related work

In this section, we present the most related literature to our work, including matrix completion, matrix factorization, multi-view learning, and recommender system.

2.1. Matrix completion and matrix factorization

Matrix factorization (MF) [21,22] is a classical kind of approach for recommender systems. The basic idea of MF is to factorize the rating matrix into two low rank matrices, i.e., user preference matrix and item feature matrix respectively. Then the two matrices to approximate are multiplied to the original rating matrix. Matrix completion (MC) is the method of filling in unknown entries in an uncompleted matrix [23]. MC has been widely applied to recommender system because the rating matrix is often incomplete. Most MC algorithms assume that the incomplete matrix is low rank [24,25]. The rank minimization problem is NP-hard, thus, it cannot be applied to practical applications. However,

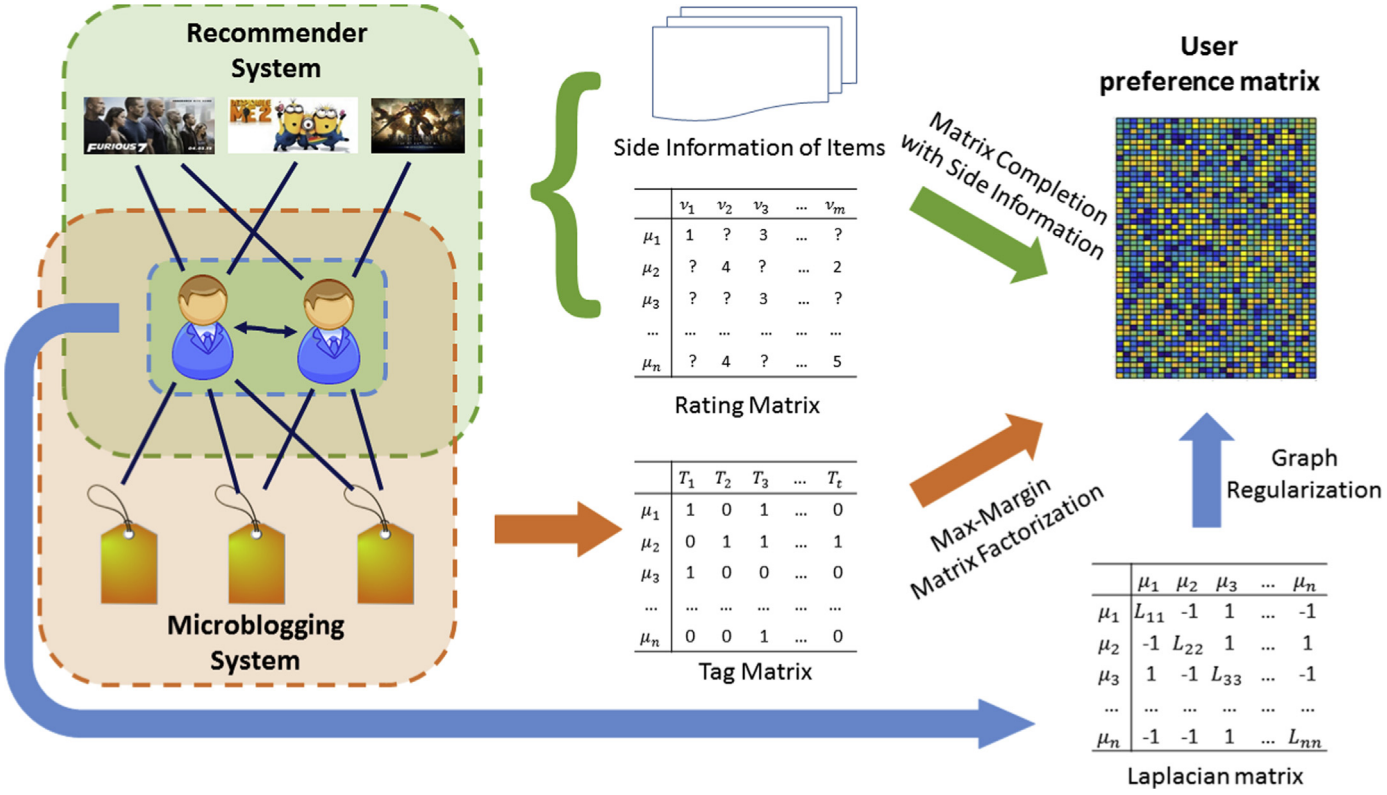

Fig. 1. MVUPL model.

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