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Comparison and Evaluation of Recommendation Systems on Social Networks

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ABSTRACT

Social network based-recommendation has some benefits that it approach used for improve of recommendation systems. Recommendation systems are appropriate tools for provide useful and suitable recommendations in social networks. Nowadays web users are not only consumers of information, but they actively participate in social networks. We checked dimensions of recommendation systems on social networks in this paper and reviewed the related articles and then classified those based on the main technique for articles. We categorized the articles into four techniques, includes tag-based, context-based, social influence-based and trust-based recommendation system on social network. Finally we compared properties of articles in each category and then explained advantages and disadvantages of each model.

KEYWORDS: recommendation system, social network, trust, tagging, context.

1. INTRODUCTION

The plurality and popularity of social networking sites sank users into huge volumes of information and create a great challenge in terms of information overload. When people join social network web sites, first create a profile. User profiles are unique pages that people can express emotions and thoughts. User profile is a backbone of social network. The recommender technology is superior to other information filtering applications because of its ability to provide personalized and meaningful information recommendations (Zhou, Xu, Li, & Josang, 2012).

Social network based-recommendation uses for improve recommendation systems because of its benefits. For example, as long as cold-start users are connected to the social network, it can deal with them. Main goal of some articles in recommendation system is omitting the cold start problem for new users. (Nabizadeh Rafsanjani, Salim, Mohammadhossein, & Bagheri Fard, 2013) purpose a new framework that omitted the cold start problem for new user that helps to increase the accuracy of results of recommendation system. Social network based recommendation systems are more robust to fraud, in particular to profile attacks (Jamali & Ester, 2011). Also (Sinha, 2001) compare quality of recommendation systems with friends' recommendation. Their results show that users prefer friends' recommendation against generated recommendation from system. In past, finding close friends' user on the internet was difficult. Nowadays obtaining social network information is easy trough social networks sites. So, study about the use of social network information in recommendation process will probably produce valuable results (Liu & Lee, 2010).

There has been an increase in user-generated content in recent years. User-generated content can be exploited for many applications. More accurate and sophisticate user profiles contains users' item preferences, users' topic interests and trustworthiness between users can be built by exploiting the UGC. Some new strategies in web 2.0 framework are related to social recommendation systems (Zhou, Xu, Li, & Josang, 2012). There are challenges for social network based recommendation systems, such as, low probability of finding rater at small network distance and noisy rating at large network distances. Also social network data is very sensitive (Jamali & Ester, 2011).

The rest of the paper is organized as follows. The section 2 explains properties of study and research methodology. Then the section 3 introduces the literature reviews and the related articles. Also the section 4 comparisons and evaluations models of each category with each other. Finally results and future works are explained in section 5.

2. Properties of study and research methodology

2.1. Properties of study

Social networks provide large source of data. There are many ways in which social networks can be automatically derived on the web. Members of groups listed in an HTML document can be turned into a social network. Also many online communities lack some of properties one may expect of a social network. (Golbeck,

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2005) considers many criteria for a web-based social network. These criteria use for selection of articles related to recommendation systems on social networks. Social networks on selected articles must be accessible over the web with a web browser and users must explicitly state their relationship with other people qua stating a relationship. Also the system must have explicit built-in support for users making these connections and relationships must be visible and browsable (Golbeck, 2005).

On the other hand, Recommendation systems can be divided into two areas: object recommendation and link recommendation (Naruchitparames, Gunes, & Louis, 2011). But this paper considers related models to object recommendation area.

2.2. Research methodology

Given the nature of social networks and Recommender Systems, it is difficult to limit each article to a specific field and sometimes multiple fields have been used at the same time in the purposed model of article. The main method of each model is considered to classify them. Research papers on recommendation systems on social networks are scattered across diverse journals such as information technology, information science, computer science, management and data mining. Data base of different electronic journals were searched for recommendation systems on social networks papers. The research papers were reviewed and papers were deleted that were not related to recommendation systems on social networks or don't have our properties of study. Finally, among of about 150 reviewed papers, 22 papers were found that met these conditions and were selected for the study.

3. Literature review

According to the selected papers and their main technique, we classify models of recommendation system on social networks in 4 main categories. Fig. 1 Shows papers categories that contain tag-based, context-based, social influence-based and trust-based methods. The models of each category are studied in the rest of section.

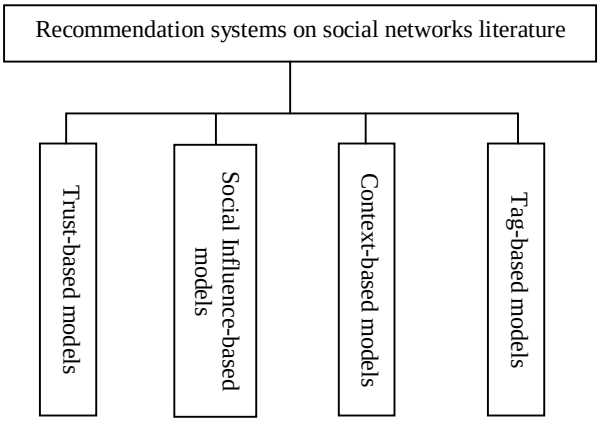

Fig.1. Recommendation systems on social networks categories

3.1. Tag-based models

Social tagging is the most important way to organize online resources (Zhang, Zhang, Gao, Guo, & Sun, 2012). Social tags can provide information about item contents and personalized preferences and as a result social tags help to generate better personalized recommendations (Wu & Zhang, 2010).

(Zhang, Zhang, Gao, Guo, & Sun, 2012) believe that information in the content of resources should be considered to improve recommendation quality and to deal with the over sparse problem. They purpose a recommendation approach for social tagging systems that combine content and relation analysis in a single model. The most advantage of this model is that even when relation information is inadequate, the model can still extract knowledge from content information and reveal relation between objects (Zhang, Zhang, Gao, Guo, & Sun, 2012).

Also, (Wu & Zhang, 2010) assume that a basic attraction may exist for each item. Results of (Wu & Zhang, 2010) shows that the usage of both tag information and attractor can significantly improve diversity of personalized recommendations. (Durao & Dolog, 2012) present a tag-based recommender system that suggests similar Web pages based on the similarity of their tags. (Lee, Chung, & McLeod, 2011) propose a novel technique for item recommendation within social networks that matches user and group interests over time, and users and tags associated with an item represent and cluster by topics. In addition, (Jin & Chen, 2012) use tags, which can be regarded as users and items feature information, to compute the similarity between users or items. Also,

(Yuan, Yu, & Zhang, 2011) propose a collaborative filtering recommendation algorithm based on the social tagging in a digital library and (Wang, Tan, & Zhang, 2010) present a novel social network based recommendation algorithm that consider users' co-tagging behaviors.

3.2. Context-based models

Traditional recommendation systems only consider users' preferences, but do not take other criteria into account like temporal, geospatial or emotion features (Pessemier, Deryckere, & Martens, 2009). (Gonzalo-Alonso, de Juan, Garcí-a-Hortelano, & Iglesias, 2009) propose a hybrid collaborative filtering model, which provides recommendations based on the context of the travelling users. Also, (Akther, Alam, Kim, & Saddik, 2012) design a new architecture for user personalization which combines both social network data and context data. In addition, (Sim, Kim, Kim, & Youn, 2012) propose a new context-aware recommendation scheme that provides recommendations of services to the user by considering of user's social position and the context.

3.3. Social Influence-based models

Social influence has rarely been considered in traditional recommender systems but play an important role in product marketing (He & Chu, 2010). (Carmagnola, Vernero, & Grillo, 2009) present SoNARS, a new algorithm for recommending content in social recommender systems that targets users as members of social networks, suggests items that reflect the trend of the network itself, based on its structure and on the influence relationships among users. (He & Chu, 2010) present a social network-based recommender system (SNRS) which makes recommendations by considering a user's own preference, an item's general acceptance and influence from friends. Also (Ha, Oh, Hong, & Jo, 2012) propose a recommendation system based on advanced user modeling by using social relationship of users. (Zhao, Yuan, Hong, Wang, Li, & Chua, 2012) present a novel approach that considers relationship strengths between user and his friends for calculate a recommendation score. In addition, (Shang, Kulkarni, Cuff, & Hui, 2012) construct a random walk based collaborating filtering model that considers items, users, item content, user profile and social network information.

3.4. Trust-based model

With the advent of online social networks, the trust-based approach to recommendation has emerged which can better deal with cold start users since users only need to be simply connected to the trust network Moreover, Trust-based approaches Are more robust to profile attacks (Jamali & Ester, TrustWalker : A Random Walk Model for Combining Trust-based and Item-based Recommendation, 2009).

(Golbeck & Hendler, FilmTrust: Movie Recommendations using Trust in Web-based Social Networks, 2006) present a recommendation algorithm that trust is core of the algorithm for prediction of ratings that is so-called TidalTrust. Also, (Massa & Avesani, 2007) propose to replace step of finding similar users with use of a trust metric (MoleTrust). (Jamali & Ester, TrustWalker : A Random Walk Model for Combining Trust-based and Item-based Recommendation, 2009) present a random walk model (TrustWalker) which combines trust-based and item-based recommendation. In addition, (Ma, Yang, Lyu, & King, 2008) propose a factor analysis approach based on probabilistic matrix factorization that is so-called SoRec. This approach assumes that the observed data is a linear combination of several latent factors. (Yang, Long, Smola, Sadagopan, Zheng, & Zha, 2011) propose a framework that exploits homophily to establish an integrated network linking a user to interested services and connecting different users with common interests, upon which both friendship and interests could be efficiently propagated. Aiming at modeling recommender system more accurately and realistically, (Ma, King, & Lyu, Learning to Recommend with Social Trust Ensemble, 2009) propose a novel probabilistic factor analysis framework, which naturally fuses the users' tastes and their trusted friends' favors together. (Jamali & Ester, A matrix factorization technique with trust propagation for recommendation in social networks, 2010) by employing matrix factorization techniques, explore a trust-based recommendation in social network that is so-called SocialMF.

4. Comparison and evaluation of models

In this section the proposed models in previous section are compared together and results are shown in tables in summery. Since, basic method in these models is collaborative filtering, limitation of them classified in some categories, such as cold-start user problem and sparseness. Also, there are some benefits in recommendation systems in social networks that are included understanding of trends in user interests (diversity of the recommendation), more accuracy recommendations and better performance. In following, we use this features for evaluating of the models.

Table1. Comparison of tag-based models

	Weakness		Benefits		
Model preference	Cold-start user	Sparseness	More accuracy recommendations	diversity of the recommendation	**Better performance**
Zhang et al (2011)	✓	×	×	×	✓
Wu and Zhang (2010)	✓	✓	×	✓	×
Durao and Dolog (2012)	✓	✓	×	×	✓
Lee et al (2011)	✓	✓	✓	✓	×
Jin And Chen (2012)	×	✓	×	×	✓
Yuan et al (2011)	×	✓	×	×	✓
Wang et al (2010)	✓	×	×	×	✓

4.1. Comparison of tag-based models

We compare tag-based models described in section 3 and review their features. Developed model by (Zhang, Zhang, Gao, Guo, & Sun, 2012) has recommendation quality outperforms traditional methods and also could deal with over sparse problem. Also, (Wu & Zhang, 2010) use tag information of user-item pairs for improve the diversity of the recommendation. Result experiments by (Durao & Dolog, 2012) show that approximately 60% of the recommendations succeeded.

Also the developed system by (Lee, Chung, & McLeod, 2011) present more accuracy recommendation with using of tags and understanding of trends in user interests over time is one of its benefits. In the same way, in (Jin & Chen, 2012) and (Yuan, Yu, & Zhang, 2011) results are shown high quality and performance and also those solve the problems of cold start users very well. Presented tag-based recommendation in social network algorithm in (Wang, Tan, & Zhang, 2010) is outperform on sparse data sets. In summery these benefits and weaknesses of models are shown in table 1. As shown in table 1, the most of models have better performance than traditional systems and a few of them have benefits of diversity of the recommendation and also a few of tag-based models can deal with cold start users and sparseness problem.

Table2. Comparison of context-based models

	Weakness		**Benefits**		
Model preference	**Cold-start user**	**Sparseness**	**More accuracy recommendations**	**diversity of the recommendation**	**Better performance**
Alonso et al (2009)	✓	✓	×	✓	×
Akther et al (2012)	✓	✓	✓	×	×
Sim et al (2012)	✓	✓	✓	×	×

4.2. Comparison of context-based models

In this section, we review properties of context based recommendation system in social network models. Presented model in (Gonzalo-Alonso, de Juan, Garcí-a-Hortelano, & Iglesias, 2009) can understand trends in users and since tackle the problem of non-correlation among the tastes of users from disparate geographical areas, which is sufficient for travelling user. Recommender systems in (Akther, Alam, Kim, & Saddik, 2012) could provide more desirable items for their customers by utilizing aggregated user profile and rich context information. Also, (Sim, Kim, Kim, & Youn, 2012) improve the accuracy of rating by using of context information. As shown in table 2, a lot of context-based recommendation system on social network models present more accuracy recommendations.

4.3. Comparison of social influence-based models

In this section, we compare features of recommender system models which explore social networks for generation recommendation or models which are based on influence of friends and network. In (Carmagnola, Vernero, & Grillo, 2009) items are recommended to members of social network based on trend of the network and the influence relationships among them. Therefore, in this model, users are likely to have more in common with members of their social networks. (He & Chu, 2010) present a model that is so-called SNRS which consider

influences of distant friends and results show that proposed method not only improves prediction accuracy of recommender systems, but is way to tackle the data sparsity and cold-start problem. Also, proposed model in (Ha, Oh, Hong, & Jo, 2012) applies advanced user modeling by using relationships between social network users and results show that this method can achieve better performance than traditional methods. Relationship between user and friends are considered as important factor in recommendation score in (Zhao, Yuan, Hong, Wang, Li, & Chua, 2012) and accuracy of recommendations are improved. Finally, (Shang, Kulkarni, Cuff, & Hui, 2012) consider item content, user profile and social network information for generation recommendation and the proposed method not only solves the data sparsity and cold-start problem but also has a good efficiency. Table 3 show comparison of social influence-based models that is included of weakness and benefit of models. As shown, social influence-based models can deal with cold start users and sparse problem and can generate more accuracy recommendations and have better performance in some cases.

Table3. Comparison of social influence-based models

	weakness		Benefits		
Model preference	**Cold-start user**	**Sparseness**	**More accuracy recommendations**	**diversity of the recommendation**	**Better performance**
Carmagnola et al (2009)	×	✓	×	×	×
He and Chu (2010)	×	×	✓	×	×
Ha et al (2012)	✓	✓	×	×	✓
Zhao et al (2012)	✓	✓	✓	×	×
Shang et al (2012)	×	×	×	×	✓

4.4. Comparison of trust-based models

Trust-based recommendation systems on social network models are compared in this section. TidalTrust and MoleTrust are addressed in (Golbeck & Hendler, FilmTrust: Movie Recommendations using Trust in Web-based Social Networks, 2006) and (Massa & Avesani, 2007) report high coverage for cold start users and more accuracy recommendations. TrustWalker outperforms both collaborative filtering methods and purely trust-based methods especially in terms of coverage but doesn't necessarily improve the accuracy of the system. TrustWalker can better deal with cold start users and also is a good solution to the problem of sparseness (Jamali & Ester, TrustWalker : A Random Walk Model for Combining Trust-based and Item-based Recommendation, 2009). (Ma, Yang, Lyu, & King, 2008) propose a solution for data sparseness problem and weak predictions. Presented models in (Yang, Long, Smola, Sadagopan, Zheng, & Zha, 2011) and (Ma, King, & Lyu, Learning to Recommend with Social Trust Ensemble, 2009) try to establish more accurate and realistic trust-based recommendation systems. Also the trust-based recommendation model in (Jamali & Ester, A matrix factorization technique with trust propagation for recommendation in social networks, 2010) lead to a substantial increase in recommendation accuracy, in particular for cold start users. In summery the benefits and weakness of the models are shown in table 4. As shown, most of models have more accuracy recommendations and are suitable for sparseness datasets and in some cases can better deal with cold start users.

Generally, the most of models focus on better performance and generating more accuracy recommendations. Also, the most of models are able to provide more accuracy recommendation to cold start users and in some cases the models make suitable recommendation with sparseness rating data.

Table4. Comparison of trust-based models

	Weakness		Benefits		
Model preference	**Cold-start user**	**Sparseness**	**More accuracy recommendations**	**diversity of the recommendation**	**Better performance**
Golbeck and Hendler (2006)	✓	×	✓	×	×
Massa and Avesani (2007)	×	×	✓	×	×
Jamali and Ester (2009)	×	×	×	×	×
Ma et al (2008)	✓	×	✓	×	×
Yang et al (2011)	✓	×	✓	×	×
Ma et al (2009)	✓	✓	✓	×	×
Jamali and Ester (2010)	×	✓	✓	×	×

5. Conclusion and future work

Social networks can play an important role in recommendation systems. In this paper we study recommendation system on social network models. We classify these models in 4 categories include: tag-based models, context-based models, social influence-based models and trust-based models. Then we study properties of each models category and review weaknesses and benefits of them. Each category of models focuses on different benefits and weaknesses and can better deal with some of them. The most of the models focus on better performance and more accuracy recommendations and try to solve cold start and sparseness problem. In future works we want to classified models according to model-based and memory based methods and compare them in these categories and rank them according to their results.

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