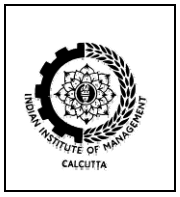

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Use of Tags in Recommender Systems: A Survey

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USE OF TAGS IN RECOMMENDER SYSTEMS: A SURVEY

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USE OF TAGS IN RECOMMENDER SYSTEMS: A SURVEY

Abstract

Recommender systems are one of the most popular systems that help in personalization of ecommerce sites and collaborative web sites. Tags are textual description given to resources by users and are prevalent in most web 2.0 websites as they help in organization and retrieval of resources. In this paper we present an overview of the way tags are used in recommender systems and also on the aspect of recommendation of tags for items. This paper surveys the work done on two aspects of recommendations based on tags (a) Recommending items to users and (b) Recommending tags for items. This paper also discusses possible extensions that can improve recommendation capabilities using tags and make better tags recommendation for items.

Index Terms: Tagommenders, Tag suggestion, Tags, Recommender Systems

1. Introduction

Recommender systems are technology-based systems that provide personalized recommendations to users. In these systems, opinions and actions of other users with similar tastes are used to generate recommendations. Recommender systems primarily use ratings data given by a user to different items present in the system to make personalized recommendations. Recommender systems are a ubiquitous feature in most ecommerce sites such as Amazon.com, Ebay.com, Netflix.com, Last.fm etc. Recommendation systems popularity is not only because of their ability to provide personalization features but also due to their impact in higher sales and profits. In[Chen, Wu et al. 2004] , it has been shown empirically on Amazon.com dataset that recommender systems indeed improved sales. However, with increasing popularity of recommender systems in ecommerce sites they have become susceptible to attacks by malicious users who try to influence the systems by inserting biased data into the system [Mobasher, Burke et al. 2007]. Recent research on trust aware recommender systems [Massa and Avesani 2004; Golbeck 2006; Massa and Avesani 2007] has shown that they are more robust against shilling attacks and are more capable of generating recommendations for new users in the system. Trust aware systems also have been shown to produce recommendations which are better than or as accurate as collaborative filtering based recommender systems. Trust

aware systems are able to make more accurate recommendation compared to traditional systems as they use the concept of trust propagation over a trust network. Because of these advantages over traditional systems, trust aware recommender systems are generating much research interest.

Traditional recommender systems help users in tackling the problem of information overload by recommending products and services that will be of interest to them from the vast universe of choices available. Popular ecommerce sites like Amazon.com suggests products users may like based on their ratings, clicked items, and purchased items [1]. Users of Digg.com receive news articles based on other articles they find interesting [2]. Netflix provides movie recommendations based on movie ratings [3]. Because of the enormous use of recommender systems in practical applications on the web, research interest in the area is immense.

Traditional recommender systems primarily use only ratings for recommending items but recent work has shown that using tags data along with the ratings seems to improve upon the traditional method of recommending. Tags are widely used for information organization on the web. A social tag is a piece of brief textual information given by users explicitly to describe and group items, thus it implies users' interests or preferences information. The social tags in web 2.0 are becoming another important information source to profile users' interests and preferences for making personalized recommendations. Tagging has emerged as a powerful tool that enables users to find, organize and understand online entities. Numerous efforts have been made to better understand and exploit the use of tags and their usage patterns.

Tagging offers users an alternate way to organize items. As users create tags, they represent concepts meaningful to them. Tags offer flexibility to the users in describing the item content and as a result provide personalized information about the user to the recommender system that leads to improved recommendation quality. A model of tagging system is shown in figure1. There are three ways in which tags play a role in recommender systems. First tags information is used in addition to item rating and content information for recommending items to users, secondly, algorithms are designed for recommending tags for items and finally tags information can be used to recommend users.

In this paper, we present a comprehensive survey of different approaches used in solving the problem of recommending items to users using tags and the problem of recommending tags for items. We first describe the approaches used for tag based item recommendation in section 2 and in section 3 we survey the approaches used in

recommending tags for item. In section 4 we discuss way in which existing capabilities of tag based recommender systems can be extended.

Table. 1. Definition of popular terms used in tagommenders.

Terms	Explanation
Folksonomy	The term folksonomy describes the taxonomy-like structures that emerge when large communities of users collectively tag resources. A folksonomy is a system of classification derived from the practice and the method of collaboratively creating and managing tags to annotate and categorize content.
Tags	A 'tag' is a descriptive keyword or phrase often used to categorize a piece of content. Tag is a metadata and it helps in describing an item and it allows it to be found again by browsing or searching.
Web 2.0	The term "Web 2.0" is commonly associated with web applications that facilitate interactive information sharing , and collaboration on the Web. A Web 2.0 site allows its users to interact with each other as contributors to the website's content, in contrast to websites where users are limited to the passive viewing of information that is provided to them.
Tag Cloud	A tag cloud or word cloud (or weighted list in visual design) is a visual depiction of user-generated tags, or simply the word content of a site. A tag cloud is a box containing a list of tags with the most prominent or popular tags receiving a darker and bigger font than less popular tags.
Tagging	Tagging is the process of assigning personal keywords (“tags”) to resources by users. The related concept folksonomy is the set of labels that emerges from the tagging process.

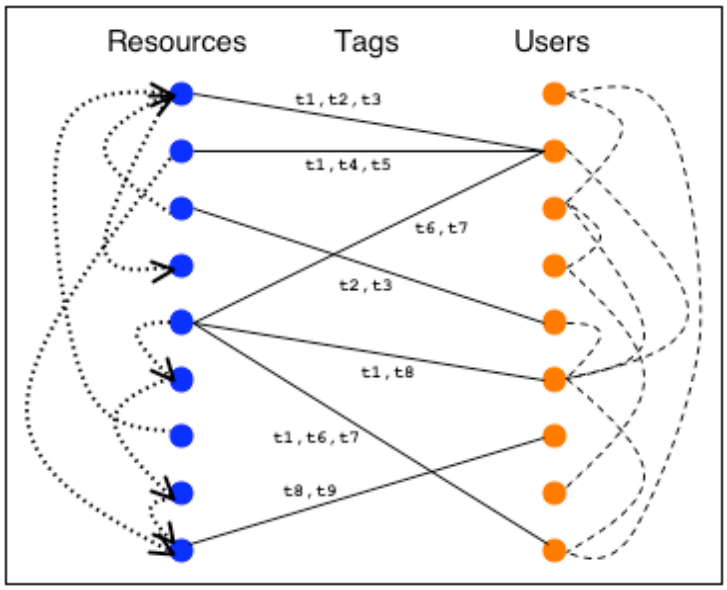

Fig. 1. Model for tagging systems [40].

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Earlier approaches for prediction in trust aware system make predictions in trust-aware systems utilizing all the trust statements present in the data. The reason explained for the superiority of trust based recommendation over traditional recommendation approach has been attributed to the fact that there is high correlation between trust and user similarity. In [Abdul-Rahman and Hailes 2000], it has been shown that user develop social connections with people that have similar tastes. In [Ziegler and Lausen 2004] they have empirically shown correlation between trust and similarity in an online community Allconsuming.net. Existing approaches in trust-aware systems assume that a trust statement passed between two users imply that similarity between both users will be high. We believe that every trust statement passed by a user A on user B does not signify that correlation between A and B will also be high. User may pass trust statements on another user on the basis of perceived notion that his preferences matches with the other user, while similarity calculated based on ratings may show that they are different. We believe that presence of trust statements between users with low similarity impacts prediction quality adversely. In this paper we propose an approach where we reconstruct the trust network by removing those statements between users where similarity between the users fall below a set threshold correlation. We also examine different weightage schemes to

generate prediction. Existing approaches only use trust as weightage. Through experimental evaluation on Epinions[1] data set we show that our proposed strategy of using reconstructed trust network for generating predictions shows substantial improvement in accuracy over existing trust-aware recommender systems.

This paper is organized as follows. In section 2 and section 3 we provide a summary of trust in web based social networks and trust-aware recommender systems respectively. In section 4 we describe our proposed recommendation approa[2]ch. In section 5 we describe the experimental evaluation process and report the results obtained in section 6. We conclude the paper in section 7.

2. Survey of Tagommender Approaches

Researches in the area related to tags in collaborative networks have focused on variety of topics like "why do people tag?" [4] or the motivations behind tagging behavior [5] or how to improve tag quality [6]. One area that has generated the most interest is in researching methods by which item recommendations can be improved by using tag information. In this section we review recommender systems literature that proposes the use of tags in recommending items.

In traditional recommender systems, the recommendation problem is primarily solved using two techniques [7]; content based and collaborative filtering based techniques. The third approach called hybrid approach combines content-based and collaborative filtering techniques. Collaborative Filtering techniques [8, 9] use rating data to generate recommendations, while content based techniques use content data i.e. keywords describing items to generate recommendations. Recently, in [10] the word tagommenders was coined for those recommender systems that use tags information in addition to ratings data and content data for generating recommendations. Definitions of popular terms used in tags based recommender systems are given in Table 1. As in traditional recommender systems, we classify tags based recommender systems into two categories namely; collaborative filtering based tagommender and profiling based tagommender systems. Collaborative filtering based tagommender systems primarily use ratings data (mostly explicitly given) along with tags data to generate recommendations, while profiling based tagommender systems generate recommendations by profiling users based on their tagging behavior and content data of items they have tagged.

2.1 Collaborative filtering (CF) Based Tagommender Systems

Collaborative filtering (CF) based tagommenders are those systems which integrate tags information into standard CF systems based on user based and item based algorithms. Tags information integrated into the CF systems can be explicit tagging information or inferred tag preference information. Most of the approaches that are categorized into CF based tagommenders can be explained by the model given in [10]. Figure 2 illustrates the model. In [10] tag preferences were inferred from tag searches, tag applications, tag quality, movie ratings and movie clicks. Combining inferred tag preferences data and ratings data final recommendations were generated. It was shown that the accuracy of the recommender system that integrates hybrid tags preferences data (i.e. tag preference algorithm that combining explicit and implicit preferences data) into CF based recommendation outperforms existing CF algorithms. An approach to incorporate tagging information into a model based CF procedure has been proposed in [11]. Tagging information is used to regularize the matrix factorization step in the framework proposed in [11]. The proposed algorithm was evaluated on the movielens data set and shown to outperform CF algorithms. It is also shown as a solution for the cold start problem i.e. the problem of recommending items to new users. Similarly, in [12] it is shown that social tags information combined with CF based methods can help improve recommendations made to cold start users. In [13] a fusion mechanism is proposed that captures the relations between the three dimensions of users, items and tags by extending the existing user-item correlation matrix with tags data. It applies an algorithm that fuses user based and item based CF algorithms so that the correlations between users, items and tags can be captured simultaneously. [14] also develops a unified framework that tries to model the relationship between the three dimensions users, items and tags. This proposed method results show significant improvement over CF algorithms when evaluated over on real life data sets of Last.fm and BibSonomy.

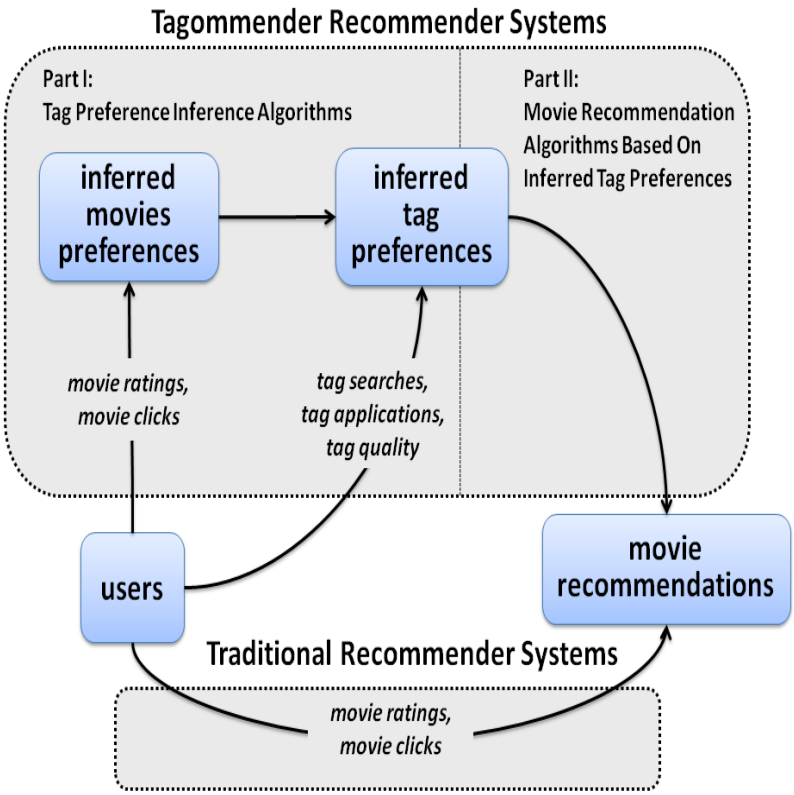

Fig. 2. Model for Collaborative Filtering based tagommenders [10].

2.2 Profiling Based Tagommender Systems

Profiling based tagommender systems are primarily based on refining the profile of each customer through tags data. Profiling based tagommenders systems may use ratings data or CF algorithms but the most critical part of recommendation generation is in creating accurate profiles of customer based on their tagging behavior. In [15] popular tags are used to profile a user. First popular tags are identified, then user is profiled by representing users' original tags and users' topic interests based on the popular tags. This approach is shown to provide accurate profiling information of a user that is then used to find similar users. In [16] and [17] recommendation profiles are created by associating each user with tags clouds that represent their interests. This tags clouds are matched with the collaborative tagging based folksonomies created for describing each item. In [17] the basic idea is to have users creates their own profiles by specifying the most relevant objects in the folksonomy that represent their interests. Folksonomies as a valuable source of information for users interests has also been explored in [18] for learning user profiles. Profiles are inferred by using a Byes text classification model on both textual description of items and tags

provided by users. The recommendation process then exploits the profiles learned. An approach to integrate content-based profiles representing long-term user interests with tags based user profiles acquired by capturing users tagging data has been proposed in [19]. In [20], the approach uses the three-dimensional relationship between users, items and tags as used in [13, 14] to profile users and generate most like-minded neighbors or similar items.

The are few more approaches used for recommending items to users based on tags data. In [21] it is shown that hierarchal clustering of tags is an effective means of generating recommendations in collaborative tagging systems. This approach is shown to be more effective in generating recommendations in spare folksonomies as it removes clusters that are not directly related user's context. Similar to approach used in [19], [22] proposes an approach of integrating users tags and expert developed item taxonomy together to make personalized recommendations.

3 Survey of Tag Suggestion Approaches

Tags are applied by users to items for the purpose of organization and retrieval of items. High quality relevant tags also help in generating better recommendations. Most of the responsibility of tagging lies with the user. Research has shown that even though users realize the benefit of tagging, most people do not tag their resources [23]. It is seen that [24] the perceived benefits of tagging are vaguely defined as a result the user is reluctant to give the required effort. Tag suggestions algorithms help solve the problem by suggesting tags that are relevant thus enabling the user to effectively and efficiently attach tags with items. In [25] the motivations behind tagging and the role of tag suggestion in the systems were studied. The study shows that tag suggestions has a large impact on users tagging behavior as relevant tag suggestions can encourage tagging and provides ideas to users for other possible tags. How social tagging can be enhanced by tags suggestion from a controlled vocabulary in described in [26]. The results show the importance of tag suggestions for vocabulary and retrieval.

Tag co-occurrence is the most popular tag suggestion algorithm. [27,28, 29,30] are some approaches proposed to extract co-occurring tags. In [28] tag-tag correlation network construction is proposed to find co-occurring tags, graph mining approaches like spectral clustering [29] and k-way graph partitioning [30] has also been proposed. For tag suggestion in blogs approaches like VSM, TF-IDF [31] and resource similarity [32] has been proposed. The different tag suggestion algorithms for were compared in [33] and was concluded that a good tag suggestion algorithm should blend different algorithms to provide better suggestions. In [34, 35, 36] various tag suggestion

algorithms have been proposed and implemented tested on the photo sharing sit Flickr.com data set. In [34, 35] a ranked list of tags is presented to the user based on his tagging activity and tagging activity of other users in the systems. In [34] the proposed algorithm forms group-tags matrix, groups that are formed topic wise are associated with tags by using cosine similarities both on the user and the group profiles and the item for which suggestions has to be made. In [35] a hybrid algorithm is proposed by combining Naïve-Bayes and tf-idf approaches. A tag co-occurrence strategy is proposed in [36]. Tag co-occurrence statistics is first extracted, and then based on two tag aggregation strategies and a promotion function tags are suggested to the user. While approaches explained earlier primarily used the collective knowledge of users present in system i.e. the collaborative tagging activity of the users to generate tag suggestions, [37,38] use geo tags i.e. location data to generate tag suggestions for flickr datasets. In [37] the proposed system spirit tagger suggests tag that captures the spirit of the location. Spirit tagger suggests tags that are popular at that particular location. Geographically representative tags are discovered for locally prevalent tags at a particular geographic location. Zonetag [38] uses information about users own tagging history, tagging activity of other users in the flickr community at that particular location to generate a prioritized suggested tag list. To generate the final list several heuristics considering spatial, social and temporal attributes of the tags are applied. Users social network data is used to suggest tags in [39]. Tagging information from four sources are used to make tag suggestions, tags applied to all photos in the systems, tags applied by the users, tags applied to photos of user's social contacts and tags applied to photos in the groups in which the user is a member. Experimentally they show that relevant recommendations are possible through this approach.

4. Future Extensions & Conclusion

Introduction of tag template could be kept as future work, as these templates would minimize the task of the users and would enhance an option for better tag collection and proper classification of tag clouds. Although the focus of the analysis of tag selection methods revolves around three basic types of signals (implicit user behavior, a user's own ratings, aggregate user ratings), more complex techniques may lead to improved accuracy. Future work could explore more sophisticated methods for estimating tag preference. The exploration of more complex algorithms, such as those based on machine learning techniques are left, as future research work. One would also like to validate the techniques using other tagging applications, whether the design principles that is present

generalize to other types of content such as images, articles and bookmarks can be taken as part of the future thoughts. Further research may also show that rating tag-clouds are a useful and more efficient way to find neighbors with similar tastes. To compare the recommendations provided by different tagging schemas (manually tagged vs. automatically derived from the title or the abstract) can be kept aside for further research. The tag information can be used to improve the standard user-based and item-based collaborative filtering approaches.

Further research may show that rating tag-clouds are a useful and more efficient way to find neighbors with similar tastes. It was believed that recommendation algorithms can be improved by combining them with more traditional content-based recommender strategies. Although it was only used in Flickr data in this work, the proposed tag ranking method is a general approach and can be applied for other data sources (e.g., Youtube for video tag ranking). The data sets were mainly available for Movielens, Netflix, Flickr .These approaches can be similarly carried out for other respective sites like ebay, Facebook and Amazon as the future work

Relationships between ratings and tags may also be used to infer the tags that should be applied to a certain movie. One important question related to the findings is how tagommenders will perform in domains other than MovieLens. We plan to investigate alternative tag recommendation strategies and study resource or user recommendation algorithms. Other approaches such as association rules mining and neural networks are worth considering for recommendation in Folksonomies. The extensions include an improvement of users and items of their trusted ones, guided tags, tag template and a provision of more flexible and less intrusive types of recommendations. The recommendation algorithms have not exploited any collaborative recommender techniques. One can also elaborate on the results presented regarding schemes based on tag co-occurrence and information value and will examine whether these results hold among many different tagging applications. The tag information can be used to improve the standard user-based and item-based collaborative filtering approaches. The taxonomy of tagging motivations would benefit from additional data from more ZoneTag users over a longer period of time, especially as ZoneTag is incorporated into more users' daily practice. Future work might explore different tagging mechanisms paths for encouraging people to tag, algorithms for generating better tag suggestions, and an investigation of the information value of individual tags for each resource. The phone is the primary channel and almost the last chance for content annotation, thus these in formations can also be used to make the recommendations, which can be also kept as a part of the future work.

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