

# Review on the Research Progress of Recommendation System Algorithms

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**Abstract**— With the wide application of mobile Internet and smart phone, geographical social network has become an indispensable social information platform in People's Daily life. Since human is a group with typical social attributes, group activities are the state portrayal of People's Daily life and work in the real world. Therefore, in this new social information platform, the recommendation service requirements related to groups and group activities are becoming more and more important tasks in the current recommendation system. Although a large number of studies have been conducted to solve the problem of group recommendation oriented to group activities, there are still some problems in the research of group recommendation :(1) cold start (2) data sparsity. In this paper, the research on popular recommendation algorithms is systematically analyzed and sorted out. Mainly from the current existing research methods and the advantages and disadvantages of the current scheme to summarize; Finally, the characteristics of the current algorithm and the prospect of the future are summarized.

**Index Terms**—Recommendation algorithm, User preference, Recommendation system.

## I. INTRODUCTION

In recent years, with the rapid development of various mobile social applications and location services, location-based social networks (LBSN) have greatly changed people's lifestyle. LBSN can share users' information online, such as the items and services they use, the places they visit, and the activities they participate in[1].

Social networks provide a convenient platform for people to communicate and interact on a global scale. "Users around the world are using social networks to share information and connect with others over the Internet." On social networks, users can communicate with people they know or don't know in real life, or find others who share the same interests or inclinations in politics, economics, music or sports. Advertising agencies can advertise their projects on social media and gain more popularity in a short period of time. Twitter, Facebook and other social media encourage users to express their thoughts, opinions and details of their lives on the platform. Users' posts and online social interactions can be used to accurately infer many user persona attributes, gender, race, age, political interests and location, among other things[2].

Point-of-interest recommendation (POI) is very important for LBSN websites, and has attracted more and more attention from the academic community. The POI recommendation system not only satisfies the user's

preference for POI, but also provides location-based intelligent advertising, thus helping LBSN websites increase their revenue.

At present, POI recommendation system is faced with two problems that need to be solved urgently: data sparsity and cold start. Cold start problem refers to the fact that the recommendation system does not have enough information about new users, which leads to the inability to provide effective recommendations for them. Data sparsity refers to the fact that the number of user check-in records in LBSN is limited, and the number of interest points is very large, so the information in the "user-interest point" matrix is not enough to identify similar users or interest points.

## II. RELATED WORK

### A. Social Networks

Online social networking platforms have become an indispensable part of people's lives in modern society, and these enterprises have gained a large number of users. As of January 2020, Facebook had 2.4 billion users, ranking No. 1 among all social networking applications. Social networking has the advantages of instant messaging, information sharing and Posting comments for users. '

At first, people mainly used social networks to express some of their thoughts. As time goes by, online activities become more complex and diverse. The boom in social networking has led to a huge amount of user-generated content, with 66% of users' tweets about themselves, most of which are free and publicly available.

In addition, more and more users are joining location-based Social networks (LBSN) to enjoy different location-related services, such as friend finding, location-of-interest search, check-in, and geotagging photo sharing.

### B. Recommendation Algorithm

Recommendation algorithm is to make use of some user behavior, through certain steps and mathematical calculation, speculate the user may be interested in or need things, and then recommend to the user. The recommendation system is essentially an information filtering system, which selects the information useful to the user from the mass of information.

## III. COLLABORATIVE FILTERING ALGORITHM

Collaborative filtering algorithm is a widely used algorithm. Based on the comparison object of collaborative filtering algorithm, it can be divided into the following two types: the first is user-based recommendation algorithm. User-based recommendation algorithm is a filtering algorithm, which is used to locate and find the user group that is interested in the target user according to the preference of

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the target user. The other is the item-based recommendation algorithm. The item-based recommendation algorithm includes calculating the similarity and comparative similarity of items, calculating the similarity and comparative similarity of items according to the relationship between target items and existing users and existing behavioral data, and finally providing users with high similarity items[8].

#### A. User-based collaborative filtering

According to the user's rating matrix, it finds the users who are similar to the target users, and recommends the items or items that they have not logged in to the target users according to the preferences of the similar users. After finding similar users, the similarity is taken as the weight, and the predicted score of target users is calculated by similar users' rating of the item[9]. It is necessary to calculate the similarity between users and the user's rating of the current project respectively: To calculate the similarity between users, we need to find the nearest neighbor of the current user. There are a variety of methods to find the nearest neighbor. At present, there are two commonly used algorithms to calculate the nearest neighbor. One is based on cosine algorithm, and the other is based on association algorithm.

#### B. Item-based collaborative filtering

In 2003, Amazon introduced an item-based recommendation algorithm. The algorithm needs to calculate the similarity between the target item and the items that the user has already purchased or evaluated, and to predict the items that the user is interested in. According to the calculated item similarity matrix, the items that the user is interested in are added to the list of items recommended to the user. Compared with the user-based recommendation algorithm, if the number of users is small, the user-based recommendation method can achieve better prediction results. In particular, it performs well in small and ordinary scale e-commerce sites. Thought is based on project recommendation algorithm involving project not only user, because of this, the recommendation algorithm based on project can according to the project of nearest neighbor recommend good computing the similarity between the project and the project ahead of time, the algorithm is able to calculate in advance in the database user ratings of similar project weighted sum, and then concludes that the user rating for the forecast of the project. When a user needs to recommend an item, it will find the item with high similarity to the previously recommended item in the database and recommend it to the user. In this case, the number of similar items is related to the number of items rated by the user, because the number of items rated by the user is usually relatively small, so the predicted value can be obtained online in advance.

#### IV. CONTENT-BASED RECOMMENDATION ALGORITHMS

The basic idea of the algorithm is to construct preference

vectors that can represent the user's interests and hobbies according to the user's history (the commonly used method of constructing preference vectors is TF-IDF technology extraction). Then attribute vectors representing the characteristics of the item are constructed according to the metadata of the item or item. Finally, an appropriate similarity calculation method such as cosine similarity is used. The higher the preference degree, the higher the probability of selecting the item.

The content-based recommendation process includes Item keyword extraction, item-to-item similarity calculation, and Item CF recommendation. Item keyword extraction is to represent item content information as a space vector.

#### V. HYBRID RECOMMENDATION ALGORITHM

This algorithm is not a specific algorithm, but to solve the problems in the above recommendation algorithms, some improvement strategies and algorithm implementation are proposed to improve the accuracy of recommendation.

The main problem is data sparsity. Sparsity problem refers to the problem that the data sets that have interacted with the user input of a specific or specific similar group in a recommendation system account for too small a proportion in the whole data set. For example, in a movie recommendation system, some movies are only rated by a small number of users, so they are rarely recommended to users with similar tastes, even if those small number of users give high ratings, which leads to poor recommendation results.

Different solutions are proposed to solve the problem of data sparsity. Based on collaborative filtering algorithm, Zhang uses step filling to solve the data sparsity problem[3]. Yang proposed a block-coupled nonnegative matrix factorization method by grouping matrices to improve the reconstruction ability of extremely sparse matrices[4]. Roko proposed a scheme based on dual-separation clustering and dual-mean interpolation to reduce the sparsity[5]. Zhang alleviates the data sparsity problem in the recommendation algorithm by clustering nodes in a bidirectional network[6].

#### VI. ADVANTAGES AND DISADVANTAGES OF VARIOUS RECOMMENDER ALGORITHMS

Each algorithm has its own advantages and disadvantages, among which collaborative filtering recommendation algorithm is the most widely used algorithm at present. Collaborative filtering recommendation algorithm is one of the most efficient algorithms in the field of information recommendation, which is based on the analysis of product attributes to achieve recommendation[7]. The advantages and disadvantages of various recommendation algorithms are shown in Table 1.

Recommendation algorithm	Advantage	Disadvantage
Collaborative filtering algorithm	Recommendation performance improves over time; Can provide users with new points of interest; Recommend personalized, high degree of automation; Does not require domain knowledge and can handle complex unstructured phenomena	Sparsity of user-product matrix; Scalability and cold start; Rating data dependence on users

Content-based algorithm	The results are easy to understand and interpretable. No specialized domain knowledge is required; No user rating data is required	Limited by new users/new products; Recommendation results lack of surprise; "Degree" has a bad effect on the recommendation algorithm
Hybrid algorithm	The above problems such as cold start and data sparsity are solved, and the execution efficiency of the recommendation algorithm is improved	The algorithm structure is complex and the implementation is difficult

Table 1

## VII. HYBRID RECOMMENDATION ALGORITHM

### VIII. CONCLUSION

By comparing and analyzing the popular personalized recommendation algorithms, this paper introduces the advantages and disadvantages of different recommendation algorithms and gives corresponding evaluation indexes. The great significance of the research on recommender system for economy and society is as follows:

( 1 ) To help users screen out the matching data from the huge data and provide users with better recommendation services.

( 2 ) Through the data analysis of the recommendation system, users' interests and hobbies can be analyzed, and then timely recommend the corresponding products to users, so as to retain the old customers, but also attract new customers. In this way, turnover can be increased.

With the passage of time, many problems related to recommendation have gradually appeared in the recommendation system, and these problems have also attracted the attention of scholars in the industry. Further research on recommendation system is as follows: firstly, the method of obtaining user preference and the method of extracting features from recommendation objects; The other is about the security of recommendation system and multi-dimensional recommendation system.

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