Summary of recommendation system development

LIU Liling

1 Beijing, Haidian District, Zhong Guan Cun South Street, No.5 Yard, Beijing Institute of Technology, China

Abstract. A recommendation system is an information service system that connects users and projects: for one thing, it helps users discover potential projects of interest; for another thing, it helps project providers to deliver projects to users who are interested in it. The recommendation system is a powerful system that can add value to the company or business. In the future, it will continue to be researched and developed to bring a better experience to users.

1. INTRODUCTION

A recommendation system is a tool that actively finds information that may be of interest to a user from a large amount of information. Building a system that supports online user decisions, recommending a personalized, highly-matched product or project is a core issue in the recommended system area. It can be traced back to cognitive science, approximation theory, information retrieval, prediction theory, management science, and customer selection models in the market \(^1\). In view of the theoretical and practical application value of the recommendation system, this paper reviews the research progress of the recommendation system, and attempts to lay a foundation for further research on the recommendation system theory and the expansion of its application field.

2. RELATED WORK

2.1. Recommendation system and algorithm

The recommendation system is based on recommended techniques. The recommended technique, also known as personalized information filtering, is used to predict whether a given user will like a particular project (predictive problem) or to identify a set of N items of interest to a given user (top-N recommendation) problem. The recommendation system proactively provides users with items that may be of interest, essentially by linking users and projects in a certain way. Figure 1 shows the working principle of the recommendation system. From left to right, the input data source is followed by a recommendation algorithm to generate recommendation results for personalized recommendation. Different recommendation systems use different recommendation algorithms, so the core of the recommendation system is to use different recommendation algorithms according to different data sources.
The recommended algorithms are endless, and different classification results can be obtained according to different classification criteria. The mainstream recommendation algorithms are divided into three categories: content-based recommendations, collaborative filtering recommendations, and hybrid recommendations. With the deepening and development of the recommendation system research, more and more algorithms and models have emerged. According to the model, it is divided into nearest neighbor model, hidden factor model and graph model. It can also be divided into e-commerce domain recommendation, social network domain recommendation, multimedia domain recommendation, mobile application domain recommendation, cross-domain recommendation, etc., depending on the application domain. The recommended system classification framework is shown in Figure 2. The left branch of the frame diagram is the application area of the recommendation system, such as books, texts, pictures, movies, music, shopping, TV programs and others. The right branch is used by the recommendation system. Data mining techniques such as association rules, clustering, decision trees, K-nearest neighbors, link analysis, neural networks, regression, and heuristics.

2.2. Deep learning technology

As more and more data on the Internet can be acquired, multi-source heterogeneous data including images, texts, and tags contain rich user behavior information and personalized demand information, and a mixture of multi-source heterogeneous auxiliary information is combined. The recommended method is more and more important because it can alleviate the problem of data sparseness and cold start in the traditional recommendation system, but the auxiliary information often has complex features such as multi-modality, data heterogeneity, large-scale, data sparseness and uneven distribution. The research on hybrid recommendation methods combining multi-source heterogeneous data still faces serious challenges.

In recent years, deep learning has made breakthroughs in the fields of image processing, natural language understanding and speech recognition, which has become a boom of artificial intelligence and brings new opportunities for the research of recommendation systems. On the one hand, deep learning can characterize the massive data of users and projects by learning a deep nonlinear network structure. It has a powerful ability to learn the essential features of data sets from samples, and can
obtain deep feature representations of users and projects. On the other hand, deep learning can achieve the unified representation of data by mapping different data into a single hidden space by performing automatic feature learning from multi-source heterogeneous data \cite{4}. Based on this, the traditional recommendation method is combined. It is recommended to effectively utilize multi-source heterogeneous data to alleviate the problem of data sparseness and cold start in traditional recommendation systems.

Covington et al. \cite{5} proposed a deep neural network model (see Figure 3) for YouTube video recommendation by using multi-source heterogeneous data such as user information, context information, historical behavior data, and project feature information.

![Covington's Recommendation system](image)

**Fig.3 Covington’s Recommendation system**

### 2.3. Knowledge map

On May 17, 2012, Google officially proposed the term “knowledge map” \cite{7}. The knowledge map is intended to describe the various entities or concepts that exist in the real world, and the relationships between them. Each entity or concept is identified by a globally unique ID, each attribute-value pair is used to characterize the intrinsic properties of the entity, and the relationship is used to connect the two entities to characterize the association between them. Knowledge maps can be combined with a variety of data sources to enrich data semantic information, and can provide services to users in combination with inferred implicit information. With the development requirements of information retrieval, smart city and other application fields, applying knowledge maps to these areas to improve user experience and system performance has become a hot topic in academic and industrial circles.

In the field of recommendation systems, people tend to focus on the connection between users and projects, and lack of considerations for the interconnection between users and users, projects and projects. The knowledge map-based recommendation system enhances the semantic information of the data by connecting users and users, users and projects, and projects and projects to further improve the accuracy of recommendation. It has important research significance and practical value, and gradually becomes a recommendation system, which nowadays is one of the most active branches of research.

### 3. OVERVIEW OF TYPICAL RECOMMENDATION ALGORITHMS

#### 3.1. Demographic-Based Recommendation

The basic assumption of this method is that "a user may like an item similar to a user similar to it." When we need to personalize a User recommendation, we use the User Profile to calculate the similarity between other users, and then select the top K users that are most similar to them, and then use those users' purchase and score information to recommend. A simple and common recommendation is to use the Items covered by these users as a list of recommendations, sort by the average of the scores of Item on these Users, and supply the sorted list of recommendations to the user.
3.2. Content-Based Recommendation
The first step in a typical Content-Based approach is to build a User Profile. A simpler construction method is to consider all the items that the User has ever scored, and make a weighted average of the Item Profiles of these items as the User Profile of the User. Obviously, the strategy for building a User Profile can be complex. For example, we can consider the time factor and calculate the Profile of User in different time periods to understand the changes in User's preference on historical data. With the User Profile, we can start recommending. The simplest recommendation strategy is to calculate the similarity between all the items that the user has not tried and the user's User Profile, in order of similarity. A list of recommendations is generated and output as a result. Besides, the recommendation strategy can also be very complicated, such as considering the real-time interaction data collected during the user interaction process on the data source to determine the ordering, using the decision tree and artificial neural network on the model, but the core of these methods The links are all calculated using the similarity between the User Profile and the Item Profile.

3.3. Collaborative Filtering-Based Recommendation
Collaborative Filtering-Based Recommendation refers to collecting the past behavior of the user to obtain explicit or implicit information about the product, that is, according to the user's preference for the item or information, discovering the relevance of the item or the content itself, or the relevance of the user, and then Based on these associations, recommendations are made. According to the foregoing, recommendations based on collaborative filtering can be based on User-based Recommendations, based on Item-based Recommendations, and based on subclasses such as Model-based Recommendation. The user's preference or scoring matrix for the item is often a large sparse matrix. In order to reduce the amount of calculation, Clustering items for Collaborative Filtering can be used.

4. RECOMMENDED SYSTEM POTENTIAL DEVELOPMENT DIRECTION

4.1. Variety
The data available in the recommendation system is complex and complex. For example, information in the social network, location location information, and other context-aware information are taken into account. Not only does the amount of data increase, but the computational complexity also increases exponentially. In addition, the recommendation system research involves privacy protection. How to ensure personalized recommendation and protect user's privacy is a confrontational problem, which brings great challenges to researchers and developers.

4.2 Interpretable
As an important product in the field of artificial intelligence, the recommendation system is widely accepted and applied. The core of the recommendation is the rationality of the high recommendation result, which also requires the recommendation result to be well interpretable, although this has long been known. It is realized, but the special research on interpretability is still lacking. In the current research, the interpretability discussion of the recommendation algorithm is generally the selection process after the algorithm evaluation. With the high demands of users, the research of “recommendation reasons” has received more and more attention in industry and academia.

5. CONCLUSION
A recommendation system is an information service system that connects users and projects: on the one hand, it helps users discover potential projects of interest; on the other hand, it helps project providers to deliver projects to users who are interested in it. The recommendation system is a powerful system that can add value to the company or business. In the future, it will continue to be researched and developed to bring a better experience to users.
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