

# Recommender Systems: A Survey

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**Abstract:** The aim of recommender system is to provide services and product to the user to improve the customer-relationship management. Researchers recognize that recommendation is a great challenge in the field of Business, education, government and other domains. So it is essential that high quality, review of current trends, not only in the theoretical research result but also in practical developments should be conducted in recommender systems. This paper summarizes the related recommendation techniques.

**Keywords:** Recommender systems, recommendation techniques, E-service personalization, e-commerce, e-government

## I. INTRODUCTION

Recommender system can be defined as a program which will recommend the most suitable items to the user by predicting the user interest on the item based on interactions between items and users [1]. The aim of recommender systems is to reduce the information overload by extracting the relevant services from huge amount of data nothing but personalized services [2]. The important aspect of recommender system is to ‘guess’ a user’s preferences and interest by analyzing the user way of acting with the item.

E-service personalization techniques are represented by recommender systems. Early research in recommender systems grow out of information retrieving and filtering research [3]. Recommender systems emerged as an independent research area in mid-1990s. Commonly used recommendation techniques are collaborative filtering (CF) [4], content-based (CB) [5] and knowledge-based (KB) [6] techniques.

With the development in the recommendation techniques and approaches, more recommendation system (software) has been implemented and many real-world recommendation applications have been developed. Recommender systems application include recommending movies, music, TV program, books, websites, conferences and learning materials, and also it includes the fields of e-commerce, e-government, e-library, e-business services.

## II. RECOMMENDATION TYPES

### A. Non-Personalized Recommendation

In non personalized recommenders everyone is going to receive the same recommendation. The site does not know

who the user is. If we go to amazon.com as an anonymous user it displays the items that are currently viewed by previous member. This is one example of a non personalized recommendation. As suggested by the name, non-recommender systems do not take into account the personal preferences of the customer. The recommendations produced by these systems are identical for each customer.

There are two definitions in this – Predictions and Recommendations.

- 1) *Predictions:* Predictions are bold statements and they come in the form of scores, stars and counts. Prediction is an estimate of how much a user will like an item. They are often scaled to match some rating scale. They are also often tied to search or browsing for specific products.
- 2) *Recommendations:* Recommendations do not make bold statements like predictions. They are just suggestions for items that user might like. They are often presented in the form of “top N lists”. They just place items without any numbers associated with it.

### B. Personalized Recommendation

A personalized product recommendation isn’t based on an assumption or guess. Personalized recommendations are based on user behavior. These are items that have been continuously viewed, considered, or purchased with the particular customer is currently considering. Personalization technology enables the dynamic insertion, customization or suggestion of content in any format that is relevant to the individual user, based on the user’s implicit behavior and preferences, and explicitly given details. A personalized product recommendation is an enabling mechanism to overcome information overload occurred when shopping in an Internet marketplace.

## III. RECOMMENDATION TECHNIQUES

This section reviews the main traditional recommendation techniques like collaborative filtering-bases, content-based, knowledge-based and hybrid methods [7].

### A. Content-Based Recommendation Techniques

Content-based (CB) recommendation techniques recommend the articles that are similar to items considered (preferred) previously by particular user [5]. The main principles of CB recommender systems are: 1) To examine the description of the item chosen by the particular user. These preferences are stored in a user profile. 2) To compare each item's attributed with the user-profile, so that the items with a high degree of similarity with the user profile will be recommended [6]. Two techniques have been used to generate recommendation in CB recommender systems.

- 1) Discovering recommendation based on traditional information retrieval methods, such as cosine similarity measure.
- 2) Generating recommendation based on statistical learning and machine learning methods.

#### B. Collaborative Filtering-Based Recommendation Techniques

Collaborative filtering-based recommendation techniques help the user to make choices based on view-point of other people who share similar absorption [8]. CF techniques can be divided into user-based and item-based CF approaches [9]. In the user-based CF technique user receives the items liked by similar users. In the item-based CF approach user will receive the recommendations items that have similar to those they liked in the past. The similarity between the user or item can be calculated by Pearson correlation-based similarity [10], constrained Pearson correlation (CPC)-based similarity, cosine-based similarity, or adjusted cosine-based measures.

#### C. Knowledge-Based Recommendation Techniques

Knowledge-based recommendation offers items to user based on knowledge about the user, items and their relationship. KB recommendations keep hold of functional knowledge that describes how a particular item meets specific user's needs, which can be based on assumption about the relationship between a user's need and recommendation. Case-based reasoning is a common expression of KB recommendation technique in which case-based recommender systems represent items as cases and generate the recommendations by retrieving the most similar cases to the user's query or profile [11]. Ontology, as a formal knowledge representation method, represents the domain concepts [12] and the relationships between those concepts.

#### D. Hybrid Recommendation Techniques

To attain higher performance and defeat the drawbacks of traditional recommendation technique, a hybrid recommendation technique that combines the good features of two or more recommendation technique into one hybrid technique [13]. The most common practice in the existing hybrid recommendation techniques is to combine the CF

recommendation techniques with the other recommendation techniques in an attempt to avoid cold-start, sparseness and/or scalability problems.

#### E. Computational Intelligence-Based Recommendation Techniques

Computational intelligence (CI) techniques include Bayesian techniques, artificial neural networks, clustering techniques, genetic algorithms and fuzzy set techniques. In recommender systems, these computational intelligence techniques are widely used to construct recommendation models.

#### F. Social Network-Based Recommendation Techniques

Social network analysis (SNA) has been used in recommender systems as a result of the dramatic growth of social networking tools in Web-based systems in recent years. To help improve user experience, recommender systems provide the facility for the user to engage in social interaction with the other user. These trends offer opportunities for making recommendations by utilizing users' social ties, especially for systems whose rating data is too sparse to conduct collaborative filtering.

### IV. E-GOVERNMENT RECOMMENDER SYSTEMS

Electronic government refers to the use of Internet, information and technologies to support government to provide information and services to businesses. Sudden growth of e-government has caused information overload and it will make the users unable to make a decision from huge amount of information. This increase in information overload could affect the effectiveness of e-government services. Recommender system is adopted in e-government to overcome this issue. Some of the applications include government-to-citizen (G2C) and government-to-business (G2B) services.

#### A. G2C Service Recommendation

To support personalized citizen's access and services, a multi-agent system was presented by De Meo et al. The proposed system will be able to identifies and suggest the interesting services for a user by considering the user's profile and device profile.

#### B. G2B Service Recommendation

In G2B services, many items from a business perspective are one-time items, such as events, which typically receive ratings only after they have ended. Traditional CF techniques cannot recommend these kinds of items due to the sparse rating data.

## V. E-BUSINESS RECOMMENDER SYSTEMS

Many recommender systems have been developed for e-business applications. But some systems concentrate on recommendation to individual customer, which are business-to-consumer (B2C) systems, while other aims to provide recommendation to business users, which are called business-to-business (B2B) systems. This e-business recommender system refers to recommender systems for B2B applications.

Customer relationship management is very important for the telecom industry. To support telecom Companies in recommending suitable products and services to their business and individual customers, a telecom recommender system has been developed. It was found that in e-business recommender systems, the KB approaches, such as ontology [12] and semantic Techniques are widely integrated with CF and CB recommendation methods. The main reason for this is that E-businesses have a high need for domain knowledge to assist their recommendations.

## VI. E-SHOPPING RECOMMENDER SYSTEM

In last few years, many e-shopping recommender systems have been developed to provide guidelines to customers. E-shopping is a highly popular field of E-commerce. Rating is popular function in e-shopping systems, including electronic products.

Many of the largest commerce websites, such as Amazon and eBay, already use recommender systems to help their customers find products to purchase [15]. In these B2C e-commerce websites, products can be recommended based on the top overall sellers, customer demographics, or an analysis of the past buying behavior of the customer as a prediction for future buying behavior. Some advanced models are also proposed by academic literatures for different criteria of e-shopping environments.

E-shopping recommender systems are usually implemented in online purchasing for both digital products (music, movies, etc.) and physical goods (books, bags, etc.). From the application perspective, researchers have developed a number of successful e-shopping systems in which to employ their novel algorithms.

## VII. E-LIBRARY RECOMMENDER SYSTEM

Digital libraries are collection of digital objects along with services. Digital library applications use recommender systems to locate and select information and knowledge sources to the users.

Fab, part of Standard University Digital Library Project[14], is a hybrid recommender system which combines both CF and CB recommendation techniques. To provide better personalized e-library services, a system called CYCLADES was presented; it provides an integrated environment for individual users and group users in personalized and flexible way. The hybrid recommendation approach which combine CB, CF and KB techniques used in

e-library recommender systems. The reason for using hybrid approaches is that they take advantages of different recommendation techniques. Fuzzy techniques, in particular multi-granular fuzzy linguistic modeling, are used to represent and handle the flexible information of linguistic labels.

## VIII. CONCLUSIONS

Recommender techniques and their applications are summarized. The classic recommendation approaches, such as CF, CB and KB, still play a major role in almost all kinds of applications, but hybrid recommender system are more popular. Some of new recommendation techniques, such as social network-based recommender system and context awareness-based recommender systems, played an important role in recent application developments. Some techniques, such as fuzzy logic, have been applied in all kinds of recommender systems application domains to handle various uncertainties. Recently, recommender system is emerged in new application platforms, such as mobile, TV and radio platforms.

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