

Expert Systems with Applications 39 (2012) 10059–10072

Contents lists available at SciVerse ScienceDirect

Expert Systems with Applications

journal homepage: [www.elsevier.com/locate/eswa](http://www.elsevier.com/locate/eswa)



# A literature review and classiﬁcation of recommender systems research

Deuk Hee Park, Hyea Kyeong Kim, Il Young Choi, Jae Kyeong Kim ⇑

*Department of Management, School of Management, KyungHee University, 1 Hoeki-Dong, Dongdaemoon-Gu, Seoul 130-701, Republic of Korea*

## a r t i c l e i n f o

*Keywords:* Recommender systems Literature review

Data mining technique Classiﬁcation

## a b s t r a c t

Recommender systems have become an important research ﬁeld since the emergence of the ﬁrst paper on collaborative ﬁltering in the mid-1990s. Although academic research on recommender systems has increased signiﬁcantly over the past 10 years, there are deﬁciencies in the comprehensive literature review and classiﬁcation of that research. For that reason, we reviewed 210 articles on recommender sys- tems from 46 journals published between 2001 and 2010, and then classiﬁed those by the year of pub- lication, the journals in which they appeared, their application ﬁelds, and their data mining techniques. The 210 articles are categorized into eight application ﬁelds (books, documents, images, movie, music, shopping, TV programs, and others) and eight data mining techniques (association rule, clustering, deci- sion tree, k-nearest neighbor, link analysis, neural network, regression, and other heuristic methods). Our research provides information about trends in recommender systems research by examining the publi- cation years of the articles, and provides practitioners and researchers with insight and future direction on recommender systems. We hope that this paper helps anyone who is interested in recommender sys- tems research with insight for future research direction.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Recommender systems have become an important research area since the emergence of the ﬁrst research paper on collaborative ﬁl- tering in the mid-1990s (Resnick, Iakovou, Sushak, Bergstrom, & Riedl, 1994; Shardanand & Maes, 1995). In general, recommender systems directly help users to ﬁnd content, products, or services (such as books, digital products, movies, music, TV programs, and web sites) by aggregating and analyzing suggestions from other users, which mean reviews from various authorities, and users (Frias-Martinez, Chen, & Liu, 2009; Frias-Martinez, Magoulas, Chen, & Macredie, 2006; Kim, Ji, Ha, & Jo, 2010). These systems use analytic technology to compute the probability that a user will pur- chase one of the products at each place, so that users will receive recommendations for the right products to purchase.

Recommender systems are generally classiﬁed into collaborative

ﬁltering (CF) and content-based ﬁltering (CB). In general, CF uses an information ﬁltering technique based on the user’s previous evalu- ation of items or history of previous purchases. However, this tech- nique has been known to reveal two major issues: sparsity problem and the scalability problem (Claypool et al., 1999; Sarwar, Karypis, Konstan, & Riedl, 2000a, 2000b). In contrast, CB analyzes a set of documents rated by an individual user and uses the contents of the documents, as well as the provided ratings, to infer a user proﬁle

⇑ Corresponding author. Tel.: +82 2 961 0508.

*E-mail address:* [jaek@khu.ac.kr](mailto:jaek@khu.ac.kr) (J.K. Kim).

that can be used to recommend additional items of interest (Basu, Hirsh, & Cohen, 1998). However, the syntactic nature of CB, which detects similarities between items that share the same attribute or characteristic, causes overspecialized recommendations that only include items very similar to those of which the user is already aware (Lopez-Nores, Garca-Duque, Frenandez-Vilas, & Bermejo- Munoz, 2008).

Over the last decade, most of researchers have studied new ap- proaches of recommender systems in order to solve these problems of CF and CB, and to implement them into real world situations. Speciﬁcally, applying data mining techniques to recommender sys- tems has been effective in providing personalized information to the user by analyzing his or her preferences.

However, more research is needed to be applicable in real world situations because research ﬁelds on recommender systems are still broader and less mature than in other research areas. There- fore, the existing articles on recommender systems must be reviewed with an eye toward the next generation of recommender systems, which will improve recommendation methods to offer more useful and appropriate information to users.

In this research, we reviewed and classiﬁed articles on recom- mender systems that were published in academic journals between 2001 and 2010, in order to gain insight on recommender systems. This research is organized as follows:

* 1. The research methodology used in this study is reported.
  2. Criteria for classiﬁcation of research papers on recom- mender systems are presented.

0957-4174/$ - see front matter © 2012 Elsevier Ltd. All rights reserved. doi:10.1016/j.eswa.2012.02.038

10060 *D.H. Park et al. / Expert Systems with Applications 39 (2012) 10059–10072*

* 1. Research papers on recommender systems are analyzed and the results of their classiﬁcations are presented.
  2. Conclusions are presented, and the limitations and implica- tions of this study are discussed.

We hope that this research will accentuate the importance of recommender systems and provide researchers and practitioners with insight on recommender systems research.

1. Research methodology

The purpose of this study is to understand the trend of recom- mender systems research by examining the published articles, and to afford practitioners and academics with insight and future direc- tion on recommender systems.

Hence, we will verify the distribution of research papers on recommender systems by their year of publication, and classify the research papers by the data mining techniques used for recom- mendation and by the application ﬁelds used. However, considering the nature of research on recommender systems, it would be difﬁ- cult to conﬁne each paper to a speciﬁc discipline. Additional proof of this difﬁculty can be seen from the fact that research papers on recommender systems are scattered across diverse journals such as marketing, information technology, information science, com- puter science, and management. As a result, it is necessary to com- pile the increasing number of research papers on recommender systems systematically. The following electronic journal databases were searched to provide a comprehensive bibliography of research papers on recommender systems:

* ABI/INFORM Database;
* ACM Portal;
* EBSCO Academic Search Premier;
* EBSCO Business Source Premier;
* IEEE/IEE Library;
* Science Direct.

The search process of research papers on recommender systems was performed on the top 125 MIS journals. The search was per- formed based on ﬁve descriptors: ‘‘Recommender system’’, ‘‘Rec- ommendation system’’, ‘‘Personalization system’’, ‘‘Collaborative ﬁltering’’, and ‘‘Contents ﬁltering’’. Two authors reviewed the full text of each research paper, and papers that were not truly related to recommender systems were deleted if the two authors agreed to do so. If the authors’ opinions were different, another author reviewed the paper and decided whether to delete it or not. The following research papers, set forth in the description below, were excluded because they were unﬁt for our research:

Conference papers, master’s and doctoral dissertations, text- books, unpublished working papers, non-English papers, and news articles were eliminated, Unlike these publications, papers published by academic journals are thought to be reli- able and worthy of comment, because they are published after peer review.

●

Because research on recommender systems is relatively current, we have only searched research articles published between 2001 and the end of 2010. This 10-year period is considered to be representative of recommender systems research.

●

Only research papers that described how recommender systems can be applied were chosen.

●

We selected 210 research papers on recommender systems from

46 journals. Each research papers was prudently reviewed and classiﬁed into one of the eight categories in the application ﬁelds

and data mining techniques. Although the investigation was not exhaustive, it provides as a comprehensive basis for understanding recommender system research.

1. Classiﬁcation method

Our classiﬁcation framework consists of recommendation ﬁelds and data mining techniques. In this research, we classify the research papers that were reviewed into eight categories of appli- cation ﬁelds and eight categories of data mining techniques. The overall graphical classiﬁcation framework for recommender sys- tems research papers is presented in Fig. 1.

* 1. *Classiﬁcation framework for application ﬁelds*

Many recommender systems have been used to provide users with information to help them decide which products to purchase (Schafer, Joseph, & Riedl, 2001). However, it is not easy to ﬁnd papers that classify research papers systematically, even though recommender systems have been applied to diverse business areas. Accordingly, it is meaningful to investigate application ﬁelds. Our research adopts the basic classiﬁcation scheme of Schafer et al., 2001, who have classiﬁed recommendation applications by real world, such as books, movies, music, shopping and others. We clas- sify research papers by application ﬁelds such as books, docu- ments, images, movies, music, shopping, TV programs and others. Through in-depth reviews of research papers, classifying shopping ﬁelds involves online, ofﬂine, and mobile shopping product, classi- fying document ﬁelds involves papers, blogs and web pages. Also, other ﬁelds involve a minority of recommendation ﬁelds such as hotel, travel, and food.

* 1. *Classiﬁcation framework for data mining techniques*

In general, data mining techniques are deﬁned as extracting or mining knowledge from data. These techniques are used for the exploration and analysis of large quantities of data in order to discover meaningful patterns and rules (Berry & Linoff, 2004). They can be used to lead decision making and to predict the effect of decisions. Signiﬁcantly, many researchers have used data mining techniques to improve the performance of recom- mender systems. Consequently, it is meaningful to classify the research papers according to data mining techniques. We widely classiﬁed data mining techniques into the following eight categories: association rule, clustering, decision tree, k-nearest neighbor, link analysis, neural network, regression, and other heuristic methods.

* + 1. *Association rule:* Association rule mining refers to the discov- ery of all association rules that are above user-speciﬁed min- imum support and minimum conﬁdence levels. Given a set of transactions in which each transaction contains a set of items, an association rule applies the form X Y, where X and Y are two sets of items (Cho, Kim, & Kim, 2002).

)

* + 1. *Clustering:* The clustering method identiﬁes a ﬁnite set of categories or clusters to describe data. Among the clustering methods, the most popular are *K*-means and self-organizing map (SOM). *K*-means takes the input parameter, *K*, and par- titions a set of n objects into *K* clusters (Berry & Linoff, 2004). SOM is a method for an unsupervised learning, based on an artiﬁcial neurons clustering technique (Lihua, Lu, Jing, & Zongyong, 2005).
    2. *Decision tree:* Most popular classiﬁcation methods are deci- sion tree induction. Decision tree induction techniques build decision trees to label or categorize cases into a set of known

Thank you for using [www.freepdfconvert.com](http://www.freepdfconvert.com/) service!

Only two pages are converted. Please Sign Up to convert all pages. <https://www.freepdfconvert.com/membership>