Career Goal-based E-Learning Recommendation Using Enhanced Collaborative Filtering and PrefixSpan

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ABSTRACT

This article describes how e-learning recommender systems nowadays have applied different kinds of techniques to recommend personalized learning content for users based on their preference, goals, interests and background information. However, the cold-start problem which exists in traditional recommendation algorithms are still left over in e-learning systems and a few of them have seriously affected the learning goals of users. Thus, an intelligent e-learning system have been developed which can recommend professional and targeted courses according to their career goals. First, an enhanced collaborative filtering (CF) approach is proposed considering users’ career goals and background information. Then, the relevance between career goals and courses are calculated to alleviate the cold-start problem and recommend specialized courses for users. Finally, a PrefixSpan algorithm is combined with the above methods to generate a personalized learning path step by step. Some experiments are carried out with real users of different professions to test the performance of the hybrid algorithm.

KEYWORDS

Career Goal, Collaborative Filtering, E-Learning Recommendation, PrefixSpan, Sequential Rule Mining

1. INTRODUCTION

The tremendous development of information technology nowadays has led to great changes in conventional face-to-face education. In addition to paper-based books, learners can find abundant digitalized learning materials on the Internet for self-study. However, without guidance and supervision from teachers, it becomes very difficult for learners to choose the right learning materials and fully understand all aspects of knowledge (Hwang, 2005).

Therefore, many researchers have devoted themselves into exploiting e-learning recommender systems which can automatically consider users’ background knowledge, behavioral preference, and interests and so on. The recommender systems have been used in many areas including e-commerce, e-learning, e-library, e-government and e-business services, with different kinds of recommendation techniques (Lu, Wu, Mao, Wang, & Zhang, 2015). Content-based (CB) and collaborative filtering (CF) are the most frequently used techniques in the e-learning area. However, considering the diversity of e-learning resources, which makes it difficult to calculate their content similarity, the CF technique is more appropriate in e-learning systems (Chen, Niu, Zhao, & Li, 2014).

Nevertheless, the traditional CF technique only focuses on the rating similarity, which makes recommendation results unprofessional and untargeted to users with different backgrounds and goals.

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In addition to this, the data sparsity and cold-start problems in the CF technique make it rather difficult to recommend accurate learning materials for new users or low-rated users. Except for combining with other recommending techniques to address these drawbacks, the authors integrated users’ career goals with CF technique. As proposed by Mills and Fadel (2012), e-learning is a fast-growing industry which can bring a great deal of positive career opportunities. On the one hand, considering users’ career goals can deliver more specialized learning materials for them, because learners with similar career goals and background information (e.g. profession, major) have a higher possibility to learn the same materials than those with just similar ratings. On the other hand, it can alleviate the drawbacks in CF technique because that new users or low-rated users can be recommended learning materials according to their career goals.

Furthermore, users in e-learning systems have their own long-term learning characteristics which are called learning path instead and cannot be dug out through CF technique. Therefore, there is a growing trend of applying data mining techniques into e-learning (Castro, Vellido, Nebot, & Mugica, 2007; Romero, Ventura, & García, 2008). Association rule mining is often used to generate learning paths for users (Mihai, 2015). However, unlike the famous beer-and-diaper recommendation case in e-commerce, the learning path is a kind of coherent and time-ordered process. Thus, sequential pattern mining which is a restrictive form of association rule mining is more suitable in e-learning recommendation because it attempts to find inter-session patterns that consider not only the occurrences, but also the order between the occurrences of items (García, Romero, Ventura, & Calders, 2008).

In this study, the authors will introduce an intelligent e-learning recommender system using a hybrid method which combines career goal-based CF with sequential pattern mining. First, an enhanced collaborative filtering method is proposed which pays attention to users with similar career goals and background information (i.e. profession, major) when doing similarity calculations. Second, the relevance between the career goals and courses is taken into account in order to alleviate the drawbacks of CF technique and make the recommendation more accurate and professional for users with diverse career goals. Meanwhile, the authors also consider the difference in users’ background knowledge to provide more utility and targeted courses for each learner. Finally, a sequential pattern mining technique called PrefixSpan is combined with the above methods to recommend learning path step by step and guide users to achieve their career goals efficiently and effectively.

2. RELATED WORK

The techniques most frequently used in recommender systems are collaborative filtering and content-based filtering. The content-based filtering (CB) technique recommends an unvisited item to user based on its attribute similarity with old items liked by this user (Pazzani & Billsus, 2007), while collaborative filtering (CF) technique uses rating data to calculate similarity (Su & Khoshgoftaar, 2009). Because that CB technique always leads to over-specialized results without considering users’ preferences and interests, the CF technique is more appropriate in recommender systems.

The neighbor-based CF can be classified into two types: one is user-based collaborative filtering method which calculates the similarity between users; the other is item-based collaborative filtering, which compares the similarity of items. Nevertheless, the CF technique has severe limitations, which are data sparse and cold-start problems (Ansari, Essegaier, & Kohli, 2013). In order to overcome the problems of collaborative filtering, some researchers have tried to improve CF approaches and collect data from other sources. A collaborative error-reflected model was proposed by Kim et al. (2011) to address the cold-start problems in recommender systems by calculating the predicting errors of similar users. Zhang et al. (2013) used data from social networks to discover the relationship between users’ preferences and tagging, thus alleviating the data sparsity and cold-start problems when applying CF technique to do manufacturing service recommendation. In addition, many researchers have chosen to combine CF with other techniques to recommend suitable items for new users.
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