

Personalized Links Recommendation Based on Data Mining in Adaptive Educational Hypermedia Systems

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Abstract. In this paper, we describe a personalized recommender system that uses web mining techniques for recommending a student which (next) links to visit within an adaptable educational hypermedia system. We present a specific mining tool and a recommender engine that we have integrated in the AHA! system in order to help the teacher to carry out the whole web mining process. We report on several experiments with real data in order to show the suitability of using both clustering and sequential pattern mining algorithms together for discovering personalized recommendation links.

1 Introduction

Adaptive and intelligent web-based educational systems (AIWBES) provide an alternative to the traditional just-put-it-on-the-web approach in the development of web-based educational courseware [4]. Their main objective is to adapt and personalize learning to the needs of each student. The task of delivering personalized content is often framed in terms of a recommendation task in which the system recommends items to an active user [17]. Recommender systems help users find and evaluate items of interest. Such systems have become powerful tools in many domains from electronic commerce to digital libraries and knowledge management [23]. Some recommender systems have also been applied to AIWBES for recommending lessons (learning objects or concepts) that students should study next [19] or for providing course recommendation about courses offered that contribute to the student's progress towards career goals [8].

Recommender systems can use data mining techniques for making recommendations using knowledge learnt from the action and attributes of users [23]. The objective of data mining is to discover new, interesting and useful knowledge using a variety of techniques such as prediction, classification, clustering, association rule mining and sequential pattern discovery. Currently, there is an increasing interest in data mining and educational systems, making educational data mining a new and growing research community [20][21]. The data mining approach to personalization uses all the available information about users/students on the web site (in the web course) in order to learn user models and to use these models for personalization. These systems can use different recommendation techniques in order to suggest online learning activities or optimal browsing pathways to students, based on their

preferences, knowledge and the browsing history of other students with similar characteristics.

In this work, we are going to describe the use of data mining techniques for links recommendation in AIWBES. The task of links recommendation in web-based education can be seen as a special type of adaptive navigation support due to the fact that they share the same goal of helping students to find an optimal path through the learning material [4]. Adaptive educational hypermedia systems can adaptively sort, annotate, or partly hide the links to make it easier to choose or to recommend to the students where they should go from a certain point. This technology is one of the most popular in AIWBES and there are a lot of systems that use it, such as ELM-ART [28] (and its descendents), AHA! [7], KBS-Hyperbook [11], etc. The originality of our personalized recommender system consists in the use of data mining together with hyperlink adaptation. Only a few other recommender systems use data mining for recommending links [8].

This paper is arranged in the following way: first we describe the related background and two architectures for personalization based on-web usage mining. Then, we describe the data mining tool and links recommender engine that we have developed and integrated into the AHA! system. Finally, we describe the experiments that we have carried out, conclusions and future work.

2 Background

Recommendation and personalization techniques can be classified into three different categories [17]: rule-based filtering systems, content-filtering systems and collaborative filtering systems. Rule-based filtering systems rely on manually or automatically generated decision rules that are used to recommend items to users. Content-based filtering systems recommend items that are considered sufficiently similar to the content descriptions in the user profile. Collaborative filtering systems, also referred to as social filtering, match the rating of a current user for items with those of similar users in order to produce recommendations for items not yet rated or seen. Some recent techniques used in collaborative filtering are based on data mining in order to infer recommendation rules or build recommendation models from large data sets [23]. Some of the most common data mining techniques in these recommender applications are clustering, sequence and association mining.

- Clustering is a process of grouping objects into classes of similar objects [13]. It is an unsupervised classification or partitioning of patterns (observations, data items, or feature vectors) into groups or subsets (clusters). This technique groups records together based on their location and connectivity within an n -dimensional space. The principle of clustering is maximizing the similarity inside an object group and minimizing the similarity between the object groups. There are many clustering methods [13], including hierarchical and function-based algorithms. One of the most well-known and commonly used is the k -means algorithm [16] that tries to minimize the distance of the objects to the centroid or mean point of each cluster.