

Adaptive Mechanisms in Virtual Education Environment

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Abstract - Knowledge mining process based on logs in virtual education systems is one from many techniques, which can help to receive information for automated adaptation – selection of study materials. Target of this Article is to describe possible ways of Automated Adaptation for walk-through study materials in virtual education environment. Article describes goals and weaknesses for several adaptive algorithms in opposite to manual modification of study materials. Algorithms respect Student Activity Protocol, Study Groups and Authors for finding best available adaptation. Benefit of this solution is to simplify user orientation in study materials and growing efficiency of their education.

Index Terms - activity protocol, adaptive algorithm, e-learning, intelligent education

INTRODUCTION

Use of typical information systems or if you like e-learning system which offers study materials and obtaining knowledge about users from these systems in order to feedback has some constraints. Adaptive hypermedia in learning process can be used for personalization of content, navigation or presentation of information presented to users. Personalization can increase effectiveness of users learning process.

Adaptation of presentation or navigation in system depends on previous or actual knowledge of the student in system and actual student's behavior. For the preparation purpose of better learning materials personalized for user it is necessary to obtain knowledge about user behavior in the system. There are some different methods how to analyze obtained data. We can target to specific area such as course productivity, course quality, suitability of usage course, etc. [13]. Our target is to improve course by the adaptive techniques and personalization, which is backed by data analysis from protocol activities.

In this paper we target to virtual education WWW environment. Offered learning materials usually are several web pages, which are interconnected by hypertext links. User's behaviors in system are usually saved into database, with these obtained data working adaptive mechanisms.

ADAPTIVE HYPERMEDIA

Adaptive hypermedia allows adaptation of content, style of presentation and navigation to particular user or group of users. Advantage of use of adaptive hypermedia (not only for learning) is that they allow increasing effectiveness of the learning by the adaptation of learning material to individual user [3].

Hypermedia can be defined as a group of different type of media (text, pictures, audio, video ...) used in applications, which are interconnected by hypertext links [4].

Adaptation in adaptive hypermedia systems is based on knowledge about content of individual pages, relationships between them and hypothesis about knowledge, preferences and other characteristics of the user [3]. Adaptive systems not only offer learning material to the user, but also collect information about user's behavior in system and based on this adapt content and style of offered materials.

Every adaptive hypermedia system is using adaptation techniques for adaptation of learning material. There are two groups of adaptation techniques – adaptation of content and adaptation of navigation. Nowadays, adaptation is often called personalization [6, 12].

Most systems working with adaptive hypermedia are based on specific model, e.g. AHA! system is based on AHAM model [6, 8]. Most systems consist of these parts:

- **Domain model:** describes the application domain with fragments, pages and concepts. Individually pages are connected through hypertext links.
- **User model:** holds information about users and their behavior in the system. Attribute values are updated when the user browses through the page.
- **Adaptive engine:** which performs the actual adaptation according adaptation rules and generates pages in such a way that user can distinguish desired from undesired information by use of some of many existing adaptation techniques.

Some systems contain adaptive model for stored rules for adaptation mechanisms. For adaptation is necessary to obtain information on which the adaptation will be based – it is necessary to observe user behavior in the system, his

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activities, which pages he visited and how many times and the sequence of visited pages and how much time he spent on particular page.

ADAPTIVE MECHANISMS

Adaptive mechanisms can be divided on two types: *manual* and *automatic* adaptive mechanisms.

In the first case are not adaptive mechanisms exactly. That means, all modification making authors by self depending on some analysis. One of the ordinary mechanisms is usage of statistic evaluation on the end of course. Author makes statistic evaluation and then modifies content of study materials. For example, authors want to analyze if there are differences between students behavior of full and part time students and on this base decide, if is necessary modify course separately for full time and separately for part time students. After course finishing author makes a statistic evaluation and on this based modifies content to next students. For evaluation of course can be used: statistical analysis, data analysis such as clustering or decision trees, etc.

In the second case exists some algorithms, which makes decides and modification (adaptation) based on protocol activities of user. Premise is algorithm designed for work in real time. For example, author wants to advise to user which toward a given topic is relevant other topic in study materials. Mostly, there have been related pages with specific 'relevancy' weight to understanding study material to study topic [5]. Some examples for automatic adaptation: Full Scan algorithm, mining sequential patterns, hash based algorithm, etc.

Manual and automatic adaptive mechanisms differences

Manual adaptive mechanisms (MAM) are effective after some part of time proceeding of course or on the end of course. Automatic adaptive mechanisms (AAM) can be used in real time. This is big advantage of AAM.

Modification of offered study materials in MAM makes author by self. This is time consuming. Author has to know structure of study materials mostly. AAM can modify offered study materials self. System has properties and rules for these modifications. There is no need author's knowledge of structure offered study materials.

Author or person, who wants to make manual adaptation, has to know some kinds of analysis, their usage and understanding their results. AAM have logic for data evaluation and usage of results. These results can be modified by author, if it is necessary.

AAM automatically can provide adaptation to actual user or group of users. But MAM are not possible to target to actual user in the system. It is possible target to group of users for next session, in MAM.

It is possible combine both mechanisms MAM and AAM. In a future we want to try to find new mechanisms which will be full automatic for adaptation of study materials. These mechanisms will be return results for every user exact and will be without modification of study materials by author.

AUTOMATIC ADAPTIVE MECHANISMS

AAM use some several adaptive algorithms. This paper describe small fraction of them. Adaptation use data mining from protocol activities of user. There are three basic algorithms for data mining and usage in adaptive environment. Because user activities in system looks like transactions in electronic shops, it is possible to use tree basic techniques for data mining: association rules mining, sequential patterns mining and traversal patterns mining [11].

- **Association rules mining:** in the case of electronic shops this technique is used to search group of similar products based on user knowledge (preferences). In adaptive systems it is used to search relationships between concepts. This technique is suited to authors, which produce or modify the course. For example Apriori algorithm represents association rules mining [1].
- **Sequential patterns mining:** technique is resembled as association rules mining. This technique calculated only with visited concepts. Sequential patterns apply one-self to recommended concepts. From the user log we can deduce, which page is the most visiting but it is not possible to specify, which page will be visited in a future. Technique of sequential patterns make possibility to find pages, which user would visit in future – recommended pages. There is analogy with Apriori algorithm [2].
- **A traversal pattern mining:** is sometime called as a continuous sequential patterns. This technique is mostly used for web server log analysis. In adaptive systems is recommended to user relevant pages for visiting. Algorithms that represent traversal patterns are full scan (FS) - selective scan.

For all algorithms is premise that system holds sessions of user and data for concrete sessions, e.g. who accessed the page, what pages were requested, how long each page was viewed, etc. On this data can be used algorithms such as clustering, classification, association rules or sequential patterns. The results of these algorithms can be used for several aspects, e.g. searching path profiles of users for predict future, predict future user behavior or offering recommended links (see next chapter).

Clustering techniques can be used for searching similar sessions based on occurrence patterns of URI references. User session can be mapped into a multidimensional space as vectors of URI references. By this can search relevant or significant features.

ALGORITHMS FOR ADAPTATION OF NAVIGATION

In this part are describe some algorithms for adaptation of navigation that they are most usage. In next chapter we describe one of the possibilities for adaptation of navigation in adaptive systems.

One of the most usage techniques is base on student model [15]. Binary vector denote v represents student's knowledge where $v_i = 1$ means that the student has successfully mastered concept (page) i , and $k_i = 0$ means the

opposite. This technique is based on session and current state of his knowledge in system. The state of variable is change by the click to link of some concept (page) and reviews the concept (page) to value I . As the student reviews concepts, newer concepts become available. For annotation about new concepts are used colored icons [15].

Other technique appears from previous. For annotation of relevant links to concept are used colored icons with more states. This relevancy is calculated based on the *threshold* parameter for each concept individually. Threshold is calculated as in (1)

$$threshold = 0.8 * [(all_concepts - mastered_concepts) / all_concepts] * all_clicks \quad (1)$$

For example, if there are 15 clicks to concept and there are 12 concepts assigned to the concept (6 prerequisite and 6 outcomes), then user has to make $0.8 * (12 - 6 / 12) * 15 = 6$ clicks to master the concept [16].

The most technique for adaptation of navigation is based on Social Navigation Support (SNS) [9]. This technique is based on social navigation theory (Dourish & Chalmers 1994). These man define SNS as “moving towards cluster of people” or “selecting subjects others have been examining them”. For example (Brusilovksy) used two type algorithms (traffic based and annotation-based) in system AnnotatEd system [9].

MODIFIED RESULTS OF FULL SCAN ALGORITHMS

This part describes usage of full scan (FS) algorithm for finding recommended links and our new possibilities of modification of FS algorithm results for creating recommended links. The main of target is notified to user, which has the highest weight (relevancy) of link context to specific page and made easier decision for user about relevant page reference to visit it or not. Modified results can improve orientation in hyperspace than non-modified results of FS algorithm. For modification of results we introduce pages and links relevancy weight, as you can see in next chapter. These values are necessary for modification of FS algorithm results.

Problem Description

To notify user about specific link relevancy for him and his study process, is necessary to determinate not only weight of link but weight of content offered by other page. Weight determination is not simple and all weight values should have been given to every user individually. Every user has a different style of learning and personalization is basically difficult. The next problem is occasion of author to advise which content of text are more and which less important. One of the possibilities is non automatic weights setting of pages by author. Non automatic weights setting are necessary for creation new pages. The better occasion is for example automatic (semi-automatic) setting by the ontology and modifying by the neural networks. It is subject of next research.

We can determinate several relevancy weights (WR) for all pages. For example we can use percentage valuation by

displaying weights in every page. Now is possible say to user, which is the important study content for him in light of relevancy in concrete subject. The traditional case of referencing to several pages is self WR page poor. From the other one point of view can be one page more relevant (it has greater valuation) than other page for some case based on study material. There are necessary to determinate WR between the links of several pages. If page has references at each other then weights can have same or different valuation in both ways of relevancy view within actual topic. Relevancy from the one side can be different than from the other side. It is necessary set WR into links every way. Usage of weights in pages and links show figure 1.

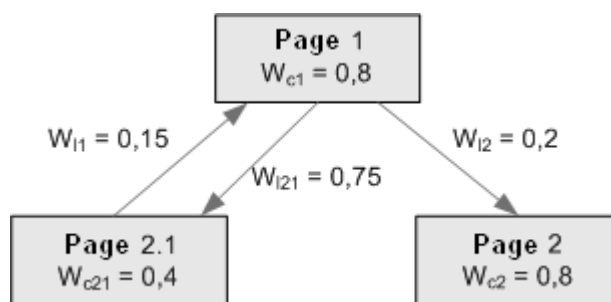


FIGURE 1
DIFFERENT WR FOR LINKS IN OPPOSITE DIRECTION

WR of hypertext links and pages can have relevancy restriction. WR can be determinate in case of summary study material, one chapter, paragraph etc. In adaptive environment system it can offer related links in ordered list by the value of weights (link recommendation), for example by the traversal pattern algorithm [7]. Recommended (related) links and the most frequently links from all users can be string together by interconnection with properties of concrete user or user group and the result is offered to concrete user or group[9].

Usage modified results of FS algorithm

Specification of FS algorithm outgoes from DHP (direct hashing and pruning) algorithm [7]. FS algorithm was used in adaptive hypermedia systems ALEA, see [11]. Authors compared tree techniques for data mining. The result of this comparing shows recommended links for users. They start from visited to non-visited concepts because in tutorial process users very often come back to previously visited concepts.

Our main idea is integrate results of FS algorithm with WR within the scope of all subject matter, and with WR of links within the scope of actual topic of concept. As a result are recommended links to pages in two categories: recommended links within the scope of all study material and recommended links within the scope of actual topic of page. Usage of FS algorithm and modified results is shown on Figure 2.

Modified part of log in database

TID	Page
1	C1 C3 C4
2	C2 C3 C5
3	C1 C2 C3 C5
4	C2 C5

Result of FS algorithm
(C2 C3 C5)

Weights of pages

Page	Weight
C2	0,75
C3	0,70
C5	0,25

FIGURE 2
RESULTS OF FS ALGORITHM

Left table in Figure 2 contains session identifier TID, and set of visited pages. Results of FS algorithm are tree qualifications for page recommendation C2, C3 and C5. System can display user links to pages. But in case of pages have WR within the scope of all study material; see right table in Figure 2, the result of algorithm can be modified. From the table we can see, that pages C2 and C3 have relevancy within the scope of all study material 'relatively big'. Page C5 has relevancy 'relatively small'. We determinate a minimum limit of relevancy within the scope of all study material, denote L and determinate value to 0,35. By applying limit LA to results of recommended pages is possible to eliminate pages, which are not relevant for link in study material.

In case of results, as shown Figure 2, are relevant recommended pages only C2 and C3. Page denoted C5 have not to be displayed. It is possible to use another technique than displaying and hiding recommended links, for example highlighting of background color. In the case of page C5 can be highlighted of other color. More information about usage modified results of FS algorithm, see [5].

We propose relevancy weights determination to every user individually. There are two possibilities. If we have on the beginning of course the entrance test, we can set the weight by the results of this test for every user individual. In case that we have not entrance test, there are next two possibilities. Set the weights for every user the same to default value (for example to 80 %) and during user sessions in systems modify these values individually. Another access is let the choose user how is fill. That means: user is thinking that know study subject very well or good or he does not know. By this decision we can determinate relevancy values for current user and in next time modified by the results of tests.

CONCLUSION

Next our works is design new adaptive mechanisms or modify the most usage mechanisms for virtual education system called Barborka. Mechanisms integration to e-learning system will offer more flexible responds to student's knowledge. The main target is offer a proposal of explanation of basic term or hyperlink to basic term explanation for student which do not understand term consists of basic term. Next target is offer more different explanations of terms based on knowledge of student. Different explanations of terms means describe terms by other definitions or use different visualization, e.g. text,

picture or graph etc. All piece of knowledge about student behavior automatically store, modify and use for next student proceedings in virtual education system by the adaptive mechanisms.

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