

Mining User Access Patterns Efficiently for Adaptive e-Learning Environment

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Abstract—Web is an excellent tool for imparting distance education. Several sophisticated e-learning environments have been developed and are used around the world and will revolutionize the research and education field in years to come. e-learning is powerful, because it allows individuals to learn ‘anywhere, anytime’ and gives instant access to specific knowledge. However, different behavior, attitudes and aptitudes of individuals affect their learning, and these learning environments need to be adapted according to these individual differences, in order to maximize learning outcomes. This is known as adaptive web based e-learning.

The same technology is being developed for e-commerce sites also, to track and understand customer’s buying behavior. Predicting their needs will help in improving usability of e-commerce site, but, hardly any efforts are done in education and research field to understand learners’ behavior in e-learning systems and modify the e-learning site accordingly. Academicians contributing to web content in e-learning environments, have absolutely no medium on how to evaluate a learner’s activities and differentiate between their on-line behaviors, to make e-learning more effective. Similarly, for a learner using e-learning site, the full potential of the site is not exploited due to lack of recommendations/hints from the site that should adapt its course content to learner’s learning pace, interest or previous behavior.

Adaptive e-learning environment is self-improving and helps

- Educators- in evaluating learning process, thereby making the web application more effective for learners.
- e-learners- web application could automatically guide the learner’s activities and intelligently recommend resources, content and suggest areas to improve their performance based on online assignment results.

For this, the web log data of completed activities and sequence of events, user profile data along with their evaluation result data can be mined, to deliver tailored e-content, as required by the learner.

Index Terms—Adaptation, association mining, web personalization.

I. INTRODUCTION

E-learning courses, in reality, are designed based on “Same Content-Fits All”. While in reality, learning ability of each student is influenced by student’s geographical, cultural factors, his individual learning abilities, his background like his basic education and his exposure to new learning technologies. As in [1], the goal of adaptive e-

learning is aligned with exemplary instruction: delivering the right content, to the right person, at the proper time, in the most appropriate way—any time, any place, any path, any pace (NASBE, 2001).

Web has become a huge repository of information and so may e-pages keep getting added, while human capability to find, read and retain information remains limited. Web gives easy access to information to users but users have varying needs, preferences and competence of learning. Hence while navigating they often tend to lose their basic aim of inquiry.

Also information on the web is often not effectively organized to suit different types of learners; they spend most of their productive time in un-necessary interactions.

Moreover, students use these environments, away from formal classrooms and out of sight of their educators. Hence, determining their learning behavior that is, how learners are responding to these environments, is a complex problem.

Web Personalization is new approach of alleviating these problems by delivering personalized e-content, without having asked for it explicitly, to suit their learning behaviors. This is made possible by web usage mining - a process that relies on application of statistical and data mining methods to Web log data, resulting in set of useful patterns that can be analyzed to understand learner’s navigational behavior and patterns.

Learner’s navigational behavior can be analyzed in order to improve web content, perform learner behavior studies, make topic recommendation and improve his/her learning outcome.

Web usage mining consists of three consecutive phases, namely preprocessing and filtering, pattern discovery and pattern analysis. The result of analysis is then used to improve the overall effectiveness of the web content and personalize it according to each learner’s behavior and profile.

Creating personalized e-content can present significant challenges. There are numerous questions concerning adaptive online education systems, those needs to be addressed, as in [2]:

- What best technological approaches should be considered for adaptation?
- Which characteristics of the learners should be considered for input?
- Which models should form the system’s design?
- How should input about learners be captured and automatically related with additional data on the learning process?
- How should the system store the relevant information and in what format?
- How should we assess the performance and benefits of the system?

These should lead to an approach to construct an adaptive e-learning system which needs minimum input from learners

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and dynamically restructure itself.

II. WEB PERSONALIZATION IN E-COMMERCE

Connecting web and users in e-commerce sites in a personal way has increased profits by enhancing purchasing experience and customer satisfaction. e.g. Amazon.com is a personalized site that recommends books to purchase based on preference information.

Web access history has been used by researchers to make web sites more adaptive to entice potential customers and also to keep current customers loyal.

III. E-COMMERCE GOALS V/S E-LEARNING GOALS

While in e-commerce, the goal is to increase profit by understanding customer's buying behaviors, in e-learning the goal is to increase effectiveness of the e-learning site by understanding learner's ability, area of interest & access patterns. Moreover, goals in e-learning are not well defined and difficult to quantify / qualify.

IV. HOW IT WORKS?

Every single request received by Web Server is logged into access log, which contains: origin of request, time stamp and resources requested, whether the request is for web page (containing course content), a quiz, discussion etc. The log maintains learner's navigation details and activities from the site. In order to extract interesting patterns, web log analysis is performed on these access logs. Although there are tools available for web log analysis but they do not make clear, the implicit usage information and hidden trends.

As in [3], the Web server log files contain 1) domain name of request 2) user name generating request 3) method of request-whether GET/POST 4) details of resources requested 5) size of data sent back 6) result of request(i.e. success/fail/error etc).7) URL of referring page 8) cookie etc. However, the information captured depends on the need and on tool's capability.

While this may record, the actual use of resource on a site, it does not record user behavior like frequent backtracking or frequent reloading when resource is cached by server or proxy.

Major steps for Web data analysis are:

- Preprocessing data by removing irrelevant entries.
- Identifying sessions and mapping staggered learning sessions.
- Relate access log entries to learning activities.
- Tracking of the paths for accessed web resources.
- Integrate with other learners.

Web mining tools uses data warehousing technology for pattern discovery and trend summarization from Web Log. However, it is not integrated in e-learning systems and it is not easy for an instructor who is not technically expert in data mining, to use this tool and improves effectiveness of the e-learning content.

As in [3], s/he should be able to identify paths frequently visited, paths never visited, the clusters of learners etc. The system should be able to recommend shortcuts to frequently visited pages based on previous users and should adapt itself according to e-learners' pace or topics of interest.

In addition, web servers do not log the sufficient data, there is a need of more specialized logs and provide collaboration support to tap benefits of personalized e-learning.

While some tools using data mining techniques to help academicians/instructors and learners are being developed, the research is still in its infancy.

V. RECENT RESEARCH

Evaluating learning behavior in online media is a complex problem. This requires the development of effective methods of determining and evaluating learner behavior in e-learning environments.

- Some studies have found a relationship between learning outcomes and web site usage. Like (Comunale, et al., 2002) found evidence to suggest that higher course is related to more frequent website use or another one that found no correlation (Hernández-García, et al., 2008).
- Another study by (Hijón et al., 2008b) found important differences on the students' accesses patterns on the morning and evening courses.
- A more recent study (Gao & Lehman 2003) investigated learning outcomes of students using Web-based learning environments providing different levels of interactivity.
- A study by (Lu, et al 2000) which analyzed log file interactions with different resources on a courseware website found a relationship between frequency of access, to learning resources and final exam scores.
- An analysis of student use of a courseware website by (Peled & Rashty, 1999) found out that the most popular online activities were passive and involved getting information rather than contributing.

VI. CHALLENGES

There is not much effort done in education and research field to understand learner's behavior. There are not many tools/approaches that can capture the required data and present that in a format to make e-learning more powerful & effective. Moreover,

- Users' geographical and cultural factors impact the creation of content for a global e-learning system.
- Users have individual learning abilities and preferences
- Lack of social and technical skills of users for implementation damages the perception on e-learning.
- Identifying sessions is a challenge since HTTP is a stateless protocol and do not keep track of semantic sessions.
- Learning session can span many days.
- Mapping access log entries with actual learning activities consist of replacing script calls with their assigned parameter values with concrete activities.
- Entries' of all users are mixed in the log, as one single page request from user may generate multiple entries.

VII. EXISTING SYSTEMS

Adaptive learning systems use a variety of approaches to

assess learner's styles and learning preferences. Overall, results seem encouraging, but it is clear that there is a lot of research left to be done to test the success of these systems.

Some of the researchers did not formally assess the system's effectiveness and their only purpose was to present their approach and system design (Sun, et al, 2007). Students' feedback of the adaptive learning systems was quite positive. Overall students found the adaptive functionality of the system to be useful (Papnilolaou, et al, 2003).

VIII. CONCLUSION

Adaptive online learning systems have significant potential to benefit students and improve learning outcomes. Given the differences in learning styles and abilities, web-based learning programs should avoid imposing a "Same Content fits all" model.

Navigation patterns vary according to learner's characteristics (time zone, gender, goals, previous technical exposure etc.). Classification and Clustering should be done on the basis of learner's characteristics. Pattern Analysis of Access Patterns should be done to find out most frequently traversed path, entry and exit points, distribution of user session duration etc.

The Adaptation Model should 'learn from these suggestions' before restructuring itself automatically. It can accordingly, pre fetch frequently accessed pages, eliminate weak links and determine best way to adapt the e-learning system.

Finally, we need Recommendation based Association Mining, (in discovering relevant associations between learning activities & generating association rules that are applied in real time), antecedent of a rule should show current session activities & consequent should suggest recommended next step in the learning session.

Despite there are some research on data generated on e-learning systems, there is still lack of standard methods to, first, obtain the required information about learner

interactions, second, with the overall method to analyze the information obtained and third, that provides methods of treating the information and visualizing it in a way, that results in greater and faster teachers' comprehension of what is happening.

Effective e-learning develops learners interest, attracts learners globally thereby enhancing e-learners' self-esteem and confidence. Effective and adaptive e-learning, that needs minimum input from user and automatically adapt itself, is the next step of eLearning technology and applications that will serve the students and teachers of tomorrow.

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