History-Enriched Digital Objects as a Factor of Improvement of Adaptive Educational Web Site Navigation

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Case study
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Abstract: Modern educational websites offer a wealth of information and content intended for both students and teachers. Such facilities often are not grouped in a single location. While students are in need of fast and efficient access to certain content, teachers are in need for an insight into the learning process of students. By using capabilities of Ajax, it is possible to implement a system for mutual support, where teachers and students who have knowledge of the desired resource would share it with students who are in need of such information in real time. History-enriched digital objects can be used to store information about knowledge sharing. In combination with the records of user's behavior from the log files, this shared knowledge can make a significant contribution to the successful design and navigation of adaptive web sites. Adaptive web sites can change their content and presentation based on the previously recorded user's behavior.

Key words: History-enriched digital objects, Web design, Internet technology, Data mining.

Introduction

The educational process is largely based on the opportunities offered by information technology. Teaching content and information about lectures are given on the web sites of educational institutions, and their amount increases daily. The increase in the volume of content is beginning to arise as a problem when there is a need of separation of the useful content.

"One of the tendencies in education is the continually growing amount of learning content which must be acquired by the student. Almost every generation's curricula are extended by a certain amount of new, updated or revised material. With this infestation of learning content, another issue arises, namely that the time which is intended for learning this amount of content is growing ever shorter for each subsequent generation."[8]

„Systems such as educational experiences change in terms of modernization and globalization. Students are required to improve the style of self - teaching and their skills."[1]

Educational web sites are faced with frequent changes, which have to be met. In this sense there is a clear similarity with the situation in the business. "Contemporary business millieu is faced up with frequent changes. The market has its own challenges, and companies are making efforts to meet them in the best possible way."[9]

History-enriched digital objects can be used to keep the history of user's interactions with Web site. Such objects could be achieved by using Ajax technology. In combination with the log files, they could significantly contribute to the improvement of adaptive navigation of web sites. Students would be able to rely on knowledge of their colleagues and teachers in the process of finding useful content in real time, while once recorded knowledge could be used in future processes of student's learning.

Adaptive Websites and Log Files

Adaptive web sites are kinds of sites which form a model of user behavior based on the previously recorded user behaviors, and then based on these models they change their structure and presentation. Some of the first papers dealing with the theme of adaptive web sites are [7] and [6].This idea is being further developed in many other papers.

Log files are being used as a source of information. These files contain information about requests of the website user in a format that is standardized and suitable for computer processing. These files are automatically created and filled by the web server. Log files are discussed in [5].

History-Enriched Digital Objects

The main disadvantage of log file information is that relatively small amount of information is recorded about the user requests. There is justification for the usage of history-enriched digital objects in situations where information about user behaviors that are not recorded in the log files have to be collected.

"The notion of history-enriched digital objects is similar to physical wear. Usage leaves wear. Physical wear is an emergent property and though it generally remains unremarked upon until it causes a problem, it is also tattooed directly on the worn object, appearing exactly where it can make an informative difference."[4]

In this paper, the usage of such objects is intended for keeping the record of knowledge sharing among users. When a user gives a suggestion to another user, details of knowledge sharing are recorded in a database and used for improvement of the adaptive website navigation in future.

Ajax

Ajax combines several technologies that work together (XHTML, CSS, DOM, XML, XSLT, XML, HttpRequest). Ajax engine is located between the user and the server and it is designed for rendering pages for users and communicating with the server on behalf of users.

"The Ajax engine allows the user's interaction with the application to happen asynchronously - independent of communication with the server. So the user never stares at a blank browser window and an hourglass icon, waiting around for the server to do something."[3]. Comparison of the traditional model of web applications and Ajax model is given in Figure 1.

Ajax represents the basis for interpersonal support systems which are referred in this paper. The activities of this system are recorded and used for improvement of adaptive website navigation in combination with data from log files. Ajax allows periodic refresh of the section with the proposed shortcuts, while the rest remains seemingly unchanged, and as such it is suitable for study by the user (student or teacher).

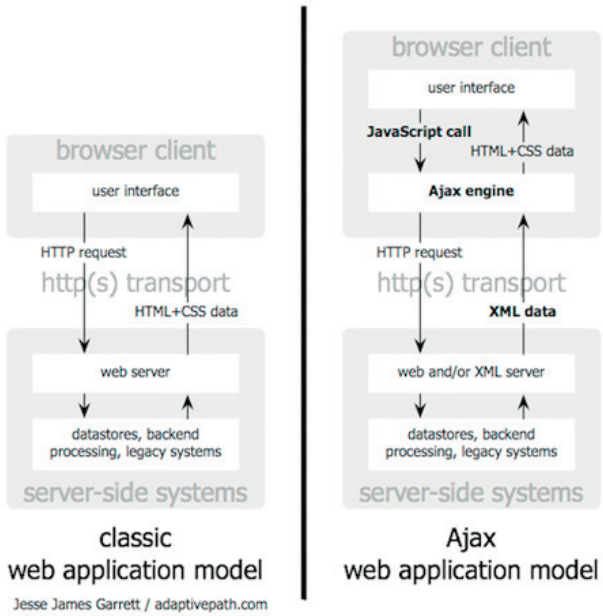


Figure 1: "The Traditional Model For Web Applications (Left) Compared To The Ajax Model (Right)." [3]

Interpersonal Support

In the article [2], possibilities of interpersonal support in real time are discussed. Block with suggested links is located on the web site pages and it has been implemented by using Ajax. There is a button which enables users to request assistance from other users regarding the selection of some of the proposed

shortcuts. The procedure is described in the example illustrated in Figures 2, 3 and 4. User Tom, clicking on the button, requests help in selecting some of the proposed connections, and user Tim gives him a suggestion about connection that leads to the document with the important content..

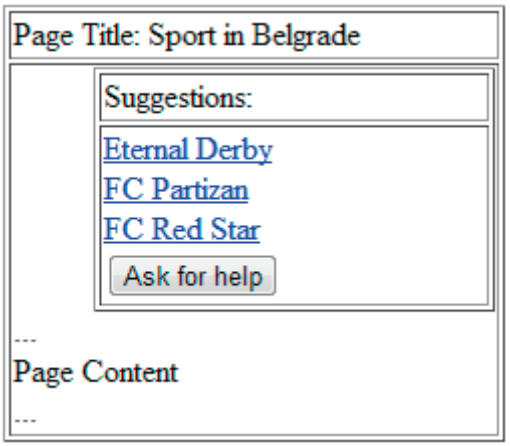


Figure 2: Page Entitled "Sport In Belgrade", Which Was Visited by the User Called "Tom" Contains Three Links to Recommended Web Pages

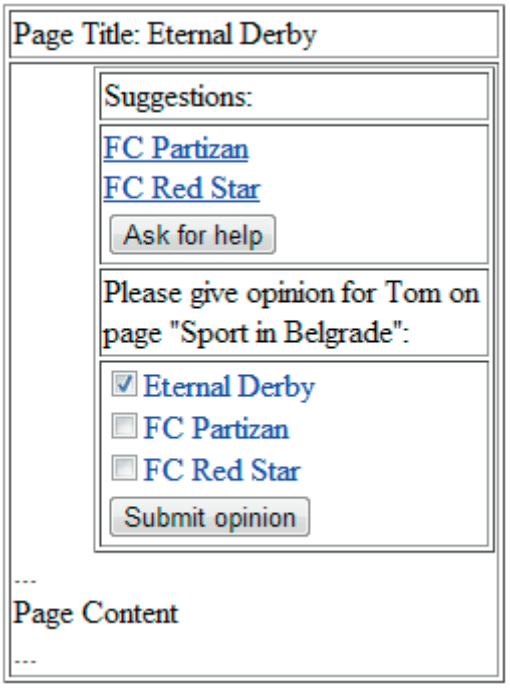
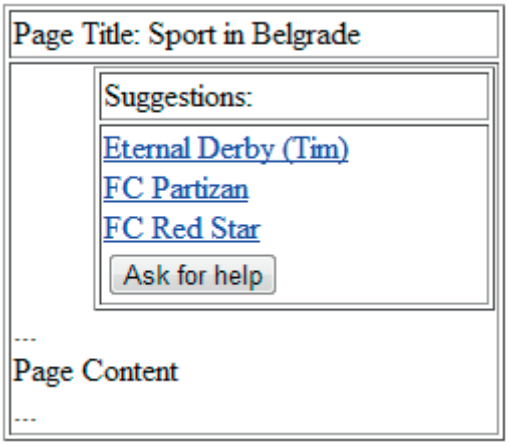


Figure 3: Page Entitled "Eternal Derby", Which Was Visited By "Tim" Contain Two Recommended Links to Web Pages, But it Also Contains the Request For the Suggestion to "Tom"

Figure 4: Page Entitled "Sport In Belgrade", Which Was



Visited by the User "Tom", Contains Three Recommended Links to Web Pages, With the Stated Recommendation Made by the Provider of Assistance Identified as "Tim"

All user requests for suggestions and responses to those requests can be recorded in the database. This data can be archived in a certain period of time and then used to improve adaptive web sites. It would be very interesting to compare the observed relationships between documents by using the model of previous user behaviors (the source would be log files) versus relationships between documents identified by using data from the system proposed in this paper.

History-Enriched Digital Objects and Improvement of Navigation

Interpersonal support, which is illustrated in the previous section, allows users to share knowledge almost instantaneously. Depending on the speed of response and refresh rate of Ajax section, it is possible to get answers within the time limit which is measured in seconds. This knowledge brings immediate benefits to the applicant.

Another possibility that arises is the archiving of these interactions and the subsequent use of data mining techniques in order to obtain useful information which could be used to improve the navigation of the (adaptive) web site. Conceptual model is presented in Figure 5 and physical model designed for the archiving of interactions which are the result of interpersonal cooperation activities, is presented in Figure 6.

The table "User" is intended to keep a record of all known users of the system identified by their

user names and IP addresses in case when the user is logged onto the system. If the IP address is the same (access from the same computer, for example) it is possible to distinguish the users according to their user names. Table "Session" keeps a record of any session where a request for assistance or respond to a request for assistance came from. Users can be unambiguously determined on the basis of the session, since each session has exactly one user. During the session, user can send a request for help while being on a document (web page), which is recorded in the table "Request". A document from where the request originates, a session from which the request is sent and time when the request is sent to the table "Request" are being recorded for each request. For each request there could be one, none or more responses from one or more user sessions (each session has its own user). The response to the request is identified by id values of the request which has been responded to, id document which is indicated by the response and the id of the session where the response came from. Also the time, when each of the responses is received, is being recorded in the table "Answer". Id value, the path and the name if there is any, are determined for each document (web page). These values are being recorded in the table "Document".

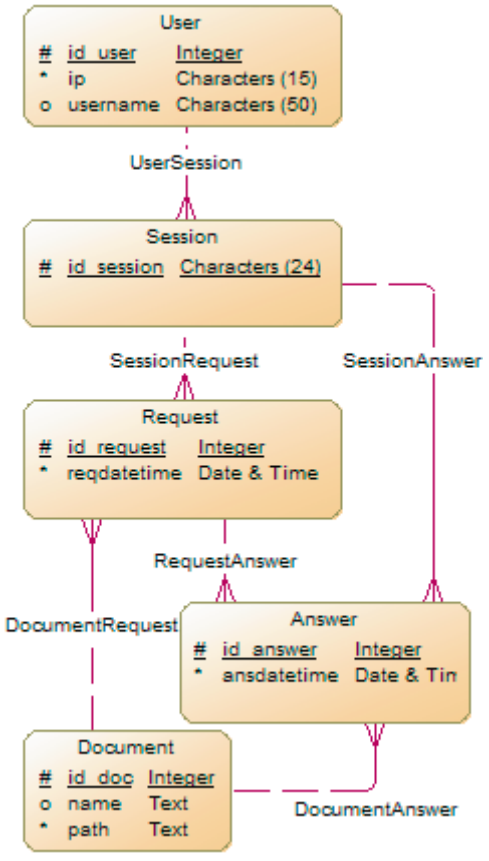


Figure 5: Conceptual Data Model

These tables can form a small database that could be placed on a web server. This database could record any interactions between users in a certain period of time. Data that would be kept in such a database might not be extensive as that from the log files, but would more directly reflect the needs of users.

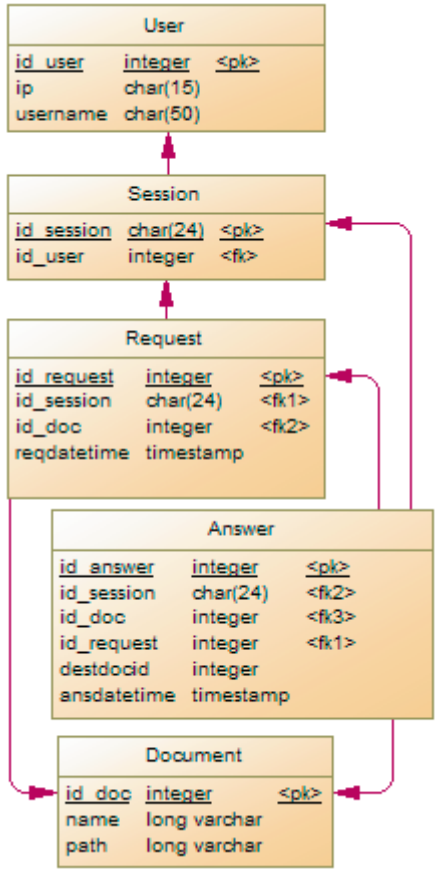


Figure 6: Physical Data Model

Such recorded data is ready for later application of Data mining techniques with the aim of extracting the useful knowledge. One of the applications is the determining of promising shortcuts based not only on the previously recorded user behaviors in the log files but also on interpersonal support. In the example shown in [2], the suggestion which user Tim gave could be used in the future if some user had the same request from the same page.

Another application could be found in the validation of existing system for suggesting shortcuts. Specifically in Figure 2, Tom gets a list of shortcuts offered by the system. This list of shortcuts is obtained from the previous models of user behaviors. Such a list could be, for example, received from large amounts of data recorded in log files. Although the data from the log files is very extensive and easily generated, it is often limited to a small number of attributes. On the other hand, the usage of History-enriched digital objects often requires specialized solutions such as solutions offered in this article. Such solutions require some effort but can offer additional benefits. In the example in [2], the shortcuts can be ranked on the basis of the frequency of the registered user paths. On the other hand, when using History-enriched digital objects it is possible to take into account the suggestions of users recorded in the system proposed in this paper.

Conclusion

The approach proposed in this paper should provide the necessary prerequisites for the archiving of user knowledge, which are related to the access to desired resources. Interpersonal support that has been proposed in [2] allows users to help each other when choosing a link to the proposed documents. In this way, users who seek help can get it very quickly, while still not having decided about where they could continue their session. Archiving of these suggestions can help future users. Small information system that is proposed in this paper allows such archiving and it is directly related to the solutions given in the article [2]. Data, which is expected as a result, is ready for applying data mining techniques in order to improve the navigation structure of adaptive web sites.

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