

# Website Navigation Adaptation Based on Behavior of Users

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Web portals contain large amount of information from which various groups of visitors could benefit. Unfortunately, the website does not “know” its users and so the presented content is not personalized. Visitors often see the content in which they have no interest [2]. Web portals also contain large amount of links and it is difficult to choose which link to follow. Users surfing the web leave digital footprints that reflect their interests and preferences. We can analyze this information and use it for content personalization. Moreover, some users can discover an interesting page hidden deeper in the web portal’s hierarchy. Users who behave similarly do not have to find it again, they can benefit from mutual recommendation of pages.

We propose a method for adaptive navigation support and link recommendation within a web portal. It is based on the analysis of users’ navigational patterns and their behavior on the web pages. We also mine the portal to extract interesting information which is presented in a new way. Web pages of the portal are enriched with new sections with links that might interest the user.

Each user selects different approach while browsing through a web portal. One user can follow links to certain depth and then backtrack if he has not found the desired information. Other user can use more the breadth first approach. In this case he tries basically to visit all links from the menu and returns straight to the main page. Based on users’ activity we discover four basic navigational patterns [3] in their clickstreams and group the users according to the prevailing patterns. Within each group we compare users using cosine similarity method on their clickstreams. For each user  $u$  in every group we get a list of other users from his group sorted by their similarity to  $u$ . We select top  $N$  similar users and recommend links to  $u$  which they found interesting.

The way a user behaves on a web page reflects his interest in this page. We monitor actions he conducts which include *time spent*, occurrence of *scrolling events* and *copying text into clipboard*. Comparing these actions with actions of other visitors to the same page indicates the degree of the user’s interest. We do the comparison

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using collaborative filtering method, as we describe in [4]. This enables us not only to compare users but also to predict user's interest in a web page he has not visited yet. For the prediction we take computed interest of his top  $N$  similar (according to clickstream comparison) users who already visited the web page.

We apply proposed method of adaptive navigation and link recommendation to the web portal of our faculty ([www.fiit.stuba.sk](http://www.fiit.stuba.sk)). First we analyze the portal's web pages and extract useful information. Many pages inform about an upcoming event. Therefore we create a personalized calendar of events for each user and insert it to the web page. The calendar contains two kinds of events:

- Event which interests the user (according to our interest estimation method). We add reminder about this kind of event to user's calendar.
- Event which the user does not know about yet, but which similar users found interesting. We recommend link to this event and add it to user's calendar.

To evaluate proposed method we use a solution based on adaptive proxy server [1]. Adaptive proxy server is a platform that enables implementation of various methods and techniques of content and navigation adaptation. It tracks user's actions and modifies HTTP requests and responses. We implemented a plug-in which enhances the web pages with personalized sections. These include calendar with events personalized to every user and links to pages which we recommend him to visit. Recommendations are periodically computed by an independent tool for every user who visits the web portal. Our plug-in also inserts controls for explicit feedback. Users can express their interest (positive or negative) in the visited web page. They can also state if they would or would not recommend the page. Explicit feedback is used for evaluation of the contributions of proposed method to browsing experiences of visitors. Using proposed method we can personalize other sections of web page that contain links as well. We can sort these links according to expected interest of user. By comparing clickstreams we get communities of similar users which can be used also in other applications.

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