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Social Adaptive Navigation Support for Open-Corpus E-Learning

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Abstract

Adaptive hypermedia is an alternative approach to the traditional approach "one size fits all". Adaptive Navigation Support (ANS) is one of the adaptation techniques used to help users find their way in hyperspace. ANS has created interesting opportunities in e-learning applications to address users with different learning goals and different knowledge level. However, adaptive hypermedia techniques are well designed for closed-corpus that could be manually tagged by an expert and are not easily applicable in an open-corpus such as collection of online resources. In this paper, we are presenting a new approach for supporting ANS through social navigation and footprint of other users in an educational application. The new approach is called Social Adaptive Navigation Support (SANS). We have developed a C programming tutorial called KnowledgeSea that supports SANS. We have evaluated KnowledgeSea with two semesters of classroom studies. The result of studies supports the idea of SANS and suggests more powerful navigation support for future work.

1 Introduction

With increase pf popularity of hypermedia as a tool for presentation of information, adaptive hypermedia was established to help users access information in more personalized way. Adaptive Hypermedia is an alternative approach to the mindset of “all users are like me.” Adaptive Hypermedia systems try to support the personalization by building a model of individual’s goals, preferences, and knowledge (Brusilovksy, 2001). Adaptive Hypermedia systems can be useful in different application area such as commercial application. There has a lot of attention in application of Adaptive Hypermedia in educational system since educational applications are dealing with users with different learning goals, different interests, and different knowledge background.

1.1 Adaptive Navigation Support

Adaptation and personalization could be supported in different ways that are called *adaptation techniques* (Brusilovksy, 1997). One technique of adaptation is *adaptive navigation support* that tries to help users navigate through hyperspace and prevent users from being lost. Adaptive navigation support supports personalization through adaptation of the presentation of links to users’ goals, needs, and preferences. Adaptive navigation support could be offered through different methods such as direct guidance, hiding, sorting, and annotation. In *direct guidance* method Adaptive Hypermedia system determines the most appropriate page to be seen next and therefore instead of offering several links it just offers a “next” or “continue” button that would take the user to the most appropriate page. In *hiding* approach, adaptive hypermedia system finds out

the inappropriate and non-relevant links and makes them hidden for the specific users. This could be done by not presenting those links in the usual link format to prevent drawing user attention into them. In *sorting* approach, as the name suggests, adaptive hypermedia system sorts the links from the most relevant and most appropriate to the least relevant and least appropriate. This method of adaptations could be very useful in information retrieval systems that deal with large number of links. Augmenting the links with some kind of visual cues supports adaptive navigation support through *annotation*. This could be done through coloring of links or annotating links with icons for representation of appropriateness and relevance.

1.2 Closed Corpus VS. Open Corpus

Most of the abovementioned techniques are well suited for limited set of resources, which is called *closed corpus*. These techniques rely heavily on the expert knowledge and manual tagging of information by expert (Henze and Nejdl 2002). Therefore these techniques are not easily applicable for extensive amount of information such as online information, which is called *open corpus*. However, in terms of educational material, World Wide Web is a valuable resource for providing various kinds of educational material.

On the other hand, because of extensive amount of available resources, students very often feel lost and run into difficulty finding what they are looking for. Therefore, it is very critical to offer navigational support in personalized form to prevent this mystification. However, the navigation support in context of open-corpus should be offered through techniques that requires minimum amount of manual tagging. One promising field in this area is information retrieval that tries to classify documents automatically through various machine-learning techniques. Another quite new direction in this area is supporting adaptive navigation through social navigation. We call this new method, *social adaptive navigation support*, which is the focus of this paper.

1.3 Social Navigation

The idea of *social navigation* was introduced by Mathew Chalmer, and Paul Dourish, which is formally defined as “Navigation towards cluster of people” and generally means following footprint of others and learning from what others have done (Dourish and Chalmer, 1994). The idea of social navigation has created interesting collaboration opportunity by providing dynamic information about what other users of the system are doing. Social navigation could be very helpful in different application area. A well-known and pretty mature application of social navigation could be seen in recommender systems such as Amazon.com that recommends its product based on purchase behavior of users with same preferences. Very recently, there has been some interest in application of social navigation in online educational system. These systems try to provide information about action of other students to support collaboration. Educo (Kurhila et al, 2002) and COFIND (Dron et al, 2001) are example of these kind systems.

2 KnowledgeSea

KnowledgeSea is a mixed corpus C programming tutorial that tries to bridge the gap between open and closed corpus. We call it mixed-corpus because it includes both closed-corpus material in the form of lecture notes that are well designed for the purpose of the course, and also it includes open-corpus material in the form of providing links to online resources and other web-based material in context of C programming. KnowledgeSea is designed to help users navigate from lectures to relevant tutorial pages in a map-based horizontal navigation format. The map is self-organized using neural network techniques to cluster similar documents together. Moreover, KnowledgeSea offers social adaptive navigation support in different context that would be discussed in details in this paper (Brusilovsky and Rizzo 2002).

KnowledgeSea system consists of three main views that are presented in figure 1 through 3: main interface, cell content interface, and content pages.

2.1 Map Interface

Figure 1 - General view of KnowledgeSea system

As it can be seen in the figure 1, first interface of the KnowledgeSea system is a map of different C programming concept. The cells close to each other include concept that are related to each other. Several different icons could be seen in the map that represents different information about the educational aspect of the system. Firstly, each cell has pretty different background; the color of the background represents the group traffic that means the number of visits group of students has made on documents inside each cell. All the cells of the map initially have very bright shade of blue. As students start visiting pages, the background color of the cell including visited documents gets darker and darker. The changes of the background are in a very smooth way that create large spectrum of blue in the map. In this way, student could easily follow footprint of others by visiting cells with darker background.

In addition, the small person icon ( ) represents the traffic made by the specific students that means the number of visits she or he has made on documents inside specific cell. The same schema is applied here as well that the color of the icon is set to very bright blue and as the student start visiting more and more pages the color of the icons gets darker (.) This makes the map personalized for each student. In this way students could easily follow others and also compare their navigation behavior with others. If the color of the person icon is brighter than the background it means that the specific student has made less visits than the average number of visits in the group of students. Therefore this could give her or him a clue for what to visit next.

Moreover, the paper icon ( ) inside each cell represents the density of documents inside that cell. If the cell includes larger number of documents the larger stack of pages would be shown on the cell ( ).

Additionally a small sticky note icon is put on the stack of the papers that represents at least one document inside the cell includes some notes written by a visitor of the page ( ). The details about writing note and annotation in the system are provides in following sections.

2.2 Cell Content Interface

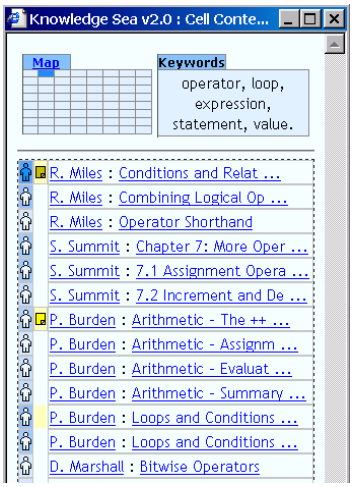

Figure 2 - Cell content interface

Cell content interface presents the documents inside each cell as it can be seen in figure 2. At the left top part of this interface, small view of the map is shown to make user aware of her or his position in the map. Also in the right top part it presents the keyword of the documents inside this specific cell to help student in what they are looking for without going through each document. All the links inside the cell content interface are annotated with group and student traffic with the same schema as described above. The background color represents the number of visits made by group of students and the icon color represents the number of visits made by the specific student. Moreover, the links are also augmented by small square with shades of yellow background and yellow sticky note. Similar to traffic representation, the yellow background represents the number of annotation made by group of students for the specific document and the yellow sticky note represents the number of annotation made by the specific student for the specific document.

2.3 Content Page Interface

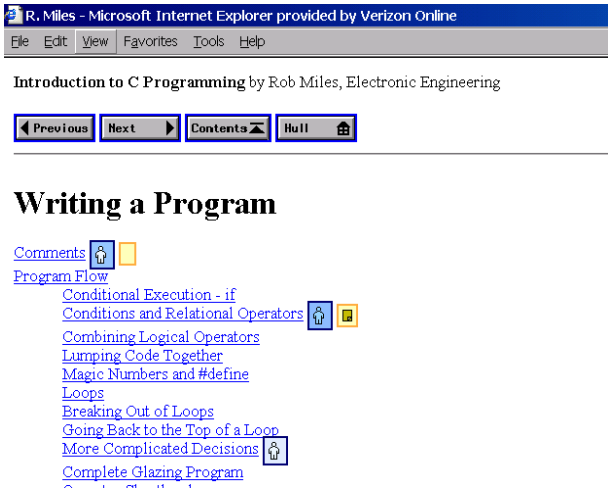

Figure 3 - Top part of content page interface

When students click on the link, the content of the page would be opened in a new page. All the navigation activities of student inside the content pages are tracked in the user model to offer the personalized and social navigation support. The same social adaptive navigation support as mentioned in the previous sections is provides for links inside pages as it can be seen in figure 3.

At the right side of the links that have been visited by the student, small traffic and annotation square could be seen that have the same meaning as described above.

Moreover, at the bottom part of the page, students could see the notes made by themselves and other students. They could see notes of others if they have specified it as public annotation. In this section, student could write notes. Notes could be in the private form; meaning that nobody else could see it, or it could be in public format meaning that other students could see it as well. Notes could also have different type, including a general type, a problem the students has encounter while reading the page, or a praise and something positive the student has found while going over the content of this page.

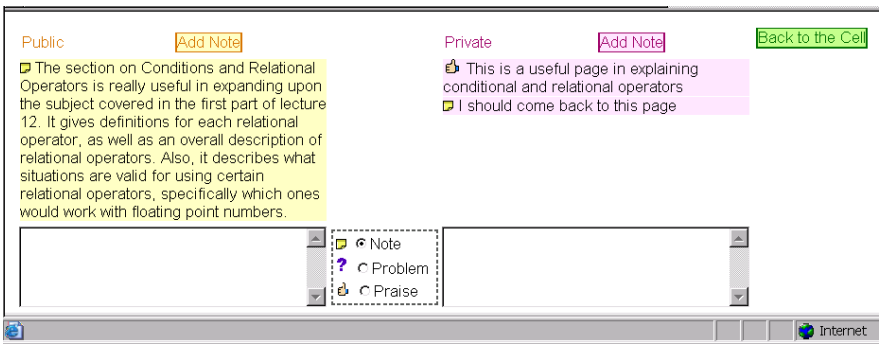

Figure 4 - Bottom part of content page interface

Moreover, from the content page interface student could be go back to the cell content interface and to the map to follow a new path.

3 Classroom Study

To evaluate the system we have conducted two semester of classroom study. This paper includes the result from the first study done in Fall 2003 semester since the data for the latter is not completed yet. The evaluation is done through analysis on users log and also an online questionnaire that was conducted at the end of the semester. Filling the questionnaire was optional for the students, but they would receive extra credit for doing it. The study was done in an introductory C Programming course in School of information science that is being thought by Prof. Peter Brusilovsky. The class includes 30 students, 24 male and 6 female students. Out of 30 students, 18 students (5 female, and 13 male) used the KnowledgeSea system. Out of 30 students, a4 students (5 female, 9 male) answered the questionnaire.

3.1 Analysis of Features of the KnowledgeSea

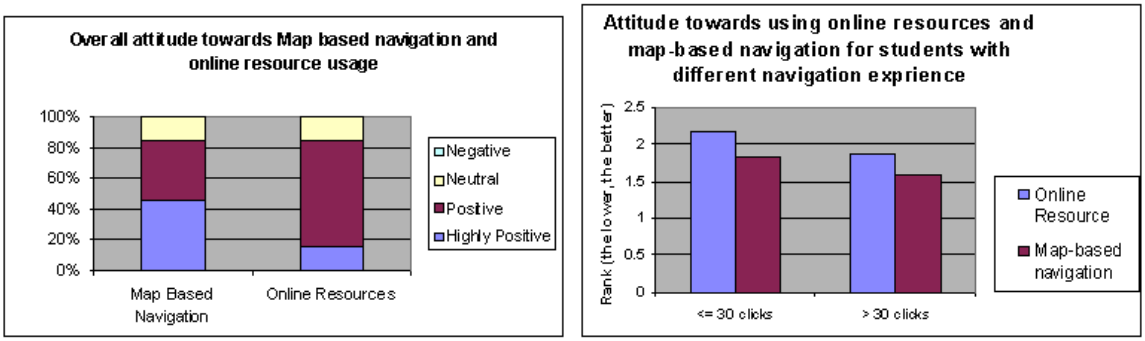

Figure 5 - attitude toward map-based navigation and online resource usage

The above figure, presents positive attitude of students toward main features of the KnowledgeSea system. Over 80% of students find the map based navigation and usage of open-corpus material positive or highly positive and nobody found these features negative. The positive attitude is stronger among student who used the system more as it can be seen in the right part of the figure 5 that presents the rank of these features made by students (The lower rank the more positive attitude).

3.2 Analysis of Social Adaptive Navigation Support

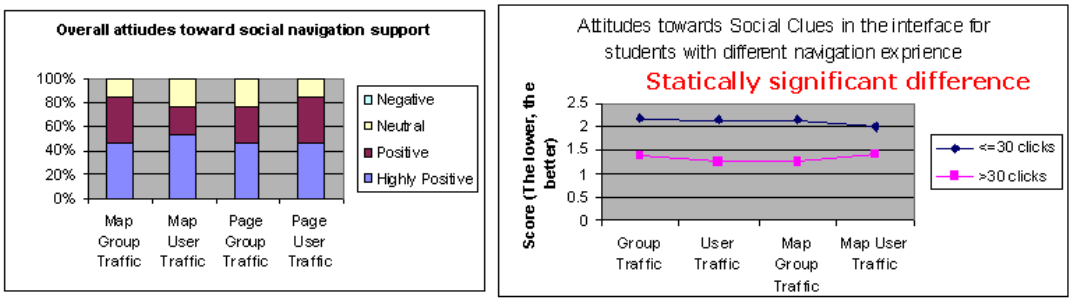

Figure 6 - attitude towards social adaptive navigation support

Figure 6, represents overall students' attitude toward social adaptive navigation support offered by the system. As it can be seen in the left part of the figure, around 80% of the students found these features positive or highly positive and nobody found them negative. Moreover, more positive attitude could be seen among students who used the system more often and the difference is statistically significant even though the number of students were small.

3.3 Analysis of Attitude towards Annotation Ability

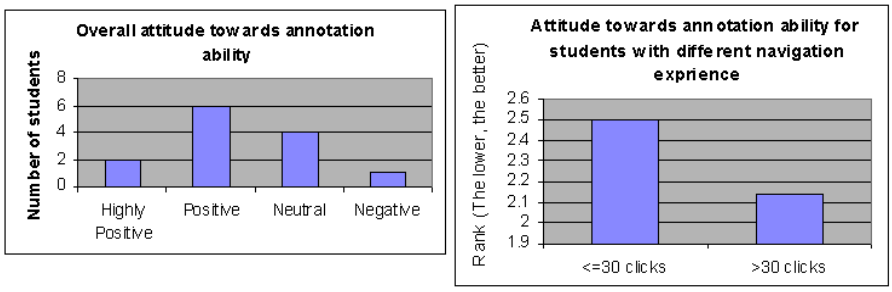

Figure 7 - Students' attitude towards annotation ability of the system

Figure 7, represents overall students' attitude toward annotation ability offered by the system. As it can be seen in the left part of the figure, around most of the students found annotation ability helpful and more positive attitude could be seen among students who used the system more.

3.4 Analysis of Usage of the System

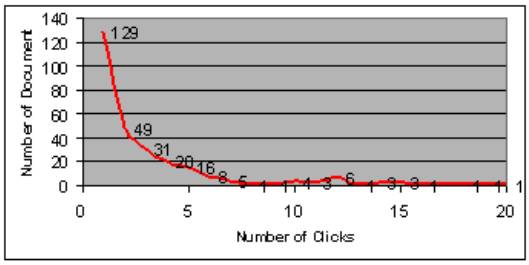

Figure 8 - Analysis of usage of the system

Figure 8, represent the overall document access pattern. As it can be seen in the figure, few document have been visited for large number of times while large number of documents have been visited a few times. This pattern could be due to social adaptive navigation support meaning that since students follow each other's path, so many students visited the same pages for large number of times.

4 Conclusion and future work

Current report presents the results of independent study conducted by the author in spring of 2004 as a part of her PhD program. Overall the KnowledgeSea system has been evaluates as helpful tool for learning. However, feedback from students shows that they are still looking for more navigation support and they still spend a lot of not necessary time finding what they are looking for. As the new direction of this project, I am looking at applying machine learning techniques for automatic classification of documents based of different educational aspect, importance, and relevance. I have performed preliminary work in classification of document based on learning resource type and we are looking into integration of these machine-learning techniques into the KnowledgeSea system to be evaluated by students.

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