

Adaptive Socio-Recommender System for Open Corpus E-Learning

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Abstract. With the increase popularity of online education, the task of providing the right information to the right users has become a real challenge. Adaptive Hypermedia has been established as one solution to this challenge. However, many adaptation techniques are well suited for *closed-corpus* and are not compatible in *open-corpus* situation. Our solution for open-corpus adaptive navigation support is Social Adaptive Navigation Support (SANS). The most noticeable form of SANS could be offered through tracking visiting behavior of users, which we call *traffic-based* SANS. However, the fact that students visited a page does not mean that they found it useful. Therefore, we are also looking at *annotation-based* SANS in which students are encouraged to annotate the tutorial pages they visit. As part of my PhD research, I have developed a system that supports both traffic-based and annotation-based SANS. We have evaluated the system with two semesters of classroom studies. The result of the studies supports the idea of SANS and suggests more powerful navigation support for future work.

1 Introduction

Wide and extensive amount of information on the World Wide Web, has made online education so influential. Yet, with increase of popularity of online education, the difficulty of the task of providing right information to the right users has become a real challenge. Adaptive Hypermedia has established as one solution to this challenge. Educational Adaptive Hypermedia systems try to offer learners personalized information by building a model of the individual's goals, preferences, and knowledge. Adaptation and personalization can be supported through various adaptation techniques [3]. One known adaptation techniques is adaptive navigation support. This technique offers learners help with navigation to prevent them from being lost in the hyperspace [2].

However, these techniques are best suited for limited set of resources, which is known as *closed corpus*. Since these techniques rely heavily on the manual tagging of resources by an expert, they are not well matched for extensive amount of online resources that are known as *open corpus* [8]. Navigation support for open corpus materials should be offered through techniques that require a minimum amount of manual tagging. One promising approach to eliminating manual tagging is taken in information retrieval research. There, documents are classified automatically through

When students click on a link in the cell content window as shown in figure 1, the content of the page will be opened in a new window. All the navigation activities of students, including visiting the tutorial pages and writing notes, inside AnnotatEd are tracked in an individual student model for adaptation support. Figure 2 presents general view of AnnotatEd.

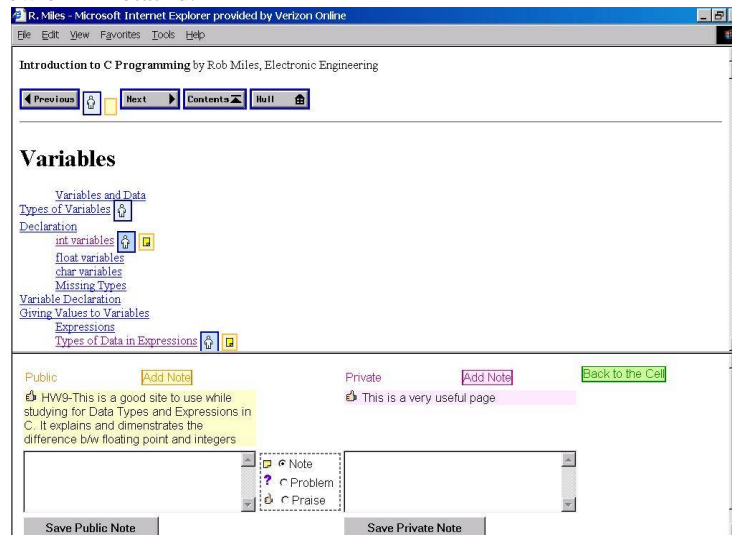


Fig. 2. General view of AnnotatEd system



3 Annotation-Based vs. Traffic-Based SANS

KnowledgeSea and the AnnotatEd system support SANS in different ways. The most noticeable action of the users to be learned from is the pattern of visiting tutorial pages. These usage pattern can be analyzed to learn which are the most useful pages. This is what we call *traffic-based* SANS that provides navigation support through the visiting patterns of other users [4]. However, the fact that a student visited a page does not prove that was useful. Therefore, it is important to be able to collect better evidence of students' thought about each visited page. To tackle this problem, AnnotatEd combines traffic based SANS with new approach that we call it *annotation-based* SANS. AnnotatEd tries to encourage students to annotate tutorial pages. Students could benefit from writing and annotating in two important ways: First, writing is proven to be a meta-cognitive strategy that involves students in active learning and engages them with more effectively in the learning process. As summarized by Bonifazi et al, annotation could help learners to remember better by highlighting the most significant part of a text, could encourage learners to think when they add more ideas to what they are reading, and could help learners to clarify and make sense of the material while they try to reshape the information [1]. Second, students' annotations could be used to create more meaningful SANS than is possible using only traffic pattern. Students' annotations could create an important trail for

other learners to follow by recording their thoughts about specific tutorial resource and could give more comprehensible recommendation about the resources.

To provide the ability to write notes, all pages of AnnotatEd include an annotation section at the bottom of the page as can be seen in figure 2. The annotation ability is designed in a very simple and clear way to avoid any extraneous load on students. In the first version of the system students could only write private annotations with no description about the type of the annotation. In the new version of the system, however, every annotation can be in a private or public format, which determines the population who can see that specific annotation. In the case of a public note everybody can see it and in the case of a private note, just the author of the note can see it. Students' notes are now also divided into three different types: "General", "Praise", or "Problem". These divisions are designed to help students more effectively organize their thoughts about each page, both for themselves and other learners.

At the top of the annotation section students can see all previous notes written by themselves or others in two different columns. The right column includes all the private notes and the left column includes all public notes. The notes in the public section can have pink or yellow backgrounds. A pink background shows that the note was written by the current student and a yellow background shows the note was written by others in the group. To write private or public notes, students can click on associated "add note" button.

AnnotatEd offers traffic-based SANS by annotating the links inside pages with the "man on background" icon: . This icon represents both the students' own and group traffic. The blue background gets darker with increasing group usage of that link. The man portion of the icon is a representation of student's own traffic using the same metaphor. The color of the icon (different shades of blue as well) gets darker with increasing usage of that specific link by the current student. In the new version of the system, AnnotatEd also offers annotation-based SANS by augmenting the links inside pages with the "sticky note" icon: . This icon represents both the students' own and group annotation density. The background becomes a darker shade of yellow with increasing group annotation. The central "sticky note" portion of the icon becomes darker with increasing density of the students' own annotation.

4 Evaluation

To evaluate the KnowledgeSea and AnnotatEd system we have conducted two semesters of classroom study in an introductory C programming course at the University of Pittsburgh. Evaluation is done through analysis of users' logs and also via an online questionnaire that was administered at the end of each semester. In fall 2003, 30 students were enrolled in the class. Out of those 30, 18 students used the system and 14 answered the questionnaire. In spring 2004, 27 students were enrolled in the class. Out of those 27, 25 used the system and 22 filled out the questionnaire. As shown in figure 3, more than half of the students appreciated the ability to write annotation and very few students found this feature negative.

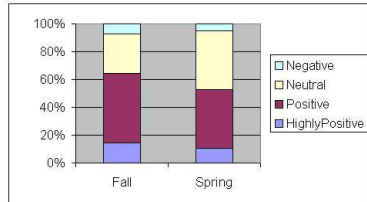


Fig 3. Students' attitude towards ability to write annotation

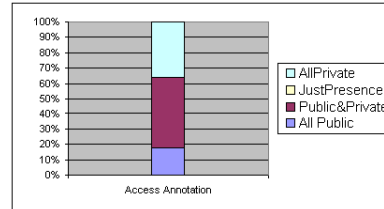


Fig. 4. Students' attitude towards public and private annotations

As mentioned before, the first version of the system that was evaluated in the fall semester. This version only offered private annotation in general type giving students no information about annotations written by others. In that study overall 5 students out of 18 who used the system, made some annotation. However, those 5 students accounted for almost 75% of the system usage and wrote over 120 annotations. This shows some correlation between the amount of usage of the system and writing notes. On the other hand, more than half of the students (Fig. 4) were interested in having the option of making public and private annotations, and in being able to view the public annotations of others. The abovementioned result was the motivation for providing both public and private annotation in the next version of the system. Moreover, at the end of the study, in reviewing the annotations we observed that most of the them fell in two categories: praise, a positive thought, or problem, a negative thought. Accordingly, in the second version of the system that was evaluated in the spring semester, we added the option of private and public annotation as well as the ability to categorize the note as “praise”, “problem”, or “general”.

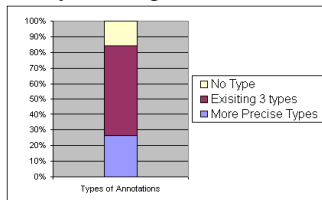


Fig. 5. Students' attitude towards types of annotations

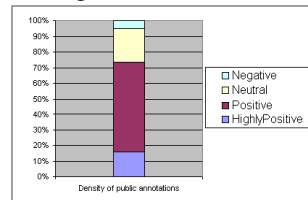


Fig. 6. Students' attitude towards indication of density of public annotations

After these changes, our results show a decline in both number of annotations and in positive attitude toward the annotation facility. In the spring semester, as shown in figure 3, about 10% fewer students appreciated the ability to annotate. Also only 4 out of 25 students who used the system made any annotations, and those students made just 28% of all visits to the system, which shows many students who used the system most, did not make use of the annotation feature. We hypothesized that the new interface has caused some confusion; however, since our data is from two different cohorts we need more data to evaluate this hypothesis. Yet, our questionnaire results (Fig. 5) show that more than 80% of students liked the option of typed annotations. A better-designed interface, therefore, might encourage more usage of the annotation system. However, as shown in Fig 6, students still reported very positive attitudes toward the indication of public annotation density for adaptive navigation support.

5 Future Work

Overall students have expressed positive attitudes toward the KnowledgeSea system as well as its social adaptive navigation supports. However, feedback from students shows that they are still looking for more navigation support and they still spend a lot of unnecessary time finding what they are looking for. As the new direction of my PhD research, I am looking at combining machine-learning techniques with social usage information. This should allow us to offer more navigation support by automatically classifying resources based their importance, and relevance. I am also investigating how to classify a document's level of difficulty based on student's footprints as well as on an automatically learned measure of the document's novelty. Another big challenge in this research is encouraging students to make annotations. Although many students appreciate the ability to annotate, they rarely write notes while going over the material. A key challenge is to make writing annotations more and more beneficial for students by connecting their notes with different sections of the system, and by presenting navigation support based on these annotations. In addition, I am looking at adding an online highlighting feature. Highlighting should be easier and more intuitive for students. Our survey result indicates that about 75% of students are interested in having the ability to highlight the online material they are reading.

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