Improving Structural Salience by Content Adaptation with Summaries

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Abstract

Users have a better chance to comprehend a text the better its coherence and structural salience is. Presentation adaptation will be used to attain more support for link structure comprehension. We plan to examine the effectivity and efficiency of the user's domain knowledge acquisiton. Therefore, assessment of both, internal (percent correct answers at tests) and external data (external tests, user satisfaction and goal attainment) is considered.

Hypertext and Text Comprehension

With the increase of powerful script languages and server capabilities in recent years, dynamic hypertext structures are getting more frequent. Due to this evolution, hypertext is gaining relevance as an information retrieval and learning medium not only in learning and teaching environments but also in occupational and leisure contexts. The nature of dynamic systems is the generation of a specific page at runtime just in the moment the user requests that page. This offers specific construction facilities to adapt page content presentation to the requesting user. The system may be equipped with some algorithms reflecting the editor's ideas of how the hypertext structure should be adapted to different users. Therefore, this kind of system is called adaptive. Adaptivity is distinguished from the more passive concept of adaptability, which means an adaptation to different user characteristics mostly by the choice of the users themselves. An adaptable system is able to vary presented pages in reflection of different user parameters having been set not by the system but by external instances such as the user himself.

With both adaptation strategies the presented structures may differ in content presentation or navigation support, just to cite the highest level of difference (Brusilovsky, 2001). One adaptation method is to vary the presented page content (e.g., de Rosis, F., De Carolis, B. & Pizzutilo, S., 1993). User adaptation may be accomplished by comparing user's navigation behavior to a basic structure of prerequisites, called the domain model. Therefore, the decision how to present a requested page depends on the comparison of the user model and the domain model. The domain model consists of the underlying knowledge structure of prerequisites and inferences. If page A has to be learned before page B, page A will be called prerequisite for page B. The prerequisite structure for all pages is part of the domain model.

Readers have the best chance to comprehend a text if it has a high level of local and global coherence. If the elements in adjoining sentences of a text are matching on a very basic contextual level, the text is said to have local coherence. Global coherence means a collective contextual framework on the level of the whole text. A text will be gobally coherent, if the course domain or its reasonable context is transparent in all paragraphs of the text. In other words, a text with a clear thread has a high global coherence. Text comprehension not only depends on textual characteristics but on reader characteristics, as well (e.g., Langer, 1984). However, for our work we focus on text attributes rather than on user characteristic differentiation. Local and global text coherence are a requirement for reader's comprehension, regardless of their individual abilities. Thus, even without investigating user's different abilities or charateristics we will be able to support users with adapted texts for better understanding.

Knowledge may be divided into two different main areas: declarative and procedural knowledge. Declarative knowledge deals with the knowledge about facts and concepts. In opposite, procedural knowledge describes how to use (declarative) knowledge to achieve a desired state. Our hypermedia learning environment aims to impart declarative knowledge rather than procedural. Thus, our approach deals with acquisition support of declarative knowledge by providing the user with adapted hypertext.

Declarative knowledge is commonly assumed to be structured in propositions that can be seen as nodes with specific connections between them (e.g., Kintsch & van Dijk, 1983). A hypertext learning environment aims to elaborate the user's declarative knowledge by presenting several knowledge concepts as hypertext pages. Thus, hypertext has a similar propositional structure as the declarative knowledge itself, although the pages of a hypertext structure are not to be confused with knowledge nodes (Eklund, 1999). A learner who is working with texts and exercises in a domain will consolidate a propositional mental domain model similar to the propositional structure of the domain. Knowledge acqusition and its integration in the user's existing mental model will be easier with a more transparent link structure. The effort to match links and nodes would require less work load. By an adaptive connectivity structure presentation, users may create their mental models more adequately.

Text adaptation based on summaries

To obtain a more salient connectivity structure between the nodes means not just to present more links between the pages but to create a more coherent text. Peter Foltz (1992) examined the superiority of a hypertext structure to linear texts by summary insertion. He constructed three different hypertext versions: linear text, hypertext and adaptive hypertext with additional summaries. In the third version, summaries of skipped pages were inserted on top of the requested page, when the distance between the actual page and the requested page was "too big". The exact summary insertion algorithm is not listed here. The reason for summary insertion was to increase text coherence to facilitate text comprehension. His system adapted content presentation to the assumed user's knowledge without a user model but only on the information of the actual and the required page. Thus, the same summaries would have been inserted for users with different navigations histories. If one user had used the same link on a page twice, the same page content would have been presented without having considered the pages visited meanwhile.

Based on this idea, we propose to provide users with a salient domain structure when they leave the suggested course track. To reach this, an extension of Foltz' approach by the usage of a user model would be accomplished. The system uses concept prerequisites to decide which summary to present and which not. Only summaries of not yet learned prerequisite concepts are presented on a requested page. A second use of a link would then only lead to the same page presentation, if the user wouldn't have visited and learned some relevant concepts in the meantime.

In addition to mere summary presentation, it is possible to provide the user with links to the pages the summaries are from. If the user wants to have a glance at a specific referred page, he may do so. There, he may have the choice to go on at the point he came from or at the page he glanced at. Thus, the suggested procedure of extended summary insertion is a combination of content adaptation and user guiding.

The courses used for this work are created in NetCoach, a platform independent authoring tool for adaptive online courses (Weber, G., Kuhl, H.-C. & Weibelzahl, S., 2001). The dynamically generated hypertext page is presented to the users by their browsers. No special software is required. In NetCoach, concepts and pages are equal. Knowledge concepts and hypertext pages therefore have the same structure. Prerequisite features and their adaptive utilization as guiding aids are basic features in the NetCoach system.

In NetCoach, the user model contains information about the user's exercise performance within the course and the visited and thus learned pages. By defining prerequisite pages, the system is provided with a basis to justify its decision for different user guiding. The comparison between user model and domain model with its prerequisite structure yields enough information for the system to guide the user through the course.

NetCoach supports the dynamic generation of summaries. Authors may activate summary support by selecting the respective option in the editor. In addition, the author may define an introductive text which will be presented on top of all summaries to point out the additional user specific nature of the following sentences. If the summary option is activated, a summary may be specified for each concept. Each summary may be formatted seperately. We want to keep concept summaries as short as one sentence for not to overload one presented page with more summary text than concept text. Therefore, the summaries are not meant to be a substitute for the summarized concepts but hints to knowledge sources where the user may acquire knowledge to understand the current page.

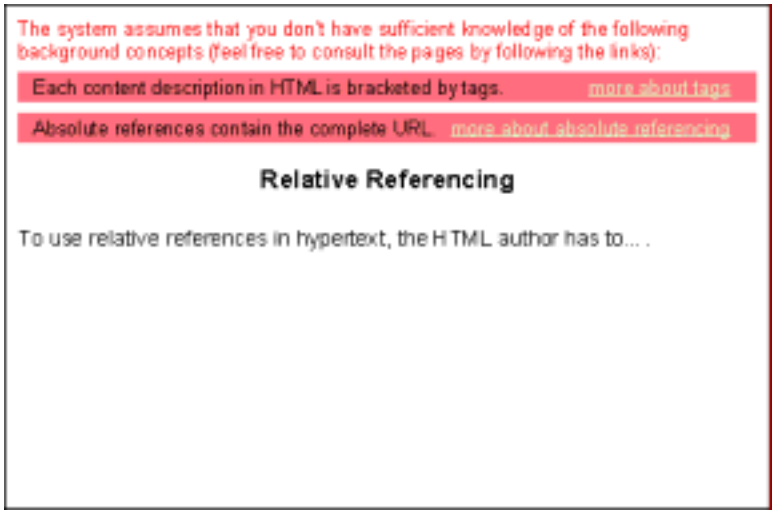

Figure 1: In this case, a user has not fulfilled two requirements for the actual page and may decide to follow the links to the respective pages.

In Figure 1, the page presentation design with two summaries is displayed. In the presented example of the HTML domain, the author marked the HTML tag concept and the absolute referencing concept as prerequisites for the relative referencing concept. The user requested the page about relative referencing without having learned these concepts. Thus, the user revceived additional information through summaries and has the choice to gaze at the respective detailed pages. The accentuation of the summaries and their links is obvious. Working in a course, the user receives a summary of not completely learned prerequisite pages on top of a requested page. They may be used as addititional hints for the propositional structure. Within these summaries references to the respective pages may be integrated to provide the user with a choice to gaze at these pages. There, the user may learn more about the lacking content on the referred page and after that return to the initial page.

Evaluation

We plan to investigate the effectivity of the proposed procedure by assessing different data types. User's knowledge acquisition may be appraised by examining the percentage of correct answers in several exercises throughout the course. In addition, we plan to create an external exercise which will be processed after finishing the course. Furthermore, subjective measures of the individual goal attainment and satisfaction with several course and system aspects may be assessed in a questionnaire at the end of the course.

For evaluation purposes, we plan to use a course which domain should be relevant not only for a specific group but to a broad variety of users to attain a more generalizable effect assessment. Therefore, the used sample should contain users from different domain types. The exact topic of the course is not yet defined.

The basic experimental design will provide two groups of users. Both groups will work on the same course but one half will additionally receive the summaries while the other half will work with the same course just without the summaries. We hope to confirm the following hypotheses:

1. The use of text based guiding leads to a higher level of user satisfaction and subjective goal attainment.
2. Text based guiding helps users to consolidate their mental model of the domain structure which leads to a better performance in internal and external exercises.

Future Perspectives

A first additional feature may be the option to declare the summarized pages as already known. This declaration may be accomplished by the user right at the time the he gets the hint of not yet learned pages. Then, he may set a mark for each known concept. Marked pages would not be summarized in the future anymore, because the system assumes them as known.

Second, summaries of prerequisite pages may not only depend on the context they stem from but on the context they are presented in. Each concept is another context for the summarized pages and therefore may need a specific (more locally coherent) embedding. Thus, additionally summiaries may be adapted to the context of the requested page and presented within the text.

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