IN: Proceedings of the 10th ACM Conference on Hypertext and Hypermedia. Darmstadt, Germany. February 1999.

Individual Tables of Contents in Web-based Learning Systems

Cornelia Seeberg[1,2], Achim Steinacker[1], Klaus Reichenberger[1], Stephan Fischer[1] and Ralf Steinmetz[1,2]

1
Industrial Process and System Communications
Dept. of Electrical Eng. & Information Technology
Darmstadt University of Technology
Merckstr. 25 • D-64283 Darmstadt • Germany

2
GMD IPSI
German National Research Center
for Information Technology
Dolivostr. 15 • D-64293 Darmstadt • Germany

{Cornelia.Seeberg,Achim.Steinacker,Klaus.Reichenberger,Stephan.Fischer,Ralf.Steinmetz}@kom.tu-darmstadt.de

ABSTRACT

The iTeach project of the Darmstadt University of Technology builds a webbased adaptive hypermedia teaching and learning environment for multimedia and communication technology. Hereby, the demands of diverse user groups, user levels and especially of diverse learning strategies are taken into account. Besides information gained from the interaction with the user, the system uses standardized content relations and meta-information to adaptively compile a selection from the set of available information units (media bricks). A subset of the meta-information represents the compiled lesson on a high level and is presented to the learner as a dynamically generated table of contents. Subjects which are topics in one scenario can be subtopic in the next or not occur at all. Our approach can help closing the gap between free navigation and static guidance in an adaptive hypermedia system.

KEYWORDS: adaptive hypermedia systems, learning environment, domain models, navigation, guided tours, multimedia

MOTIVATION

The content of the iTeach system, currently being developed at the TU Darmstadt, is the printed book "Multimedia: Computing, Communications & Applications" by Ralf Steinmetz and Klara Nahrstedt consisting of about 1000 pages, and a selection of Java applets [3]. The aim of iTeach is to have individual views on this material according to the needs and preferences of the individual users, and to find and to propose a suitable path, hence a suitable composed lesson. To be able to accomplish this, the content and meta-information concerning the content must be represented in a formal way, that enables the system to operate on it. As a result the system can play the role of a guide for the user. In order to find a suitable path, the system makes use of a user profile and of the meta-information. In the beginning, the profile is filled with the demands and preferences of the learner. While the learner is working with iTeach, it keeps track of what information the user has already seen/learnt, what additional material the user has demanded to see, the results of the tests etc.

KNOWLEDGE BASE: RELATIONS AND RULES

There are two spaces in which the knowledge base is modelled a domain model, which we call the ConceptSpace, and the MediaBrickSpace, where knowledge is represented in small modular pieces of text, in images etc. The concepts and the actual content are therefore separated. The ConceptSpace represents the domain, the MediaBrickSpace is a set of possible explanations of this domain. The concepts are comparable to possible chapter headings and are interconnected by semantic relations. There are different possibilities to choose a set of relations. Our semantic relations strongly guide the composition of lessons but do not predetermine a unique set of topics and the order of these, to make application of different learning strategies possible. In the following we will describe in an exemplary way the rules that operate on the different categories of the profile and on the relations in the ConceptSpace to compile a adequate outline for a lesson. The rules which are responsible for choosing the global structure of the lesson use the semantic relations corresponding to the learning aim. Note that these rules are not a hardwired part of the system. At this stage, we modelled some rather straightforward didactic rules ourselves, later we want to give the domain experts working with the system the possibility to specify their own rules. Examples for rules using the semantic relations: In his/her profile, the user is characterized as a student learning for exams. In this case the system will search for concepts which are related to the chosen topic by the relations "uses", "part_of" and "is_a". The selection of the topics has to be coordinated with their order arising from the chosen learning strategy, e.g., hierarchical: Definition - broader term- component - application. In other cases the selection of the topics uses, on a small scale, inferences on the ConceptSpace. Example: The topic is related to another by the relation "problem". Then the system would most probably find a concept representing a solution for this problem among the more specific concepts (i.e. one that is connected by a "is_a" relation). Example: A File Server generally has the problem that it doesn't fulfil the requirements of real time applications. A subclass of file servers, the media servers, solve this problem. The lessons are finally put together by combining a set of media bricks. They can be in form of text or other multimedia elements such as images, graphics, video and audio streams and - with the main focus - animations realized as Java applets. Also these multimedia elements satisfy the requirements of modularity. This requires that the format of the media bricks enables the system to describe the content, grade of detail, and the underlying pedagogical concept of the media brick. Thus it is possible to integrate a media brick in a lesson, independent of the kind of media.

Particular emphasis of our work lies on the issue of coherence [3]. When a user of a hypertext does not have the possibility to choose the pages, i.e. he/she cannot establish the relation between the parts of the lesson by himself/ herself, he/she is more likely to expect a coherent lesson, a lesson where the relations between the parts are obvious, although they are put together by someone else. For this purpose the media bricks are not only linked to the corresponding concept but also interconnected in the MediaBrickSpace by rhetorical relations based on the Rhetorical Structure Theory [1]. Examples for such rhetorical relations are "deepen" or "explain". It is a major task of the system, to make this relations explicit. In general, the rules for building the lesson out of the relevant media bricks, have to use the rhetorical relations and the characteristic of the media bricks, in order to match the users level of difficulty, media preferences and coherence expectations. Simultaneously, they have to work off the structure of the lesson compiled earlier and to fulfil the demands of the user’s learning strategy. Note that the learning strategy requires rules working on both spaces. These goals are not always easily harmonized: The system will, for instance tend to select as the next media brick one that is connected to the current one but also one that is connected to the next topic in the planned structure.

A TABLE OF CONTENTS FOR EACH USER!

As an example how we overcome the gap between free navigation and static guidance by using the meta-information described above, we suggest a dynamicallygenerated table of contents. Dynamically generated tables of contents combine the best of both worlds: The interests of the user are made manifest by the outline, the structure, of the lesson. This task can be achieved by applying the user profile instead of constraining the user to choose the media bricks by himself/herself. As with a guided tour the lessons are coherent, and more security is given to a sensible course of text/media. Rules working on the ConceptSpace are responsible for creating the outline according to the user profile; rules working on the MediaBrickSpace are responsible for the coherence of the lesson.

DYNAMIC TABLE OF CONTENTS

Generally, a table of contents is the rough structure of lessons. Any kind of table of contents is motivated by semantic relations. A table of contents gives the reader anoverview of the lessons and shows the view the author has of the subject. Therefore we can consider the table of contents as a path through a net of concepts. We observe that not every path can serve as a table of contents, nor does every structure of a topic make sense. Since the aim of the iTeach system is to be adaptive to the needs and preferences of the specific user we need more than just one table of contents: We need a table of contents for each single user. This cannot be obtained by having several static tables of contents. If the set of media bricks would be static we could precompute every possible way through the material. This means, every possible learning strategy etc., could be realized and presented to the user. But since our system is open for extensions of both ConceptSpace and MediaBrickSpace including media bricks from external sources, we must be able to generate the tours through the material dynamically for every user. Our system is able to fulfil this task because of the partition into ConceptSpace and MediaBrickSpace. The concepts/topics are modelled separately from the descriptions, therefore every concept can be picked up to be the main topic. The semantic relations which allow the diverse structuring of the topics make it possible to tell the difference between sensible and senseless structures, i.e. table of contents. The ConceptSpace with its manifold semantic relations is a starting point for different and meaningful ways to construct tables of contents. Topics which are chapter headings in one lesson can be subchapters in another.

USER ACCEPTANCE

An evaluation of the system was made: A Multimedia Technology course of the Darmstadt University of Technology was splitted in two parts for one session, one group attended the normal lecture, the other group used the Multibook choosing a learning strategy. The result of a test shows that the understanding of the topic in both groups were about the same. The Multobook user esteemed highly especially the possibility to choose a leraning startegy.

REFERENCES

[1] Mann, W.C., Thomson S.A., Rhetorical Structure Theory: A theory of text organization; Technical Report RS-87-190, Information Science Institute, USC ISI, USA 1987

[2] Steinmetz R., Nahrstedt K., Multimedia: Computing Communications & Applications 2nd edition, to be published, Prentice Hall, 1998

[3] Thüring M., Hannemann J., Haake J.; Hypermedia and Cognition: in Designing for Comprehension; Designing Hypermedia Applications, Communications of the ACM, 1995