3 Related research

Hypertext documents tend to overwhelm the reader with too much information, or an inappropriate level of detail is presented. Several studies and systems propose solutions to these problems.

In his survey, McTear mentions two systems. METADOC uses a technique called "stretchtext" where classifications of users and concepts are used to vary the amount of detail presented. The HYPERFLEX system can guide the user to information judged to be relevant by recommending topics based on preferences, goals and needs of different users. Matrices are used to link topics in a document and to link topics with nodes representing particular user goals. The system learns through user feedback, by adjusting the weights of the links [*McTear93*].

The system KN-AHS achieves adaptivity by using the shell system BGP-MS. The user may ask about more information related to hotwords, and the data presented reflects what the system believes the user knows. The self-explanatory user interface stimulates user navigation. Knowledge about the user is both based on an initial interview with the user and by deducing what the user knows based on navigational behaviour. [*Kobsa+94*].

Three systems are exemplified by Kules: AVANTI is a system that customizes web pages about a metropolitan area for different users (tourists, handicapped, elderly, residents). INTERBOOK is an advanced WWW application and supports incremental learning. In a web-environment the HTML model and the HTTP protocols limit the details about user actions. Therefore in order to infer what the user know, the system keeps track of what the user has seen. Finally, ORIMUHS is a context-sensitive help system and employ sophisticated user models [*Kules00*].

Even though simple user models are able to represent all the necessary knowledge to achieve curriculum sequencing and adaptive guidance, the knowledge state of a user in www-based learning systems is complicated to maintain. Weber et. al present a solution using a combination of an overlay model and an episodic user model [*Weber+97*]. The episodic learner model (ELM) stores knowledge about the user in terms of a collection of episodes. In our work, we take a quite similar approach to the structure of the knowledge based tutoring system ELM-ART II, whose steps are:

1. Translating text to small sections of units/HTML-code associated with concepts to be learned.
2. Building a conceptual network with links among related concepts. When a page is visited, the corresponding node in the network is updated. Dynamic slots are stored with the learner model for each user and make it possible for the system to guide the user optimally through the domain. By marking concepts of a unit as known an inference process (possible recursive) that marks all prerequisites to

this unit as inferred, is started. This corresponds to the curriculum sequencing and adaptive guidance noted above.

3. Recording all interactions of the learner (the student) in an individual learner model
4. Using traffic lights visible to the user during surfing as a metaphor for annotating links, should reflect the information in the user model.
5. Dealing with inconsistent knowledge by means of tests.
6. Incorporating means for the user to re-use the code of previously analysed examples and to easily navigate an optimal learning path by clicking a *next* button. This feature also helps the user from getting lost in the hyperspace.

This approach has several advantages: it provides a selection of examples that best puzzles the present learning situation, it is suited for diagnosing solutions to problems, and it gives individualized help.

ELM-ART II differs from our work in that our focus is on developing means to semi-automatically associate concepts of high quality with each HTML unit and building a conceptual network representing the domain. Like us, Ashish et. al use formatting information in Web pages to "hypothesize the underlying structure" in order to provide integrated access to multiple Web sources in a particular domain. The sources are parsed for sections and subsections relying on heuristics for font size and indentation spaces. [*Ashish+97*]. The AHM system uses a model where the documents explain the concepts they are linked to and the links are assigned values that indicate the level of difficulty [*da Silva+98*].

We believe that once the domain model is built, adaptive variations can be made fairly easily. For example, in their WHURLE system [*Moore+01*], Moore et. al follow the track of Ted Nelson's vision of transclusion by including smaller pieces into a document led by a lesson plan and the user profile.