

“Pluggable” User Models for Adaptive Hypermedia in Education.

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ABSTRACT

Most adaptive hypermedia systems used in education implement a single user model – inevitably originally designed for a specific set of circumstances. In this paper we describe an architecture that makes use of XML pipelines to facilitate the implementation of different user models.

Categories and Subject Descriptors

H.5.4 [Information Interfaces and Presentation]: Hypertext/Hypermedia – *architectures, navigation, theory, user issues.*

General Terms

Design, Experimentation, Human Factors.

Keywords

Adaptive hypermedia, education, system architecture, user modeling, XML, XSLT.

1. ADAPTIVE HYPERMEDIA IN EDUCATION

As on-line learning is becoming increasingly pervasive, so is an appreciation of the difficulties and limitations of this approach to education. The most important issue is that using the WWW to distribute resources, as though it were a distributed photocopying machine, is of limited educational value. Although this approach can be useful to support teaching, it is unlikely in itself to provide a sound learning experience. One approach to addressing this is to develop on-line collaborative systems that foster the creation of learning communities. Another approach, one that we are concerned with here, is to leverage the techniques and technologies of adaptive hypermedia to deliver educational content that is appropriate to the needs of individual students.

Education is currently the major application of adaptive hypertext, and is an area that has been reviewed thoroughly by Brusilovsky [3]. A number of adaptive systems have been developed for educational use – such as AHA! [5]; CHEOPS [6]; Interbook [4]; and WHURLE [1]. These systems use a variety of techniques – operating at the level of the links, the content or both – to adapt the learning experience to suit individuals. One feature that they all have in common is that they construct a profile of individual users, and apply a set of

criteria, the user model, to inform the adaptation. There are significant differences between the approaches to user modeling that these systems use [2]. Any user model is imperfect from an educational point of view, in so far as it makes pedagogic assumptions that are unlikely to be valid under all circumstances. Hence it would be highly advantageous – both for research purposes, and for practical implementation in teaching – to design adaptive systems in such a way that user models are independent modules that can be “plugged” into the system. In this paper we shall describe part of the WHURLE architecture that has been designed to do just this.

2. THE WHURLE SYSTEM

WHURLE is an XML-based adaptive learning environment [1]. In WHURLE content is stored as conceptually self-contained “chunks” of information (eg a captioned image). Each chunk is formally described by an XML file, and one or more of these are conditionally transcluded [8] to form a page. The student experience, lessons, are defined by lesson plans, each of which contains a list of all of the chunks utilised in that lesson, the default structure of the information and various meta-information and configuration settings. The WHURLE rendering engine is an XSLT stylesheet that provides a navigational overlay (navigation information being derived from the structure of the lesson) and a user interface that is specified as a skin.

3. ADAPTATION BY FILTER

The concept of XML pipelines, are fundamental to the WHURLE architecture. An XML pipeline is a series of events, generated at parse-time, that flow through a predefined sequence of filters or processors. Just as a Unix pipeline uses the output of one program as the input of another, an XML pipeline uses the output document of one process as the input document of another. In WHURLE, the current page from the lesson plan being viewed is constructed into a node-tree (using XInclude [7]) that contains all of the chunks that might be required for it. This is ultimately passed in an XML pipeline to the display engine, an XSLT stylesheet that adds autonavigation and the user interface, and finally generates an HTML output document. This pipeline is thus the ideal place to implement a pluggable user model, as illustrated in Figure 1, by inserting an extra process. XML pipelines are discussed in the Cocoon documentation, found at:

<http://cocoon.apache.org/2.0/userdocs/concepts/index.html#basic-mechanisms>.

The output document, determined by the user’s current position in the lesson plan, contains all of the content that

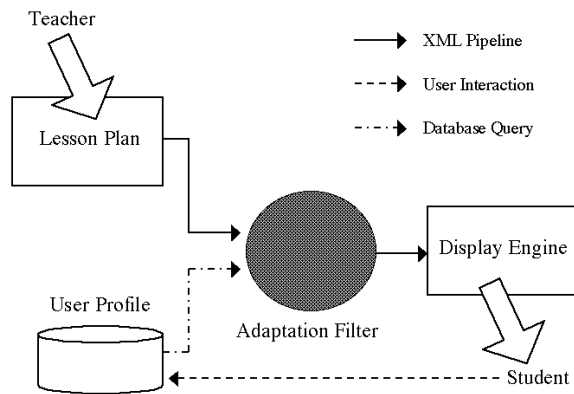


Figure 1. The adaptation filter in WHURLE. A teacher creates a lesson plan, which defines all possible content of the lesson. This is filtered, according to the user model, which makes use of information stored in the user profile. The output of the filter is rendered by the display engine, and student interactions update the user profile.

could potentially be in the page. This is then filtered by an adaptation filter (ie an XSLT stylesheet that removes those chunks that are not required for the current user – as determined by whichever user model is currently in use). Although a larger node-tree is generated than will usually be delivered to any individual user, the computational overhead is minimal due to the processing model of XInclude [7]. Because the information is processed at the level of an XML information set, the only elements processed are the top-level included items, unless the child elements are required elsewhere in the pipeline.

Currently we use an adaptation filter that implements the “Hybrid Model” [9][10], although we have also used WHURLE as a framework to deliver non-adaptive material by the simple expedient of passing the entire node-tree through to the rendering engine. In order to implement a different user model, the only part of the system that needs to be modified is the adaptation filter. It is, however, important to note that depending upon the criteria used for adaptation, some user models might require different meta-information to be stored in the chunks and/or lesson plans.

4. SUMMARY

The use of pluggable user models in WHURLE increases its flexibility, and also provides us with a potentially powerful research tool for future evaluation studies. User models are currently under development that operate on factors other than that of knowledge and ability; such as preferred learning styles. Also, WHURLE is to be a test system for user models developed by the Minerva:ADAPT project:

<http://wwwis.win.tue.nl/~alex/HTML/Minerva/>

All of these applications are facilitated by the flexibility of this architecture.

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