Modelling of Adaptive Hypermedia Systems

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Abstract: *The amount of information on the web is permanently growing. The orientation within the information is becoming more and more complicated. It is necessary to develop a system able to adapt the information for the needs of the user and to personalize the presentation of information according to his/her preferences. In this paper we discuss current approaches used in the research, both advantages and disadvantages of the developed models and our proposals for their extensions.*

Key words: *meta-model, web adaptation, web personalization*

INTRODUCTION

Personalization of the web is a complex problem. The problem is possible to solve on different levels of approach. We can focus on searching a web space, the filtration of the information from several sources, or we can modify a presentation of information in compliance with a user model. In this paper we will focus on user-modelling approaches. In the first section we will describe some of the well-known models for personalized hypermedia like AHAM [1], Munich reference model [2] and FOHM [3]. In the next section we will focus on some improvements proposed by scientists searching in hypermedia technology. We will mention the utilization of the meta-model in adaptation technique selection [6] [7], the trend of a general model formalization [8], and the application of active rules as a description of adaptive behaviour [11] [12].

EXISTING WEB MODELS

For the developing of personalized web several models have been designed. We will describe some of them in the next paragraphs.

AHAM

Adaptive Hypermedia Application Model (AHAM) [1] is one of the first and well-known formal models for adaptive hypermedia. It is an extension of the Dexter model, a widely used reference model for hypermedia. The adaptation is based on a *domain model*, a *user model* and a *teaching model*, which consist of *pedagogical rules*.

As the Dexter model, AHAM also focuses on the *storage layer*, the *anchoring* and the *presentation specifications*. The *domain model* uses concept components for an abstract representation of information. A component's information consists of a set of attribute-value pairs, a sequence of anchors and a presentation specification.

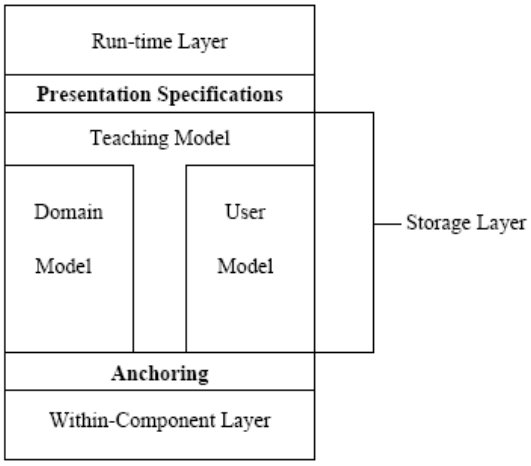

Figure 1: The AHAM model [1]

Munich reference model

This model is also an extension of the Dexter model and in similar way it adds a *user model* and *adaptation model*. The main difference between The Munich Reference Model [2] and AHAM is that AHAM specifies the adaptation rule language, while The Munich Reference Model uses object-oriented specification. It is described with the Unified Modelling Language (UML) which provides the notation and the object-oriented modelling techniques.

FOHM

The Fundamental Open Hypermedia Model (FOHM) [3] is based on the prior work with the Fundamental Hypermedia Protocol (OHP) providing a reference model and an architecture for the Open Hypermedia systems. It provides the facility to attach context and behaviour objects to the model at various locations. An engine, Auld Linky, is required to instantiate and process the model.

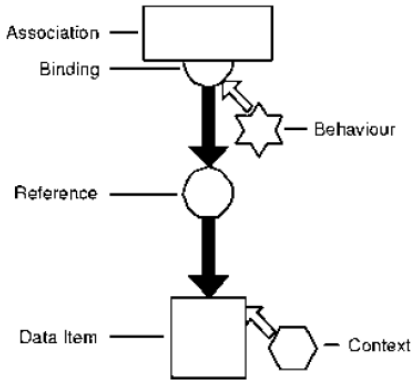

Figure 2: The Structure of a FOHM Object [3]

GAHM

The Goldsmiths Adaptive Hypermedia Model (GAHM) [4] is an abstract model. It takes a formal approach to the modelling of adaptive hypermedia. The model consists of three groups of functions. The *H-Region* functions model non-personalisable hypermedia-based interaction, the *P-Region* functions model user-initiated tailoring and the *A-Region* functions model system-initiated tailoring of hypermedia content.

GAM

Generic Adaptivity Model (GAM) [5] is a state-machine-based model, which is not restricted only to hypermedia. However, it can be used as the basis for adaptation in all kinds of applications. Compared to AHAM, the GAM is a more low-level model and does not provide hypermedia specific concepts. On the other hand, the GAM provides an explicit *interface model* and the concepts of push-and-pull adaptation. The research group of the Nijmen University plans to develop a model on the top of the GAM, which would be applicable in the area of adaptive hypermedia.

META-MODEL APPROACH

In adaptive hypermedia systems there are used several adaptation techniques. As mentioned in the paper [6], different known techniques work most efficiently in different contexts.

There are two categories of the adaptation methods [16]. The first one is a Content Level Adaptation (also called adaptive presentation), and the second one is a Link Level Adaptation (also called adaptive navigation). We will provide a brief overview of the main methods.

Adaptive presentation methods

Additional Explanations

In an adapted document the basic content of the page is extended with particular information. Additional information is shown with respect to user's knowledge.

Prerequisite Explanations

With the appliance of the user model, the system checks, if the user's knowledge complies with all prerequisites. The explanation of all missing prerequisites is added to the document to facilitate the comprehension of the concept.

Comparative Explanations

New concepts are explained in the way of linking them with some concepts already known to the user. Typically, the similarities and differences between these two concepts are pointed out.

Sorting Explanations

Parts of the document are sorted according to the relevance of information to the objectives of the user. The level of his knowledge, possibly some other characteristics, are taken into account.

Explanation Variants

In the source document there is defined a number of different explanations of a given concept. In the final document the most suitable variant for the user is shown.

Adaptive navigation methods

Direct Guidance

In this method the user is sequentially guided through the hyperspace. The "next button" is offered to the user. The system selects the best page suitable for the user in compliance with the information stored in the user model. Another possible technique is to choose a sequence of pages. This sequence should help the users to find their paths in the hyperspace.

Adaptive Sorting

The links in the hypermedia document are sorted according to the importance for the user. The sorting of the links can be made by the similarity of the links in a current document. Another way of sorting is made by the prerequisites. This method is similar to the one used for the adaptive presentation. The only difference is that instead of showing corresponding text, links with needed information are labeled with a higher relevance.

Adaptive Hiding

This method excludes the possibility of visiting pages with no relevant information. Links leading to such pages are hidden or disabled. This restriction avoids the user to be lost in a large hyperspace.

Links Annotation

In this method the links are annotated to show some information about the content of the pages to the user. The annotation can be provided in a textual form. Another way is to use some visual augmentation, e.g. relevance is represented by a colored sign next to the link.

Several studies have shown that users with different knowledge of the subject may appreciate different adaptation technologies. Therefore, it is necessary to develop a system capable of adapting the very adaptation technology to the given user and context. For this purpose a meta-model should be used as a basis for a meta-adaptive system [7]. The main feature of a meta-adaptive system is that it should examine the existing results of the adaptation technique application. Based on the application successfulness, the system should select the appropriate technique for the context, instead of using an ad-hoc approach.

UNIFYING MODEL APPROACH

The approach to adaptive hypermedia development has been mostly application-oriented. As a result, there are some ad-hoc systems that are neither interoperable nor interchangeable. Recent research focuses on the development of the systems that will have such features [8]. The study in [8] has proved that although each adaptation model uses different representations of hypermedia structures and different approaches to manipulating them, there are important underlying commonalities in terms of the components found within adaptive hypermedia systems and the interactions between them.

The aim is to find the way how to devise such an architecture at a suitable level of abstraction, that can represent the functionality that is unique to the adaptive hypermedia systems. The components of such an architecture, like user-models and decision-making algorithms, should be treated as plug'n'play black box components and be included as and when required. This approach could lead to the standardized adaptive hypermedia architecture.

ACTIVE RULES APPROACH

Active rules are the rules with a specific form: Event-Condition-Action. The adaptation system based on these rules was proposed by French researchers [11]. By means of the active rules it is possible to integrate all existing techniques into the system. Furthermore, this system allows to introduce new adaptation strategies more easily.

Inspired by the production rules in the expert systems, the active rules are applied in the database domain. However, these rules have not been largely used in the adaptive hypermedia domain by now. Nevertheless, a high level language based on the rules may be used for a reusable personalization specification which can be mapped to different web modelling methods [12].

A rule is formed by an event, a condition and an action to be performed. When the user activates a link, an event is launched and the corresponding rule is evaluated. The action specifies the adaptation action to perform.

CONCLUSIONS AND FUTURE WORK

As we can see, all the approaches mentioned above try to extend existing models for the hypermedia design and to generalize them for easier use and interchangeability. Our aim is to develop such a general model. We will focus on the mentioned promising techniques and we will try to extend them and apply them in our improved modeling methodology.

The aim of our research will be the specification of an appropriate formal approach to the general conceptual meta-model design. An automatic system for the adaptive web design will be based on this model. The final methodology for the adaptive web design should be able to use appropriate adaptation techniques and should allow an easy extension. A partial outcome of the research will be an appropriate formal description.

We will try to formalize a general meta-model compounded of black-box components. These components will enable an easy extension of currently used techniques in a

plug'n'play manner [8]. We want to use *active rules* [11] [12] [13] as a suitable description of the adaptive behaviour. The selection of appropriate adaptation methods could be accomplished by some heuristic methods for the information retrieval. We think that for this purpose the *Probabilistic Latent Semantic Analysis* (PLSA) [14] or a *Vector Space Method* [15] will be the most appropriate. Some inspiration can be gained also from the conceptual methods proposed in [9] [10].

We will carry out several experiments and in this way we will verify the resulting adaptation system based on the proposed meta-model.

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