AH 12 Years Later: a Comprehensive Survey of Adaptive Hypermedia Methods and Techniques

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Abstract

A hypermedia application offers its users much freedom to navigate through a large hyperspace. Adaptive Hypermedia (AH) offers personalized content, presentation and navigation support. Many Adaptive Hypermedia Systems (AHS) are tightly integrated with one specific application and/or use a limited number of techniques and methods. This makes it difficult to capture all of them in one generic model. In this paper we examine adaptation questions stated in the very beginning of the adaptive hypermedia era and elaborate on their recent interpretations. We will reconsider design issues for application independent generic adaptive hypermedia systems, review open questions of system extensibility introduced in adjacent research fields and try to come up with an up-to-date taxonomy of adaptation techniques and an extensive set of requirements for a new adaptive system reference model or architecture, to be developed in the future.[1]

Introduction

The research field of adaptive hypermedia and adaptive web-based information systems (AHS for short) has been growing rapidly during the past fifteen years and this has resulted in new terms, models, methodologies and a plethora of new systems[1]. Adaptive systems are becoming more popular as tools for user-driven access to information. Adaptation of an information system or service to a user has been proven to be a powerful and useful concept [1]. It is particularly helpful for the reduction of the information overload which is frequently experienced on the Internet or a large scale information system.

Since this explosion in the AHS area, only a few general overviews of the field have been made to capture all up-to-date techniques, methods, approaches and applications. The latest was Brusilovsky's paper [1] that presented an updated survey of adaptive hypermedia methods and techniques. In parallel a first reference model for adaptive hypermedia applications, called AHAM [2] was defined.

In this work we provide a comprehensive overview of AH methods and techniques since their introduction 12 years ago and at the same time also come up with a set of requirements and a modular structure that can be used to update the first generic AH model AHAM that was introduces 10 years ago.

AH Methods and Techniques

AH techniques and methods refer to methods of providing adaptation and their generalization correspondingly. Both techniques and methods can be applied to content, presentation and navigation adaptation. In [3] adaptation to presentation was not considered separately. In this paper we distinguish *adaptive presentation* far beyond Brusilovsky's *content and navigation techniques*. Namely, we differentiate the three forms of adaptation: content adaptation, adaptive navigation and adaptive presentation support.

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[1] An interested reader can find the full version of this work in
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Summarizing new trends for a vision of future generic AHS

Giving a review of existing and new approaches to building an AH system, and revisiting Adaptive Methods and Techniques we summarize our vision on the future that will result in an updated AHS reference architecture, highlighting key points, which will incorporate new trends in AH research to provide greater adaptivity and flexibility of the system.

Ontologies. In many AHS authors create not only the information space but also the concept space for applications. In order to start combining the adaptation from different applications, taking advantage of what one AHS has learnt about the user in another AHS, the meaning of the concepts must be agreed upon. Therefore, instead of arbitrary conceptual structures adaptive applications are becoming based on ontologies. Combining the user models and the adaptation from different applications based on the same ontology is a feasible problem, but when different ontologies are used, the problem of ontology mapping must be tackled first, making the reasoning on the Semantic Web within the boundaries of AH field more challenging.

Open corpus adaptation. Most AHS deal with a known set of information items, whether it is a single course, a "bookshelf" or a whole encyclopedia. In such applications a concept space can be mapped onto the document space by the author. Even though open corpus is not a completely new research field, adaptive applications increasingly consider open corpus adaptation, where resources come from search results in large and dynamic learning object repositories or from a Web search engine. In order to perform adaptation to an unknown document space, the mapping between concepts and documents can only be done at run-time, bringing the fields of hypermedia, databases and information retrieval together.

Group adaptation. With few exceptions AHS perform adaptation to individual users. However this process can be significantly extended by taking into account actions undertaken by other users and the adaptation has been performed for other users, perhaps with a similar profile or belonging to the same (manually or automatically created) group. Determining the best partitioning of users into groups (that can be also done through collaborative tools adapted to each group features) and finally fitting this within adaptation model is another challenge and subject of ongoing research.

Data mining. The behaviour of user groups may provide information that can be used to improve the navigation structure of an application. Data mining is a valuable tool in this respect. For example, clustering users into groups based on their navigational patterns can be used to automatically suggest hyperlinks or products to a user or customer, based on the common interests of the members of the group.

Higher order adaptation. We are beginning to see applications that not only monitor the user's behaviour in order to perform adaptation, but also to decide to adapt the adaptation behaviour. Monitoring the user and the adaptation process will allow systems to deduce (in)directly how to refine existing rules or construct new ones.

Context awareness. On the one hand shifting from Application Model to Context Awareness will help to decouple and make AH systems and applications less integrated with and dependent upon the environment in which they are used. On the other hand considering a context model will allow the system to be sensitive and adapt in many other ways, rather than following a certain number of fixed adaptation rules. In this respect adaptation to context may also be referred to as a higher order of adaptation, providing monitored results to devise new rules in a particular context.

Multimedia adaptation. We mention the possibility of mapping existing content adaptation techniques on multimedia content, which results in a certain level of technique abstraction irrespectively to a content type. Future systems should provision this content type independence at every application level: authoring, adaptive engine or presentation generation.

References

[1]   P. Brusilovsky. Adaptive hypermedia. *UMUAI* 11(1-2):87-110, Springer, 2001.

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[3]   P. Brusilovsky. Methods and techniques of adaptive hypermedia. *UMUAI* 6(2-3): 87-129, 1996.