FROM ADAPTIVE HYPERMEDIA TO THE ADAPTIVE WEB

[PETER BRUSILOVSKY AND MARK T. MAYBURY]

W eb systems suffer from an inability to satisfy the heterogeneous needs of many users. For example, Web courses present the same static learning material to students with widely differing knowledge of the subject. Web e-stores offer the same selection of "featured items" to customers with different needs and preferences. Virtual museums on the Web offer the same "guided tour" to visitors with very different goals and interests. Health information sites present the same information to readers with different health problems. A remedy for the negative effects of the traditional "one-size-fits-all" approach is to develop systems with an ability to adapt their behavior to the goals, tasks, interests, and other features of individual users and groups of users.

The Adaptive Web is a relatively young research area. Starting with a few pioneering works on adaptive hypertext in early 1990, it now attracts many researchers from different communities such as hypertext, user modeling, machine learning, natural language generation, information retrieval, intelligent tutoring systems, cognitive science, and Web-based education.

Adaptive hypermedia and adaptive Web systems belong to the class of user-adaptive software systems [10]. A distinctive feature of an adaptive system is an explicit user model that represents user knowledge, goals, interests, and other features that enable the system to distinguish among different users.

An adaptive system collects data for the user model from various sources that can include implicitly observing user interaction and explicitly requesting direct input from the user (see the accompanying figure). The user model is used to provide an adaptation effect, that is, tailor interaction to different users in the same context. Adaptive systems often use intelligent technologies for user modeling and adaptation. Whereas an adaptive system automatically adapts to the user given a user

model, an adaptable system requires the user to specify exactly how the system should be different, for example, tailoring the sports section to provide information about a favorite team [9].

In different kinds of adaptive systems, adaptation effects could be realized in a variety of ways. Adaptive hypermedia and Web systems are essentially collections of connected information items that allow users to navigate from one item to
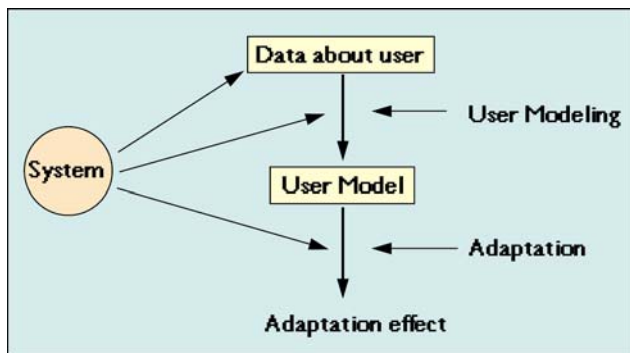
The structure of an adaptive software system.

another and search for relevant items. The adaptation effect in this reasonably rigid context is limited to three major adaptation technologies—adaptive content selection, adaptive navigation support, and adaptive presentation. When the user searches for relevant information, the system can adaptively select and prioritize the most relevant items. When the user navigates from one item to another, the system can manipulate the links (for example, hide, sort, annotate) to provide adaptive navigation support. When the user gets to a particular page, the system can present its content adaptively.

Over the last 10 years, researchers in adaptive hypermedia and Web systems have explored many user modeling and adaptation methods. The first "pre-Web" generation of adaptive hypermedia systems explored mainly adaptive pre-

sentation and adaptive navigation support and concentrated on modeling user knowledge and goals [3]. Empirical studies have shown adaptive navigation support can increase the speed of navigation [8] and learning [4], whereas adaptive presentation can improve content understanding [2]. The second—Web—generation extended the scope of adaptive hypermedia by exploring adaptive content selection and adaptive recommendation based on modeling user interests [5]. The first empirical studies report the benefits of using these technologies [1]. The third—mobile—generation is now extending the basis of the adaptation by adding models of context (location, time, computing platform, bandwidth) to the classic user models and exploring the use of known adaptation technologies to adapt to both an individual user and a context of the user's work [6].

Currently, the principal application areas of adaptive Web systems are education, information retrieval, and kiosk-style information systems. Most recent systems are exploring new, promising application areas such as e-commerce, medicine, and tourism. Research-level systems constitute the majority of adaptive Web systems, but a few suc-

Overview of articles in special section, in order of appearance.				
Article Title	**Application Area**	**Adaptation**	**User Model**	**Related Field**
Adaptive Interfaces for Ubiquitous Web Access	Information Retrieval	Content Selection	Interests	Machine Learning
Personalization Techniques for Online Recruitment Services	Information Retrieval	Content Selection	Interests	Machine Learning
Putting Personalization into Practice	Information Retrieval	Content Selection	Interests	Machine Learning
From Adaptive Hypertext to Personalized Web Companions	E-Commerce	Presentation	Interests	Natural Language Generation, Agents
The Role of Adaptive Hypermedia in a Context-Aware Tourist GUIDE	Tourism	Content Selection	Context, Interests, Preferences	Ubiquitous Computing
Personalization in Business-to-Customer Interaction	E-Commerce	Presentation	Interests, Knowledge	Natural Language Generation, Agents
Personalized Multimedia Information Access	Information Retrieval	Content Selection and Presentation	Interests, Preferences	Natural Language Analysis and Generation
Adaptive Educational Hypermedia on the Web	Education	Navigation Support and Presentation	Knowledge	Intelligent Tutoring Systems
Personalized and Adaptive Systems for Medical Consumer Applications	Medicine	Presentation	Medical Record	Natural Language Generation
Personalized Hypermedia and Information Privacy	Overview of privacy legislation and user-modeling needs			

ADAPTIVE HYPERMEDIA AND WEB SYSTEMS ARE ESSENTIALLY COLLECTIONS OF CONNECTED INFORMATION ITEMS THAT ALLOW USERS TO NAVIGATE FROM ONE ITEM TO ANOTHER AND SEARCH FOR RELEVANT ITEMS. THE ADAPTATION EFFECT IN THIS REASONABLY RIGID CONTEXT IS LIMITED TO THREE MAJOR ADAPTATION TECHNOLOGIES—ADAPTIVE CONTENT SELECTION, ADAPTIVE NAVIGATION SUPPORT, AND ADAPTIVE PRESENTATION.

cessful industrial systems [1, 7, 11] show the commercial potential of the field.

This special section was inspired by the First International Conference on Adaptive Hypermedia and Adaptive Web-based Systems held in Italy in August 2000 (see AH2000.itc.it). The core of the section is formed by four articles written by some of the leaders of the field. Billsus and coauthors discuss the prospects of using adaptive systems for accessing various kinds of Web information resources from mobile handheld wireless devices that are expected to become the computing platform of the future. André and Rist show how animated agents can be used to create the next generation of adaptive presentation in hypermedia, from personalized information assistants to "inhabited places" hosting a team of animated agents. Light and Maybury discuss the transition from present-day text search engines to personalized query-based multimedia search and personalized question answering. Kobsa provides a comprehensive review of the conflict between privacy legislation and the user modeling needs of adaptive systems. This previously ignored issue is becoming the most critical problem in the development of adaptive Web and hypermedia systems as they move from research labs into the real world.

To complement these visionary feature articles, other experts in the field have contributed short articles presenting their work on adaptive Web systems for such promising application areas as tourism, e-commerce, Web-based education, online health information, and job banks. Collectively, the articles in this section provide a good introduction to and an overview of the area of adaptive Web systems, covering major technologies and application areas, as illustrated in the accompanying table.

We hope this special section will serve as useful introduction to adaptive Web systems. To learn more, and to participate in this rapidly evolving field, we encourage readers to consider attending the second conference in the series, AH'2002, to be held in Malaga, Spain in late May (see www.lcc.uma.es/ah2002 for more information). **C**

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