Preface

Abstract

Adaptive hypermedia systems can tailor content presentation and navigation support to individual users by taking into account a model of the user's goals, interests, and preferences. There are two types of adaptation: adaptability and adaptivity. The former allows users to modify the content presentation and navigation facilities by themselves, and the latter includes systems that adapt to users automatically, based on the observed users' preferences. This preface provides an introduction to this book, which presents recent advances in adaptive hypermedia research and demonstrates its use in modern applications, including requirements analysis, architectural aspects, modelling techniques, applications development, and evaluation methodologies.

Introduction

Hypermedia systems, one of the most recent developments in information technology, have already made a particularly important contribution to the delivery of e-content through the Internet. Hypermedia systems are unique in that they provide not only a linear path through the content, but a multitude of branches that users can explore at their own pace. However, not all types of users are able to develop their own navigation paths. In the past decade, many studies have found that individual differences have significant impact on information seeking in hypermedia systems (Chen & Macredie, 2002), and stressed the importance of tailoring the content and the navigation support to users' characteristics and backgrounds. Consequently, a part of hypermedia research has focused on developing systems that can accommodate users' individual differences, and led to the introduction of a new generation of hypermedia systems, called *adaptive hypermedia systems* (Brusilovsky, 1996). Adaptive hypermedia systems build a model of the goals, preferences, and knowledge of the individual user and

use this throughout the interaction to adapt the content, navigation support, and layout to user needs (De Bra, Brusilovsky, & Houben, 1999). In a broad sense, adaptive hypermedia systems provide two forms of adaptation: adaptability and adaptivity. The adaptability allows users to actively interact with a system and customize it, that is, user-driven modification of content presentation, navigation features, and functionalities. The adaptivity is the capacity of a system for automatic adaptation to users' needs based on users' preferences, behaviour, and trails (Stephanidis, Savidis, & Akoumianakis, 1995).

The first adaptive hypermedia system was developed in 1990 (Van Ginderen, 1990), but it was not Web based. Most existing adaptive hypermedia systems use Web technology. The ELM-ART system (Brusilovsky, Schwarz, & Weber, 1996a), its successors ELM-ART II (Weber & Specht, 1997) and InterBook (Eklund & Brusilovsky, 1999) can be regarded as the first generation of adaptive hypermedia systems that were used on the Web. The works of Brusilovsky (1996, 2001) provide reviews of a wide range of adaptive hypermedia systems from various domains.

This book presents recent advances in adaptive hypermedia research and demonstrates adaptive hypermedia use in modern applications. In order to develop an all-around understanding of adaptive hypermedia, it is necessary to cover a wide range of issues from the different stages of their development. To this end, the book is organised into five sections: (1) Requirements Analysis, (2) Architectural Aspects, (3) Modelling Techniques, (4) Applications Development, and (5) Evaluation Methodologies. The rest of this preface provides a synopsis of each section.

Requirements Analysis

Requirements analysis involves defining users' information needs, identifying user problems, and setting objectives for adaptability and adaptivity of a system. For example, users' information needs may depend on their prior knowledge, which includes previous understanding of the content and level of experience with the system. This factor has been found to have significant impact on users' interactions with hypermedia systems (Ford & Chen, 2000). Experts and novices have different preferences to interacting with hypermedia systems and require different levels of navigation support (Farrell & Moore, 2001). In addition, disorientation, or 'being lost' in the hyperspace, is a phenomenon commonly experienced by hypermedia users (Nielsen, 1990). Various approaches have been suggested in practice in order to alleviate this situation, such as advance organizers (Shapiro, 1999), graphical overviews (de Jong & van der Hulst, 2002), and structural cues (Hsu & Schwen, 2003). Their purpose is to help users identify where they are, where they have been, and where they can go.

In the context of adaptable and adaptive hypermedia, prior knowledge and disorientation problems are two important issues that need to be considered in the stage of requirements analysis. In Chapter 1, Stelmaszewska, Blandford, and Buchanan identify novices' difficulties in using a digital library and illustrate how interface design can improve the interaction of novices with digital libraries. Chapter 2 by Herder and van Dijk investigates how to identify users getting lost in the hyperspace on the basis of

their navigation styles, and discusses adaptation techniques that help users' orientation and navigation.

Architectural Aspects

Architecture describes the structure of an application in terms of components, the way they are integrated, and the fundamental mechanisms and patterns by which they interact. As mentioned above, most existing adaptive hypermedia systems are implemented on the Web, where applications are essentially open and extensible, and can change on an ongoing basis. Therefore, it is necessary to adopt a flexible architecture, which is scalable, can be applied to a wide range of applications, and can be expanded to include future improvements, in order to increase application performance and reduce deployment, testing, and maintenance costs.

Developing a flexible architecture involves both design patterns and software frameworks. In this book, three chapters address these issues. In Chapter 3, Houben, Aroyo, De Bra, and Dicheva identify three main classes of adaptive concept-based systems: adaptive Web information systems, adaptive hypermedia systems, and adaptive task-based systems. They provide representative examples, and identify the similarities and differences of these systems. In Chapter 4, Tobar and Ricarte describe a graphic tool named E-ACM, which offers an integrated vision for four complementary modelling perspectives that should be considered in the design and assessment of adaptive hypermedia systems: abstraction levels, services, traditional concerns, and goal conditions. In Chapter 5, Paramythis and Stephanidis illustrate a generic framework for the development of adaptive Web-based hypermedia systems and services by using the PALIO tourist information system as an example. The main goals of the framework are to: (i) support a wide range of adaptive hypermedia techniques in a domain-independent way; (ii) provide constructs that facilitate the declarative specification of adaptive behaviour; (iii) enable the clear separation of adaptation components, so that their implementation can be varied independently; and (iv) achieve orthogonality with existing Web-publishing approaches, so that the framework can be easily integrated into existing non-adaptive systems and services.

Modelling Techniques

Recognizing users' needs or preferences plays an important role in achieving adaptive behaviour in hypermedia systems. To this end, content-based filtering and collaborative filtering are two approaches that have been widely used in adaptive hypermedia systems. In the content-based approach, user profiles are created using features extracted from content that a user liked or used in the past. Subsequently, new content is provided by matching a user's profile to the features of this content (Lang, 1995). The collaborative filtering approach builds up profiles of user groups and then, using a computational method, tries to match current the user's profile to similar profiles. Se-

lected data from these profiles are then used to provide recommendations (Shardanand & Maes, 1995). Nevertheless, these two approaches rely on subjective user profiles that may be prone to biases, or on standing profiles that may become outdated with changing user needs or interests (Mobasher, Cooley, R., & Srivastava, 2000). Machine learning and data mining techniques try to overcome these shortcomings and have been used widely in adaptive hypermedia systems, such as the Web Personaliser (Mobasher et al., 2000) and the PageGather (Perkowitz & Etzioni, 2000).

In Chapter 6, Müller discusses the most prominent machine learning algorithms used in adaptive hypermedia systems, including Naive Bayesian Classifiers (NBC), Bayesian Network (BN), Artificial Neural Networks (ANN), and Inductive Logic Programming (ILP). He discusses various theoretical and practical aspects of these techniques and provides recommendations for their use in adaptive hypermedia.

On the data mining front, the most commonly used approach is to divide data into groups, namely content, structure, and usage data (Mardria, Bhowmick, & Lim, 1999). Along this classification, there are three essential groups of data mining techniques: content mining, structure mining, and usage mining (Srivastava, Cooley, Deshpande, & Tan, 2000). In particular, usage mining is considered very useful for the development of adaptive hypermedia systems. Chapter 7 by Koutri, Avouris, and Daskalaki presents a comprehensive review of Web usage mining techniques in the context of adaptive Web-based hypermedia systems, and discusses relevant criteria for deciding on the suitability of these techniques when building an adaptive Web site.

Another approach for modelling users' information needs and preferences is based on the use of soft computing for processing multiple attributes, such as evaluation of content relevance, observation of navigation patterns, and so forth. Fuzzy logic is a soft computing technique eminently suitable to model users' needs and preferences, as it handles well imprecision and vagueness inherent when dealing with multiple attributes (Cordon & Herrera-Viedma, 2003). In Chapter 8, Sicilia and García Barriocanal propose a model named MAZE and explain how adaptive hypermedia models, architectures, and systems can be generalised to their fuzzy or uncertain counterparts, resulting in richer modelling frameworks that can be better applied to model imprecise behaviours.

Lastly, another important issue, modelling users' interests, is covered in Chapter 9. Matsuo discusses two types of user interest: consistent interest and spot interest. The former is a broad field that a user is interested in for a relatively long time, while the latter is a specific topic that a user is interested in temporarily. He proposes a new word-weighting algorithm called Interest Relevance Measure (IRM) for measuring a user's spot interests based on the user's consistent interests.

Applications Development

Adaptive hypermedia techniques have been applied to several Web-based applications, such as online learning (Papanikolaou, Grigoriadou, Kornilakis, & Magoulas, 2002), electronic commerce (Wang, Chuang, Hsu, & Keh, 2004), and search engines (Liu, Lieberman, & Selker, 2002). Paucity of research considers the potential of using

adaptive hypermedia techniques in other application domains. To fill this gap, the book focuses on applications such as virtual museums, semantic retrieval, knowledge management, and digital TV.

In Chapter 10, Lepouras and Vassilakis present a dynamic, adaptable, and multilingual Web site for virtual museums that takes into account preferences of the users as well as their cultural and educational background. The adaptability is not only applied in the presented items, but also in the surrounding environment and the methods that are available to the users for their interaction with the virtual world. In this way, each exhibit may be represented by a variety of methods, such as 3D photographs, 3D models, 2D photographs, videos, animation, audio clips texts, and so forth. In addition, interaction methods are decoupled from exhibits' digital representations, since the same exhibits may be associated with different interaction methods, based on user requests and the user profile.

Garlatti, Iksal, and Tanguy use, in Chapter 11, the Semantic Web and virtual documents to develop a flexible adaptive hypermedia environment called SCARCE (SemantiC and Adaptive Retrieval and Composition Environment), which is able to manage and to specify selection, filtering, and organisation at a semantic level. Chapter 12 by Razmerita demonstrates the ways of enhancing personalised user support by integrating user modelling processes in knowledge management systems (KMSs), including expertise discovery, networking and collaboration, learning and change, and personalisation. Examples are used to illustrate specific types of adaptations and personalised services for KMSs.

There are two chapters to discuss digital TV in this book: a theoretical review and an empirical study. In Chapter 13, Masthoff and Pemberton give an overview of the application domain of personalised interactive TV. Based on the work of Brusilovsky (2001), they discuss the potential advantages of integrating adaptive hypermedia techniques into the personalised interactive TV, the potential difficulties of using them, and the extensions that may be necessary to the techniques if they are to be successful in this domain. Chapter 14 by Lekakos and Giaglis covers a new application area for adaptive hypermedia in digital TV: personalised advertisements. It discusses an approach based on user-driven ratings that utilizes users' lifestyle indicators in combination with neighbours' ratings to infer prediction about unobserved items under a collaborative filtering perspective. Lekakos and Giaglis have found that this approach performs better than the Pearson-based approach, particularly when few items are available.

Evaluation Methodologies

Adaptive hypermedia systems increase the functionalities of conventional hypermedia, reducing users' cognitive overload and disorientation by combining free browsing with personalisation. A variety of techniques can be used for the flexible delivery of e-content, including adaptive presentation and adaptive navigation support (De Bra, Brusilovsky, & Houben, 1999). However, there is still limited knowledge as to the effectiveness of these techniques, which, in turn, influences the usefulness of adaptive hypermedia systems. Arguably, this is due to the lack of systematic evaluative works

for adaptive hypermedia systems (Weibelzahl, 2001). Therefore, evaluation is recognised as critically important to validate existing approaches and to provide concrete prescriptions for developing user centred adaptive hypermedia systems. Among a variety of methodologies for user-based evaluation, questionnaire, interview, and observation are considered very popular. In this vein, the book has two chapters that address issues of evaluation.

Chapter 15 by Weibelzahl presents a checklist that identifies problems and pitfalls that arise when evaluating an adaptive system through empirical study. The problems and pitfalls cover the complete evaluation procedure, starting with the definition of goals and criteria, the planning of a study, operation, analysis, and interpretation, to presenting and packaging the results. The author emphasizes that the checklist should work as a guideline for proper empirical design rather than as a set of prescriptive instructions.

Recently, it has been indicated that analysing users' log files can provide valuable information for evaluation purposes. Towards this direction, a promising approach is the visualisation of users' log files which consists of presenting the data in some visual form, allowing individuals to gain deeper insight for the use of the system from data, draw conclusions, and directly interact with the visualisation tool (Ankerst, 2001). Sobol and Stones deal with this issue in Chapter 16. They describe a method for logging and visualising individual user paths through a database-driven Web site, named Direction Mapping and Sequence Chart (DMASC) system. In their work, visualisation tools are employed to reveal usage data, which show how users interact with a Web site. These usage data can be used to improve site design and structure, and form the basis of adaptation rules.

Concluding Remarks

Adaptable and adaptive hypermedia systems offer users content presentation, interface features, and navigation support that accommodate their needs. This book attempts to provide an overview of the state of the art in adaptive hypermedia, covering several issues in the field, architecture, techniques, and applications in 16 chapters. We hope that these 16 chapters offer researchers, students, and system designers a full range of information that can be beneficial for their understanding of adaptability and adaptivity in hypermedia systems, stimulate their interest to encourage further research, and help them develop advanced skills for the critical evaluation of adaptive hypermedia systems.

It seems obvious that this area needs much more research to yield the form of evidence that can drive design and exploitation of adaptable and adaptive hypermedia systems. In particular, much more emphasis must be placed on the appropriate design of adaptive hypermedia systems that can accommodate individual differences. With this in mind, the shift from traditional hypermedia systems to adaptive hypermedia systems would be more meaningful and valuable.

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