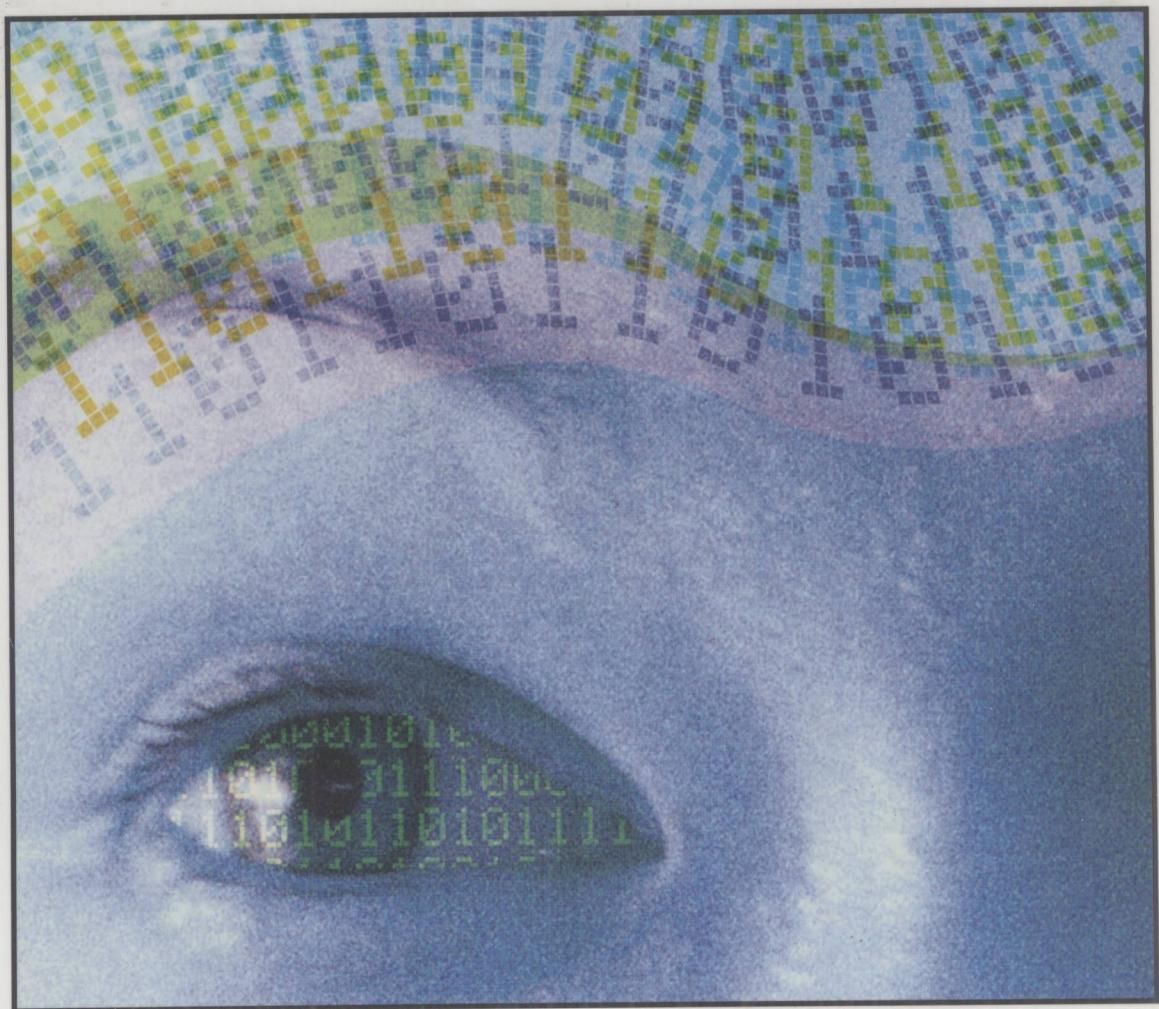


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Intelligent User Interfaces

Adaptation and Personalization
Systems and Technologies



Constantinos Mourlas & Panagiotis Germanakos

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Intelligent User Interfaces: Adaptation and Personalization Systems and Technologies

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Foreword

Access to online information is now a pervasive part of many of our lives, whether at work or at play. Indeed, the Internet has become such an important influence that it hardly seems possible to remember a time before the World-Wide Web, even though the first browsers only arrived on the scene less than 15 years ago. Today, billions of users access the Internet on a daily basis, with the leading search engines handling tens of billions of queries per month, and the volume of online information continues to grow at near exponential rates.

Unfortunately, for many, finding the right information quickly and easily continues to be a challenge and the *one-size-fits-all* nature of most information services does little to acknowledge the distinctive information needs that we all invariably have. In this context the idea that information services can adapt to the needs and preferences of individuals, or groups of users, has attracted considerable attention and so-called *personalized* user interfaces represent an important step forward in the development of online services that are capable of proactively responding to the needs of the individual.

The prospect of personalized information services and interfaces, which can intelligently adapt to our changing circumstances and contexts, has the potential to dramatically change the way that we interact with a wide range of online services. Already, a number of organizations have made great strides when it comes to offering their customers more personalized online experiences. For example, Amazon's now famous recommendation engine drives significant additional sales by promoting products that are relevant to individual customers, given their past purchases. Set-top-boxes such as Tivo have changed the way that people watch television, by recommending and proactively recording TV shows based on their learned viewing preferences. And, more recently, mobile telephone operators such as Vodafone and O₂ provide their subscribers with access to mobile portals that automatically adapt their structure, so that relevant content and services are promoted to individual subscribers, based on their access patterns. These are just a few of the examples of large-scale personalization deployments within the different consumer markets. In each case the benefits of personalized and adaptive information services have been enjoyed by consumers (through more efficient access to relevant information) and operating companies, through increased sales or growth in user activity.

What is especially exciting about this book is that it brings together, in a single volume, a diverse collection of research on a variety of topics that drives developments in the area of personalized and intelligent user interfaces. These chapters have been written by leading researchers and cover a wide range of applications areas, from e-government to e-commerce, as well as providing a comprehensive account of the component technologies that underpin intelligent user interface technology. Indeed the reader will also benefit from an understanding of the various human factors associated with adaptivity and personalization, from user perceptions of adaptive systems to the privacy and security issues that are associated with user profiling and personalization.

This book is accessible to a wide range of individuals and should be read by academics, students, and professionals with an interest in the design and development of intelligent user interfaces and the applications of personalization technology. For the reader it provides a comprehensive account of the core challenges facing the development of the next generation of personalized and adaptive information services. And whether researcher or practitioner, the reader will come away with an appreciation and understanding of the major strands of work that make up this exciting area of research.

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Preface

The explosive growth in size and use of the World Wide Web as a communication medium has been enthusiastically adopted by the mass market. The new developments in ICT along with the growth of mobile and wireless communication allowed service providers to meet these challenges developing new ways of interactions through a variety of channels enabling users to become accustomed to new means of service consumption in an “anytime, anywhere and anyhow” manner. However, the nature of most information structures is static and complicated, and users often lose sight of the goal of their inquiry, look for stimulating rather than informative material, or even use the navigational features unwisely. Hence, a number of researchers and practitioners studied adaptivity and personalization to address the comprehension and orientation difficulties presented in such systems; to alleviate navigational difficulties and satisfy the heterogeneous needs of the users, allowing at the same time Web applications of this nature to survive.

During the last years there has been huge effort from researchers to identify the peculiarities of each user group, analyze and design methodologies and systems that could alter the given raw content, and deliver them up-to-date personalized information as such, or with regards to products or services. Nonetheless, to date, there has not been a concrete definition of personalization. So far, the many adaptive hypermedia and Web personalization solutions offering personalisation features seem to meet an abstract common goal: to provide users with what they want or need without expecting from them to ask for it explicitly. There is a necessity therefore for further consideration and analysis of parameters and contexts such as users’ intellectuality, mental capabilities, socio-psychological factors, emotional states and attention grabbing strategies to be extensively investigated. All these characteristics could affect the apt collection of users’ customization requirements and along with the ‘traditional’ user characteristics (i.e. name, age, education, experience, interests, etc.), to constitute a comprehensive user profile that serves as the ground element of most of these systems offering in return the best adaptive environments to their preferences and demands.

Besides the content and services, which figure as the main personalization substance, also processes and communication need to become adaptive. New systems need to adapt their execution at run time according to new system requirements and requests that arrive from a dynamic and complex runtime environment where other processes coexist and share the same resources. The network resources and protocols should adapt their transmission according to the communication needs and characteristics of the connection of the individual user. The mobility of the user, the variation of bandwidth during communication, the loose connections and the network congestion are some of the main factors that network adaptation should be taken into account.

CHALLENGES

The field of adaptive systems and networks has received great attention from the research community in the last years with the explosion of new applications and services which have to be executed in a

dynamic and continuous changing environment. It further covers a wide spectrum of applications with similar behaviour and properties where the term adaptivity is met in three different variations:

Adaptivity of content and services; in this category the content and services have to be adapted according to user preferences and system constraints. Adaptive hypermedia, Web personalization and Intelligent User Interfaces are some of the main representatives of this category where content, navigation and appearance / aesthetics have adapt according to (i) the user profile and (ii) the device characteristics of the user (e.g. monitor resolution, bandwidth allocation, etc.) also referred as QoS constraints. Adaptive and personalized services share in this case the same basic goal; that is to provide users with the desirable or necessary content without requiring from them to ask for it explicitly. Thus, adaptivity of content and services is the provision to the individual of tailored products, Web-based content, multimedia-based services, information or information relating to products or services. The issue of adaptivity of content and services is a complex one with many aspects that need to be examined. Such issues include, amongst others: (i) what content to present to the user, (ii) how to show the content to the user, (iii) how to ensure the user's privacy, (iv) how to create a global personalization scheme, etc.

At the higher level, adaptivity of content and services is realized in one of two ways: (i) Services or Web sites that require users to register and provide explicitly information about their interests and needs, and (ii) Services or Web sites that automatically extract the user profile by tracking the behavioural navigation pattern of the users. At the lower level, adaptivity of systems and processing is required for the implementation of such applications and services.

Adaptivity of systems and processing; the current interest on systems and processing is focused on the ability of these systems to adapt their execution at run time according to changing system requirements and requests that arrive from the dynamic and complex runtime environment where other objects or processes are running concurrently and share the same computational as well as other resources. The emphasis here is not to the adaptive content but to the adaptive execution of the processes. The traditional systems although they perform well in static information spaces they appear inadequate for new and evolving environments like multimedia servers, streaming media presentations, ubiquitous computing, soft real-time systems, agent computing and Grid computing. Recent research has given interesting results in the above areas where new operating systems and programming environments have been implemented supporting high levels of adaptivity without sacrificing the predictability and the correctness of the system during execution.

Adaptivity of networks and communication; current interest in network technology is focused on the development of new distributed applications like distributed multi-media information systems, media streaming, desktop conferencing and video-on-demand services. Each such application needs adaptive behaviour and Quality of Service (QoS) guarantees, otherwise users may not accept them since these applications are expected to be judged against the quality of traditional services (e.g. radio, television, telephone services). Some of these issues become even more complicated once viewed from a mobile user's perspective, when wireless communication media and mobile device constraints are involved and the demand for adaptive communication "anytime, anywhere and anyhow" is presupposed. The emphasis here is on the communication and transportation of information along with the ability of the network resources and protocols to adapt their transmission according to the communication needs and the characteristics of the connection of the individual user and the others. The mobility of the user, the variation of bandwidth during communication, loose connections and the network congestion are some of the main factors that adaptation should take into account.

Henceforth, the main focus of this book is to concentrate on the various aspects of adaptivity in one place. The book provides a very broad view of adaptive systems and networks with main focus on adaptivity. It attempts to present all the research results produced in the area of adaptive systems and networks covering a wide spectrum of applications, systems and networks starting from the higher level

applications and personalization issues and then presenting the lower level issues of adaptive operating systems and processing and the adaptivity of networks and communication.

ORGANIZATION OF THE BOOK

This book is composed of five sections, with a total of seventeen chapters, each of which is described briefly below:

Section I: Theoretical Aspects of Adaptive and Personalized User Interfaces

Chapter I realizes the importance of the various techniques implemented by most Web personalization systems nowadays to extract the user profiles. User profiles serve as the main component of such systems. With the use of various techniques that are based on given user preferences, the navigation behaviour and the Web-based content they return the requested personalized result. Main scope of this chapter is to present the various techniques employed by such systems with regards to user profiles extraction and introduce a comprehensive user profile, which includes User Perceptual Preference Characteristics. It further analyzes the main intrinsic users' characteristics like visual, cognitive, and emotional processing parameters incorporated as well as the "traditional" user profile characteristics that together tend to give the most optimized, adapted and personalized outcome. Finally, it presents a Web adaptation and personalization system that implements the proposed comprehensive user profile as well as evaluation results that further support their importance and impact of cognitive and emotional factors in the information space.

Chapter II considers a number of challenges with regards information access, such as navigation, search and recommendation. It describes how they can be addressed by using techniques that allow information services to respond more intelligently to the needs and preferences of individuals and groups of users. Each challenge is being addressed in the form of a case study focusing on one particular mode of information access (navigation, search, and recommendation) and an application scenario (mobile portals, Web search, and e-commerce), to describe how user profiling, personalization, and adaptive interface design can be combined to produce a more efficient and effective information service.

Chapter III underlines the significance of human factors and how they influence learners' performance and perception in Web-based instruction. In this vein, the study presented in this chapter, investigates this issue in a Web-based instructional program that was designed to teach students how to use HyperText Markup Language (HTML) in a United Kingdom (UK) university.

Chapter IV identifies the importance that innovative personalization services are required to extend the traditional user profiling techniques with semantic-based information. The use of semantic-based information provides additional clues as to the reasons the user may or may not be interested in certain objects. The primary goal of this chapter is to present a comprehensive overview of the state-of-the art techniques and methodologies which integrate personalization technologies with semantic knowledge, exploring the challenges that such research areas pose to today's information society.

Section II: Adaptive Content and Services

Chapter V realizes that the current mobile communications paradigm has not been built to support the co-existence of different technologies caused by the evolutionary character of the transition to next generation systems, leading eventually to the heterogeneity of the networks and systems. Therefore, it

argues that intelligent mechanisms should exist for identifying the context and the particular high-level requirements of an application and mapping them to appropriate reconfiguration operations on the underlying hardware and software infrastructure. To this end, context management, knowledge building and the respective decision making process are key factors for the service personalisation and system adaptation of future mobile communications. A need for middleware platforms, that will abstract this management load and complexity and enable an end-user seamless service experience, emerges.

Chapter VI underlines that most information retrieval services purport a *one size fits all* model whereby the same information is disseminated to a wide range of information users despite the individualistic nature of each user's needs, goals, interests, preferences, intellectual levels and information consumption capacity. This leads to a sub-optimal model because information users, who are intrinsically distinct, are not only compelled to experience a generic outcome but are further required to manually adjust and adapt the recommended information artifacts according to their immediate needs or preferences in order to achieve the desired results. Therefore, this chapter argues that there is both a case and a need to design information services that take into account the individuality of information users, and in turn aim to personalize the information seeking experiences and outcomes for users.

Chapter VII supports that the variety in citizens' skills and expectations along with the problems they face has as consequence that each citizen has different perceptions concerning the quality of public e-services. It is apparent, therefore, that a "one fits all" e-government services' assessment is not efficient, since their evaluation should be organized in a way to serve every citizen individually. Consequently, it further suggests that for the realization of such a customized and adaptive evaluation of e-government services, an intelligent, semantic-based platform is needed which allows each citizen to put emphasis in quality dimensions related with the problems he/she faces, depending on his/her skills and expectations. This part further presents a semantically adaptive interface for measuring portal quality in e-Government.

Chapter VIII discusses the solution to the WWW cognitive overload, and more specifically to e-Government services, is most probably an issue of personalization. On this ground, it introduces the design and implementation of Web information systems supporting personalized access to multi-version resources in an e-Government scenario. Personalization is supported by means of Semantic Web techniques and relies on an ontology-based profiling of users. It further introduces a reference infrastructure, describes the organization and presents performance figures of a prototype system the authors have been developed.

Chapter XI introduces new techniques for supporting the adaptation and personalization issues in the design and development of Intelligent User Interfaces, mainly by adapting services based on user preferences and user device characteristics. The user characteristics, the data collection particularities and the system capabilities are matched with the visualization method properties, in a context-based adaptive visualization environment to be used in the Historical Archive of the University of Athens, in order to support information seeking tasks.

Section III: Adaptive Processing and Communication

Chapter X argues that the integration of semantic knowledge is the primary challenge for the next generation of personalization systems and the automatic collection of data. Therefore, it provides an overview of approaches for incorporating semantic knowledge into Web usage mining and the personalization processes. It discusses the issues and requirements for successful integration of semantic knowledge using different sources, such as the content and the structure of Web sites for personalization. It further presents a general framework for fully integrating domain ontologies with Web usage.

Chapter XI investigates the development of adaptive software focusing on a design strategy for the implementation of parallel media servers with an adaptable behavior. This strategy makes the timing properties and the quality of presentation of a set of media streams predictable. The proposed adaptive scheduling approach exploits the performance of parallel environments and seems a promising method that brings the advantages of parallel computation in media servers. It further presents an efficient placement strategy for data frames as well as an adaptability strategy that allows appropriate frames to be dropped without sacrificing the ability to present multimedia applications predictably in time.

Section IV: Innovative Applications with Adaptive Behavior

Chapter XII supports that information transfer constitutes, in most cases, an important side of multimedia applications. Nonetheless, a dimension that is often overlooked in such cases, particularly in respect of quality considerations is the one of cognitive style, especially since it affects the ways through which people organize and perceive information. Accordingly, in this chapter, it is explored the impact of cognitive style on a user's perception of quality for dynamic multimedia content. In particular, it focuses on two dimensions of cognitive style: the Verbalizer / Imager and Field Dependent / Field Independent, because the first refers to information representation, while the latter relates to information organization.

Chapter XIII discusses about the limitation of the human memory, a well-acknowledged experience by everyone. In terms of computers, however there is the ability to store huge amounts of information for an unlimited time without loss of precision, and there are state-of-the-art mobile devices in general that provide features for creating reminders, linking notes to time and dates, and for managing time. However, these techniques require from the user to capture this data manually, and thus the quality of such memories greatly depends on his/her cognition and carefulness. This chapter provides a discussion on the various challenges related to building and exploiting augmented personal memories in everyday life. It concentrates on a number of crucial aspects: the importance of abstraction processes for building this memory and the design of a user interface for supporting interaction between user and memory. It further illustrates the authors' approach with examples of processing and exploiting information about the user's location in the shopping assistant SPECTER.

Chapter XIV discusses that learner models, understood as digital representations of learners, have been at the core of intelligent tutoring systems since from their original inception. Learner models facilitate the knowledge about the learner necessary for achieving any personalisation through adaptation, while most intelligent tutoring systems have been designed to support the learning modelling process. In this respect, this chapter provides an analysis of the migration of open learner modelling technology to common e-learning settings, the implications for modern e-learning systems in terms of adaptations to support the open learner modelling process, and the expected functionality of a new generation of intelligent learning environments. This analysis is supported by authors' recent experience on an e-learning environment called LeActiveMath, aimed at developing a web-based learning environment for Mathematics in the state of the art.

Chapter XV underlines the fact and discusses that even though humans need assistance in Web-based learning, most current IT systems appear as more or less complex tools. The more ambitious the problems in the application domain are, the more complex the tools are. This is one of the key obstacles to a wider acceptance of technology enhanced learning approaches. In e-learning, they need to "learn" about the learner and to build in accordance an internal model as a basis of adaptive system behavior. Steps toward assistance in e-learning are systematically illustrated by means of the authors' e-learning projects and systems eBuT and DaMiT. These steps are summarized in some process model proposed to the e-learning community.

Chapter XVI identifies that the process of training and learning in Web-based and ubiquitous environments brings a new sense of adaptation. With the development of more sophisticated environments, the need for them to take into account the user's traits, as well as the user's devices on which the training is executed, has become an important issue in the domain of building novel training and learning environments. This chapter introduces a system called eQ, to the realization of personalized adaptation, in terms of dealing with the stereotypes of e-learners, having in mind emotional intelligence concepts to help in adaptation to the e-learners real needs and known preferences.

Section V: Security, Privacy and Personalization

Chapter XVII supports that privacy and personalization are currently at odds, with the technical solutions for privacy protection to represent a special kind of so-called Privacy-Enhancing Technologies (PET). This chapter proposes an evaluation framework for PETs that considers the following dimensions: (a) What high-level principles the solution follows, (b) what privacy concerns the solution addresses, and (c) what basic privacy-enhancing techniques the solution employs. It describes and categorizes major privacy principles from privacy laws as well as other desirable principles in the context of privacy protection. It discusses privacy concerns and how different privacy principles address them. It further describes the techniques that have been used in the main types of privacy-enhancing personalization solutions, addressing how they relate to the major privacy concerns and privacy principles, with the necessary analysis findings.

IN SUMMARY

The contribution of this book may be considered innovative and multi-fold since it brings together the three broad research areas of (a) adaptive content and services, (b) adaptive systems and processing and (c) adaptive communication and networks sharing the same goal of adaptation and personalization. It contains: (a) extensive investigations of the adaptation and personalization fields, based on researches and reviews; (b) further considerations and analysis of parameters and contexts identifying relationships between these two areas of research which effectively share the same goal: to adapt according to the specific user characteristics; (c) systems, technologies and methodologies assigned to a number of application areas trying to approach the topic from a more global perspective, including their advantages and disadvantages, efficiency, effectiveness, share-ability and interoperability as well as other vital attributes and capabilities that will help someone to finally distinguish the most prominent approach to the specific personalization problem; and finally it (d) offers solutions and suggestions for the design and development of adaptive applications and systems that could provide more usable and qualitative content and services adjusted to the needs and requirements of the various users and the execution environment.

This book is a useful tool for academics, teachers and researchers, professionals in the field of intelligent user interfaces and technology, and to people that belong to the broader field of the information communication technologies (ICT). The book covers a large number of topics in the area of adaptation and personalization of the content, processing and communication. It provides pragmatic references, analysis, new methodologies, and architectures that tend to approach the subject more comprehensively providing latest suggestions and solutions.

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Constantinos Mourlas and Panagiotis Germanakos
Athens, Hellas
January, 2008

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