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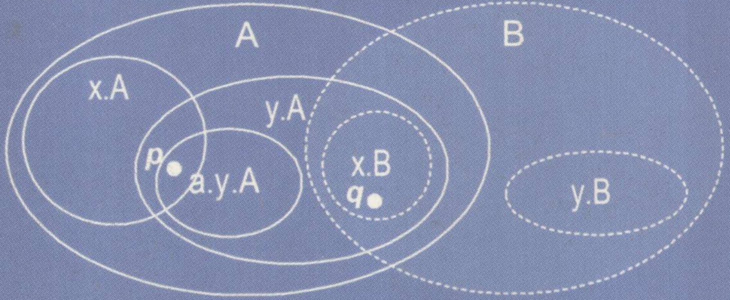

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Cataloging-in-Publication Data applied for

A catalog record for this book is available from the Library of Congress.

Bibliographic information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the Internet at <http://dnb.ddb.de>.

CR Subject Classification (1998): H.5.2, H.5.3, H.5, H.4, H.3, C.2, I.2.1, D.2, K.8

ISSN 0302-9743
ISBN 3-540-21003-2 Springer-Verlag Berlin Heidelberg New York

Springer-Verlag is a part of Springer Science+Business Media

springeronline.com

Printed in Germany

Typesetting: Camera-ready by author, data conversion by Olgun Computergrafik
Printed on acid-free paper SPIN: 10985229 06/3142 5 4 3 2 1 0

Lecture Notes in Computer Science 2954
Edited by G. Goos, J. Hartmanis, and J. van Leeuwen

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Preface

The ongoing migration of computing and information access from the desktop and telephone to mobile computing devices such as PDAs, tablet PCs, and next-generation (3G) phones poses critical challenges for research on information access.

Desktop computer users are now used to accessing vast quantities of complex data either directly on their PC or via the Internet – with many services now blurring that distinction. The current state-of-practice of mobile computing devices, be they mobile phones, hand-held computers, or personal digital assistants (PDAs), is very variable. Most mobile phones have no or very limited information storage and very poor Internet access. Furthermore, very few end-users make any, never mind extensive, use of the services that are provided. Hand-held computers, on the other hand, tend to have no wireless network capabilities and tend to be used very much as electronic diaries, with users tending not to go beyond basic diary applications.

This "state-of-practice" presents a dramatic contrast to the technological vision, and the emerging "state-of-the-art" devices, which are small, very powerful, wireless networked computing platforms. Providing access to large quantities of complex data on such devices while users are on the move and/or engaged in other activities poses significant challenges to the information access community and brings together many classical computing domains, such as information retrieval (IR), human-computer interaction (HCI), information visualization, and networking. This volume contains 21 papers that approach these challenges from different directions. The bulk of the papers come from the Workshop on Mobile and Ubiquitous Information Access that was held as part of Mobile HCI 2003 in September 2003.[1] Other papers were specially invited, to complement the presented papers and extend the volume.

Overview

The 21 papers in this volume have been grouped into the following four parts. Many of the papers fall into more than one category, and sometimes our choice has been somewhat arbitrary, but hopefully still useful.

Foundations: Concepts, Models, and Paradigms

The field is young, so it is not a surprise that some work is being done on basic concepts and visions of the future. In *The Concept of Relevance in Mobile and Ubiquitous Information Access*, Coppola et al. discuss the concept of relevance in the mobile, wireless, and ubiquitous information retrieval arena. In *Conversational Design as a Paradigm for User Interaction on Mobile Devices*, Leong borrows from well-established linguistics research and he presents a design paradigm for user interfaces on mobile devices based

[1] Mobile HCI 2003 was part of the Mobile HCI series (see `www.mobilehci.org`); its proceedings were published in LNCS volume number 2795.

on Grice's conversational implicatures. *One-Handed Use as a Design Driver: Enabling Efficient Multi-channel Delivery of Mobile Applications*, by Nikkanen, presents several practical and useful guidelines for mobile devices and applications, based on both a literature review and lessons learned at Nokia. In the last paper in this part, *Enabling Communities in Physical and Logical Context Areas as Added Value of Mobile and Ubiquitous Applications*, Pichler discusses how to provide added value to mobile users, maintaining the importance of designing services that are very specific to the context area, and how to foster communities based on both physical and logical contexts.

Interactions

Of course, interaction problems are paramount. One of the key issues when working with mobile devices is how to input data to a mobile device with very poor input devices. The other, symmetrical, key issue is how to fully exploit the small available display area. The second paper of this part discusses the former; the other ones the latter. In *Accessing Web Educational Resources from Mobile Wireless Devices: The Knowledge Sea Approach*, Brusilovsky et al. evaluate the use of Self-Organizing Maps (SOMs) for information access to educational resources. In *Spoken Versus Written Queries for Mobile Information Access*, Du et al. analyze IR effectiveness when the query is input via speech: they present a prototype and its experimental evaluation. In *Focussed Palmtop Information Access Combining Starfield Displays with Profile-Based Recommendations*, Dunlop et al. present two applications using starfield displays on a PDA and exploiting advanced collaborative filtering techniques: Taeneb CityGuide recommends restaurants and Taeneb ConferenceGuide presents the timetable of a conference.

Applications and Experimental Evaluations

Several approaches are used for implementing applications. Following a strong tradition in both the HCI and IR communities, evaluation is deemed a crucial issue and several papers focus on experimental studies of mobile applications. In *Designing Models and Services for Learning Management Systems in Mobile Settings* Andronico et al. propose a survey of previous systems for mobile learning, and describe an ongoing project. Cignini et al., in *E-Mail on the Move: Categorization, Filtering, and Alerting on Mobile Devices with the ifMail Prototype*, present a prototype allowing e-mail categorization, filtering, and alerting on mobile devices, and its first experimental validation. In *Mobile Access to the Físchlár-News Archive*, Gurrin et al. illustrate the Físchlár-News system, processing digital video and audio news stories, which is capable of segmentation, collaborative filtering-based recommendation, and delivery on mobile devices. Mai et al., in *A PDA-Based System for Recognizing Buildings from User-Supplied Images*, describe a prototype providing navigational and informational services to an urban mobile user based on GPS and building recognition achieved through image processing techniques. In *SmartView and SearchMobil: Providing Overview and Detail in Handheld Browsing*, Milic-Frayling et al. overview their SmartView technology, which makes Web pages with complex layout more accessible to mobile devices, and show and evaluate its integration into SearchMobil, to help the users of a small screen display estimate the relevance of retrieved Web pages. The paper titled *Compact Summarization* *for Mobile Phones*, by Seki et al., deals with the very important (for mobile devices) issue of summarization: these authors present a new summarization method based on the genre of a document and they evaluate it. On the same topic, Sweeney et al. in *Supporting Searching on Small Screen Devices Using Summarisation* discuss and evaluate by means of a user test how summarization can improve IR on small screen devices. In *Towards the Wireless Ward: Evaluating a Trial of Networked PDAs in the National Health Service*, Turner et al. discuss and evaluate, by means of an on-field user study, several important issues on the usage of PDAs in the medical field. Finally, in *Aspect-Based Adaptation for Ubiquitous Software*, Zambrano et al. delve into software engineering issues: they propose Aspect Oriented Programming (AOP) as a solution to deal smoothly with issues that are peculiar to the design of mobile device applications and that are not found when designing standard desktop applications.

Context and Location

A hot issue in mobile device research is, of course, how to take into account and exploit the context in which the user is. In *Context-Aware Retrieval for Ubiquitous Computing Environments*, Jones et al. perform a thorough analysis of context-aware retrieval: they present definitions, links with other disciplines (IR, information filtering, agents, HCI), and a description of their own findings. Nussbaum et al., in *Ubiquitous Awareness in an Academic Environment*, propose and evaluate a prototype that, on a campus, enhances student relationships by fostering face-to-face meetings. In *Accessing Location Data in Mobile Environments: the Nimbus Location Model*, Roth proposes the Nimbus framework, a formal model for location information, integrating physical and semantic information. The paper *A Localization Service for Mobile Users in Peer-to-Peer Environments*, by Thilliez et al., describes a localization service based on a peer-to-peer (P2P) architecture, featuring location-based queries. Finally, in the last paper of this volume, *Sensing and Filtering Surrounding Data: the PERSEND Approach*, Touzet et al. present an application dealing with the issues of distributed databases, proximate environments, and continuous queries.

Acknowledgements

We thank the organizers of Mobile HCI 2003 for their support of the workshop. We also thank the members of the Program Committee (Peter Brusilovsky, George Buchanan, Keith Cheverst, Oscar de Bruijn, Marcello Federico, Matt Jones, Mun-Kew Leong, Joerg Roth, Ed Schofield, and Leon Watts) for their efforts on behalf of the workshop.

December 2003

Fabio Crestani
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Organizing Committee
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Table of Contents

Foundations: Concepts, Models, and Paradigms

Interactions

Applications and Experimental Evaluations

Context and Location

The Concept of Relevance in Mobile and Ubiquitous Information Access

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Abstract. We discuss how the wireless-mobile revolution will change the notion of relevance in information retrieval. We distinguish between classical relevance (e-relevance) and relevance for wireless/mobile information retrieval (w-relevance). Starting from a four-dimensional model of e-relevance previously developed by one of us, we discuss how, in an ubiquitous computing environment, much more information will be available, and how it is therefore likely that w-relevance will be more important than e-relevance to survive information overload. The similarities and differences between e-relevance and w-relevance are described, and we show that there are more differences than one might think at first. We specifically analyze the role that beyond-topical criteria have in the w-relevance case, and we show some examples to clarify and support our position.

1 Introduction

It may surprise you, but we can hardly imagine what information overload is. Just stop one minute and think how our world will probably be in ten years or so. As soon as mobile wireless devices will ubiquitously enter our lives, the nowadays complaints about having access to too much information will be seen with a small ironic grin and perhaps some nostalgia. We are not speaking only of palm top devices, cellular phones, laptop computers, pagers, MP3 players, and similar already commonly used device; we are thinking also of networked digital cameras and video-cameras, thermometers, traffic lights, GPSs for cars and – why not – bikes, skates, pogosticks, and even walking people, game stations, and so on. Thousands of interconnected information processing devices will be available to each of us anytime anywhere. Each mobile device will sense its environment to gather information from the physical world and make it available to its user (or users). Each device will also exchange information with other (mobile and non-mobile) devices, mainly by means of some wireless communication network. Probably, users will (continue to) directly exchange information among them. Also, devices will probably change the physical environment, to

F. Crestani et al. (Eds.): Mobile and Ubiquitous Info. Access Ws 2003, LNCS 2954, pp. 1–10, 2004.

a greater extent than nowadays static and non-ubiquitous desktop machines. A similar view is expressed, for instance, in [12].

All the mobile devices can be seen, from the user point of view, as information access tools: they will filter incoming information and retrieve available information, trying to present to the user all and only the relevant information. Of course, the user will be interested in accessing information that is not only relevant in the strict sense, but also of a high quality, timely, serendipitous, of the appropriate grain size, perhaps rare, and so on. Since there is not an agreement about which of these features are relevance features, we will use the term "relevance" in a very general way, denoting with relevant information the information that the user wants.

But what is relevance in the new mobile/wireless/ubiquitous scenario? This paper is a first and preliminary attempt of answering this question. We hope both to help traditional information retrieval researchers to appreciate some complications peculiar to the mobile domain, and to persuade researchers working in the mobile and wireless field of the importance of the information access approach. Therefore, we try to stay at a level high enough to be understandable by an interdisciplinary audience.

The paper is organized as follows. In Section 2 we will briefly overview the research about the concept of relevance in classical non-mobile *Information Retrieval* (henceforth IR). We name relevance in classical IR *e-relevance* (for electronic relevance, but this is not the only reason, as we will explain in Section 5). In Section 3 we will re-analyze the relevance concept in the mobile case. In turn, we name this relevance *w-relevance* (for wireless relevance, but, again, see Section 5). We show that, from an intuitive point of view: (i) w-relevance is an extension of e-relevance; (ii) w-relevance is much different from e-relevance than one might think at first; and (iii) beyond-topical criteria, one aspect of e-relevance that has recently received a lot of attention in non-mobile IR, are both much more emphasized and much more important in the mobile case. In Section 4 we propose some simple examples and scenarios to support our position. Section 5 concludes the paper.

2 E-Relevance: The Non-mobile Information Retrieval Case

Relevance (e-relevance) is a subject that has been intensely studied for years in the IR field, and it is still a hot topic today. We will not review in detail the field, since some well known surveys are already available [14, 20, 21, 22, 23].

Classical information retrieval equates e-relevance with topicality: the query submitted to an IR system specifies the topic(s) that a relevant document has to deal with. For example, if a university professor is looking for documents to prepare her next lesson for this afternoon, she needs of course documents that deal with the matter that she is going to explain to her students. But she also wants those documents as soon as possible (if a document arrives after the lesson, it is useless), at the right complexity level (if a document is too difficult, students will not understand it), and so on. And these features go beyond the topic: they are completely independent of it.

Therefore, the topical view is short-sighted. Indeed, we have now a large amount of research that demonstrates how topic is only one of the criteria that users use when judging the e-relevance of the retrieved documents. For a review of this line of research, that started in the 60es and has received a lot of attention (especially at Syracuse University) in the 80es and 90es see [1, 14]. Since the criteria, elicited from users or found by experts, tend to constitute a stable set (i.e., very few new criteria are found in the most recent studies), it is likely that we have an almost correct and complete list of relevance criteria.

Actually, the exploitation of beyond-topical criteria is not the only way to get closer to the "real" relevance, i.e., the relevance the user is interested in. A more general approach that takes into account this aspect has been proposed by one of us some years ago [9, 15]: the various kinds of relevance are classified in a four-dimensional space, distinguishing among them on the basis of a precise classification. The four dimensions are:

- *Information resources*, containing document, surrogate, and the information that the user receives when reading a document.
- *Representation of the user problem*, containing the real information need, the perceived information need, the request (or expressed information need), and the query (or formalized information need).
- *Time*, containing the time instants from the arising of the user's need to its satisfaction.
- *Components*, containing topic, task (what the user has to do with the retrieved information), and context (everything beyond topic and task as, for example, what the user already knows about the topic being sought, or the time that the user has to complete the search).

These four dimensions allow one to distinguish among the various kinds of relevance, and to speak, for instance, of: the relevance of a document to the query at query expression time for what concerns the topic component (the classical relevance used in IR); the relevance of the information received to the real information need at the time of final need satisfaction for what concerns topic, task, and context (the relevance the user is interested in); and so on. This classification can be used in the implementation and evaluation of IR systems.

This topic/task/context distinction has been used in some respect. Reid [18] proposed an evaluation methodology that uses the task as the starting point for building a test collection. The development of IR systems dealing with beyond-topical e-relevance has been rather slow, however some examples now exist. Researchers at MIT recently developed an IR system that, in some way, goes beyond topical criteria [13]. This system, named GOOSE (GOal Oriented Search Engine), allows the user to choose among a list of tasks (called "goals" by GOOSE authors), and uses a large common sense knowledge base to exploit the task specification for building a better query. In such a way, Liu and colleagues implemented, perhaps without explicitly noting it, an IR system that tries to work taking into account beyond-topical factors of relevance, as suggested in [15].

One can also assume that, although each search and each information need concern a different topic, there are indeed some beyond-topical components of user's needs that are more stable, i.e., the context in which the consecutive search sessions by one user take place [10, 11]. Some first experiments show that, for a given user, contexts are indeed more stable than topics, and may be used to improve the ranking of documents retrieved after a query, but the usefulness of this approach is still under investigation.

Another approach for including beyond topical criteria in an IR system is to build an *IR assistant*, namely a system that, during information seeking, observes user behavior and gives suggestions aimed at improving the effectiveness of the search and of the searcher [3, 4, 16]. Some of the suggestions might be of a topical nature (e.g., to add some terms to the query to better represent the topic being sought for), but also non-topical suggestions can be provided, like suggesting a paper related in some way to those judged as relevant so far (e.g., the PhD thesis by, or a short biography of, the author of a paper judged as relevant, or a references list, and so on). This line of research has still to be proven effective, but initial laboratory experiments show positive results. Also "just-in-time information retrieval agents" [19] build their queries with beyond-topical components (mainly context).

Even if the existence of beyond-topical criteria for e-relevance is not in discussion, what seems not yet recognized, or assessed, is the actual importance of these criteria in real-life IR. In the next section we discuss, on the basis of the classification in [15], how and why the w-relevance scenario is different.

3 W-Relevance: The Mobile Information Retrieval Case

One might simply repeat the above analysis in the w-relevance case, and thus just state that there are various kinds of w-relevance and there are some beyond-topical components of w-relevance that should not be overlooked. However, we believe that there are important differences between e-relevance and w-relevance. The beyond-topical criteria in the mobile IR case become more critical: they are different from, and have a higher importance than, those in non-mobile IR. Therefore, topicality is an abstraction that works in a perhaps satisfying way (even far from perfect) in the e-relevance case but, as soon as the real world comes into playthe shortcomings of this approach are manifest (examples will be shown in Section 4). Also, there are more kinds of w-relevance than kinds of e-relevance. As we will discuss in the following, the main reason for these differences is that in the e-relevance case we can comfortably seat inside the "information world", whereas in the w-relevance case we have to move into the "real/physical world".

All the e-relevance models proposed in past years need to be modified to become adequate models of w-relevance. In this section we revise and extend the model proposed in [15], in each of the four above mentioned dimensions.

3.1 Information Resources

In the non-mobile case, the user of an IR system is usually interested in retrieving information; a typical user is a scholar that needs documents on a new topic, to study them, to write a paper or book, and so on. This is obtained by retrieving a number of information sources (books, articles, Web pages, etc.), from which the user can extract the relevant information. In the mobile IR scenario, it is often the case that the user is interested not just in information, but in obtaining some (possibly material) *thing*, only partially described by information (e.g., a physical place or a pair of blue jeans): besides surrogate, document, and information, the information resources dimension should therefore include also the things, and should perhaps be renamed as *resources*. In other terms, often the retrieved information and, in general, the database are instrumental, since they are means to reach the end of possessing, or obtaining, some thing, not the end itself. Besides the relevance of retrieved information, we also have the relevance of the retrieved thing: the user will not evaluate the information sources, but the described physical object, that in the meantime might change or disappear even without an immediate reflection on the information source content. This brings up the issue of consistency between the database and the real world.

3.2 Representation of the User Problem

Since in the mobile IR scenario, besides the real information need (that is in turn beyond the information need perceived by the user), it is often the case that the user is interested in some *thing*, we can say that the user usually has a *thing need* (that should then be added to the second dimension, namely the representations of the user problem). Therefore, if we look at the first two dimensions, we can say that from the relevance of the retrieved information to the information need, we have moved to the relevance of the retrieved thing to the thing need. Using Bateson's [2] terminology, w-relevance deals more with *Pleroma* (the physical world), whereas e-relevance deals mainly with *Creatura* (the informational world): in w-relevance we have a much stronger coupling with the real, physical world. If one photocopies an article in a library (e-relevance scenario), you can anyway read the article later. If someone buys the last item of your favorites blue jeans just after your query to a "blue jeans database", you cannot have them anymore (w-relevance scenario). In the former case you are interested in information, whereas in the latter you are interested in a thing.

3.3 Time

Another dimension of relevance that increases its importance in the w-relevance case is *time*, in two senses. First, often the user needs "quick and dirty" information: things change faster, replication is more difficult. Second, in the real world, since time is irreversible, if something is lost it is lost. In the Creatura one can often rely on backups, copies, and replication; in the real world, "carpe diem". This is perhaps the deep motivation behind the often stated claim that users of mobile devices are more interested in precision than in recall, usually justified, in a perhaps too simplistic way, by the small display area on mobile devices: having a full list of the relevant items can be useless if the list is so long that the time required for examining it is longer than the lifetime of relevant items.

Another aspect of w-relevance, related to both the strong coupling with the real-world and time, is the database change rate: since the real world changes quickly and continuously, the database has to quickly change accordingly to stay up-to-date.

The intuitive importance of time is also confirmed by a survey made last year in Singapore among users of PIRO, a commercial system developed by C5solutions [5]. PIRO presents to mobile users using WAP phones the directory listings of commercial retail relevant to user's current need. Eight users filled in a 29 questions questionnaire having the purpose to rate the importance of various relevance criteria for presenting commercial applications on a mobile device. Of course the small sample size does not allow any certain inference, but it is worth noting that two out of the three