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Modeling and Retrieval of Context

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Preface

Computing in context has become a necessity in modern and intelligent IT applications. With the use of mobile devices and current research on ubiquitous computing, context-awareness has become a major issue. However, context and context-awareness are crucial not only for mobile and ubiquitous computing. They are also vital for spanning various application areas, such as collaborative software and Web engineering, personal digital assistants and peer-to-peer information sharing, health care workflow and patient control, and adaptive games and e-learning solutions. In these areas, context serves as a major source for reasoning, decision making, and adaptation, as it covers not only application knowledge but also environmental knowledge. Likewise, modeling and retrieving context is an important part of modern knowledge management processes.

In addition, context can play a role in determining what information a system should provide. This is important for supporting the users of automated or intelligent systems, for tasks such as explaining how solutions are found, what the system is doing, and why it operates in a certain way. The methods applied and the advice given have to be explained, so that the user can understand the process and agree on decisions. Context is equally important for deciding when to provide uncertain or blurred information, e.g., when using a tracking system in situations for which either revealing the current position, or denying access to it, would have adverse effects.

In this wide range of applications, context is now more than just location. It is seen as a multi-dimensional space of environmental aspects, even including non-physical facets like emotions. Hence, models for representing context have evolved from using simple key-value pairs to using current methods and techniques derived from artificial intelligence and knowledge management, e.g., logic, object relationship models, and ontologies.

Appropriate context management methods are an important prerequisite for using this contextual information, e.g., to determine or assign a context to a situation, to cope with the fuzziness of context information and, especially because of mobility, to deal with rapidly changing environments and unstable information sources. Therefore, advanced models, methods, and tools are needed to provide mechanisms and techniques for structured storage of contextual information, to provide effective ways to retrieve it, and to enable integration of context and application knowledge. This entails the need for artificial intelligence mechanisms in context-aware applications.

Nine papers from the Second International Workshop on Modeling and Retrieval of Context, MRC 2005, held at the 19th International Joint Conference on Artificial Intelligence, in Edinburgh, Scotland, July 31–August 1, 2005, were selected and extended for this book. A major goal of the workshop was to study, understand, and explore the handling of context in IT applications. The follow-

ing papers illustrate the state of the art of context modeling and elicitation as well as identification and application of context in different application scenarios.

Anders Kofod-Petersen and Jörg Cassens propose an interdisciplinary approach, using Activity Theory, to model context and then populate the model for assessing situations in a pervasive computing environment. Thus, they provide a knowledge-intensive context model from a socio-technical perspective.

Sven Schwarz introduces a context model for personalized knowledge management applications. The approach is based on an ontology that describes different aspects of a knowledge worker's information needs. Contextual information is gathered by user observation. The paper describes several implemented example applications.

Dominik Heckmann describes a service for modeling situations and retrieving contextual information in mobile and ubiquitous computing environments using Semantic Web technology. The paper introduces a General User Model and Context Ontology, called GUMO.

The next three papers describe layered architectures for context management, each with a different focus. The first paper describes a generic architecture, the second paper focusses on contextualized decisions, and the third paper deals with imperfection and aging of contextual information.

Kayu Wan, Vasu Alagar, and Joey Paquet describe and evaluate a generic, component-based architecture for developing context-aware systems. They propose a three tier model in which the first tier deals with perception, the second tier deals with context management, and the third tier deals with context adaptation.

The paper by Oana Bucur, Philippe Beaune, and Olivier Boissier discusses steps towards contextualized decisions. It addresses the problem of how to distinguish relevant from non-relevant context for a given task. The basis of the solution is a context definition and model for a context-aware agent that is able to learn to select relevant contexts. The three tier architecture comprises a layer of context sources, a context management layer, and a layer of agents that reason with context.

Andreas Schmidt deals with imperfection handling and controlled aging of contextual information. The paper presents a three layer model and its application to a context-aware learning environment for corporate learning support. The model distinguishes an internal layer with a context information base, a logical layer containing context feature values, and an external layer where the context information is applied.

The papers by Maria Chantzara and Miltiades Anagostou and by Aviv Segev (as well as by Bucur, Beaune, and Boissier mentioned above), present approaches to identifying appropriate contexts.

Maria Chantzara and Miltiades Anagnostou look into quality-aware discovery of context information. They introduce the Context Matching Engine which allows discovery of appropriate context sources for customized context-aware services.

The paper by Aviv Segev deals with identification of multiple contexts of a situation. The context recognition algorithm presented uses the Internet as a knowledge base. In the example described the real-time approach is successfully applied to ongoing textual conversations such as chats.

The paper by Michael Fahrmair, Wassiou Sitou, and Bernd Spanfelner proposes a generic mechanism for designing context awareness and adaptation behavior with formal methods. It introduces the concept of an adaptation context as a characterization of the system after carrying out an adaptation.

We hope that this research snapshot will be a useful foundation for future research on modeling and reasoning about context.

February 2006

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