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Editors

Next Generation Intelligent Environments

Ambient Adaptive Systems

Second Edition

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Foreword

The technological changes we have all witnessed in our lifetime are breathtaking and raise the intriguing question as to what the future will bring. It is hard to believe that the Internet as the public knows it (e.g. the World Wide Web) has been in our homes barely 25 years, but in that short time has embedded itself inseparably into our daily lives radically changing, for example, the nature of commerce, entertainment and education. Even bigger changes beckon with the Internet of Things promising to move the Internet from managing data to controlling the physical fabric of our lives in the form of buildings, transportation, factories and other physical environments. The sheer complexity of such visions, involving ecosystems comprising tens, hundreds or even thousands of collaborating embedded computers and people, is mind-boggling and represents major challenges to technology designers as to how to manage such systems, in ways that ensure people fully benefit from such technology. While there are various views for solutions to this challenge, this book is rooted in the concept of intelligent environments, which takes it inspiration from aspects of human intelligence and how we deal with the management of complex systems, notably by the application of reasoning, planning and learning.

The notion of people being in control of technology is a central tenant of the intelligent environments paradigm which, in turn, has huge implications for the design of the technology. For instance, it has given rise to the mantra frequently voiced by designers of intelligent environment technology, that "the user is king (or queen)", meaning that technology should, with only a few exceptions (e.g. safety), always do what the user requests. In addition, the drive towards humanising technology has led to a desire for the human interface to be as natural as possible by, for example, using voice dialogue or gesture recognition. This strategy has implications for the artificial intelligence which seeks also to adopt a human-friendly form of reasoning (fuzzy logic). The overall hope is to drive technology in a more human amenable direction.

Towards these goals, this book describes research, funded by the European Community's 7th Framework Programme that aimed to investigate how the vision for intelligent environment ecologies comprising people and technology might be best

realised. In general terms, the work sought to create context-aware environments that used sensors to perceive the world and applied ontology (and fuzzy logic) to interpret the context and operate environments. As was emphasised earlier, at the core of intelligent environments are the needs of people who do not think in computational terms and value privacy and trust. As a consequence, the work incorporates trust models, fuzzy decision making mechanisms and speech dialogue which, collectively, function in a more human-like way. A particularly noteworthy aspect of the research was the adoption of a novel conceptualisation, a "bubble", that can be viewed as a virtual container of computational resources belonging to an owner and used to achieve tasks while providing clearly defined boundaries to aid the enforcement of privacy requirements.

Beyond being a valuable record of a key European project, the book is an important compendium of knowledge on key areas of intelligent environments. For instance, the book opens with two highly illuminating chapters that discuss network adaptation and middleware issues based on the use of Service-Oriented Architecture, OSGi and UPnP technology, which are especially suitable for intelligent environments which require highly dynamic adaptation and reconfiguration. Knowledge is a key aspect of any intelligent system, and Chap. 3 presents a particularly interesting scheme for mixing and aligning heterogeneous ontologies. Privacy and trust are critical factors for user acceptance of intelligent environments, an issue which is extensively discussed in Chap. 4. Chapter 5 explains how fuzzy logic can form a bridge between the imprecise and often probabilistic reasoning favoured by people and numeric calculations employed in computers. An especially important contribution is the use of type 2 fuzzy logic to facilitate set adaptation to match perception drift, such as the meaning of warm as seasonal weather changes. Chapter 6 provides an in-depth discussion of human-computer interfaces for intelligent environments, making the case that some kind of adaptation in the user interfaces is a vital factor in improving their usability in intelligent environments and presenting a novel adaptable interface, namely, the Interaction Agent. Speech dialogue provides a particularly natural means of interacting with intelligent environments. Chapter 7 describes an approach based on user-centred adaptation which alters the content, flow and structure of the ongoing dialogue using short-term and long-term strategies. Chapter 8 complements the fuzzy rule-based reasoning by introducing a framework for hybrid planning which implements multiple search strategies. Finally, Chap. 9 overviews the key user experience principles, concluding by describing the project outcomes. It is evident, of course, that the journey on researching intelligent environments is far from complete. As was voiced in the opening sentence of this paragraph, predicting the future is challenging, but for those of you interested in ensuring that the direction of travel leads to a better future, you can perhaps take heart from the 1971 Alan Kay quotation: "The best way to predict the future is to invent it", which might be reworded as, while the future cannot be predicted, we can have a significant hand in shaping it. In that respect, this book represents a major milestone in the advancement of intelligent

environments, providing a valuable single point resource for anyone interested in getting a comprehensive insight into the main technologies and issues surrounding the development of intelligent environments and the development of a better future. I applaud the authors for their valuable contribution to the field.

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