Agent-Oriented Software Engineering
Report on the 4th AOSE Workshop
(AOSE 2003)

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Agent-Orientation is emerging as a powerful new paradigm in computing. Concepts, methodologies and tools from the agents paradigm are one of the best candidates for the foundations of the next generation of mainstream software systems. The Agent-Oriented Software Engineering (AOSE) workshop is an international event that brings together researchers and groups active in the area of agent-based software development. Here we briefly report on the fourth edition of the AOSE workshop.

Introduction

The explosive growth of application areas such as electronic commerce, enterprise resource planning and mobile computing has profoundly and irreversibly changed our views on software systems. Nowadays, software is to be based on open architectures that continuously change and evolve to accommodate new components and meet new requirements. Software must also operate on different platforms, without recompilation, and with minimal assumptions about its operating environment and its users. Furthermore, software must be robust and autonomous, capable of serving a naïve user with a minimum of overhead and interference.

Agent concepts hold great promise for responding to the new realities of software systems. They offer higher level abstractions and mechanisms which address issues such as knowledge representation and reasoning, communication, coordination, cooperation among heterogeneous and autonomous parties, perception, commitments, goals, beliefs, and intentions – all of which need conceptual modelling. On the one hand, the concrete implementation of these concepts can lead to advanced functionalities, e.g., in inference-based query answering, transaction control, adaptive workflows, brokering and integration of disparate information sources, and automated communication processes. On the other hand, their rich representational capabilities allow more faithful and flexible treatments of complex organizational processes, leading to more effective requirements analysis and architectural/detailed design.

The workshop on AOSE is an international event focusing on concepts, methodologies, techniques and tools for building agent-oriented software systems. As a natural place for this event, the fourth edition of the workshop (AOSE 2003) has been hosted by the Second International Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS 2003) held in Melbourne, Australia on July 2003.

The workshop built on the success of the three previous AOSE workshops. The AOSE-2000 workshop was held at the ICSE2000 conference in Limerick, Ireland, in June 2000; the AOSE-2001 workshop was held at the Fifth International Conference on Autonomous Agents (Agents 2001); and the AOSE-2002 workshop was held at the Autonomous Agents & Multi-Agent Systems (AAMAS 2002). The papers collected in the proceedings show the range of results achieved in several areas such as methodologies, modeling, architectures, and tools.

The workshop, co-organized by Jörg Müller (Simens AG, Germany), James Odell (James Odell Associates, Ann Arbor, MI, USA), and myself, accepted 14 full papers out of 43 submissions. These papers were reviewed by at least 3 members of an international program committee composed of 25 researchers. The workshop program included an invited talk, a technical session in which the accepted papers have been presented and discussed, and a closing plenary session. It congregated more then 50

attendees among researchers, students and practitioners, who contributed to the discussion of research problems related to the main topics in AOSE.

Invited Talk

As part of the AOSE 2003 program, an invited talk was given by Prof. Michael Huns on *Software Agents – the future of web services*. Prof. Huns described how Web Services will become more agent-like, and how the envisioned capabilities and usages for the Semantic Web will require implementations in the form of multiagent systems. He also described how the resultanting agent-based Web Services will yield unprecedented levels of software robustness.

Technical Papers

The AOSE 2003 program included four technical sessions: (1) *Methodologies and Tools,* (2) *Patterns, Architectures, and Reuse,* (3) *Modeling Agents and Multiagent Systems*, and (4) *Roles and Organizations.*

The *Methodologies and Tools* session was composed of four papers. The first paper by Pericles A. Mitkas et al., introduced Agent Academy, a framework for constructing multiagent applications and training agents, which supports the design of agents behaviors and reusable agent types, the definition of ontologies, and the instantiation of single agents or multiagent communities. In Agent Academy, the training of agents is supported by data mining techniques. The paper by Ruben Fuentes et al., presented how to verify multiagent systems specifications using human organization metaphor. Activity theory is used to understand and explain misunderstandings, inconsistencies and mistakes inherent to the development of complex multiagent system. The paper by H. Van Dyke Parunak et al., illustrated a taxonomy of multiagent interactions. It is based on terms such as correlation, coordination, cooperation and congruence and can be used for describing agents interaction and supporting the communication. The last paper by Jose G. Quenum et al., presented a method for automatic derivation of agent interaction models from generic interaction protocols. Separating the coordination and functional aspects, the method offers a way to build an effective agent's interaction model by means of a unification algorithm.

The *Patterns, Architectures, and Reuse* session was composed of three papers. The first paper by Hrishikesh J. Goradia et al., presented the Component-Based Agent Framework (CBAF), which enables software engineers to design set of agents using Sun's BDK, a visual component-based toolkit, and wiring together desired blocks of functionality. The paper by Christos Georgousopoulos et al., discussed an approach for supporting FIPA interoperability for legacy multiagent systems. The approach is based on FIPA-compliant gateways and tested on digital library, part of the Synthetic Aperture Radar Atlas (SARA). The last paper by Denis Jouvin et al., discussed the notion of dynamic composability and flexible architecture (dynamically modifiable), in the context of conversational multiagent systems. The paper presented a design pattern to build dynamic and flexible architectures based on the role delegation paradigm.

The *Modeling Agents and Multiagent Systems* session was composed of four papers. The first paper by Adriana Giret et al., presented a recursive approach to develop large-scale multiagent systems where each component may consist of other multiagent systems. A multiagent system is modeled recursively in terms of agent models, task-goal models, interactions models, organizational models and environment models. The paper by Anna Perini et al., sketched a framework which relies on an agent-oriented methodology that provides a modeling language for inter-mixing formal and informal specifications. Formal techniques are used to guide and support the analyst while building and refining a multiagent system conceptual model. The paper by Thomas Juan et al., introduced the ROADMAP meta-model, designed to describe intelligent adaptive systems in open environments, using organizational concepts such as roles. The meta-model captures the understanding of properties of the systems as well as the perspective on organizational model. The last paper by Agostino Poggi et al., demonstrated how UML can be exploited and extended to model the deployment of a multiagent system at the agent level. The formally-based UML 2.0 meta-model is extended in order to support the semantics of agents, mobile agents and their supporting platforms.

The last session on *Roles and Organizations* was composed of three papers. The first paper by James Odell et al., discussed the importance of considering possible changes of the roles played by agents in real-world multiagent systems. The

paper described an illustrative application where such role changes are important, analyze and classify the various kinds of role changes over time that may occur, and show how this analysis is useful in developing a more formal description of the application. The paper by Jacques Ferber et al., presented a set of general principles from which organization centered multiagent systems may be designed. The paper pointed out some of the drawbacks of classical agent centered multiagent systems and discussed how to solve them using an agent/group/role–based framework. The last paper by Qi Yan et al., presented a new definition of agent based on "soft gene" and role. This leads to a diagrammatic modeling method for supporting multiagent systems analysis and design.

Plenary discussion

After the technical sessions the workshop proposed a plenary session on the future research and challenging problems in AOSE. The discussion focused mainly on two topics: (1) AUML as the standard language for analyzing and designing multiagent systems and (2) web services as a strategic application area for multiagent systems.

Conclusions

The success of the AOSE workshops is due to the quality of the accepted papers and AOSE 2003 was not exception. We believe that the presented papers reflect the field's state of the art very well. Furthermore, we anticipate that they constitute an excellent basis for an in-depth and fruitful exchange of thoughts and ideas on the various issues of agent software engineering.

More information about AOSE 2003 and the three previous editions are available at http://www.csc.liv.ac.uk/~mjw/aose. The post-proceeding of the workshop will be published by Springer-Verlag in the "Lecture Notes in Computer Science" (LNCS) series, hopefully in 2004.

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