An Introduction to Software Engineering for Multi-Agent Systems

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Abstract

The significance of multi-agent systems research and technology is increasing due to the growing need to engineer complex distributed software systems. Agent-based computing is rapidly emerging as a powerful technology for the development of complex software systems, synthesizing contributions from many different research areas including artificial intelligence and software engineering. The aim of this tutorial is to give participants a grounding in Software Engineering for Multi-Agent Systems, which is one of the current growing areas of Computer Science.

1. Motivation

In recent years agents have become a powerful technology that can be applied to several significant applications. In addition, with the advances in Internet technologies, multi-agent systems are undergoing a transition from closed monolithic architectures into open architectures in which agents operate and move across different environments. Openness introduces additional complexity to the system modeling, design and implementation. Thus, the development of appropriate methodologies to develop agent-based solutions is a key issue in getting the agent technology into the mainstream of software development.

In this context, the general purpose of this tutorial is to introduce the agent-based software engineering. Other specific purposes include: (i) introduce the agent paradigm; (ii) present some methodologies and modeling languages that are well-known in the literature; (iii) present our ongoing research on multi-agent systems modeling; and (iv) update the Brazilian software engineering community in the state of the art and the future perspectives in the research on software engineering for multi-agent systems.

2. Tutorial Outline

Agent-based systems are gradually moving from research labs to the industry. Hence, there is a need for an engineering approach to develop such systems. Agent Oriented Software Engineering (AOSE) addresses this need and aims at presenting an engineering approach for agent-based systems to the industry. This tutorial will provide an introduction to AOSE as well as a motivation for its use. It will provide the participant with an understanding of the AOSE concepts and it will also explain the use of AOSE methods for building agent-based system by emphasizing the software lifecycle. The student will study the approaches within the AOSE community and will be familiarized with several methods for specifying agent-based systems. The tutorial will concentrate on methodologies and platforms, their
applicability and their use during the software lifecycle. In particular, the goals of this course are the following:

1. Introduce basic concepts of software engineering in the context of agent-based systems.
2. Introduce the field of agent-oriented modeling methods.
3. Present some agent-oriented methodologies and modeling languages.
4. Present some agent-oriented platforms.

The tutorial begins with the definitions of Software Agent (and its properties) and Multi-Agent Systems. After the general introduction to Multi-Agent Systems, we present the TAO (Taming Agents and Objects) Conceptual Meta-model. The TAO meta-model shows the basic concepts and notions of the agent-oriented system domain, providing an ontology to capture the foundations for both agent and object-based software engineering.

The third part presents some well-known methodologies along with some of the initiatives from our research group for modeling multi-agent systems. The methodologies vary from agent-centered approaches to alternative approaches where multi-agent systems are modeled using object-oriented paradigm.

The fourth part introduces some of the existing platforms for multi-agent systems implementation. We conclude with a question and answer session. We hope the discussion will be interesting and make the audience engage in a lively debate on the theme.

No prior background in multi-agent systems and technology is expected.

3. Authors Background and Short Bios

The authors are involved with the research on Software Engineering for Multi-Agent Systems since 2000. They work at the Software Engineering Lab (LES / PUC-Rio) in the context of the Software Engineering for Multi-Agent Systems (ESSMA) Project, funded by the CNPq, Brazil.

Since 2000, several thesis and dissertations were developed on the theme at LES. These vary from methodologies and modeling languages to platforms, agent frameworks, component-based infrastructures and case studies. In order to point out the importance of the research on multi-agent systems, the group led by Carlos Lucena at LES created the International Workshop on Software Engineering for Large-Scale Multi-Agents Systems (SELMAS) at the International Conference on Software Engineering (ICSE). In 2004, SELMAS had its third edition. Carlos Lucena was involved with all SELMAS editions and Ricardo Choren was directly involved with the last edition.

Among the results of the ESSMA Project, we can point out two volumes of the Lecture Notes in Computer Science (LNCS) series, from Springer-Verlag. These books were based on the papers submitted to the first two SELMAS editions. Another LNCS volume, based on the last SELMAS edition, is under way.

The authors short bios are presented below.

Carlos Lucena received the BSc degree (1965) from the Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil, the MMath degree (1969) in computer science from the University of Waterloo, Canada, and the PhD degree (1974) in computer science from the University of California at Los Angeles. He has been a full professor in the Computer Science Department at PUC-Rio since 1982. Currently, he coordinates the Software Engineering Lab (LES) at PUC-Rio and he also coordinates the Software Engineering for Multi-Agent Systems Project (ESSMA – CNPq, Brazil). His current research interests include software design and formal methods in software engineering. He is a member of
the ACM and various other scientific organizations. He is also a member of the editorial board of the International Journal on Formal Aspects of Computing.

Viviane Torres da Silva received the computer engineer (1998), the MSc (2000) and the PhD (2004) degrees from the Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil. She has been a research associate in the Computer Science Department at PUC-Rio since 2003 and she is a member of the Software Engineering for Multi-Agent Systems Project (ESSMA – CNPq, Brazil).

Ricardo Choren received the BSc degree (1995) in computer science from the Federal University of Rio de Janeiro (UFRJ), Brazil, and the MSc (1998) and PhD (2002) degrees in computer science from the Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil. He is a professor in the Department of Systems Engineering at the Military Institute of Engineering (IME) since 2004. He is also a research fellow of the Software Engineering for Multi-Agent Systems Project (ESSMA – CNPq, Brazil). His current research interests include software design, multi-agent systems software engineering and software development methods and tools. He is a member of the ACM.

4. Selected Bibliography from the Authors


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