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Programming Multi-Agent Systems

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Revised and Invited Papers



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Preface

These are the proceedings of the Third International Workshop on Programming Multi-Agent Systems (ProMAS 2005), held in July 2005 in Utrecht (Netherlands) as an associated event of AAMAS 2005: the main international conference on autonomous agents and multi-agent systems. ProMAS 2005 was the third of a series of workshops that is attracting increasing attention of researchers and practitioners in multi-agent systems.

The idea of organizing the first workshop of the series was first discussed during the Dagstuhl seminar *Programming Multi-Agent Systems based on Logic* (see [4]), where the focus was on *logic-based approaches*. It was felt that the scope should be broadened beyond logic-based approaches, thus giving the current scope and aims of ProMAS; see [3] for the proceedings of the first event (ProMAS 2003) and [1] for the proceedings of the second workshop (ProMAS 2004). All three events of the series were held as AAMAS workshops.

Besides the ProMAS Steering Committee (Rafael Bordini, Mehdi Dastani, Jürgen Dix, and Amal El Fallah Seghrouchni), an AgentLink III Technical Forum Group on Programming Multi-Agent Systems has been very active in the last couple of years (see <http://www.cs.uu.nl/~mehdi/al3promas.html> for details on that group). Moreover, we have edited a book on *Multi-Agent Programming* [2], and ProMAS 2006 will be held with AAMAS 2006 on May, in Hakodate, Japan (see <http://www.cs.uu.nl/ProMAS/> for up-to-date information about ProMAS).

One of the driving motivations behind this workshop series is the observation that the area of autonomous agents and multi-agent systems (MAS) has grown into a promising technology offering sensible alternatives for the design of distributed, intelligent systems. Several efforts have been made by researchers and practitioners, both in academia and industry, and by several standardization consortia in order to provide new languages, tools, methods, and frameworks so as to establish the necessary standards for a wide use of MAS technology.

However, until recently the main focus of the MAS research community has been on the development, sometimes by formal methods but often informally, of concepts (concerning both mental and social attitudes), architectures, coordination techniques, and general approaches to the analysis and specification of MAS. In particular, this contribution has been quite fragmented, without any clear way of “putting it all together,” and thus completely inaccessible to practitioners.

We are convinced that the next step in furthering the achievement of the MAS project is irrevocably associated with the *development of programming languages and tools that can effectively support MAS programming* and the *implementation of key notions in MAS in a unified framework*. The success of MAS development can only be guaranteed if we can bridge the gap from analysis and design to effective implementation. This, in turn, requires the development of

fully fledged and general purpose programming technology so that the concepts and techniques of MAS can be easily and directly implemented.

ProMAS 2005, as indeed ProMAS 2003 and ProMAS 2004, was an invaluable opportunity that brought together leading researchers from both academia and industry to discuss various issues on programming languages and tools for MAS. Showing the increasing importance of the ProMAS aims, the attendance in our workshop has been growing steadily: ProMAS 2005 was the most popular of all AMAAS workshops in terms of number of registered participants.

This volume of the LNAI series constitutes the official (post-)proceedings of ProMAS 2005. It presents the main contributions that featured in the latest ProMAS event. Besides the final 14 high-quality accepted papers, we also invited two additional papers. The structure of this volume is as follows:

Invited Papers: Michael Fisher, a leading researcher in the area, gave an invited talk at the ProMAS workshop. Subsequently, he wrote a paper based on his talk, which is featured in these proceedings. We also invited Peter McBurney and Mike Luck, who were at the time actively working on the AgentLink III “Agent Technology Roadmap,” to summarize their findings from that exercise, highlighting the importance that the ProMAS topics will have in the efforts towards widespread uptake of agent technology.

- The first invited paper, *MetaTem: The Story So Far*, by Michael Fisher, illustrates MetaTem, a programming language based on the direct execution of temporal statements. After a brief introduction to temporal logic and the notion of executing a formula, a concurrent version of MetaTem is introduced. This allows to model multiple, asynchronously executing agents. These agents can be organized into groups that allow for multi-cast message passing.
- The second invited paper, *Agent-Based Computing and Programming of Agent Systems*, by Michael Luck, Peter McBurney and Jorge Gonzalez-Palacios, is partly based on the Agentlink III Roadmap, from which a nice classification of the development of MAS within the next decade is taken. The paper discusses several issues involved in multi-agent programming and open, distributed systems in general.

Multi-agent Techniques and Issues: The second part of this volume contains five papers. The first paper, *Dynamic Self-Control of Autonomous Agents* by Caroline Chopinaud, Amal El Fallah Seghrouchni and Patrick Taillibert, focuses on ensuring that a MAS behaves correspondingly to what its developers expect. As standard validation techniques still allow the occurrence of errors during execution, the paper proposes an additional approach of dynamic self-monitoring and self-regulation such that an agent can control its own behavior.

The second paper, *Bridging Agent Theory and Object Orientation: Importing Social Roles in Object-Oriented Languages* by Matteo Baldoni, Guido Boella and Leendert van der Torre focuses on describing how to introduce the notion of social role in programming languages. To limit the restrictions

on their approach, the authors extended Java itself as it is the most commonly used language to develop software agents. This way they were not restricted by specific agent or MAS architectures or other characteristics.

The third paper, *Implementation Techniques for Solving POMDPs in Personal Assistant Domains* by Pradeep Varakantham, Rajiv Maheswaran and Milind Tambe, treats the problem of using POMDPs to build agents able to make decisions in an environment that includes human beings. As this is computationally very expensive, the authors propose two new solutions to reach decisions faster, one of them is optimal and the other approximated. To achieve this, they based their work on the notion of progress or dynamics in personal assistant domains and the density of policy vectors.

The fourth paper, *Using a Planner for Coordination Of Multiagent Team Behavior*, authored by Oliver Obst, concentrates on using HTN planners to achieve coordination between agents in a MAS. This paper also presents promising results obtained during the RoboCup.

Finally, Juan M. Serrano, Sascha Ossowski and Sergio Saugar's paper on *Reusability Issues in the Instrumentation of Agent Interactions* is about engineering component interactions in large-scale open systems. To advance this issue, the authors present the RICA-J programming framework which provides executable constructs for every organizational, ACL-based abstraction of the RICA theory. Their execution semantics is defined over the JADE platform. This paper also presents a systematic reuse approach for interactions engineering.

Multi-agent Programming: The third part comprises four papers on "Multi-Agent Programming." The first paper is entitled *An AgentSpeak Meta-Interpreter and its Applications* by Michael Winikoff. It presents a meta-interpreter for AgentSpeak (i.e., the interpreter itself is written in AgentSpeak) and gives a sketch of its correctness proof. Furthermore, the paper argues that using a meta-interpreter may facilitate certain aspects such as debugging, failure handling, making selection functions explicit, and extending the language.

The second paper, *Extending the Capability Concept for Flexible BDI Modularization* by Lars Braubach, Alexander Pokahr, and Winfried Lamersdorf, deals with the *capability* construct found in the literature, and discusses how to implement an extended notion within Jadex. Capabilities allow for the implementation of BDI agents to be carried out as a composition of configurable modules, very much in the spirit of software engineering principles.

The third paper, *A Model-Based Executive for Commanding Robot Teams* by Anthony Barrett, builds upon Milind Tambe's model of flexible teamwork and combines it with a high-level language that facilitates the task of giving commands to a robotic system. From the initial global model, a compiler handles the distribution of control functions to team members.

The final paper in this part, *Hermes: Implementing Goal-Oriented Agent Interactions*, by Christopher Cheong and Michael Winikoff, presents the Hermes methodology for designing agent interaction in terms of *interaction goals*. The paper also provides guidelines on how interaction goals can be

mapped down to plans typical of BDI-like agents, therefore appropriate for many existing agent platforms.

Multi-agent Platforms and Organization: The first paper of the last part of this book is from Ichiro Satoh: *Organization and Mobility in Mobile Agent Computing*. It presents two mechanisms for dynamically organizing mobile agents distributed over several computers. In the first mechanism, a mobile agent may contain other mobile agents, while in the second mechanism a group of mobile agents are bound to one mobile agent. The migration of mobile agents is determined by the migration of the agents that contains/binds other agents.

The second paper, *Programming MAS with Artifacts*, is from Alessandro Ricci, Mirko Viroli and Andrea Omicini. It discusses the role of coordination artifacts as first-class entities in the development of MAS. In particular, there is a discussion on the implementation of MAS in terms of programming coordination artifact that coordinate the behavior of programmed individual cognitive agents.

The third paper, *Programming Deliberative Agents for Mobile Services: the 3APL-M Platform*, written by Fernando Koch, John-Jules C. Meyer, Frank Dignum, and Iyad Rahwan, presents a platform for building MAS where individual agents execute on handheld and embedded computational devices. Individual agents are implemented by a 3APL-inspired programming language.

The fourth paper, entitled *Implementing Multi-Agent Systems Organizations with INGENIAS*, is by Jorge J. Gomez-Sanz and Juan Pavon. This paper discusses some general requirements for organization modelling that can be used to analyze, design, and implement MAS. The discussion is accompanied with an example of a MAS developed with the INGENIAS methodology and implemented on the JADE platform.

Finally, the last paper of this book is by Mengqiu Wang, Mariusz Homeostasis and Martin Parvis: *Declarative Agent Programming Support for a FIPA-Compliant Agent Platform*. This paper focuses on the relation between high-level declarative agent models and low-level agent platforms that enable the communication between agents. In particular, it discusses how declarative agent programming support can be provided to develop MAS on the OPAL platform that supports FICA standards.

We would like to thank all the authors, the invited speaker, Programme Committee members, and reviewers for their outstanding contribution to the success of ProMAS 2005. We are particularly grateful to the AMAAS 2005 organizers for their technical support and for hosting ProMAS 2005.

November 2005

Rafael H. Bordini
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Organizers ProMAS 2005

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Organization

ProMAS 2005 was held as a workshop of the Fourth International Joint Conference on Autonomous Agents and Multi-Agent Systems, in Utrecht, The Netherlands, on July 2005.

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