Preface

These are the post-proceedings of the International Workshop on Programming Multi-Agent Systems (ProMAS 2008), the sixth of a series of workshops that is aimed at discussing and providing an overview of current state of the art technology for programming multi-agent systems.

The aim of the ProMAS workshop series is to promote research on programming technologies and tools that can effectively contribute to the development and deployment of multi-agent systems. In particular, the workshop promotes the discussion and exchange of ideas concerning the techniques, concepts, requirements, and principles that are important for establishing multi-agent programming platforms that are useful in practice and have a theoretically sound basis. Topics addressed include but are not limited to the theory and applications of agent programming languages, the verification and analysis of agent systems, as well as the implementation of social structure in agent-based systems (e.g. roles within organizations, coordination and communication in multi-agent systems).

In its previous editions, ProMAS constituted an invaluable occasion bringing together leading researchers from both academia and industry to discuss issues on the design of programming languages and tools for multi-agent systems. We are very pleased to be able to again present a range of high quality papers at ProMAS'08. After five successful editions of the ProMAS workshop series, which took place at AAMAS 2003 (Melbourne, Australia), AAMAS 2004 (New York, USA), AAMAS 2005 (Utrecht, The Netherlands), AAMAS 2006 (Hakodate, Japan), and AAMAS 2007 (Honolulu, Hawai'i), the sixth edition took place on May 13th in Estoril, Portugal, in conjunction with AAMAS 2008, the main international conference on autonomous agents and MAS. ProMAS 2008 received 27 submissions. These were reviewed by members of the Program Committee, and 12 papers were accepted for presentation.

At the workshop, in addition to the regular papers that were presented, Dana Nau (University of Maryland) gave an invited talk about planning and multi-agent systems. There are many interesting links between planning and agent programming languages for multi-agent systems. We believe that the agent programming community can learn from the progress made in the planning community, and, vice versa, may have potential to contribute to relatively new topics addressed in the planning community such as real-time and multi-agent planning. For this reason, we are also happy that Dana Nau has provided an invited paper for this ProMAS post-proceedings.

In his paper, Nau throws some light on how to cope with the intrinsic complexity that an automated planner would face in the context of multi-agent settings. Now that the field of *automated planning* has recently experienced tremendous progress and planners are able to deal with complex and reasonably sized problems, enhancing agent systems with explicit planning capabilities becomes

appealing. However, planning in multi-agent settings is much more complex than the classical planning setting: "the actions of the other agents can induce a combinatorial explosion in the number of contingencies that the planner will need to consider, making both the search space and the solution size exponentially larger." Nau describes three promising approaches to tackle such complexity, namely, state abstraction, explicit use of procedural domain information, and adequate frameworks for interleaving planning and execution. Although interesting work has already been done, both in the agent and planning communities, we believe integrating planning into multi-agent frameworks is an open challenge that will receive increasing research attention in the upcoming years.

As at previous editions, the themes addressed in the accepted papers included in this proceedings range from technical topics related to e.g. security issues to conceptual issues related to e.g. incorporating norms in multi-agent systems. More specifically, new contributions are included related to extensions and innovations of agent programming languages, contributions related to social dimensions of multi-agent systems, and contributions related to tools and environments in which agents operate.

Agent Programming Languages

The paper by Hindriks et al. presents an extension of the agent programming language GOAL with a utility-based lookahead planning capability. The idea is that quantitative heuristics added to a GOAL agent program may be used to prune some of the options for action derived by the qualitative action selection mechanism of such an agent. The paper thus allows for a mechanism to optimize agent behaviour based on costs and rewards that may be associated with an agent's actions.

The paper by Dennis and Fisher introduce an Agent Infrastructure Layer (AIL) that supports multiple, heterogeneous agent frameworks. AIL is a Java toolkit to support the implementation of a variety of agent programming languages including Gwendolen, SAAPL, and GOAL by implementing a set of transition rules that support these languages. AIL is proposed as a step towards formal verification of heterogeneous multi-agent systems that consist of agents written in a variety of agent languages.

The paper by Tinnemeier et al. introduces organisations and norms as an extension of agent programming. The programming language proposed is designed to implement multi-agent organizations. Various normative aspects of organisations including monitoring of behaviour, regimenting behaviour and sanctioning are discussed.

The paper by Novak discusses the agent programming language Jazzyk as a means for programming agents that use heterogeneous knowledge representations in order to achieve their objectives. The basic idea is that different tasks require different knowledge representation techniques and a principled approach is needed to allow for this. The semantics based on Behavioural State Machines is discussed as well as an implementation of an interpreter for Jazzyk.

Multi-Agent Systems Frameworks

The paper by Neville and Pitt describes a programming and simulation environment for prototyping and testing *societies of agents*, called PRESAGE. The Java-based environment is designed to allow developers to investigate properties that emerge from long-term, global system behaviour. The idea then is to use the PRESAGE platform for prototyping to investigate system wide performance and emergent behaviours before frameworks such as JADE or AgentBuilder are used to implement the multi-agent system.

The work by Gaud et al. presents JANUS, a platform that allows the development of *holonic* multi-agent systems. Thus, the idea behind the platform is the modeling of multi-agent systems as recursive entities. JANUS deals with an explicit representation of roles and organizations as first-class entities, and provides a direct implementation of part of the CRIO metamodel. The paper provides a complete description of the platform and describes an example of a market-like community.

The paper by Magarinop et al. proposes a complete computerized process of the Delphi protocol by which expert humans/agents can come to an agreement using iterative question-answer sessions. A model of the Delphi process using the INGENIAS methodology is first developed; the resulting INGENIAS model is a high-level, domain-independent, description of the goals and tasks involved in the Delphi method. The paper then goes on implementing and evaluating the approach by providing the details for one domain specific instance, showing an improvement over the Delphi process without the use of the INGENIAS model.

Agent Environments and Tools

The paper by Acay et al. argues that a suitable modeling of the environment would help agents to learn, understand and adapt to it at run time. To that end, the paper explores the relation between the agent reasoning and the availability of tools and artifacts populating the agent's situated environment. The authors coined the term *extrospection* to refer to the act of an agent reasoning about the tools that become available at run time.

Bade et al. deal with how information about potentially higly dynamic environments can be collected and made available to interested agents in an efficient and effective way across multiple agent platforms. In this respect an abstract model of an infrastructure for resource aware agents is proposed that allows providing generic as well as application dependent information channels which agents can use. The authors present an implementation of the infrastructure and argue that exchangeable discovery and distribution protocols as well as exchangeable query and representation languages simplify the development of agent applications based on reusable components.

The work of Serrano et al. focusses on the analysis of an implemented multi-agent system based on message exchanges recorded during actual execution runs. Concretely, the authors use aspect oriented programming to obtain information

about sent and received messages from arbitrary running agent platforms. Moreover an algorithm for achieving a logical ordering of messages sent across agents running on distributed hosts is presented. The approach is implemented in a generic tool for debugging and testing of distributed multi-agent based software systems.

The paper of Erdene-Ochir et al. is also about multi-agent tools and presents Toolipse, an integrated development environment (IDE) for building applications based on the JIAC agent platform. Interestingly, JIAC and its corresponding tools have originally been developed as closed, commercial software and have been only recently released to the public. This means that, although the presented IDE is a more recent development, it is based on many years of experience in building multi-agent systems for real industrial applications.

In the paper of Such et al. it is argued that security features are an important aspect of agent platforms, but that such features also usually tend to degrade performance. Therefore an evaluation of different security protocols has been performed and a new secure platform design is proposed based on the Kerberos security protocol and on Linux access control mechanisms. The design is realized in the Magentix platform, which the authors evaluate with respect to performance.

Agent Contest

This proceedings also include short papers related to the Agent Contest 2008 (http://cig.in.tu-clausthal.de/agentcontest2008/). The Agent Contest has been organized since 2006 in conjunction with ProMAS. This year's contest was organized by Tristan M. Behrens, Jürgen Dix, and Peter Novák from Clausthal University of Technology, Germany and Mehdi Dastani from Utrecht University, The Netherlands. The challenge for the participants was driving herds of cows into a corral by designing and implementing strategies for controlling cowboy agents. This scenario puts much more emphasis on the coordination between agents than in previous years. The actual contest took place in May 2008. As last year, the winner of this year's contest was the JIAC team from the Technische Universität Berlin, Germany. Six of the participant teams of the Agent Contest 2008 contributed a short paper that briefly describes the design and implementation of the multi-agent system developed by the team.

As for previous editions, we hope that the work described in this proceedings will contribute to the overall goal of stimulating the uptake of agent programming languages and the creation of industrial strength programming languages and software tools that facilitate the development of multi-agent systems.

December 2008
Koen Hindriks, Alexander Pokahr, Sebastian Sardina

Organization

ProMAS'08 workshop was held on Tuesday May 13th 2008, in Estoril, Portugal. The workshop was part of the AAMAS'08 Workshop Program.

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Additional Referees

Cristina Baroglio	Jean-Daniel Kant
Joris Deguet	Shakil Khan
Roberto Ghizzioli	Guillaume Piolle

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