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Danny Weyns · Viviana Mascardi ·
Alessandro Ricci (Eds.)

Engineering Multi-Agent Systems

6th International Workshop, EMAS 2018 Stockholm, Sweden, July 14–15, 2018 Revised Selected Papers

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Editors
Danny Weyns
Department of Computer Science
KU Leuven
Leuven, Belgium

Alessandro Ricci
Department of Computer Science
and Engineering
University of Bologna
Cesena, Forli/Cesana, Italy

Viviana Mascardi
Department of Computer Science,
Bioengineering, Robotics and Systems
Engineering
Università degli Studi di Genova
Genoa, Italy

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Preface

The workshop on Engineering Multi-Agent Systems (EMAS) has a threefold goal: (i) To enhance our knowledge and expertise in MAS engineering to move forward the state-of-the-art; (ii) define new directions for MAS engineering, relying on results and recommendations stemming from a diverse range of research areas; and (iii) investigate how practitioners can use or adapt established processes and methodologies for the engineering of large-scale and open MAS.

The EMAS workshop has been held as part of AAMAS since 2013, and was previously affiliated with AAMAS through the AOSE, ProMAS and DALT workshops since their inception. This 6th edition of the EMAS workshop, which was co-located for the first time with IJCAI/ECAI and ICML alongside AAMAS, took place in Stockholm, Sweden, during July 14–15, 2018. On average, around 40 people attended the different sessions of the workshop.

EMAS 2018 received 32 submissions by authors from all over the world. After a thorough review process, 21 papers were accepted for presentation at the workshop. After the workshop, authors of selected papers were invited to submit revised and extended versions of their workshop paper. This resulted in 17 chapters that are clustered around the following themes: Programming Agents and MAS, Agent-Oriented Software Engineering, Formal Analysis Techniques, Rational Agents, Modeling and Simulation, and Frameworks and Application Domains. In addition, this volume includes a state-of-the-art chapter that reflects on the role and potential of MAS engineering in a number of key facets that characterize modern software engineering practice. We have provided a brief overview of the sections:

State of the Art

Chapter 1: "Engineering Multi-Agent Systems Anno 2025" by Viviana Mascardi and Danny Weyns opens the volume by reflecting on the role and potential of MAS engineering on a number of key facets that characterize modern soft-ware engineering practice. In particular, the chapter looks at agile development, Cloud and edge computing, distributed ledgers and blockchain, Cyber-Physical Systems and Internet of Things, and green computing, highlighting opportunities for EMAS engineering, but also the challenges these facets raise.

Programming Agents and MAS

Chapter 2: "Pitfalls of Jason Concurrency" by Álvaro Fernández Díaz, Clara Benac Earle and Lars-Åke Fredlund examines to what extent the Jason programming language helps programmers in coping with difficulties caused by intra-agent concurrency, e.g., race conditions due to multiple agent intentions. The chapter analyzes a number of

strategies to mitigate concurrency problems present either in the original Jason language, or in later language extensions.

Chapter 3: Alessandro Ricci, Rafael H. Bordini, Jomi F. Hübner and Rem Collier present "AgentSpeak(ER): Enhanced Encapsulation in Agent Plans." AgentSpeak(ER) extends the AgentSpeak(L) language to support encapsulation and allow for improving Belief-Desire-Intentions (BDI) agent programming, in addition to other relevant aspects, such as program modularity, readability, failure handling, reactivity and goal-based reasoning.

Agent-Oriented Software Engineering

Chapter 4: In their chapter "Improving the Usability of a MAS DSML," which received the EMAS 2018 best paper award, Tomás Miranda, Moharram Challenger, Baris Tekin Tezel, Omer Faruk Alaca, Ankica Barišić, Vasco Amaral, Miguel Goulão and Geylani Kardas point out the need for evaluating the usability of domain-specific modeling languages (DSMLs) for MAS to leverage their adoption in practice. The authors evaluate a concrete MAS DSML, and based on the insights obtained, developed a new improved version of the language.

Chapter 5: Artur Freitas, Rafael H. Bordini and Renata Vieira present their proposal for "Designing Multi-Agent Systems from Ontology Models." This work aims at facilitating MAS engineering through ontology models that support code generation. The approach is aligned with the JaCaMo framework, and supported by a tool that generates the core code of a MAS application; the underlying ontology allows for reasoning about the MAS models under development.

Chapter 6: Massimo Cossentino, Luca Sabatucci and Valeria Seidita discuss the "Engineering Self-adaptive Systems: From Experiences with MUSA to a General Design Process," and deal with complex-self adaptive systems operating in changing and uncertain environments. Through a retrospective analysis on the use of the MUSA middleware (Middleware for User-Driven Service Adaptation), the authors identify the characteristics of a design approach for these kinds of systems.

Chapter 7: The paper "Stellar: A Programming Model for Developing Protocol-Compliant Agents" by Akın Günay and Amit Chopra presents the Stellar programming model that aims at simplifying the development of protocol compliant agents. A major benefit of Stellar is its independence from imperative control flow structures, which gives substantial flexibility to developers when implementing agents, compared to approaches that rely on this structure for compliance.

Formal Analysis and Techniques

Chapter 8: The paper "Slicing Agent Programs for More Efficient Verification" by Michael Winikoff, Louise A. Dennis and Michael Fisher focuses on efficient model checking of agent programs using an improved method of program slicing. The

proposed approach analyzes a program prior to verifying it to simplify the program by removing parts that are invariant to the verification results.

Chapter 9: Łukasz Białek, Barbara Dunin-Kęplicz and Andrzej Szałas introduce "Belief Shadowing," a lightweight and tractable approach for belief interference, that aims at adapting beliefs to new circumstances, such as belief change or revision. The idea is to perform a transient swap of beliefs, when part of one belief base is to be shadowed by another belief base representing new observations and/or beliefs of superior agents/teams. In this case no changes to belief bases are needed, substantially improving system performance.

Chapter 10: Timotheus Kampik, Juan Carlos Nieves and Helena Lindgren move a step towards "Empathic Autonomous Agents." The authors explore the notion of an empathic autonomous agent that proactively searches for conflicts with other agents, combining a utility- and rule-based approach for resolving conflicts. The authors propose an initial theoretical outline with an architecture for emphatic agents. Several challenges remain open, e.g., handling complex environments.

Chapter 11: The chapter "Dynamic Global Behaviour of Online Routing Games" by László Zsolt Varga focuses on how to measure and ensure global behavior of large-scale, open decentralized MAS. The paper shows how the inter-temporal expectations of selfish planning agents influence the quality of the global behavior of the MAS in a realistic urban traffic scenario. A critical challenge is to design the environment to drive agents toward an optimum or equilibrium.

Modeling and Simulations

Chapter 12: Igor Conrado Alves de Lima, Luis Gustavo Nardin and Jaime Simão Sichman present "Gavel: A Sanctioning Enforcement Framework." Gavel enables agents to decide the most suitable sanctioning method, with the aim of improving agency governance. The framework is evaluated through a simulation of the Public Goods Game Model with the CArtAgO simulation framework.

Chapter 13: In the chapter "Adding Organizational Reasoning to Agent-Based Simulations in GAMA," John Bruntse Larsen introduces organizational reasoning in agent simulation platforms (e.g., GAMA) to model complex social systems. The approach combines bottom-up design of BDI models with top-down organizational reasoning. The author formalizes the operational semantics of organizational reasoning and illustrates its application with a healthcare example.

Chapter 14: Tasio Méndez, J. Fernando Sánchez-Rada, Carlos A. Iglesias and Paul Cummings propose an agent-based model for "Analyzing Radicalism Spread Using Agent-Based Social Simulation." The model, that consists of a Network Model and an Agent Model, aims at improving the understanding of the influence of social links on the spread of radicalism. The Network Model updates the agent relationships based on proximity and homophily; it simulates information diffusion and updates the agents' beliefs. The model is implemented in Python.

Frameworks and Application Domains

Chapter 15: In the chapter "Engineering World-Wide Multi-Agent Systems with Hypermedia," Andrei Ciortea, Olivier Boissier and Alessandro Ricci propose an approach to engineer large-scale, evolvable MAS using hypermedia. In line with the notion of agent environments, agents are situated in a distributed hypermedia environment. Agents use hypermedia to discover and interact with other entities in the MAS. This allows the MAS to evolve at runtime and to be seamlessly distributed across the Web. A demonstrator is used to evaluate the approach.

Chapter 16: "Designing a Cognitive Agent Connector for Complex Environments: A Case Study with StarCraft" by Vincent Koeman, Harm Griffioen, Danny Plenge and Koen Hindriks describes the design of a connector that supports interfacing cognitive agents in rich environments. The approach is applied to the real-time strategy game StarCraft with the aim of establishing a design method for developing connectors for these kinds of environments. StarCraft is particularly suitable as a testbed as it requires sophisticated strategies for coordinating hundreds of units that need to handle short-term as well as long-term goals.

Chapter 17: In the chapter "Decision Process in Human-Agent Interaction: Extending Jason Reasoning Cycle," Antonio Chella, Francesco Lanza and Valeria Seidita discuss how to support agents' decision making processes using their internal state. The authors propose an extension of the Jason reasoning cycle to deal with the implementation level of the decision process and to include elements derived from the internal state. This work is intended to contribute to the challenges of knowledge representation and creation of plans at runtime.

Chapter 18: Arthur Casals, Amal El Fallah-Seghrouchni, Orso Negroni and Anthoni Othmani present how "Exposing Agents as Web Services in JADE." The chapter shows how intelligent agents using a BDI architecture can be exposed as web services and integrated with existing Cloud services. The approach is studied in the context of an agent-based personal assistant. The aim is to better understand: (i) What is the current state of production-ready MAS, and (ii) how hard it is for a software developer to understand and implement MAS-based solutions.

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April 2019

Danny Weyns
Viviana Mascardi
Alessandro Ricci

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