Advances in Multi-Agent Systems Research: Extended Selected Papers from EUMAS 2022 and EUMAS 2023

Dorothea Baumeister, Jörg Rothe, Nikos Spanoudakis, Vadim Malvone & Aniello Murano

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EDITORIAL

Advances in Multi-Agent Systems Research: Extended Selected Papers from EUMAS 2022 and EUMAS 2023

Dorothea Baumeister[1] · Jörg Rothe[1] · Nikos Spanoudakis[2] · Vadim Malvone[3] · Aniello Murano[4]

This special issue contains some carefully selected papers that substantially extend and improve their preliminary versions, which were presented at the *19th* and *20th European Conference on Multi-Agent Systems* (EUMAS 2022, held in September 2022 in Düsseldorf, Germany, and EUMAS 2023, held in September 2023 in Naples, Italy). In the past two decades, the research in agent-based computing and multi-agent systems (MAS) has enormously and rapidly increased. This field is set to become one of the key intelligent systems technologies in the twenty-first century. Following a long tradition of its previous editions (Oxford 2003, Barcelona 2004, Brussels 2005, Lisbon 2006, Hammamet 2007, Bath 2008, Agia Napa 2009, Paris 2010, Maastricht 2011, Dublin 2012, Toulouse 2013, Prague 2014, Athens 2015, Valencia 2016, Evry 2017, Bergen 2018, Thessaloniki 2020– virtually, Israel 2021– virtually, Düsseldorf 2022, and Napoli 2023), the EUMAS conference series is the primary European forum for researchers interested and working in the theory and practice of autonomous agents and multi-agent systems, designated as the annual event of the European Association of Multi-Agent Systems (EURAMAS).

After a rigorous peer-review process for both conferences, at EUMAS 2022 a total of 23 full papers (and six short papers for the PhD Day) and at EUMAS 2023 a total of 24 full papers (plus five short papers) were accepted for oral presentation. Only some of these 47 full EUMAS papers were invited for this special issue, and all papers eventually accepted for publication in it have run through the regular reviewing process of the journal *SN Computer Science*, with at least two reviewers for each submission and several rounds of reviews per paper. The editors are grateful to the reviewers for their time and invaluable effort to improve the submissions. Their suggestions and comments on them have been very detailed and have much helped to improve the papers.

This special issue covers a broad range of topics from the field of autonomous agents and multi-agent systems:

• In *"How to Formalize Different Types of Norms in Multi-Agent Systems: a Methodology Focused on the T-Norm Model,"* Soheil Roshankish and Nicoletta Fornara study the demanding task of transforming norms expressed in some natural language into formal norms represented by a preselected model for multi-agent systems. Focusing on the T-Norm model, which can express a rich set of different types of norms, they develop a methodology for this challenging task. However, the proposed methodology is general enough to also capture, at least partially, the formalization of norms based on other formal languages, and it will be explicitly stated which types of norms can be expressed with a given model and which cannot. Another goal of this paper is to propose and discuss a rich set of norm types that could be used to study the expressive power of different formal models of norms.

• In *"Strategic Proxy Voting on the Line,"* Gili Bielous and Reshef Meir introduce a framework for proxy voting where non-active voters may delegate their votes to active ones, their proxies. Specifically, it is studied how proxy

✉ Jörg Rothe
rothe@hhu.de

Dorothea Baumeister
d.baumeister@uni-duesseldorf.de

Nikos Spanoudakis
nispanoudakis@tuc.gr

Vadim Malvone
vadim.malvone@telecom-paris.fr

Aniello Murano
nello.murano@gmail.com

1 Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany

2 Technical University of Crete, Chania, Greece

3 Computer Science and Networks department (INFRES) of Télécom Paris, Paris, France

4 Dipartimento di Ingegneria Elettrica e delle Tecnologie, Università degli Studi di Napoli Federico II, Naples, Italy

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voting can affect the strategic behavior of non-active voters and their proxies both under complete and incomplete information. It is shown that for single-peaked preferences, the median voting rule is strategyproof for non-active voters but not for their proxies. Further, strategic behavior can provide socially optimal outcomes under mild restrictions. The results are extended to partial-information models; specifically, to regret-averse agents.

• In *"Blending BDI Agents with Object-Oriented and Functional Programming with JaKtA,"* Martina Baiardi, Samuele Burattini, Giovanni Ciatto, and Danilo Pianini are concerned with multi-paradigm programming languages for multi-agent systems, a quite popular line of recent research. While the combination of the paradigms of functional and object-oriented programming is already quite common, other paradigms can be hybridized as well. Specifically, the authors introduce JaKtA, an internal domain-specific language designed to support the definition of compact and expressive belief-desire-intention agents in Kotlin, a programming language that allows for concise and cross-platform coding and is the preferred language for Android app development. This approach can be seen as an initial attempt of blending agent-oriented programming with other prevalent programming paradigms.

• In *"CHC-Based Verification of Programs Through Graph Decompositions,"* Marco Faella, Giulio Garbi, Salvatore La Torre, and Gennaro Parlato present a novel methodology for automated program analysis that employs graph encodings of computations. They restructure the program behavior graphs by decomposing them into graphs of bounded tree-width. To this end, they introduce a notion of labeled multigraph that can be used to construct a symbolic data-tree automaton, a notion recently designed to accept tree data structures. Checking whether the data-tree language accepted by such an automaton is empty then allows to verify the original program. While the proposed methodology is applied in detail for recursive sequential programs, which do satisfy bounded tree-width, the approach is promising for an even broader spectrum of program classes, including distributed systems and concurrent programs operating under weak memory models.

• In *"Symbolic LTL_f Synthesis: A Unified Approach for Synthesizing Winning, Dominant, and Best-Effort Strategies,"* Giuseppe De Giacomo, Gianmarco Parretti, and Shufang Zhu investigate synthesis problems, which typically are supposed to find strategies winning against all possible responses from the environment. If there does not exist a winning strategy, however, one aims at finding strategies that are as good as possible. Specifically, the authors develop symbolic techniques to design winning, dominant, and best-effort strategies, which achieve the desired goal against all, the maximum subset, and a maximal subset of environment responses in the context of Linear Temporal Logic on finite traces. In particular, they present several symbolic refinements of a unified game-theoretic technique for simultaneously solving all three synthesis problems. Depending on certain key choices, such refinements can behave extremely differently, and the authors empirically test them to evaluate how they compare in practice. Remarkably, one of them has only a minor overhead relative to existing standard synthesis techniques for winning strategies.

We thank the authors for their excellent contributions to this special issue, and we proudly present them to the readers. Enjoy reading them!

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Dorothea Baumeister, Vadim Malvone, Aniello Murano, Jörg Rothe, and Nikolaos Spanoudakis.

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