

# Special Issue for the 22nd Workshop “From Objects to Agents” (WOA 2021)

Roberta Calegari<sup>a,\*</sup>, Giovanni Ciatto<sup>b</sup>, Andrea Omicini<sup>b</sup> and Giuseppe Vizzari<sup>c</sup>

<sup>a</sup>*Alma Mater Research Institute for Human-Centered Artificial Intelligence (AlmaAI), ALMA MATER STUDIO-RUM—Università di Bologna, Italy*

<sup>b</sup>*Dipartimento di Informatica — Scienza e Ingegneria (DISI), ALMA MATER STUDIO-RUM—Università di Bologna, Italy*

<sup>c</sup>*Dipartimento di Informatica, Sistemistica e Comunicazione, Università degli Studi di Milano–Bicocca, Milano, Italy*

The first Workshop “From Objects to Agents” (WOA) was held in Parma in May 2000. The workshop started as a joint initiative of the Agents and Multi-Agent Systems Working Group of the Italian Association for Artificial Intelligence (MAS-AIXIA) together with the Italian Association for Advanced Technologies based on Object-Oriented Concepts (TABOO). The workshop was meant to provide a forum for researchers and practitioners interested in understanding the possibilities that the intricate connection between agent technologies and object-oriented technologies could open. The first WOA counted more than fifty registered participants from both the academia and the software industry. In the years, MAS-AIXIA took full charge of the workshop, which shifted its focus towards all topics related to agents and multi-agent systems, and became a stand-alone initiative with an international perspective organised by an independent community of researchers and practitioners based in Italy. As such, the workshop has always been located in Italy, with the workshop Steering Committee constantly committed to involve every major Italian research group working on agents and multi-agent systems. The workshop

was hosted in the following venues (in alphabetical order): Bologna (twice), Camerino, Catania (three times), Genova, Milano (twice), Modena, Napoli, Palermo (twice), Parma (three times), Rende, Rimini, Scilla, Torino (twice), and Villasimius. Occasionally, workshop was co-located with international events to promote the participation of researchers and practitioners from foreign countries.

The twenty-second edition of the workshop, which was held as a blended, three-days event on September 1st–3rd, 2021, in Bologna<sup>1</sup>, involved more than fifty participants, and was articulated in five technical sessions, one keynote speech, two mini-school sessions, and one social event. The five technical sessions hosted the presentation of seventeen papers that were collected in a virtual volume published by CEUR<sup>2</sup>. The topics discussed in the papers covered some of the most debated subjects in the research on agents and multi-agent systems, and were not limited to the theme of the workshop, which was suggested in the call for papers as *multi-agent systems in the machine learning era*.

The keynote speech was given by Antonio Lieto, who presented the different notions of rationality developed in the field of cognitive science and showed their impact on the design and implementation of

---

\*Corresponding author: Roberta Calegari, Alma Mater Research Institute for Human-Centered Artificial Intelligence (AlmaAI), ALMA MATER STUDIO-RUM—Università di Bologna, Italy E-mail: roberta.calegari@unibo.it.

---

<sup>1</sup><http://woa2021.apice.unibo.it>

<sup>2</sup><http://ceur-ws.org/Vol-2963>

AI systems. In particular, he argued that, in order to build integrated AI systems able to exhibit a wide range of intelligent behaviours, it is of crucial importance to take into account bounded-rational and resource-rational cognitive constraints. The steering committee of the workshop decided to dedicate the keynote speech of the workshop, from the twentieth edition on, to the memory of Fabio Bellifemine, for his propulsive role in the community of software agents and for his consistent participation in the workshop and to its satellite activities.

The two mini-school sessions were intended to introduce students to selected topics of the research on agents and multi-agent systems, following a solid tradition of the workshop that dates back to 2004. In the first session, Matteo Baldoni introduced autonomous agents and multi-agent systems defining the term “intelligent” of intelligent agents and explaining the difference between objects and agents, object-oriented paradigm and agent-oriented paradigm. In the second session, Marco Gori provided participants with a refreshing look at the basic models and algorithms of machine learning in particular exploited in multi-agent systems, with an emphasis on current topics of interest that includes neural networks and kernel machines.

*About this special issue* The six papers collected in this special issue are contributions selected based on the reviewers’ suggestions, which extend and improve preliminary versions presented at WOA 2021. The papers of this special issue also include the outcomes of some of the discussions that followed the presentations at the workshop. The six selected works offer an insight into the main issues at the state of the art relating to multi-agent systems in the machine learning era.

The first paper of this special issue extends [7] and presents the PSyKE platform, a platform providing general-purpose support to *symbolic knowledge extraction from black-box predictors* via many extraction algorithms. PSyKE targets symbolic knowledge in logic form, allowing the extraction of first-order logic clauses. The extracted knowledge is thus both machine- and human-interpretable, and can be used as a starting point for further symbolic processing – e.g. automated reasoning – to be injected into agents belief bases.

The second paper of the special issue extends [4] and it is related to *plans for emergency response are complex collaborations* in which actors take roles and responsibilities. The work proposes an approach –

conceived for humans – for converting a free-form plan document into a structured version of the same document. The approach is based on a linguistic and semantic analysis that are strictly correlated and materialize in a metamodel. It contains the essential elements of an emergency plan, and it aids in interpreting the input document also reducing inconsistencies, redundancies, and ambiguities.

The third paper of the special issue extends [1] and discusses the risk sensitive scheduling strategies of production studios on the US movie market exploiting agent-based simulation. In particular the paper analyses the time series of the number of movies on release each week and the box office results of the top 10 ranking movies (ranked for box office) on the US movie market highlighting that are in counter-phase and repeatedly intersect with a seasonal trend. The authors suggest that a possible reason is a risk sensitivity adaptation in the behaviour of the movie’s distributors and in this work they provide a model supporting this hypothesis by developing an agent-based model of a movie market, simulated for 15 years. This research improves the knowledge of the US motion picture market, analysing a real-world scenario and providing insight into the behaviour of existing firms in a complex environment.

The fourth paper of the special issue extends [3] and explores the main concepts to design and implement a *trustworthy collaboration between humans and robots* and presents the first of a series of experiments draw for testing different aspects of a designed cognitive architecture for trustworthy human-robot interaction. The architecture, based on consolidated theoretical principles – theory of social adjustable autonomy, theory of mind, theory of trust – has the main goal to build cognitive robots that provide smart, trustworthy collaboration, every time a human requires their help. In particular, the experiment has been designed in order to demonstrate how the robot’s capability to learn its own level of self-trust on its predictive abilities in perceiving the user and building a model of her/him, allows it to establish a trustworthy collaboration and to maintain a high level of user’s satisfaction, with respect to the robot’s performance, also when these abilities progressively degrade.

The fifth paper of the special issue extends [5] and presents a framework that instantiates cognitive agents operating in the IoT context, endowed with meta-reasoning in the *Semantic Web*. The framework is provided with a module that performs semi-automatic ontology learning from sentences expressed in natural language; such a learning pro-

cess generates a conceptual space reflecting the domain of discourse with an instance of a novel foundational ontology called Linguistic Oriented Davidsonian Ontology, whose main feature is to increase the deepness of reasoning without compromising linguistic-related features.

The sixth paper of the special issue extends [6] and discusses a multi-agent system for e-scooter balancing based on deep reinforcement learning where agents are implemented as deep Q-Networks. The multi-agent system offers suggestions to pick or return e-scooters in order to make the fleet usage and sharing as balanced as possible, still ensuring that the original plans of the user undergo only minor changes. The main contributions of the work include a careful analysis of the state of the art in the *micro-mobility sharing systems*, an innovative customer-oriented rebalancing strategy, the integration of state-of-the-art libraries for deep reinforcement.

In conclusion, the guest editors of this special issue would like to gratefully thank all authors and reviewers – those who helped with the workshop, and those involved in the production of this volume – and, more generally, the lively, creative and sometimes volcanic community that has been regularly meeting for twenty-two years at the workshop. Finally, the guest

editors would also like to invite other researchers and practitioners to consider the workshop for presenting their most disruptive ideas and relevant results for the many years to come.

## References

- [1] F. Bertolotti and S. Roman, Risk sensitivity of production studios on the us movie market: an agent-based simulation. In *Calegari et al. [2]*, pp. 210–223.
- [2] R. Calegari, G. Ciatto, E. Denti, A. Omicini and G. Sartor, editors. WOA 2021 – 22nd Workshop “From Objects to Agents”, volume 2963 of CEUR Workshop Proceedings. Sun SITE Central Europe, RWTH Aachen University, October 2021.
- [3] F. Cantucci, R. Falcone and C. Castelfranchi, Investigating adjustable social autonomy in human robot interaction. In *Calegari et al. [2]*, pp. 49–60.
- [4] M. Cossentino, S. Lopes, L. Sabatucci and Tripiciano, Towards a semantic layer for italian emergency plans. In *Calegari et al. [2]*, pp. 144–161.
- [5] C. Fabio Longo, C. Santoro, M. Nicolosi-Asmundo, D.F. Santamaria and D. Cantone, SW-CASPAR: Reactive-cognitive architecture based on natural language processing for the task of decision-making in the open-world assumption. In *Calegari et al. [2]*, pp. 178–193.
- [6] G. Losapio, F. Minutoli, V. Mascardi and A. Ferrando, Smart balancing of e-scooter sharing systems via deep reinforcement learning. In *Calegari et al. [2]*, pp. 83–97.
- [7] F. Sabbatini, G. Ciatto, R. Calegari and A. Omicini, On the design of PSyKE: A platform for symbolic knowledge extraction. In *Calegari et al. [2]*, pp. 29–48.