

Preface

The Workshop “From Objects to Agents” (WOA) is the reference event for Italian researchers active in the Agents and Multi-Agent Systems research domain. Since its very first edition in 2000, located in Parma (Italy), WOA was conceived as a meeting occasion for researchers and practitioners from the working group on MAS of AI*IA and from the TABOO association (Advanced Technologies Based on Concepts from Object-Orientation). After that, WOA was held on a yearly basis in many different Italian locations, from north to south, gaining a conspicuous success and succeeding in gathering researchers and practitioners from various research fields, thanks to its format.

Despite stemming from an Italian initiative, WOA is an international workshop where presenters and participants exchange opinions and discuss on-going works in a friendly yet rigorous setting. Furthermore, since 2004, WOA includes a one-day mini-school, where experienced scientists and professionals can introduce younger researchers as well as Ph.D. and undergraduate students to hot topics in the fields of AI, MAS, and Programming Languages.

The 22nd edition of the workshop has been held on September 1–3, 2021 in Bologna. During these three days, more than 18 speakers joined the workshop, as well as many more listeners. In particular, this edition was structured in two mini-school sessions, one keynote speech, and in five technical sessions. The six technical sessions hosted the presentation of 17 papers collected in this virtual volume published by CEUR.

The topics discussed in the papers covered some of the hottest topics laying under the umbrella of “Multi-agent systems in the machine learning era”, as requested by the call for papers. The choice of this theme was deliberate. In fact, it has been widely recognised that artificial intelligence is here to stay, along with both its symbolic and sub-symbolic branches. While symbolic techniques played a central role in the early days of AI, the last decade has been characterised by the explosion of data-driven, machine-learning-based intelligent systems. Nowadays, the exploitation of machine learning (ML) and big data processing is so pervasive that novel results and applications are being proposed at an unprecedented pace.

While multi-agent systems (MAS) have been entangled with symbolic AI since the very beginning, it is undoubted that they have been extensively exploited in several data-intensive domains including – but not limited to – robotics, telecommunications, simulation, decision support systems, and economics. MAS and ML have the potential to benefit from each other. In fact, on the one side, it is becoming increasingly complex for agent designers to forecast all possible operating situations, so learning from data is fundamental for next-generation MAS—in order to adapt to the intricacies of an increasingly complex world. On the other side, modern ML-based solutions may easily struggle when different data-driven solution – possibly attained from disparate data sources – must be integrated, combined, reconciled or explained. Under that perspective, MAS have certainly a role to play to advance the state of the art of data-driven AI towards integration and explainability.

The intertwining between MAS and ML, therefore, aims at bringing about huge benefits to the field of data-driven AI, both at the theoretical and the practical level; however, a well-grounded integration in terms of methodologies and systems properties is far from being reached and acknowledged.

As far as the mini-school is concerned, two sessions were organised, hosting talks from experts in the fields of Logic Programming and MAS. In particular, in the first session, Matteo Baldoni discussed the history of MAS, from objects to agents. The talk introduced autonomous agents and multi-agent systems, defining the meaning of intelligence in the context of intelligent agent systems, and discussing the difference between objects and agents, focusing on the relationship between the object-oriented and the agent-oriented paradigm. The lecture ended with some remarks about JaCaMo.

In the second session, Marco Gori provided a perspective on the current status of ML and MAS, mostly based on his recent book “Machine Learning: A Constraint-Based Approach”. The talk provided participants with a refreshing look at the basic models and algorithms of machine learning – with a glance to MAS –, emphasising current topics of interest including neural networks and kernel machines.

The “Fabio Bellifemine” keynote speech was given by Antonio Lieto, who discussed the topic of “Bounded and Resource-Rational Agents for Integrated Intelligence”. There, the speaker presented the different notions of rationality as they are developed in the field of cognitive science – i.e., classical rationality (CR), bounded rationality (BR), resource-rationality (RR) – and discussed their impact on the design and implementation of intelligent systems. In particular, Lieto argued that, in order to build integrated AI systems able to exhibit a wide range of intelligent behaviours, it is crucial to take into account bounded-rational and resource-rational cognitive constraints. In doing so, two cognitively inspired AI applications – Dual PECCS and the TCL reasoning framework – were presented, showing how the outlined design perspective allowed such systems to (i) address some crucial aspects of commonsense reasoning in AI research (namely, dealing with typicality effects and with the problem of commonsense compositionality), (ii) integrate those systems with more general cognitive architectures, (iii) use their simulations as “computational explanations” to better understand the heuristics used by the human mind to face complex problems.

The 17 papers collected in this issue were presented and discussed into five thematic sessions. The final versions here included also include the outcomes of some of the discussions that followed the presentations at the workshop. The authors’ contributions cover extremely relevant research areas that include (i) trustworthy & explainable MAS, (ii) MAS & subsymbolic AI, (iii) logic in MAS, (iv) agent-based modelling & simulation, (v) language, tools & application.

In the end, the Organising Scientific Committee gratefully thanks all those who, with their work and their enthusiasm, have contributed to the success of this edition of WOA: the members of the Program Committee, the Department of Informatics Engineering and Information Sciences (DISI) of the University of Bologna, the Alma Mater Research Institute for Human-Centered Artificial Intelligence of the University of Bologna, the local organisers, the speakers of the workshop sessions, the mini-school lecturers, the sponsors, and all collaborators who participated in the organisation. Overall, they would like to thank the lively, creative and sometimes volcanic community that has been regularly meeting for 22 years at the workshop.

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