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, WOA was conceived as a meeting occasion for researchers and practitioners from MAS-AI*IA (the AI*IA working group on MAS) and TABOO (the association for advanced technologies based on concepts from object-orientation). Since then, WOA was held on a yearly basis in many different Italian locations, from north to south (islands included), 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 21^{st} edition of the workshop was held on September 14–16, 2020 in Bologna, as an on-line virtual meeting. During the three days, more than 18 speakers joined the workshop, as well as many more attendants. In particular, this edition was structured in two mini-school sessions, one keynote speech, and in six technical sessions—each one discussing three papers. The six technical sessions hosted the presentation of 18 papers, 17 of which are collected in this virtual volume published by CEUR in the AI*IA Series.

The topics discussed in the papers cover some of the hottest topics laying under the umbrella of "MAS for human-centred intelligent systems", as requested by the call for papers. The choice of this theme was deliberate. In fact, it is widely recognised that nowadays intelligent systems have to be human-centred, with the human(s) in the loop acting synergistically within the system. Accordingly, human-centred AI focuses on the design, development, and deployment of intelligent systems that co-operate with humans in real-time in a deep and meaningful way. There, the AI system is expected to continuously improve itself by learning from humans while creating an effective interactive experience. In such a scenario, sub-symbolic techniques play a major role to provide sophisticated features that would be hard for developers to implement otherwise. However, symbolic approaches are getting more and more attention as those that could make AI amenable to human understanding and interpretation, once suitably integrated with sub-symbolic approaches. In this context, MAS are the core of the design of intelligent systems, as they represent the *glue* making symbolic and sub-symbolic components fruitfully interoperable.

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, Fabrizio Riguzzi illustrated the role of Probabilistic Logic Programming (PLP). PLP provides a powerful combination that has already achieved successful applications in a variety of fields. The talk discussed PLP languages under the distribution semantics – one of the most impactful semantics in this area – and introduced the types of reasoning that can be performed with these languages: inference, weight learning and structure learning. In the second session, Viviana Mascardi provided an enlightening perspective on the current status of logic-based technologies for

MAS, based on her review "Logic-based Technologies for Multi-agent Systems: A Systematic Literature Review". The talk emphasised the core role of MAS in the design of intelligent systems since their very beginning and their long-term connection with logic-based technologies, thus opening new ways to engineer explainable intelligent systems.

The "Fabio Bellifemine" keynote speech was given by Alessandro Ricci discussing the topic of programming multi-agent systems—"Reflections after a decade building and using JaCaMo". There, JaCaMo is a platform that allows to program multi-agent systems integrating agent, environment and organisation as first-class design and programming dimensions, and exploiting Jason, CArtAgO and Moise as concrete technologies. Within the talk, Alessandro Ricci shared his experience, reflections, and thoughts about the future of agent-oriented programming.

The 17 papers collected in this issue were organised, presented, and discussed into six thematic sessions. The final versions here includes also include the outcomes of some of the several interesting discussions that followed the presentations at the workshop. The authors' contributions cover quite relevant research areas that include *(i)* simulation, *(ii)* organisations, norms, and argumentation, *(iii)* features of MAS as robustness, trust, and explainability, *(iv)* healthcare applications, *(v)* agents and actors for data science and *(vi)* tools and application for MAS.

Finally, the Organising Scientific Committee gratefully thanks all those who have contributed, with their work and their enthusiasm, to the success of this edition of WOA: the members of the WOA Board; 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. More generally, we would like to thank the lively, creative, and sometimes even volcanic community that has been regularly meeting for 21 years at the workshop.

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