SASO 2016 Selected, Revised, and Extended Best Papers

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The IEEE International Conference on Self-Adapting and Self-Organizing Systems (SASO) is the main forum for studying and discussing the foundations of a principled approach to engineering systems, networks, and services based on self-adaptation and self-organization. Over the past decade, it has consolidated as the primary scientific conference for sharing ideas on algorithms, technologies, tools, and applications across a wide range of scientific fields. In 2016, the conference was hosted by the University of Augsburg, in Augsburg, Germany; its scientific program comprised full papers, short papers, poster and demo presentations, workshops, doctoral symposium and tutorials. This special issue of *ACM TAAS* champions some of the most solid research results of SASO 2016, presenting selected, revised, and extended best articles.

Additional Key Words and Phrases: Self-Adaptive Systems, Self-Organizing Systems

1 INTRODUCTION - SASO 2016

The aim of the Self-Adaptive and Self-Organizing Systems (SASO) conference series is to provide a forum for the foundations of a principled approach to engineering systems, networks, and services based on self-adaptation and self-organization. The complexity of current and emerging networks, software, and services, especially in dealing with dynamics in the environment and problem domain, has led the software engineering, distributed systems and management communities to look for inspiration in diverse fields (e.g., complex systems, control theory, artificial intelligence, sociology, and biology) to find new ways of designing and managing such computing systems. In this endeavor, self-organization and self-adaptation have emerged as two promising interrelated approaches. Many significant research problems exist related to self-adaptive or self-organizing systems. A challenge in self-adaptation is often to identify how to change specific behavior to achieve the desired improvement. Another major challenge is to predict and control the global system behavior resulting from self-organization.

The tenth edition of the SASO conference held in 2016 was hosted by the University of Augsburg, in Augsburg, Germany. It has embraced the interdisciplinary and the scientific, empirical,

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and application dimensions of self-* systems; it thus aimed to attract participants with different backgrounds, to foster cross-pollination between research fields, and to expose and discuss innovative theories, design principles, frameworks, methodologies, tools, and applications.

The range of the topics was increased with respect to the previous SASO editions, and included the following main topics:

- Systems theory: theoretical frameworks and models; biologically and socially inspired paradigms; interoperation of self-* mechanisms;
- Systems techniques: techniques to specify and analyze self-* systems, like statistical physics, machine learning, multiagent systems, or other novel techniques;
- Systems engineering: reusable mechanisms, design patterns, architectures, methodologies; software and middleware development frameworks and methods, platforms and toolkits; hardware; self-* materials; governance of self-* systems, emergent behavior in self-* systems;
- System properties: robustness, resilience, and stability; emergence; computational awareness and self-awareness; reflection; antifragility;
- Cyber-physical and socio-technical systems: human factors and visualization; self-* social computers; crowdsourcing and collective awareness; human-in-the-loop;
- Data-driven approaches: data mining; machine learning; data science and other statistical techniques to analyze, understand, and manage behavior of complex systems;
- Education: experience reports; curricula; innovative course concepts; methodological aspects of self-* systems education;
- Ethics and Humanities in self-* systems;
- Applications and experiences with self-* systems in any of the following domains:
  - Smart-*: application of self-* principles to smart-grids, smart-cities, smart-environments, smart-vehicles
  - Industrial automation: embedded self-* systems, adaptive industrial plants, smart industries (Industry 4.0)
  - Transportation: autonomous vehicles, coordination between vehicles, pedestrians, and infrastructure, and traffic optimization
  - Unmanned systems: aerial vehicles, undersea vehicles, other robotic platforms
  - Internet of Things: challenges, applications, and benefits; self-* for network management, self-* applied to Cybersecurity.

2 SELECTED PAPERS

This special issue of *ACM TAAS* presents selected, revised, and extended best articles, championing some of the most solid research results discussed at the conference.

With the help of a Program Committee formed by 70 international experts, SASO 2016 accepted 14 full articles of more than 65 submitted (corresponding to an acceptance rate of about 21%), and 6 short articles. Out of these articles, six were selected based on a combination of the review evaluation reports and the quality of the presentations, and they were invited for submission to *TAAS*. They underwent a very thorough review process conducted by the *TAAS* editors and invited reviewers. At the end, they were accepted for publication. They are briefly presented here.

The article "Self-adaptation to Device Distribution in the Internet of Things," by Jacob Beal, Mirko Viroli, Danilo Pianini, and Ferruccio Damiani, addresses adaptation to changes impacting network topology, density, and heterogeneity, considering the geometric properties of the continuous environment in which the devices are situated. The authors identify a new property of distributed algorithms, eventual consistency, which guarantees that computation self-stabilizes to

a final state that approximates a predictable limit as the density and speed of devices increases. This approach is applied to a large range of programs and verified by simulation.

The article "Electronic Social Capital for Self-Organising Multi-Agent Systems," by Patricio Petruzzi, Jeremy Pitt, and Dídac Busquets, explores the role and nature of social capital with learning agents in the context of institutional design principle regarding structural self-organization, specifically in the form of multiple layers of nested enterprises. Both interagent and interinstitutional interactions are then situated in a Public Goods Game. The experimental results demonstrate that the Social Capital created both within and between the institutions beneficially affects the development of a bottom-up structure of nested enterprises.

The article "Hyper-Learning Algorithms for Online Evolution of Robot Controllers," by Fernando Silva, Luís Correia, and Anders Lyhne Christensen, addresses the performance of online evolution of robotic controllers. Two approaches are presented: the former uses the fitness score of controllers as the criterion to select promising algorithms over time, the latter relies on the behavioral diversity of controllers for algorithm selection. Both are distributed across groups of robots that evolve in parallel. The authors assess the performance of both approaches in foraging tasks with differing complexity and in configurations of a dynamic phototaxis task with varying evolutionary pressure.

The article "Feature Construction for Controlling Swarms by Visual Demonstration" (already published in V12 N2 of *TAAS*), by Karan Budhraja and Tim Oates, combines agents and swarms and integrates demonstration by image or video. The demonstrator specifies spatial motion of the agents over time and retrieves agent-level parameters required to execute that motion. The efficiency of the proposed approach relies on cheap image processing algorithms, and it is tested by experiments.

The article "Evolved Control of Natural Plants: Crossing the Reality Gap," by Mostafa Wahby, Daniel Nicolas Hofstadler, Mary Katherine Heinrich, Payam Zahadat, and Heiko Hamann, addresses a quite new topic for SASO, the collaboration between robots and natural plants. For instance, robots can be used to control the growth and motion of a natural plant, using LEDs to provide stimuli. An evolutionary robotics approach is adopted, where task performance is determined by monitoring the plant's reaction.

The article "Defining Emergent Software using Continuous Self-Assembly, Perception and Learning," by Barry Porter and Roberto Rodrigues Filho, presents a paradigm of fully emergent computer software that places the burden of understanding entirely into the hands of software itself. The resulting systems are autonomously assembled at runtime from discovered constituent parts and their internal health and external deployment environment continually monitored. An online, unsupervised learning system then uses runtime adaptation to explore alternative system assemblies and locate optimal solutions.

3 THANKS

We would like to conclude this special issue introduction by expressing our considerable gratitude to everyone who contributed to the SASO 2016 scientific program and to this Special Issue as one key result. We are, of course, indebted to the entire Technical Program Committee for their commitment and enthusiasm in all phases of the reviewing process and for the quality and insight of their reviews. We also thank the Steering Committee, the Advisory Committee, and the chairs of previous SASO editions for their feedback on past experiences and general advice along the way, which was extremely helpful. Finally, many thanks to the *TAAS* Editors-in-Chief Manish Parashar and Franco Zambonelli for the opportunity to produce this special issue.