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Editorial

Modern Trends in Multi-Agent Systems

Martin Kenyeres [1,*], Ivana Budinská [1], Ladislav Hluchý [1] and Agostino Poggi [2]

[1] Institute of Informatics, Slovak Academy of Sciences, 845 07 Bratislava, Slovakia; budinska.ui@savba.sk (I.B.); hluchy.ui@savba.sk (L.H.)
[2] Department of Engineering and Architecture, University of Parma, 43124 Parma, Italy; agostino.poggi@unipr.it
* Correspondence: martin.kenyeres@savba.sk; Tel.: +421-2-5941-1194

The term "multi-agent system" is generally understood as an interconnected set of independent entities that can effectively solve complex and time-consuming problems exceeding the individual abilities of common problem solvers. The coordinated entities forming these systems regularly interact with each other to solve various massive problems in numerous technical/non-technical applications (e.g., grid computing, bioinformatics, business, monitoring, resource management, controlling, computational biology, education, military, space research, etc.). In many modern multi-agent systems, the entities are required to be fully autonomous, to provide global decisions based on local knowledge, and to be able to work effectively in a decentralized way. The design of robust, energy-efficient, and high-performance algorithms for MASs, therefore, poses a demanding challenge for the wider scientific community. Thus, significant attention has been paid by many scientists to optimizing the operation of multi-agent systems in many respects (e.g., routing, data aggregation, communication, coordination, consensus achievement, synchronization, etc.) over recent decades.

The paper [1] addresses an extensive analysis of five frequently applied distributed consensus gossip-based algorithms for network size estimation in multi-agent systems (namely, the randomized gossip algorithm, the geographic gossip algorithm, the broadcast gossip algorithm, the push–sum protocol, and the push–pull protocol). The performance of the algorithms with bounded execution is examined in random geometric graphs, in two scenarios, and by applying two metrics used to evaluate the precision and rate of the algorithms. In the paper, it is identified which algorithms are applicable to estimating the network size, which algorithm is the best performing, how the leader selection affects the performance of the algorithms, and how to optimally configure the used stopping criterion to border the algorithms.

In [2], the authors present the software architecture for an agent-based fault diagnostic engine that equips agents with domain knowledge of IEC 61499 [3]. Using sound architectural design approaches and documentation methods, coupled with rigorous evaluation and prototyping, this paper demonstrates how quality attributes, risks, and architectural trade-offs were identified and mitigated before the construction of the engine commenced.

The authors of [4] deal with the design, implementation, experimental validation, and evaluation of a network tomography approach for performing inferential monitoring based on indirect measurements. Additionally, the authors address the problems of inferring the routing tree topology (both logical and physical) and estimating the links' loss rate and jitter based on multicast end-to-end measurements from a source node to a set of destination nodes using an agglomerative clustering algorithm. Finally, the authors implement and present a motivating practical application of the proposed algorithm that combines monitoring with change point analysis to realize performance anomaly detection.

Lembo et al. [5] study a fully graphical language Graphol, which is inspired by standard formalisms for conceptual modeling, similar to the UML class diagram and the

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ER model, but equipped with formal semantics. The authors also present several usability studies indicating that Graphol is suitable for quick adoption by conceptual modelers.

The paper [6] is focused on an approach for the modeling and simulation of the spread of COVID-19 based on agent-based modeling and simulation. The primary achievement of this paper consists of the effective modeling of 10 million concurrent agents, each one mapping an individual behavior with a high resolution in terms of social contacts, mobility, and contribution to the virus spreading. Moreover, the authors analyze the forecasting ability of our framework to predict the number of infections being initialized with only a few days of real data. The proposed approach outperforms state-of-the-art solutions.

In [7], the author provide a comprehensive discussion about the relevance of the multi-agent environment in mobility applications and describe different use cases in simulation and optimization.

The authors of [8] present the Vehicle Routing Problem simulation results in several aspects, where the main goal is to satisfy several client demands. The executed experiments show the performance of the proposed Vehicle Routing Problem multi-model and carry out its improvement in terms of computational complexity.

In the paper [9], the authors explore the possibility of applying reinforcement learning to pedestrian simulations. The learned pedestrian behavioral model is applicable to situations not presented to the agents in the training phase, and seems therefore reasonably general. This paper describes the basic elements of the approach, the training procedure, and an experimentation within a software framework employing Unity and ML-Agents (the employed ML-Agents version the authors adopted was 0.25.1 for Python and 1.0.7 for Unity).

The authors of [10] demonstrate that Wisdom-of-Crowds-Bots are competitive with other top classification methods on three datasets and apply their system to a real-world sport betting problem, producing a consistent return on investment from 1 January 2021 to 15 November 2022 on most major sports.

Two methods based on Petri nets are presented in [11] based on (i) P-invariants and (ii) Petri net siphons and traps. The intended result of the usage of these methods is to find a supervisor which allows for deadlock-free activity of the global multi-agent systems. While the former method yields results in analytical terms, the latter one needs computation of siphons and traps.

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