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Guest Editorial: Role of Agents in Traffic and Transportation

Marin Lujak[1], Ana L. C. Bazzan[2], Ivana Dusparic[3], and Giuseppe Vizzari[4]

[1] CETINIA, University Rey Juan Carlos, Spain
marin.lujak@urjc.es
[2] Federal University of Rio Grande do Sul, Brasil
bazzan@inf.ufrgs.br
[3] School of Computer Science and Statistics, Trinity College Dublin, Ireland
duspari@tcd.ie
[4] Department of Informatics, Systems and Communication, University of Milano – Bicocca, Italy
giuseppe.vizzari@unimib.it

Intelligent algorithms, particularly those utilizing autonomous agents and multi-agent systems, offer a compelling solution to the pursuit of secure, efficient, and sustainable traffic and transportation. Even though many real-world problems are inherently distributed and multi-objective, most of the literature deals with a single agent and a single objective. Such approaches may generally present robustness issues, and difficulties in responding to the generally heterogeneous individual actors' conditions changing over time. Therefore, a need arises for a way to model and train multiple agents to tackle these challenges.

This special section explores synergies among agents, multi-agent systems, multi-objective optimization, and machine learning, offering valuable insights into combining their potential within the context of traffic and transportation. This unique perspective offers an opportunity to advance the current state of the art, addressing ongoing challenges in the field. The section introduces innovative agent-based methods designed for dynamic adaptation, ensuring the smooth and efficient operation of transportation systems, even under fluctuating conditions. In combination with [1], it contains a selection of revised and extended versions of papers presented at the 12th International Workshop on Agents in Traffic and Transportation (ATT 2022) held in conjunction with IJCAI-ECAI 2022, the 31st International Joint Conference on Artificial Intelligence and the 25th European Conference on Artificial Intelligence, in Vienna, Austria on July 25th 2022. The workshop aimed to unite researchers and practitioners to discuss the modeling, simulation, control, and management of large-scale transportation systems at both micro and macro levels. The ATT 2022 workshop, as well as the IJCAI-ECAI 2022 conference in which it took place, were held in person, with a very active and lively interaction of the presenters and the audience. ATT 2022 thus continued a long success story of the eleven previous workshop editions and the trend of publishing revised and extended selected papers in special issues [2].

Following the standard reviewing procedure of the ComSIS Journal, two papers have been accepted for publication in this section, with a third added due to topic similarity. In the following, we give a short overview of the papers contained in the special section.

The first paper entitled "Comparing Reinforcement Learning Algorithms for a Trip Building Task: a Multi-objective Approach Using Non-Local Information", authored by Henrique U. Gobbi, Guilherme Dytz dos Santos and Ana L. C. Bazzan formulates the problem of multiple agents learning how to travel from an origin to a destination as a

reinforcement learning (RL) task modeled as a stochastic game. The authors consider more than one objective, non-stationarity, and inter-agent communication of local and non-local information. RL algorithms for a single objective (Q-learning) and multiple objectives (Pareto Q-learning) are compared, with and without non-local communication. These methods are evaluated with hundreds of agents, aiming at minimizing their origin-destination travel times and the carbon monoxide emissions. Results show that the use of non-local communication reduces both travel time and emissions.

The second paper titled "Sustainability-Oriented Route Generation for Ridesharing Services" authored by Mengya Liu, Vahid Yazdanpanah, Sebastian Stein and Enrico Gerding consider three pillars of sustainability: social, economic, and the environmental one. They present a multi-objective evolutionary approach based on the Non-dominated Sorting Genetic Algorithm for generating routing options in sustainable mobility on demand under six sustainable ridesharing objectives: travelling time, waiting time, overall/excess distance, travel cost, total emission, and working time balance. In addition to being aware of sustainability, their method also establishes a foundation for explainable, participatory, and dynamic mobility-on-demand services. Stakeholders can be provided with visualisations to see how different objectives affect routing solutions. A diverse range of solutions may be provided for a diverse set of users. Lastly, the proposed approach allows dynamic fine-tuning over time.

Finally, the third paper titled "Knowledge Transfer in Multi-Objective Multi-Agent Reinforcement Learning via Generalized Policy Improvement" by Vicente N. de Almeida, Lucas N. Alegre and Ana L. C. Bazzan proposes a multi-objective multi-agent reinforcement learning method in which agents build a shared set of policies during training, in a decentralized way, and then combine these policies using a generalization of policy improvement and policy evaluation to generate effective behaviors for any possible preference distribution, without requiring any additional training. This method is applied to two different application scenarios: a multi-agent extension of a four-room environment and traffic signal control considering both vehicles and pedestrians. Results show that the approach is able to effectively and efficiently generate behaviors for the agents, given any preference over the objectives.

References

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