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Guest Editorial

Agents in Traffic and Transportation (ATT 2020)

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Among the application domains of Artificial Intelligence, traffic and transportation feature the highest impact both on the life of every commuting human as well as on our society and the world desperate for sustainable and efficient transport logistics in the ongoing climate emergency. With more and more self-driving vehicles, with the overall tremendous advance in sensor and control technologies and in (spatial) data processing leading to the ubiquitous availability of up-to-date traffic information, with ever increasing mobile and distributed computational and thus reasoning power, traffic and transportation are nowadays highly exciting application domains for Artificial Intelligence. Due to the geographic, temporal, and functional distribution of transport services, especially Distributed Artificial Intelligence forms a natural fit to most of the traffic and transportation problems.

Distributed AI in general and software agent and multi-agent system technologies in particular, are aimed at solving complex learning, planning, and decision making problems in such distributed contexts by exploiting large scale computation and spatial as well as functional distribution of computing resources [9,10,12,13].

Transportation may be seen as a large system of systems, that are highly dependent on each other, while preserving a high degree of autonomy. The performance of the overall transportation system depends on the efficiency and effectiveness of the coordination of its subsystems. Typically, research on transportation systems deals with large scale, dynamic, and complex settings characterised by a variety of users and network authorities, with conflicting goals and constraints within the system. Typical applications address optimization of traffic control or management (see, e.g. [5]), efficient, fair, and envy-free routing (see, e.g. [8]) or analysing decision making of traffic participants, such as pedestrians (see, e.g. [6]).

The use of distributed Artificial Intelligence and Multi-Agent Systems for the improvement of transport systems has shown to be efficient in solving many societal challenges related to increasing the safety, sustainability, and efficiency of transportation systems (see, e.g. [2,3]).

This Special Issue presents innovative and novel solutions related to modelling of pedestrian and vehicle behavior, coordination of transportation using machine learning and data-driven approaches, as well as traffic problems. It includes selected, revised, and extended articles that were presented at the 11th International Workshop on Agents in Traffic and Transportation (ATT 2020), held in conjunction with the 24th European Conference on Artificial Intelligence (ECAI 2020) on September 4, 2020. The ATT 2020 work-

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shop happened virtually due to the Covid-19 situation. Initially, before Covid-19 pandemic outbreak, it was planned to be held in Santiago de Compostela, in Spain. Despite the uncertain contextual situation, ATT 2020 continued the success story of the ten previous editions:[1] ATT 2018, held in Stockholm, Sweden together with ECAI/IJCAI, AAMAS and ICML conferences (FAIM 2018) [1]; ATT 2016, held in New York, the USA, in conjunction with IJCAI 2016 [4]; ATT 2014, held in Paris, France, in conjunction with AAMAS 2014; ATT 2012, held in Valencia, Spain 2012, in conjunction with AAMAS 2012 [11]; ATT 2010, held in Toronto, Canada, co-located with AAMAS 2010; ATT 2008, held in Estoril, Portugal, co-located with AAMAS 2008 [7]; ATT 2006, held in Hakodate, Japan, co-located with AAMAS 2006; ATT 2004, held in New York, the USA, co-located with AAMAS 2004; ATT 2001, held in Sydney, Australia, co-located with ITS 2001 – Intelligent Transportation Systems Conference; and ATT 2000, held in Barcelona, Spain, co-located with the 4th International Conference on Autonomous Agents – Agents 00.

The preceding ten ATT Workshops engaged reputed researchers from around the world and ATT 2020 continued this trend. Researchers from various areas of multi-agent systems and agent technologies exchanged novel ideas, techniques, results, and open questions regarding scientific advancements in the design, implementation, and verification of next-generation agents in traffic and transportation. This special issue provides a wide view that shows the synergies between these areas and opens the possibility to tackle current traffic and transportation challenges in a successful advance in the current state of the art.

This special issue may be of interest to AI researchers already active or interested in a variety of research areas such as path planning, optimization, data analytics, machine learning, multi-agent systems, and their coordination. In all these areas, traffic and transportation form interesting and challenging application areas, especially when using mobile intelligent technologies. In addition, since traffic scenarios are often used as testbeds for innovative technologies, this special issue may be interesting also to researchers that do not directly address real-world traffic and transportation problems.

In the following, we give a short overview of the papers contained in the special issue.

The paper titled "Safety perception and pedestrian dynamics: experimental results towards affective agents modeling" by Francesca Gasparini, Stefania Bandini, and Marta Giltri presents empirical studies on affective states of pedestrians. As the authors argue, this is highly relevant for simulation-based pedestrian and crowd management, as more realistic agent-based pedestrian models must integrate effects of stress or pedestrian emotions. The authors present their systematic in-vivo experiments devoted to the collection of movement and physiological data of pedestrians in interaction with one another and with vehicles during walking and road crossing to identify and analyse reliable stress indicators.

Tristan Cazenave, Jean-Yves Lucas, Thomas Triboulet and Hyoseok Kim in their work entitled "Policy adaptation for vehicle routing" study the constrained vehicle routing problem with time windows in the context of large companies that have to manage a fleet of vehicles on a daily basis. Nested Rollout Policy Adaptation (NRPA), a Monte Carlo heuristic search algorithm is suggested and tested in a real-world setting for a major French company that has to plan trips of service technicians. Simulation results confirm that their new suggested approach outperforms the algorithms currently used.

The paper titled "ORNInA: a decentralized, auction-based multi-agent coordination in ODT systems" by Alaa Daoud, Flavien Balbo, Paolo Gianessi, and Gauthier Picard studies an On-Demand Transport (ODT) system and proposes a new decentralized, insertion heuristic algorithm to solve a special case of the dynamic Dial-A-Ride-Problem (DARP), in which vehicles communicate via Vehicle-to-Vehicle communication and take decentralized, yet computationally efficient decisions since traditional exact and centralized dispatching is computationally expensive.

Marin Lujak, Elizabeth Sklar, and Frederic Semet, within the work titled "Agriculture fleet vehicle routing: a decentralized and dynamic problem" focus on the problem of efficient and scalable multi-agent dynamic coordination and optimization of large agricultural vehicle and agrirobot fleets that could operate on huge land areas to effect precision farming. With this aim, they propose and formulate the agriculture fleet vehicle routing problem (AF-VRP).

The article titled "Demand-responsive rebalancing zone generation for reinforcement learning-based on-demand mobility" by Alberto Castagna, Maxime Guériau, Giuseppe Vizzari, and Ivana Dusparic proposes a Dynamic Demand-Responsive Rebalancer (D2R2) for Ride-sharing systems in Mobility-on-Demand (MoD) systems. D2R2 is a dynamic and adap-

[1] See http://www.ia.urjc.es/ATT/.

tive fleet rebalancing strategy that counter-acts the uneven geographical spread of demand and relocates unoccupied vehicles to the areas of higher demand at runtime.

Theresa Ziemke, Lucas N. Alegre, and Ana L. C. Bazzan, in the paper titled "Reinforcement learning vs. rule-based adaptive traffic signal control: a Fourier basis linear function approximation for traffic signal control", address traffic signal control based on reinforcement learning in settings with large state spaces. They use a linear function approximation, SARSA with Fourier basis features, that generalizes the state space to deal with the curse of dimensionality in the agent-based transport simulation MATSim. The results show that SARSA with Fourier basis features is able to outperform state-of-the-art rule-based adaptive methods, especially in scenarios with varying traffic demands.

Finally, the paper titled "Accelerating route choice learning with experience sharing in a commuting scenario: an agent-based approach" by Franziska Klügl and Ana L. C. Bazzan analyses the effects of sharing travel information among driver agents about the current traffic state on the road network. Through aggregating the agents' route choice experiences by Q-learning, the authors show that experience sharing can improve convergence times for adaptive driver agents.

In short, the scope of this special issue is to present a selection of very different results on how large-scale complex transportation systems can be modelled, simulated, controlled and managed – both at micro and macro level – employing and combining a broad spectrum of AI-based techniques, models, approaches. We believe this selection will be of interest to researchers active in this field and beyond, and we certainly look forward to continuing our observatory on the area of autonomous agents, multi-agent systems, and AI researches in general, applied to the context of traffic and transportation.

Acknowledgements

The ATT2020 workshop was held in September 2020. The shared work to create this special issue started only after that. Compiling a special issue containing selected, revised and extended papers within less than four months after the workshop including full-fledged peer reviewing is challenging and could only be accomplished with everybody – authors and reviewers – being highly committed and in time. Therefore, we want to thank all the authors for their valuable and timely contributions and fast, high quality revisions, even when we asked for substantial changes. This special issue would not be possible without support from a highly committed Scientific Review Committee composed of 21 academy members from the EU, Australia, Brazil, and India. We want to give special thanks to all peer reviewers for their considerable effort to provide high quality suggestions and detailed feedback in record times despite of the difficult context of the Covid-19 pandemics. Sincere thanks also to highly responsive AI Communications Editor-in-Chief Eva Onaindia and the staff of AI Communications for their professional support.

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