ΤΜΗΜΑ ΜΗΧΑΝΙΚΩΝ Η/Υ & ΠΛΗΡΟΦΟΡΙΚΗΣ • ΠΑΝΕΠΙΣΤΗΜΙΟ ΙΩΑΝΝΙΝΩΝ
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING • UNIVERSITY OF IOANNINA

ΠΑΡΟΥΣΙΑΣΗ

ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ

ΗΜΕΡΟΜΗΝΙΑ: Τετάρτη, 28 Ιουνίου 2023

ΩΡΑ: 09:30 – 11:30

ΑΙΘΟΥΣΑ: Αίθουσα Σεμιναρίων ΤΜΗΥΠ

ΟΜΙΛΗΤΗΣ: Χρήστος Σπαθάρης

Θ έ μ α

«Deep Reinforcement Learning and Generative Adversarial Modeling in Traffic Applications»

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Π ε ρ ί λ η ψ η:

Artificial intelligence (AI) has a profound impact on everyday life through its revolutionary effect on human-machine interactions. Intelligent agents form the heart of AI systems, playing a pivotal role in their functioning and capabilities and possessing the remarkable capacity to perceive, reason, and dynamically take actions with the aim of accomplishing specific goals. Agents come in diverse forms, spanning from straightforward rule-based systems to intricate deep learning models. Their training encompasses a wide range of learning schemes and computational techniques, all falling under the broad umbrella of machine learning (ML). Reinforcement learning (RL) is a prominent ML sub-field that configures agents to make sequential decisions through interaction with the environment, mimicking the way humans learn through trial-and-error. Furthermore, imitation learning (IL) establishes a nice framework that effectively combines generative modeling and principles of RL through the process of learning from expert demonstrations. Traffic management and control is a promising research area that has the potential to impact transportation and serve as an attractive application field for implementing ML approaches. The inherent complexity of the traffic domain offers numerous avenues for expansion and exploration, enabling the study of innovative strategies to optimize traffic flow, and develop sustainable transportation systems.

This dissertation is devoted on the development of novel intelligent methodologies for traffic applications, specifically on the urban road and aviation domains. Various methods, including deep reinforcement learning, hierarchical and modular learning, generative modeling, imitation learning, and multi-agent systems, are proposed to address the significant challenges of: (a) congestion management, and (b) trajectory modeling. The importance and applicability of the proposed methodologies is highlighted by the results obtained from studying simulated and real-world large-scale traffic scenarios. Through rigorous analysis and comprehensive evaluations, the findings not only validate the effectiveness of the methods but also provide invaluable insights into their practical implementation

The structure of this PhD involves three parts, in which the following problems are studied: (a) urban traffic navigation, (b) air traffic management, and (c) aircraft trajectory modeling. In the first part, the aim is to create efficient multi-agent systems for controlling and navigating fleets of vehicles in unsignalized large-scale urban road networks with complex stochastic scenarios. By employing

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multi-agent reinforcement learning (MARL) techniques, the study seeks to navigate vehicles safely, preventing collisions, and minimizing traveling time. The second part focuses on tackling congestion problems in the aviation domain, particularly focusing on the demand and capacity balance (DCB) problem in air traffic management (ATM). By employing MARL schemes and leveraging hierarchical frameworks, the study seeks to minimize flight delays, optimize airspace utilization, and reduce fuel consumption and operating costs. The final part studies generative models and trajectory modeling techniques in the aviation domain. Trajectory prediction is of an utmost importance, and IL techniques offer a promising solution by training agents to imitate expert behaviors. Modular multi-modal imitation learning can further enhance trajectory prediction by capturing various behavioral patterns exhibited during different flight phases. By leveraging expert data and modeling distinct patterns, the proposed approaches improve the accuracy and robustness of trajectory prediction systems, leading to enhanced air traffic management, and safer and more efficient flights.

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