Distributed multi-agent learning strategies for the management of traffic of connected and autonomous vehicles

Autonomous cars are vehicles equipped with sensors, actuators and computer software, enabling them to drive according to their perceived environment (road, vehicles, pedestrians, etc.). These new vehicles, whose time-to-market is estimated to a few years, will improve the road users' safety and allow new forms of mobility.

These vehicles will also be equipped with communication units allowing them to receive information from the other vehicles and the infrastructure, and to emit information toward their environment. By using the wireless communication, these Connected and Autonomous Vehicles (CAV) will introduce new possibilities for traffic management. Several researches have shown the potential benefits of CAVs on the traffic:

- at intersections, by removing the need of traffic lights while improving the traffic efficiency [1]
- on the highway, by allowing cooperative merging [2]
- on the whole road network, by preventing the risks of deadlocks [3]

The research work on the possibilities of these CAVs is still on-going and new possibilities are continuously being discovered to improve the traffic. Indeed, thanks to the recent works, it is expected that CAVs will improve safety, reduce congestion, and improve the energy consumption.

The current thesis subject aims to continue the on-going work on traffic optimization of CAVs with a new approach.

A key issue of the current solutions is the difficulty to perform online optimization of the traffic when the activity on the road is constantly changing and the evolution of the traffic at the vehicle level is hard to predict.

The recent advances of machine learning and especially reinforcement learning could be a solution to this problem. Machine learning could be used to define new strategies for traffic management at different levels (vehicle, intersection, network) able to dynamically adapt to an ever-changing environment.

In this context, the Ph. D. student will have the opportunity to work on this topic and propose novel contributions to the current state-of-the-art in the field of machine learning, traffic management and autonomous vehicles.

[1] *Modeling and controlling an isolated urban intersection based on cooperative vehicles*, Mourad Ahmane, Abdeljalil Abbas-Turki, Florent Perronnet, Jia Wu, Abdellah El Moudni, Jocelyn Buisson, Renan Zeo, Transportation Research Part C: Emerging Technologies

[2] *V2V-Based Memetic Optimization for Improving Traffic Efficiency on Multi-Lane Roads*, Alexandre Lombard, Abdeljalil Abbas-Turki, Abdellah El-Moudni, IEEE Intelligent Transportation Systems Magazine

[3] *Deadlock Prevention of Self-Driving Vehicles in a Network of Intersections*, Florent Perronnet, Jocelyn Buisson, Alexandre Lombard, Abdeljalil Abbas-Turki, Mourad Ahmane, Abdellah El Moudni, IEEE Transactions on Intelligent Transportation Systems