Behaviour optimisation and generation of training examples with offline Optimal Control

The majority of modern and state of the art approaches for the development of automated driving heavily rely on artificial intelligence (AI) and on the use of Deep Neural Networks. The AI has to be trained and tested on a large amount of driving data to achieve the reliability and safety level necessary to drive 100 millions mile without a fatal accident.
The H2020 Dreams4Cars research project aims at solving this problem using a dream mechanism to teach the agent to become an expert driver by learning from discovered potential critical situations.

This talk presents the approach used in Dreams4Cars to train the agent in the dream state via the use of optimal control techniques to model different driving behaviors. According to experimental evidence, the optimality of human sensorimotor control is constantly assumed in this project and it is used to implement the inverse models (i.e. affordances) that map sensory data with controls.

The layered control architecture of Dreams4Cars, which is biologically inspired by the human brain, foresees the use of three data streams. In particular, the first of stream (dorsal stream) creates an artificial "motor cortex" map, which is a two-dimensional map of the control space (i.e. lateral and longitudinal controls) from perceived sensory data. The value that is encoded in the motor cortex map is called salience (s) of the trajectory/trajectories. The salience originates at each couple of lateral and longitudinal control and expresses "how good" the particular choice of controls is. Points (i.e. controls) that are close in the motor cortex correspond to trajectories aiming at similar, but slightly different, directions in the space. Therefore, different regions in the cortex map correspond to different affordances (e.g., lane change, car follow etc.) which are produced with different (families of) trajectories. The height of each hump in the motor cortex is the urgency of that particular affordance and describes the active regions in the motor cortex.

The talk introduces the formulation of the inverse models as optimal control problems and the numerical approach used in Dreams4Cars to find the optimal solution that generates the optimized behavior in term of motor/salience map and affordances.
The talk also discusses computational challenges along with the approach adopted to incorporate the driving style and the characteristics dynamic response of vehicle to driver's inputs.
In the end, recent examples from the Dreams4Cars project will be shown.