A DRL-based Multiagent Cooperative Control Framework for CAV Networks: a Graphic Convolution Q Network

Jiqian Dong¹, Sikai Chen¹,²,³*, Paul Ha¹,², Yujie Li¹,², Runjia Du¹,², Samuel Labi¹,²

¹Lyles School of Civil Engineering, Purdue University, West Lafayette, IN, USA
²Center for Connected and Automated Transportation, Purdue University, West Lafayette, IN, USA
³Robotics Institute, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA, USA

ABSTRACT

Connected Autonomous Vehicle (CAV) Network can be defined as a collection of CAVs operating at different locations on a multi-lane corridor, which provides a platform to facilitate the dissemination of operational information as well as control instructions. Cooperation is crucial in CAV operating systems since it can greatly enhance operation in terms of safety and mobility, and high-level cooperation between CAVs can be expected by jointly plan and control within CAV network. However, due to the highly dynamic and combinatorial nature such as dynamic number of agents (CAVs) and exponentially growing joint action space in a multiagent driving task, achieving cooperative control is NP hard and cannot be governed by any simple rule-based methods. In addition, existing literature contains abundant information on autonomous driving’s sensing technology and control logic but relatively little guidance on how to fuse the information acquired from collaborative sensing and build decision processor on top of fused information. In this paper, a novel Deep Reinforcement Learning (DRL) based approach combining Graphic Convolution Neural Network (GCN) and Deep Q Network (DQN), namely Graphic Convolution Q network (GCQ) is proposed as the information fusion module and decision processor. The proposed model can aggregate the information acquired from collaborative sensing and output safe and cooperative lane changing decisions for multiple CAVs so that individual intention can be satisfied even under a highly dynamic and partially observed mixed traffic. The proposed algorithm can be deployed on centralized control infrastructures such as road-side units (RSU) or cloud platforms to improve the CAV operation.