Adaptively Controlling of Autonomous Vehicle for Vehicle Interaction at Unsignalized Intersections Using Reinforcement Learning

Group member and responsibility:

Pengcheng Cai: Simulation environment construction

Huiwen Xu: Simulation data and real data collection and organization

Mengxiong Wan: Reinforcement learning algorithm implementation

Zhaoxin Hu: Analysis and quantitative evaluation of results, learning algorithm optimization

Motivation and Problem statement:

For autonomous vehicle working in urban traffics, it's critical to safely and efficiently crossing an unsignalized intersection while interacting with other vehicles. Using reinforcement learning to come up with a control law in this complicated scenario is a great try for the realization of intersection automation in future.

Given the unsignalized intersection environment, the initial state of autonomous vehicle e_0, the objective position e_{final}, the states of human drive car h(t) at all the time modeled by the level-k game theorem, the action set Γ={"Maintain", "Turn left", "Turn right", "Accelerate", "Decelerate", "Break"} that a vehicle can take action from, and a discrete-time dynamic model to represent the vehicle dynamics at intersections, the goal, is to find a consecutive maneuvers to achieve the objective of the autonomous vehicle (ego car) using reinforcement learning, such that the ego car cross the intersection safely and efficiently without having collision to obstacles or other vehicles, and without breaking the traffic law.

Machine learning method:

The reinforcement learning method will be used to get the consecutive maneuvers. This method is well used in adaptively controlling an agent in an unknown environment. This method concerns with how to take actions in an environment to maximize the defined reward function, which best fits our problem.

Data sets:

The method will be constructed and evaluated using the data generated by the simulation environment we have generated in the first stage. We will also use the real data find online to test the performance of our method.

Research paper:

This project is based on the research paper "Game Theoretic Modeling of Vehicle Interactions at Unsignalized Intersections and Application to Autonomous Vehicle Control", which addressed the problem stated above.

Reference:

Li, Nan & Kolmanovsky, Ilya & Girard, Anouck & Yildiz, Yildiray. (2018). Game Theoretic Modeling of Vehicle Interactions at Unsignalized Intersections and Application to Autonomous Vehicle Control. 10.23919/ACC.2018.8430842.