Research on An Nonparametric Bayesian Method: Clustering V2V Encountering Behaviors Based on HDP-HMM

Introduction

For autonomous vehicles, the typical process of driving process usually consists a closed loop of perception, decision-making, and control. Due to uncertainties on the continuous state of nearby vehicles and their potential discrete states such as braking or lane changing, decision-making is becoming the most crucial and challenging component. Therefore, semantically understanding complex V2V (Vehicle to vehicle) encountering behaviors, wherein two or multiple vehicles are spatially close to each other, does potentially benefit autonomous car's decision-making design. In this case, due to the high dimensions of the data and uncertain states of the driving behaviors, the HDP-HMM, a nonparametric Bayesian learning (NPBL) method is implemented to clustering the V2V encountering behavior sequential data into different clusters without prior knowledge, which is beneficial to the analysis and modeling of V2V encounter behaviors.

The algorithm to be implemented

In this project, a nonparametric Bayesian approach introduced in [1] will be discussed. The stochastic process in this approach, which is called the hierarchical Dirichlet process (HDP), defines a prior distribution on transition matrices over countably infinite state spaces. The resulting HDP-HMM turns out to be data–driven learning algorithms which can be applied to predict posterior distributions over the number of states. This posterior uncertainty can be calculated when predictions are running, effectively averaging over models of varying complexity.

Data sets to be used

The dataset used is generated by the University of Michigan Safety Pilot Model Development (SPMD) program and conducted by the University of Michigan Transportation Research Institute (UMTRI). The database includes approximately 3,500 equipped vehicles' trajectories and speeds information and 6 million trips in total.

Group members and assignments allocation

Yufei Gan, ME: Mathematical modeling and data extraction
Weiyang Zhang, ME: Data preprocessing and clustering
Tao Jin, ME: Feature extraction and analysis

References

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