Behavior Planning for Autonomous Driving by Combining Neural Networks and Tree Search

Background

As the "brain" of autonomous vehicles, the capabilities of behavior decision-making are decisive for enabling safe and socially acceptable autonomous driving in all traffic scenarios. Improving the intelligence of behavioral decision-making systems is one of the core challenges for autonomous driving. The challenges of making safe decisions include observing traffic rules and reasonably interacting with other traffic participants. Furthermore, the different uncertainties of perceived traffic information such as limited sensor measurements, uncertain motion and intention prediction, and occluded objects in complex urban areas need to be handled reasonably. Although state-of-the-art autonomous driving works well under sound conditions, dealing with these problems remains nontrivial.

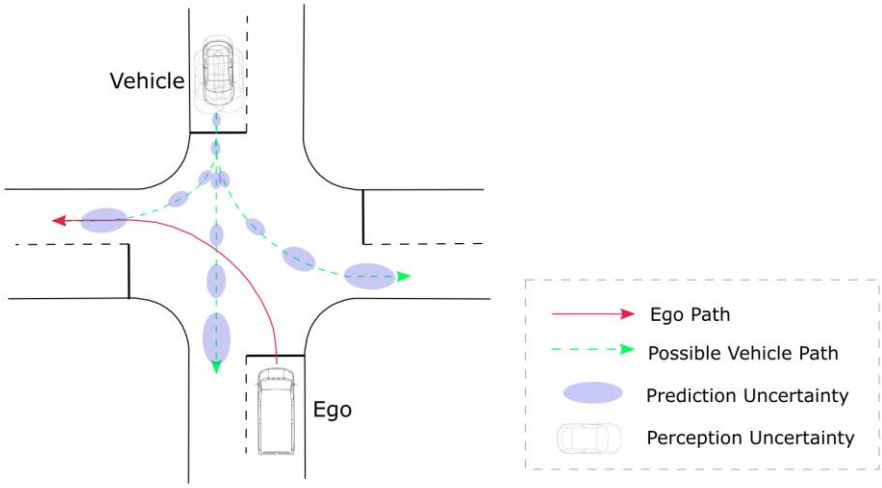

Figure 1: Decision-making in an intersection

Motivation

The potential of the Partially Observable Markov Decision Process (POMDP) planning algorithm for autonomous driving was shown in the previous research. However, long-term planning leads to combinatorial complexities, i.e. cumulative model errors, and the curse of dimensionality. This thesis investigates the integration of the planning method with learning to benefit from both the robustness of explicit reasoning and the capability to learn from data. The combination of Monte Carlo Tree Search with machine learning methods such as supervised learning and reinforcement learning will be the main focus of this master thesis.

Tasks

- Literature research for most advanced Deep RL algorithm, Supervised Learning in the application of behavior planning
- Literature research for planning with learning
- Choosing and designing proper simulation environment (for example Carla) or using our driving simulator to gather data

- Writing training pipeline
- Testing algorithm in the simulation environment

Requirements

- Solid programming skills in Python
- Good knowledge of C++, ROS, PyTorch
- Practical experience in Reinforcement Learning, Machine Learning
- Able to work independently

Application and Contact

This thesis is an external master thesis in cooperation with ZF Friedrichshafen AG. The working location is in Friedrichshafen. If you are interested in this offered thesis topics and would like to gain practical experience in developing autonomous driving in an industrial environment, please send your Application Materials including (Resume, Motivation letter and Transcript of Records) to me.

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