Ensuring Safety for Reinforcement-Learning-Based Motion Planners Using Online Verification

Background

Reinforcement learning (RL) offers promising solutions for real-world problems, especially sequential decision-making tasks in robotics, such as motion planning for autonomous vehicles [11, 5] or controling robot manipulators [9, 4]. However, since RL methods aim to learn an optimal policy through interaction with the environment, unsafe actions are likely to be taken especially during initial learning phase. To apply RL methods to real-world autonomous systems, safety has to be guaranteed during training and/or deployment. Our previous work [7] has proposed a safe RL framework which ensures safety of a high-level motion planner for autonomous lane changing on highways. However, a low-level trajectory planner is always required for this previous approach, which impedes its applicability.

Description

The goal of this thesis is to combine our previously developed online verification framework [1, 3, 10] with RL-based low-level planners to provide safety guarantee on highway scenarios as well as evaluate the approach on real-world traffic datasets [6]. The developed approach should be compared with previously developed method based on control barrier functions [8] in terms of computational time and task performance. Optionally both approaches should be extended to urban scenarios and evaluated on real-world intersection dataset [2].

Tasks

- Literature review on safety verification for autonomous driving
- Familiarize with existing software stacks for online verification and RL codes
- Implement interface between RL-based planner and safety layer
- Experiment on highD scenarios to evaluate the approach and compare with existing CBF-based approach
- *Optional: Extend online verification method and CBF method to urban scenarios*

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Good mathematical background, fundamental knowledge about control theory

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