BA/SA/MA: Development of an Algorithm for Attacker Coordination in the Context of Falsification in Autonomous Driving

Background

Autonomous driving (AD) has seen a spike of interest in recent years with increasing focus on its safety. One essential part is the testing and possible falsification of planning algorithms in critical scenarios. However, those critical scenarios only rarely occur in real-word datasets but are essential for safety assessment [1]. To tackle this problem, our chair is currently developing a software for automatically increasing the criticality of interactive scenarios as part of the EU-Horizon project i4Driving [2]. The long-term goal of i4Driving is to lay foundation to a driver license for autonomous vehicles (“KI-TÜV“). We furthermore aim to use the software to test our own planners for the TUM autonomous research vehicle EDGAR.

Figure 1: TUM Research Vehicle EDGAR

Description

Our falsification is currently facilitated via set-based predictive [3] multi-agent driving, in which our software takes control over other traffic participants (attackers) and aims to simultaneously let them perform maneuvers that produce critical situations for the Vehicle-under-Test (VUT) whilst also still following their own goals. This approach is motivated by the fact that critical scenarios in the real-world are seldom caused by malicious intend but rather by unthoughtful behavior of individuals pursuing their own goals.

Our approach analysis the reachable sets of the traffic participants, limits them to achieve traffic rule compliance [4] and predictively finds an attacking point. Afterward, a relaxed QP-Problem is solved to plan the trajectories. Finally, the VUT plans its trajectory and possible collisions are detected.

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Research area:
Autonomous Driving - Planning and Falsification

Programming language:
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Required skills:
Python, OOP, Git

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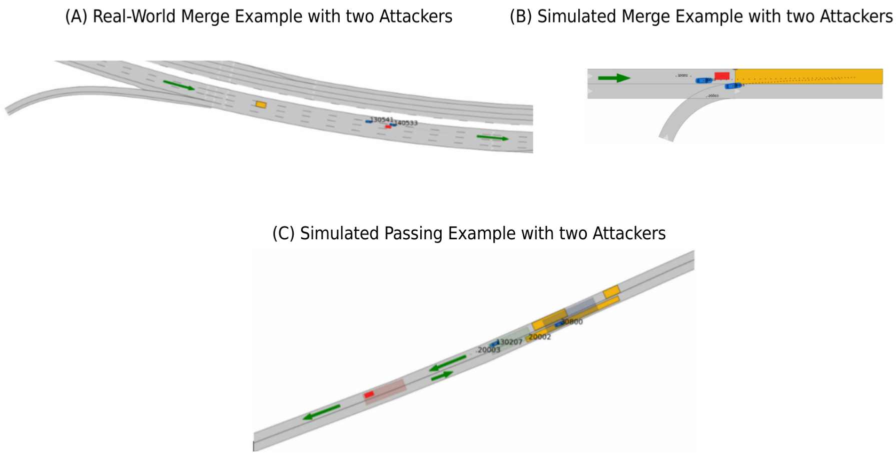

Figure 2: Exemplary Results of our Software. The VUT (red) is attacked by attackers (blue) using their reachable sets (translucent polygons).

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Although the current software has produced promising first results, there are a number of open research topics to it. One of these topics is that the attackers currently choose their point of attack via a working, but simple, spatio-temporal heuristic and do not consider the choices of other attackers. The central goal of this thesis is to improve our existing software by developing a new, robust algorithm that coordinates the attackers to make their attacks even more critical.

Coordinated multi-agent driving is an increasingly investigated field of AD [5]. Current literature mainly focuses on save multi-agent driving via centroid clustering [6], game theory [7], multi-agent MPC [8, 5] or multi-agent reinforcement learning [9] with applications such as platooning, formation driving or cooperative ACC [10].

However, there is little research on how this knowledge can be used to increase the criticality of multi-agent scenarios in testing and falsification.

Tasks

This thesis focuses on developing and integrating new algorithms (from the literature, maybe with your own spin on them and/or own ideas) for the described coordination of the attacking vehicles with the requirement that they still also pursue their own goals.

As we are in an early stage, we currently focus on simulated and real-world highway merge and passing scenarios only, specified in our own CommonRoad format [11, 12], which is used in several national and EU-wide projects. We, furthermore, recommend having intermediate skills in dealing with research code, although we can provide assistance.

Your tasks are:

1. Investigating current approaches in the literature
2. Developing one or more approaches based on our requirements
3. Implementing the approaches in an OOP, well documented, fashion
4. Evaluate the implemented strategies
5. Making your solution work with the currently used code

Application

If you are interested in the topic, please send an email to the contact information provided on the right and attach a short **CV**, your current **grade report** and your **bachelor grade report**.

If you have extra-curricular projects or a student job, please attach information about it.

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