# Formalization of Traffic Rules Considering Vulnerable Road Users

# Background

Autonomous vehicles have to obey traffic rules in order to participate in real traffic. However, traffic rules are ambiguous since judges must be able to interpret them for individual cases. Therefore, they have to be concretized and formulated mathematically so that machines can interpret them. In our previous work, we have already formalized traffic rules for German interstates (including general rules) [5] and for intersections [4]. However, we have excluded the behavior with respect to vulnerable road users (VRUs), i.e., pedestrians and cyclists. For example, the German traffic regulations (StVO) distinguishes between overtaking vehicles and cyclists.



An autonomous vehicle which has to consider two VRUs. Source: Waymo LLC

# Description

The aim of this thesis is to adapt our existing formalized traffic rules to consider VRUs and to formalize new traffic rules which are required for rule-compliant behavior of autonomous vehicles with respect to VRUs. Therefore, traffic rules have to be concretized based on several legal sources and have to be formalized in metric temporal logic (MTL) [6]. The formalized traffic rules should be evaluated with manually-created CommonRoad [1] scenarios, where our CommonRoad Scenario Designer [3] can be used to create those scenarios. An overview about already published scenarios can be found on our website<sup>1</sup>. The formalized rules should be evaluated on recorded datasets. Additionally, traffic rules should be formalized from the perspective of a VRU instead of the perspective of an autonomous vehicle.

The proposal can be adapted for a guided research.

## Tasks

- · Literature review on formalization of traffic rules and codifying law
- · Collection and documentation of relevant traffic rules
- · Familiarization with our CommonRoad tools and the existing traffic rule framework
- · Formalization of new traffic rules and adapting existing ones
- Evaluation of the formalized rules using manually-created scenarios
- Evaluation of the formalized rules on a dataset, e.g., the inD dataset [2]



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Research project: BMW Car@TUM

**Type:** BA/GR

**Research area:** Autonomous Driving, Traffic Rules

**Programming language:** C++, Python

Required skills: Good programming skills, basic logic knowledge

Language: English

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- · Formalization of traffic rules from the perspective of VRUs
- · Optional: Small (online) user study for rule evaluation
- Documentation of code and results
- · Writing thesis

## References

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- [6] Martin Raszyk, David Basin, Srdan Krstić, and Dmitriy Traytel. Multi-head monitoring of metric temporal logic. In *Proc. of Automated Technology for Verification and Analysis*, pages 151–170, 2019.

# ТШТ

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