Deep Traffic Rule Violation Prediction using Abstract Syntax Tree Features

Background

Predicting the behavior of other traffic participants is an inherently difficult task, as it aims to clairvoyantly foresee the future. However, anticipating a specific behavior of our surrounding is required to ensure traffic flow and maintain safety. Traffic rules play and important role in driver behavior prediction as they act as a strong prior on the behavior of road users, hence representing important information about the current scene. While other traffic participants often follow the traffic rules, dangerous situations may arise if this assumption does not hold anymore.

Description

Our previous work hast targeted the prediction of such events using deep neural networks. Extracting meaningful features for the prediction from the environment, however, remains a crucial problem to increase the quality of results. A recent work has shown that incorporating information from the abstract syntax tree of temporal logic formulas can improve the quality of predicted trajectories [1].

In this thesis we aim to evaluate the use of features from abstract syntax trees of signal temporal logic formulas for predicting the event of a traffic rule violation with deep neural networks[1]. The thesis builds up on our previous work [2] and will partly enhance our implementation of traffic rule evaluation.

We use formalized traffic rules as in [2], [3] that are evaluated using a existing monitoring solution[2]. A challenging aspect of this thesis is the high class-imbalance between violating and non-violating behavior, where only few samples for a violation of a specific traffic may exist.

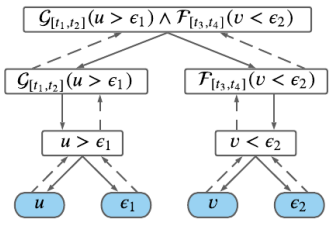

Figure 1: Abstract syntax tree from an STL formula [1]

Tasks

- Literature research on methods for traffic rule formalization, imbalanced deep learning and prediction.
- Familiarize yourself with the results and code base of previous works.
- Extract abstract syntax tree features from a driving dataset.
- Develop a NN-based model for predicting traffic rule violations.
- Compare your approach with existing approaches.

[1] To allow training of the neural networks at scale, we provide a GPU-accelerated training environment with recent and powerful NVIDIA A100 GPUs.
[2] https://github.com/nickovic/rtamt

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Research project:
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Type:
Bachelor Thesis

Research area:
Neural Networks, Temporal Logic, Prediction

Programming language:
Python, Pytorch

Required skills:
Good mathematical background, fundamental knowledge about neural networks and autonomous driving systems

Language:
German,English

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References

[1] X. Li, G. Rosman, I. Gilitschenski, *et al.*, "Vehicle Trajectory Prediction Using Generative Adversarial Network With Temporal Logic Syntax Tree Features," *IEEE Robot. Autom. Lett.*, vol. 6, no. 2, pp. 3459–3466, 2021.

[2] L. Gressenbuch and M. Althoff, "Predictive Monitoring of Traffic Rules," in *Proceedings of the International Intelligent Transportation Systems Conference*, 2021, pp. 915–922.

[3] S. Maierhofer, A.-K. Rettinger, E. C. Mayer, *et al.*, "Formalization of Interstate Traffic Rules in Temporal Logic," in *Proc. IEEE Intell. Veh. Symp.*, 2020, pp. 752–759.

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