Graph-based Prediction of Driver Behavior

Background

Predicting the behavior of other traffic participants is an inherently difficult task, as it aims to clairvoyantly foresee the future. However, anticipating the behavior of our surrounding is required to ensure traffic flow and maintain safety. Traffic rules play an 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.

As traffic scenes can be naturally modelled as graphs, where vehicles become nodes and interaction effects between vehicles become edges, graph neural networks (GNNs) have received increasing attention in driver behavior prediction [1]. By learning the optimal weights of internal message encoding modules, GNNs work by propagating information as messages along the edges in the graph, before aggregating them at the node level in a multi-layered fashion [2].

Description

In this thesis we aim to develop a GNN-based behavior prediction module using information from applying traffic rules. By representing the surrounding environment in a graph-structured fashion, we hope to achieve better generalization abilities than what can be achieved through a hand-engineered feature vector. Intuitively, given how interaction effects between vehicles can be thought of as propagating across the given traffic scene, graphs are well-suited data structures for our problem domain.

We use traffic rules formalized in temporal logic as in previous works [3], [4]. The formalization allows one to rigorously evaluate traffic rule compliance of each traffic participant. The thesis builds up on previous works in the area and will partly enhance our implementation of traffic rule evaluation.

Tasks

- Literature research on methods for graph-based behavior prediction methods and traffic rule formalization.
- Familiarize yourself with the results and code base of previous works.
- Extract graph inputs from a driving dataset.
- Develop a GNN-based model for behavior prediction in autonomous driving.
- Compare your approach with existing behavior prediction approaches.

References

[1] S. Mozaffari, O. Y. Al-Jarrah, M. Dianati, *et al.*, "Deep Learning-Based Vehicle Behavior Prediction for Autonomous Driving Applications: A Review," *IEEE Trans. Intell. Transp. Syst.*, to be published.

[2] Z. Wu, S. Pan, F. Chen, *et al.*, "A Comprehensive Survey on Graph Neural Networks," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 32, no. 1, pp. 4–24, 2021.

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Research project:
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Type:
Master Thesis

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Graph Neural Networks, Temporal Logic, Driver Behavior Modeling

Programming language:
Python, PyTorch

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

Language:
English

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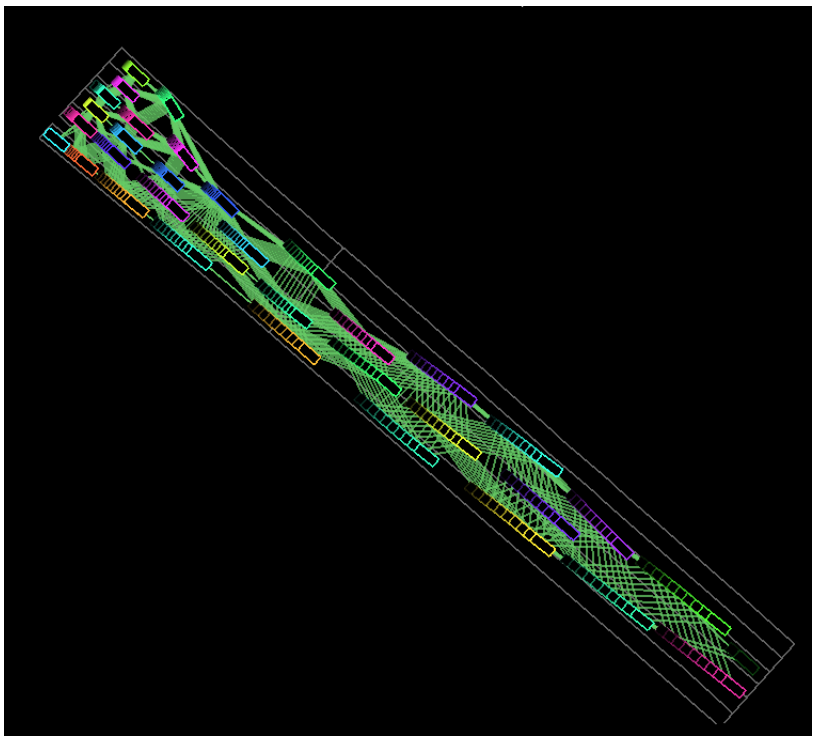

Figure 1: Example of a typical highway traffic scene. Traffic scenes contain a variable number of traffic participants, and graph neural networks offer a principled way of modeling them in a joint fashion - while being invariant to the order of processing them.

[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.

[4] L. Gressenbuch and M. Althoff, "Predictive Monitoring of Traffic Rules," in *Proc. IEEE Conf. Intell. Transp. Syst.*, 2021, pp. 915–922.

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