Graph Neural Networks for Deep Behavior Prediction in Traffic Scenes

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.

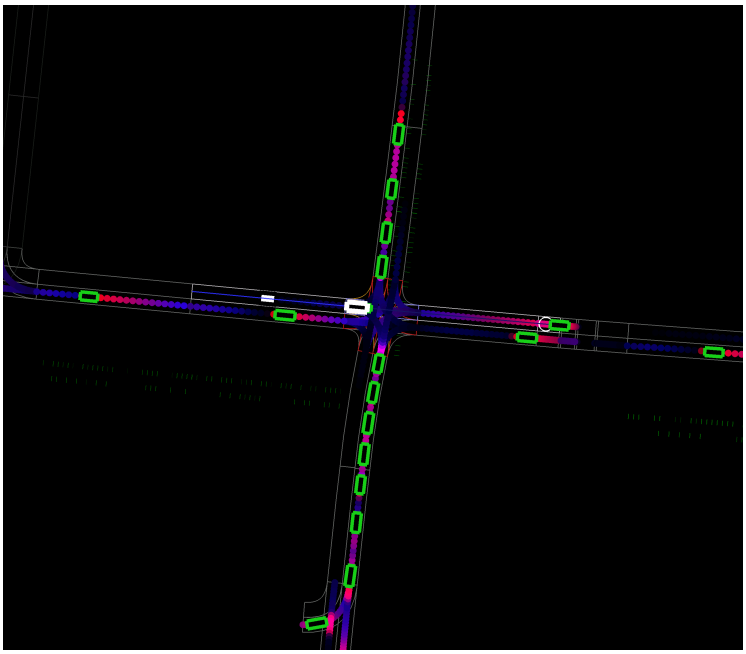

Figure 1: Example of a traffic scene. Traffic scenes contain a variable number of traffic participants as well as road networks of arbitrary topologies.

As traffic scenes can be naturally modelled as graphs, where vehicles and road segments are modelled as nodes and interaction effects are modelled as 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]. This offers a principled way of modeling the traffic environment in a joint fashion - while being invariant to the order of processing the individual nodes.

Description

In this thesis we aim to develop a GNN-based behavior prediction module. 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. We intend to apply information from traffic rule compliance by extracting the rule evaluations as node and edge features in the traffic graph. This can be formalized in temporal logic, as proposed in previous works [3], [4]. Based on the specifics of the prediction problem, we suggest incorporating the topology of the road

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Master Thesis

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Python, PyTorch

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

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network as a part of the (heterogeneous) traffic graph.

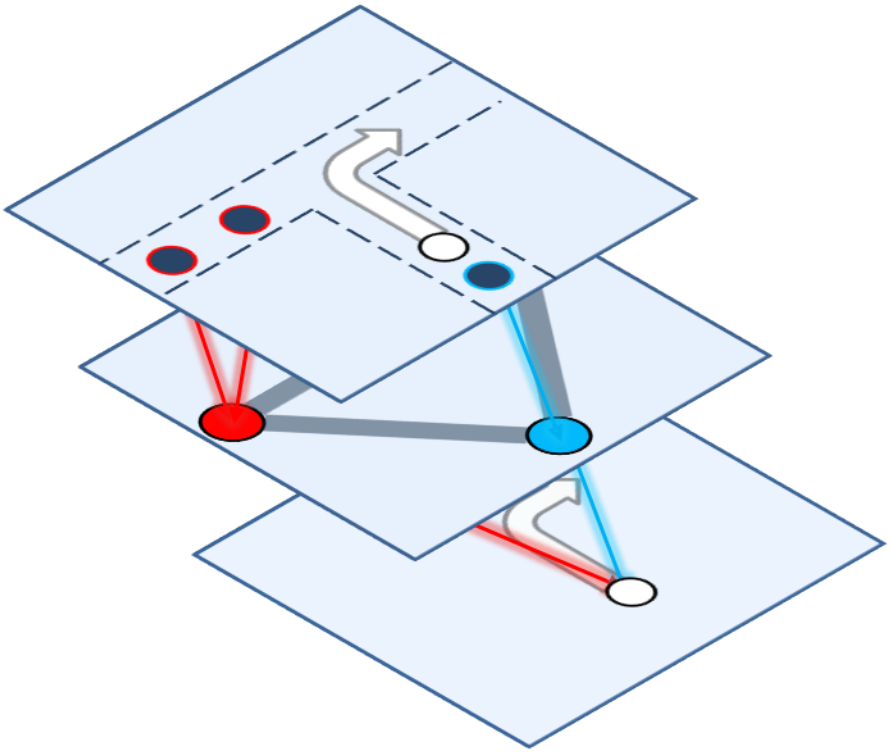

Figure 2: An illustration of a GNN-based traffic scene encoder with Vehicle-to-Infrastructure and Infrastructure-to-Ego message passing layers.

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.
- Develop a PyTorch-based GNN 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.

[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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