Göteborg, 2022-09-06

**Volvo Group Trucks Technology**
**Chalmers University of Technology**

Project overview:

# Highway autopilot using Deep Reinforcement Learning and Graph Neural Networks

More than one million people die in traffic accidents every year. One solution to improve traffic safety could be to develop safe autonomous vehicles that avoid dangerous human driving behaviors [1]. The main challenge of autonomous vehicles is decision making in complex environments such as lane changing in highways or crossing an intersection. Learning from own experiences and considering the states of surrounding vehicles is important in the decision-making process. Promising results in this area have been achieved using Deep Reinforcement Learning (DRL) [2]. An example project is available on Github: Link.

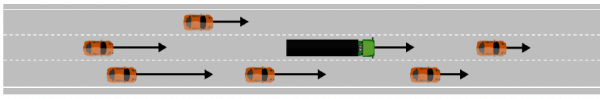

**Fig 1.** Highway driving scenario (Source: [2]).

In recent years Graph Neural Networks (GNNs) have become increasingly popular for modeling non-euclidean systems. Some popular applications combine DRL with GNNs to find control policies for multiple interacting agents [3,4]. GNNs have also achieved promising results in terms of describing the interactions between different vehicles in typical driving scenarios [5]. This project aims to use DRL with GNNs to create a highway autopilot that sets the vehicle speed, decides when to do lane changes and estimates the uncertainty of the decisions.

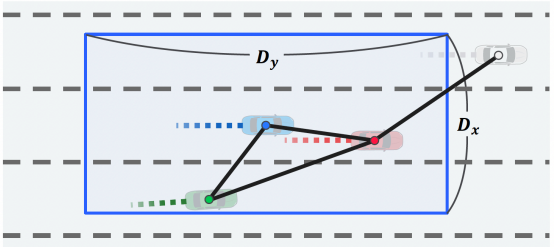


**Fig 2.** Representation of non-euclidean interactions in a driving scenario (Source: [5]).

The different tasks that can be tackled in this project in chronological order are:

1. Implement a GNN network architecture that can make predictions of traffic flow.
2. Investigate the feasibility of utilizing DRL together with a GNN to accomplish a safe driving scenario.
3. Successfully implement a DRL controller that accomplishes the desired task, utilizing a GNN within the deep Q-Network (?)
4. Estimate the uncertainty of the decisions that are generated by the DRL controller.

The aim of this project is to use advanced machine learning methods to solve problems within autonomous driving. The total work will include programming, machine learning, control theory, numerical optimization and vehicle simulation. The work is recommended for a group of students with a background in machine learning and Python with a good mathematical background. Prior experience with control theory and modeling/simulation is meritorious.

If you find this proposal interesting you can contact me at: erik.borve@volvo.com

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