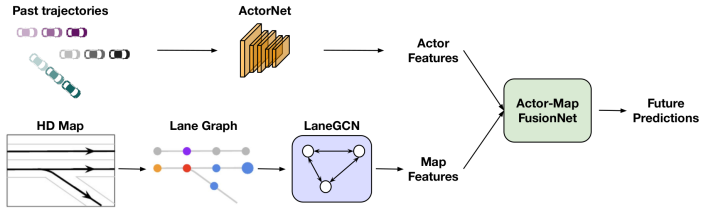
Karlsruhe Institute of Technology

Master Thesis / Bachelor Thesis

Graph-based Deep Reinforcement Learning for Autonomous Driving with Map Information

Deep Reinforcement Learning is a promising approach for autonomous driving. Often agents are trained in simulation in specific scenarios, for example highways, intersections, or merging scenarios. While they may perform well in these scenarios, the input representation is overfitted to the specific scenario, e.g. by considering only longitudinal coordinates along the road. This prohibits to transfer the learned policy to other scenarios. Using map information as an additional input to the agent, can help it generalize to new scenarios.



LaneGCN architecture for map-based prediction [2]

For prediction tasks, map-information is already used successfully within graph-based neural networks by LaneGCN and VectorNet [2,3]. For reinforcement learning, this has not been fully explored yet [4]. This work should explore the applicability of graph neural networks to incorporate map information into reinforcement learning agents.

This sounds exciting? Then apply to us! Methods and scope of the thesis can be adapted to your interests and previous knowledge. The proposed thesis consists of the following parts:

+ Literature research about reinforcement learning and graph neural networks
+ Implementation of an interface to query map information from Lanelet2 maps
+ Design of a neural network architecture to incorporate map information into reinforcement learning algorithms
+ Training the reinforcement learning agent on real driving data
+ Evaluation of the trained agent in a test environment

I am happy to answer any questions you might have. Feel free to ask for an appointment or directly ask at my office!

References

[1] Battaglia et al., “Relational Inductive Biases, Deep Learning, and Graph Networks”, 2018

[2] Liang et al., “Learning Lane Graph Representations for Motion Forecasting”, 2020

[3] Gao et al., “VectorNet: Encoding HD Maps and Agent Dynamics from Vectorized Representation”, 2020

[4] Konstantinidis et al., “Modeling Interaction-Aware Driving Behavior Using Graph-Based Representations and Multi-Agent Reinforcement Learning”, 2023

Institute of Measurement and Control Systems (MRT)
Prof. Dr.-Ing. Christoph Stiller

Advisor:
Johannes Fischer, M.Sc.

Programming language(s)[1]:
Python or Julia — advanced

System, Framework(s):
Linux

Required skills:
- Solid mathematical foundations
- Work on your own

Language(s):
German, English

For more information please contact:

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Or directly send in your application including your current grades as well as our questionnaire!

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[1] **skill levels:**

beginner	< 500 lines of code (LOC)
advanced	500 – 5000 LOC
proficient	> 5000 LOC