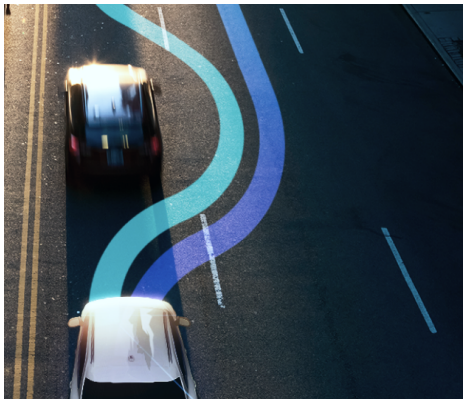
Karlsruhe Institute of Technology

Master Thesis



Motion Planning for Autonomous Driving [1] (left), GPT [2] (right)

Generalizing in Deep Learning-based Motion Planning using Large Language Models

Autonomous driving technology has seen significant advancements in recent years, primarily driven by the integration of deep learning models. Ensuring that *motion planning* models can generalize to a wide variety of real-world scenarios, however, remains a critical challenge. Addressing this issue is essential for enhancing the safety and reliability of autonomous vehicles.
Recently, *Large Language Models (LLMs)* have demonstrated impressive capabilities across diverse tasks, including text generation [2] and motion prediction for autonomous driving [3]. Leveraging the generalization power of LLMs in motion planning could potentially bridge the gap in model performance across different domains. Moreover, LLMs have the potential to improve the explainability of deep learning-based methods, providing clearer insights into how models make decisions.
The goal of this thesis is to explore and evaluate the generalization capabilities of LLMs in the context of motion planning tasks for autonomous vehicles.

The proposed thesis consists of the following parts:

+ Literature research about deep learning-based motion planning, especially LLM-based approaches
+ Analyze on which level LLMs can be applied in motion planning (encoding environment information or generating trajectories)
+ Implementation of a motion planning baseline model and a LLM improved version of it
+ Compare the performance of the models on the nuPlan benchmark [4]
+ Investigate the generalization capabilities of the models e.g. on the interPlan benchmark [5]

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

[1] `https://www.nuscenes.org/nuplan`
[2] `https://chatopenai.de/`
[3] A. Seff et al., "MotionLM: Multi-Agent Motion Forecasting as Language Modeling." 2023.
[4] H. Caesar et al., "NuPlan: A closed-loop ML-based planning benchmark for autonomous vehicles." 2022. `https://arxiv.org/abs/2106.11810`
[5] M. Hallgarten, J. Zapata, M. Stoll, K. Renz, and A. Zell, "Can Vehicle Motion Planning Generalize to Realistic Long-tail Scenarios?" arXiv, 2024. `http://arxiv.org/abs/2404.07569`

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

Advisor:
Marlon Steiner, M.Sc.

Programming language(s)[1]:
Python advanced

System, Framework(s):
Linux, PyTorch

Required skills:
- Prior knowledge of deep learning and its implementation in python
- Understanding complex deep learning-based model architectures
- Work on your own

Language(s):
German, English

For more information please contact:

Marlon Steiner

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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