Master Thesis
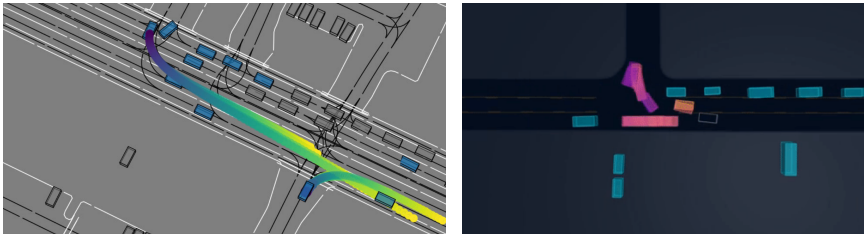

Deep Learning-based Motion Prediction task [1] (left), Benchmark for Motion Planning: Waymo Open Sim Agents Challenge [2,3] (right)

From Deep Learning-based Motion Prediction to Motion Planning and Simulation

The task of *motion planning* for autonomous driving is to find a single suitable trajectory that is safe, comfortable, and efficient. In contrast, *motion prediction* involves estimating the future trajectories of all traffic participants. In current modular software architectures for autonomous vehicles, motion prediction and motion planning are often treated as separate tasks. However, recent research has shown that integrating these tasks can lead to improved performance and robustness [4,5].

The goal of this thesis is to investigate the integration of deep learning-based motion prediction and motion planning [5] in the context of autonomous driving. Therefore, a state-of-the-art motion prediction model [1] will be utilized to implement a motion planner. The integration of those two modules will be evaluated in a simulation environment, such as the Waymo Open Sim Agents Challenge [3] or the nuPlan benchmark [6]. We are especially interested in overcoming purely reactive behavior and enabling safe navigation through traffic.

The proposed thesis consists of the following parts:

+ Literature research about motion prediction and motion planning and their integration
+ Adapt and retrain a motion prediction model [4] to serve as a motion planner
+ Evaluate the motion planner on the WOSAC benchmark [2]
+ Investigate the influence of different integration strategies on the performance

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

[1] R. Wagner, Ö. Taş, M. Steiner et al., "SceneMotion: From Agent-centric Embeddings to Scene-wide Forecasts." 2024.
[2] https://waymo.com/open/challenges/2024/sim-agents/
[3] N. Montali et al., "The Waymo Open Sim Agents Challenge." arXiv, 2023. http://arxiv.org/abs/2305.12032
[4] S. Hagedorn, M. Hallgarten, M. Stoll, and A. Condurache, "Rethinking Integration of Prediction and Planning in Deep Learning-Based Automated Driving Systems: A Review." 2023.
[5] M. Hallgarten, M. Stoll, and A. Zell, "From Prediction to Planning With Goal Conditioned Lane Graph Traversals." arXiv, 2023. http://arxiv.org/abs/2302.07753
[6] H. Caesar et al., "NuPlan: A closed-loop ML-based planning benchmark for autonomous vehicles." 2022. https://arxiv.org/abs/2106.11810

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

Room: 234 → just come by!
Phone: +49 721 608-43789
Email: marlon.steiner@kit.edu

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

[1] **skill levels:**
beginner   < 500 lines of code (LOC)
advanced   500 – 5000 LOC
proficient   > 5000 LOC