Institute of Automotive Technology
TUM School of Engineering and Design
Technical University of Munich

Master's Thesis

# Continual Learning of Complex Motion Patterns for Vehicle Motion Prediction in Autonomous Racing

The TUM Autonomous Motorsport team is at the forefront of developing advanced software for autonomous racing vehicles, participating in and winning cutting-edge racing series such as the Indy Autonomous Challenge (IAC) and the Abu Dhabi Autonomous Racing League (A2RL). Pushing the limits of autonomy, performing precise overtaking maneuvers at speeds exceeding 270 km/h - where milliseconds count - requires highly efficient software.

Training data for real-world vehicle motion prediction in autonomous racing, particularly involving complex interactions between multiple agents in the unstructured environment of a racetrack, is limited due to the high costs involved, so prediction models are trained in simulation. On track, however, opponents utilize different parameter sets, racing lines, and levels of aggression. Since observed trajectories provide their own labels a few seconds later, every session generates a continuous stream of supervision that a frozen model cannot exploit.

This research project investigates continual learning strategies that allow the prediction network to learn opponent-specific behavior patterns online, evaluating adaptation speed, catastrophic forgetting, and runtime cost.

**Work packages:**

- Literature research on continual, online, and few-shot learning
- Design and implementation of continual learning pipeline in motion prediction
- Evaluation of the pipeline in closed-loop simulation environment
- Analysis of the results and identification of directions for future research

**Requirements:**

- Enthusiasm about deep learning and autonomous driving
- Good programming skills in Python/C++
- Excellent Grades in ML- / DL-related courses
- Ability to collaborate in a team and engage in interdisciplinary research

If you are interested in this project, send me (marcel.weinmann@tum.de) your CV and grade report (Application Deadline 14.09.2026).