B) Racing line optimization algorithms for high performance and/or automated vehicles (1 student)

The basic goal of any racing sport is to complete a certain number of laps in the minimum possible time. In order to achieve this goal, it is useful to determine the optimal trajectory for a given racetrack, taking into account the physical properties of the racing vehicle. This problem is mostly called the minimum lap time problem (MLTP). The planning of time-optimal trajectories at the limits of handling is of great practical interest. In racing, it is common to use numerical optimization methods to determine the lap time for specific race cars. The aim of this project is to develop of a toolbox for racing line optimization for high performance and/or automated vehicles through advanced control strategies, e.g., machine learning algorithms.

Required skills:
-MATLAB & Simulink programming
- Python
- Knowledge of control engineering (e.g., gained from university courses)
- AI (highly desirable but not essential as it will be learnt during the project)
- Proactivity

References:
1) Christ, F., Wischnewski, A., Heilmeier, A., and Lohmann, B., “Time-optimal trajectory planning for a race car considering variable tyre-road friction coefficients”, Vehicle System Dynamics, International Journal of Vehicle Mechanics and Mobility, vol. 59, no. 4, pp. 588–612, 2021.
2) Heilmeier, A., Wischnewski, A., Hermansdorfer, L., Betz, J., Lienkamp, M., and Lohmann, B., “Minimum curvature trajectory planning and control for an autonomous race car”, Vehicle System Dynamics, International Journal of Vehicle Mechanics and Mobility, vol. 58, no. 10, pp. 1497–1527, 2020.
3) S. Garlick, and A. Bradley. Real-time optimal trajectory planning for autonomous vehicles and lap time simulation using machine learning. Vehicle System Dynamics. 60. 1-21.2021.