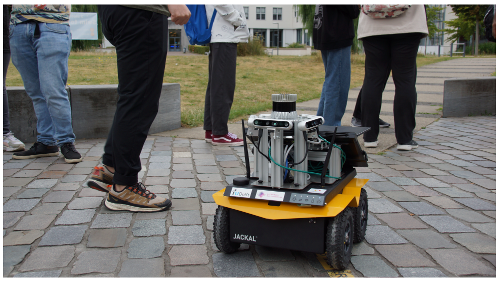
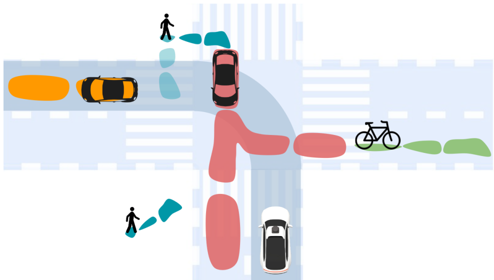
Prediction and Planning Integration for Autonomous Vehicle Applications

MSc. Project at Autonomous Multi-Robots Lab, Cognitive Robotics, TU Delft





Brief Description: In the past years, there has been an increasing strive towards the development of algorithms for autonomous vehicles. These algorithms are generally aimed at specific tasks of the perception and planning pipeline such as obstacle detection, prediction of future intentions of traffic participants, as well as the planning and control of the autonomous vehicle. More often than not these algorithms are developed as standalone modules with little to no interface to other modules in the pipeline. An essential component for the effective operation of a motion planner is a comprehensive prediction model. This model must possess the capacity to anticipate various behaviors exhibited by traffic participants along with their respective probabilities. To address this requirement for multi-modality, it is imperative that the dataset used for training the prediction model encompasses a diverse range of scenarios to accurately discern between different modes. In the domain of autonomous driving, simulation frameworks play a pivotal role in generating traffic datasets derived from either real-world recorded data or hand-crafted scenarios.

Requirements: The focus of this thesis is on developing a framework for seamlessly incorporating different modules of the perception and planning pipeline. Special importance is placed on being able to integrate different kinds of prediction models - be they deterministic or probabilistic - with different kinds of planners. The design requirements are as follows:

1. The interface between prediction and planning modules, both of which can be either deterministic or probabilistic.
    - Accounting for compatibility between single-agent and multi-agent modules.
2. Evaluation of the combined prediction-planning pipeline in a desired environment (e.g. CommonRoad [1]).

3. Training the prediction module on a desired dataset.
    - Ensure that the dataset is rich enough to account for the cases relevant for the evaluation of the pipeline. Possible options for achieving this could either be through data analysis of existing dataset or the generation of (semi-)synthetic datasets.
    - The current set of scenarios provided by CommonRoad may lack the necessary diversity to effectively capture the multi-modality inherent in real-world traffic scenarios. Given this limitation, hand-crafted scenarios may be required to be generated to capture the multi-modality.
4. Evaluation of how the efficacy of the prediction model impacts the operational behavior of the motion planner will be conducted, with particular emphasis on the contingency planning strategy outlined in reference [2].

Desired Qualities:

- Motivated and independent.
- Good problem-solving skills.
- Very good experience with Python programming.
- Familiar with optimization and motion planning.
- Familiar with machine learning and neural networks.

Start Date: August to November 2024

For further questions or to apply, please contact Anna Meszaros (a.meszaros@tudelft.nl) or Khaled Mustafa (k.a.mustafa@tudelft.nl). When applying, please provide a short motivation, an up-to-date CV, a transcript of your current degree program, and the intended start date.

Group information: www.autonomousrobots.nl

References:

[1] M. Althoff, M. Koschi, and S. Manzinger. Commonroad: Composable benchmarks for motion planning on roads. *IEEE International Vehile Symposium*, pages 719–726, 2015.

[2] K. Mustafa, D. Jarne Ornia, J. Kober, and J. Alonso-Mora. Racp: Risk-aware contingency planning with multi-modal predictions. *IEEE Transactions on Intillegent Vehicles*, 2024.