

Enabling one-dimensional Motion Planning in CommonRoad Benchmark Suite



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Background

Performing numerical experiments is a crucial part in the development of motion planning algorithms for autonomous vehicles. In order to make development and research results reproducible, the benchmark suite [CommonRoad](#) was developed [1]. CommonRoad provides all information required to reproduce experiments like scenarios, vehicle models and cost functions. Also, auxiliary functionality is provided, e.g., for visualization or drivability checking of planned motions [2]. CommonRoad is designed to provide a base for planning in the two-dimensional position domain \mathbb{R}^2 . However, there are use cases, where planning in an one-dimensional position domain, e.g., along a reference path Γ , is desired. This can be the case for autonomous systems operating in restricted operational design domains (ODDs), or systems, where the lateral movement is controlled by separated functionality. An example is the shuttle system of ZFs daughter company [2getthere](#), which operates along a static path of magnetic landmarks. Note, that even if we consider only one positional domain for planning, constraints and rules based on the multi-dimensional environment still apply.

Description

The aim of this thesis is to extend the CommonRoad benchmark suite to support one-dimensional motion planning problems. First, the required information must be defined (e.g. reference path, start and goal specification, intermediate goals). Then, the underlying XML structure of CommonRoad shall be adapted accordingly. CommonRoad provides a set of ready-to-use vehicle models. This set shall be extended by models for one-dimensional movement, e.g., longitudinal point mass models of third or fourth order. To evaluate solutions of one-dimensional planning problems online, a cost function shall be added, that only considers metrics for motion in one positional dimension.

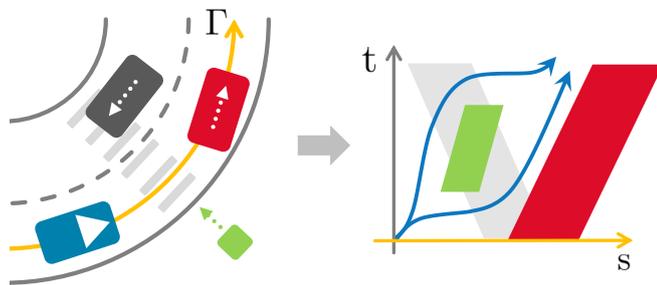


Fig. 1: Example scenario and representation as one-dimensional planning problem.

Tasks

- Add one-dimensional vehicle models to the [CommonRoad vehicle models](#) and adapt the [drivability checker](#) respectively.
- Specify and add one-dimensional planning problems to the CommonRoad XML structure (see [CommonRoad documentation](#)).
- Add a cost function to the [CommonRoad cost functions](#), that only considers longitudinal motion.
- Create representative example scenarios and write a tutorial jupyter notebook solving a one-dimensional motion planning problem.
- Optional: Implement functionality to set CommonRoad elements, like dynamic objects, into a relation to the one-dimensional planning problem (e.g. should an object driving on the oncoming lane be considered?).

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Advisor:

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Research project:

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Type:

Bachelor's Thesis

Research area:

Motion Planning, Scenario Description

Programming language:

Python, XML

Required skills:

Good programming skills, interest in autonomous driving

Language:

English

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References

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- [2] Stefanie Manzinger Murat Can Üste Christian Pek, Vitaliy Rusinov and Matthias Althoff. Commonroad drivability checker: Simplifying the development and validation of motion planning algorithms. In *Proc. of the IEEE Intelligent Vehicles Symposium*, 2020.



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