

LLM-Based Architectural Refactoring and Unification of CommonRoad Scenario Designer



Technical University of Munich



Department of Informatics
Chair of Robotics, Artificial
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Systems

Background

The development and validation of autonomous-driving functions require a large number of traffic scenarios. Such scenarios are used to evaluate motion-planning and prediction algorithms, test autonomous-vehicle software stacks, and support research publications and student projects. The CommonRoad Scenario Designer [1] is an open-source toolbox for converting, creating, editing, and visualizing maps and traffic scenarios. It supports OpenStreetMap, Lanelet/Lanelet2, OpenDRIVE, SUMO, and CommonRoad, and provides an application programming interface, a command-line interface, and a graphical user interface.

The existing Scenario Designer is implemented as a Python-based desktop application. Its graphical user interface provides functionality for map conversion, road-network editing, obstacle editing, traffic simulation, and scenario metadata manipulation. Currently, a new browser-based graphical user interface is being developed using React and svg.js. The current web application supports loading and visualizing CommonRoad scenarios, while interactive editing of road networks, vehicles, and trajectories is under development.

At present, both implementations are developed separately. Before unifying them, the existing architecture must be analyzed to determine which components should be extracted into independent reusable toolboxes and which should be integrated into the web-based application. Large language models can support this process through repository-level code analysis, dependency discovery, refactoring, and test generation.

Supervisor:

Prof. Dr.-Ing. Matthias Althoff

Advisor:

Shuaiyi Li

Research project:

Type:

BA

Research area:

Software Engineering

Programming language:

Python, JavaScript/TypeScript

Required skills:

Good programming skills in Python and JavaScript/TypeScript, good knowledge of Git and web development, basic knowledge of large language models, self-motivated working

Language:

English

Date of submission:

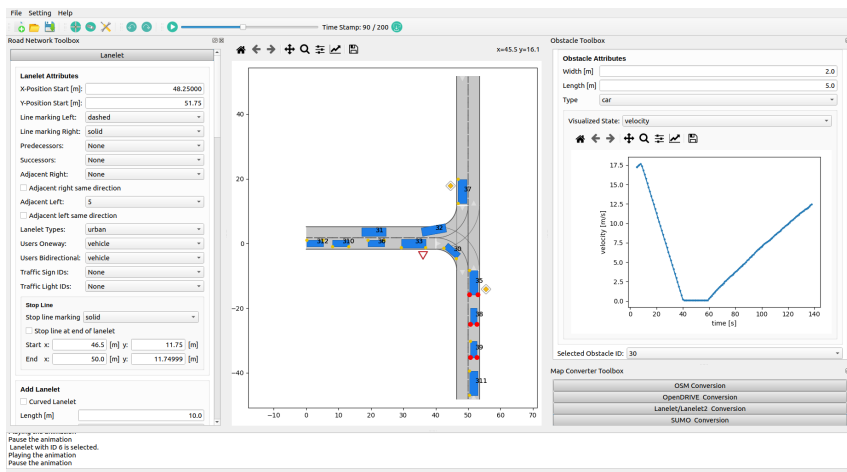
Flexible

For more information please contact us:

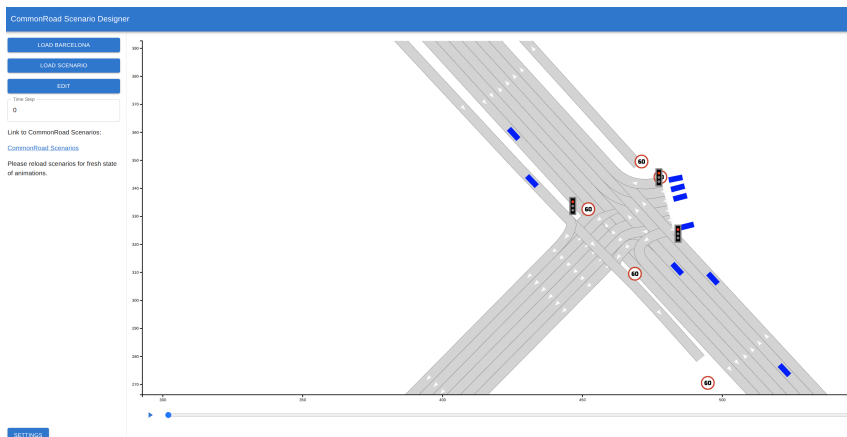
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Existing desktop Scenario Designer



Web-based Scenario Designer

Description

The main goal of this thesis is to conduct an LLM-assisted architectural refactoring of the existing CommonRoad Scenario Designer and the currently developed web-based Scenario Designer. The implementation should proceed in small, verifiable steps, with generated changes reviewed and validated through automated tests. The resulting system should reuse existing functionality wherever possible and support loading, visualizing, editing, validating, and saving CommonRoad scenarios. Particular attention should be paid to interactive road-network editing and the manipulation of vehicles and their trajectories. The thesis shall also evaluate the usefulness and limitations of the LLM-assisted refactoring process, including the correctness of generated modifications, the required manual intervention, and the preservation of existing functionality.

Tasks

- Familiarize yourself with the CommonRoad format and both Scenario Designer implementations.
- Analyze the architecture and dependencies of the existing Scenario Designer. Evaluate which components should be extracted into separate toolboxes and which should be integrated into the web application.
- Design a target architecture and an LLM-assisted refactoring workflow. Implement and validate the interface between the React frontend and the Python backend.
- Document the implementation and evaluation results in a thesis report.

References

- [1] Sebastian Maierhofer, Moritz Klischat, and Matthias Althoff. Commonroad scenario designer: An open-source toolbox for map conversion and scenario creation for autonomous vehicles. In *Proc. of the IEEE Int. Conf. on Intelligent Transportation Systems*, pages 3176–3182, 2021.



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