

Automatic Traffic Scenario Conversion from OpenSCENARIO to CommonRoad

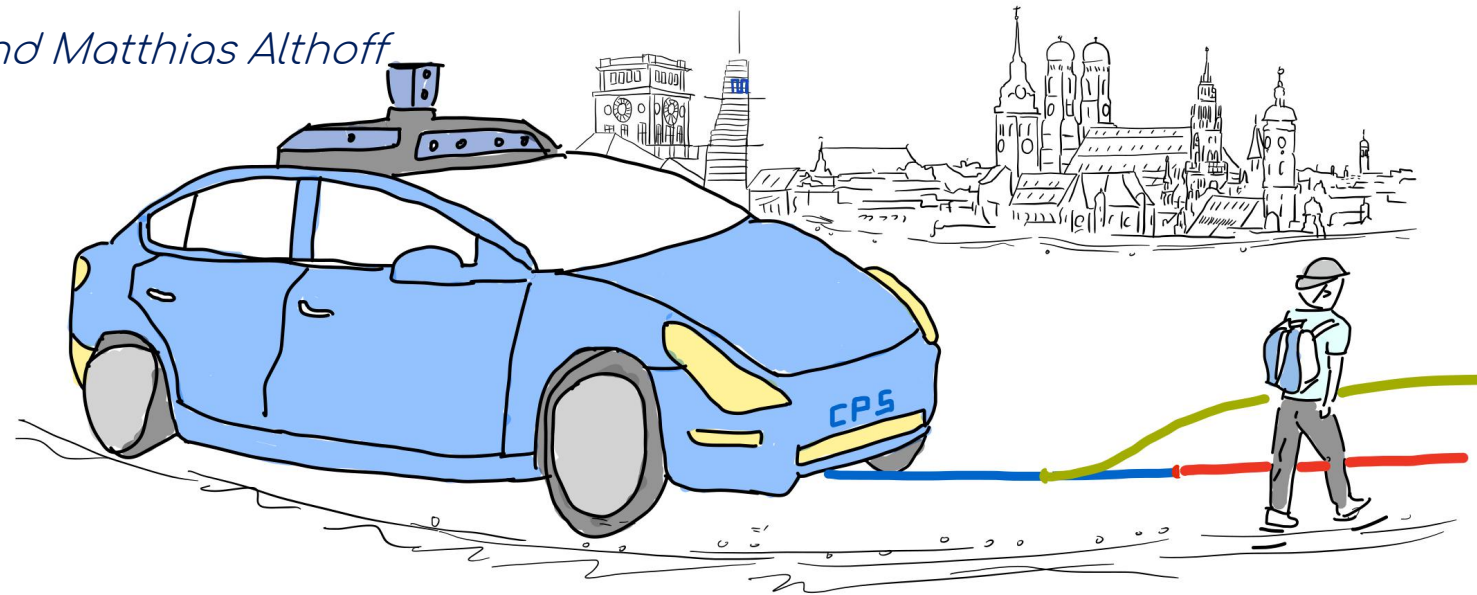
Sebastian Maierhofer

on behalf of Yuanfei Lin, Michael Ratzel, and Matthias Althoff

2023/09/26 - Bilbao, Spain

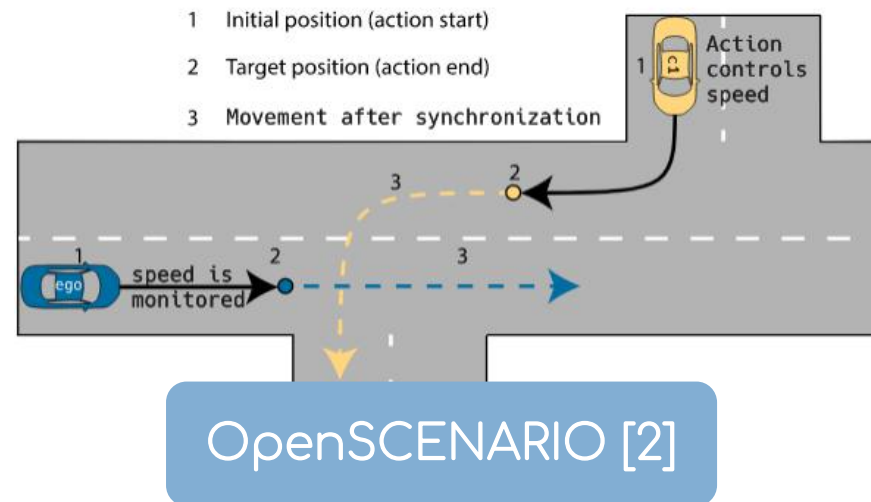
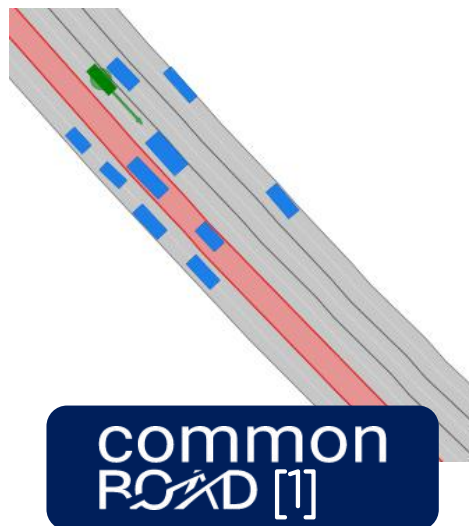
Cyber-Physical Systems Group

Technical University of Munich



Motivation

- Shortage of both open-source and commonly-used scenarios
- Different applications support specific scenario formats based on their purposes



```
1 wiggle = Range(-10 deg, 10 deg)
2 ego = Car with roadDeviation wiggle
3 c = Car visible, with roadDeviation resample(wiggle)
4 leftRight = Uniform(1.0, -1.0) * Range(1.25, 2.75)
5 Car beyond c by (leftRight, Range(4, 10)),
6   with roadDeviation resample(wiggle)
```



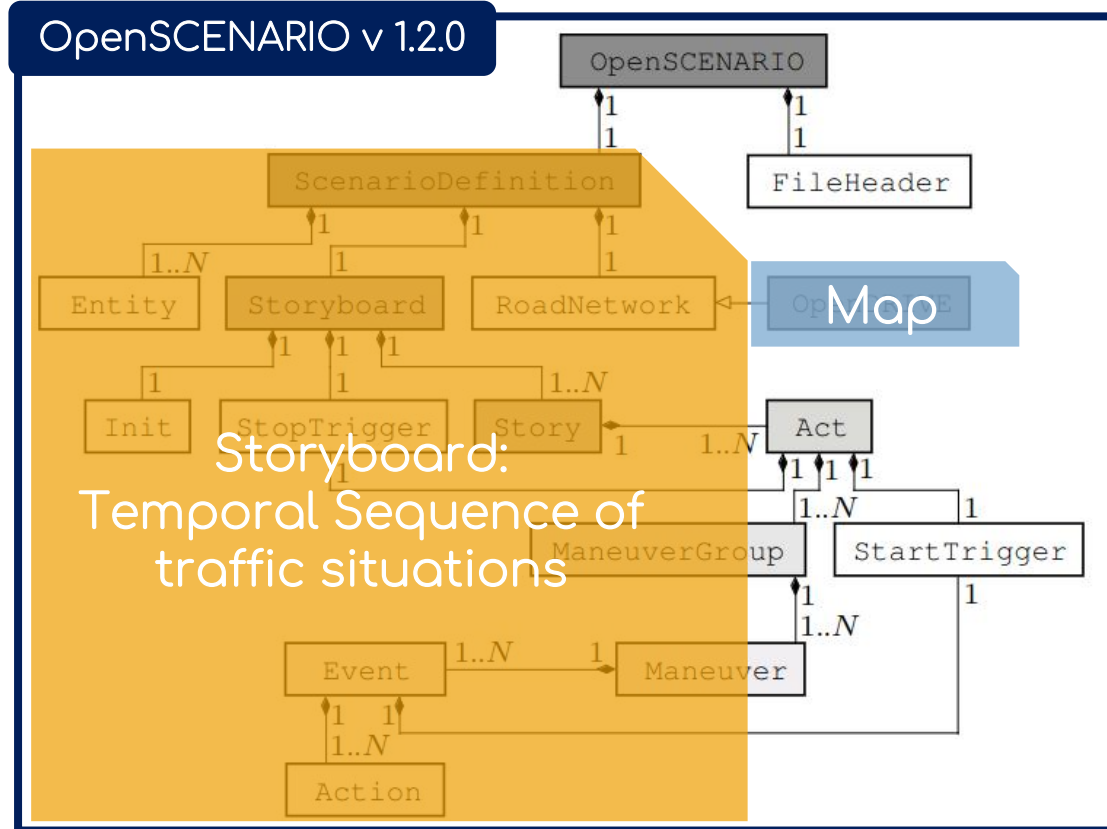
[1] M. Althoff, M. Koschi, and S. Manzingler, "CommonRoad: Composable benchmarks for motion planning on roads," IV 2017.

[2] <https://www.asam.net/standards/detail/openscenario/>

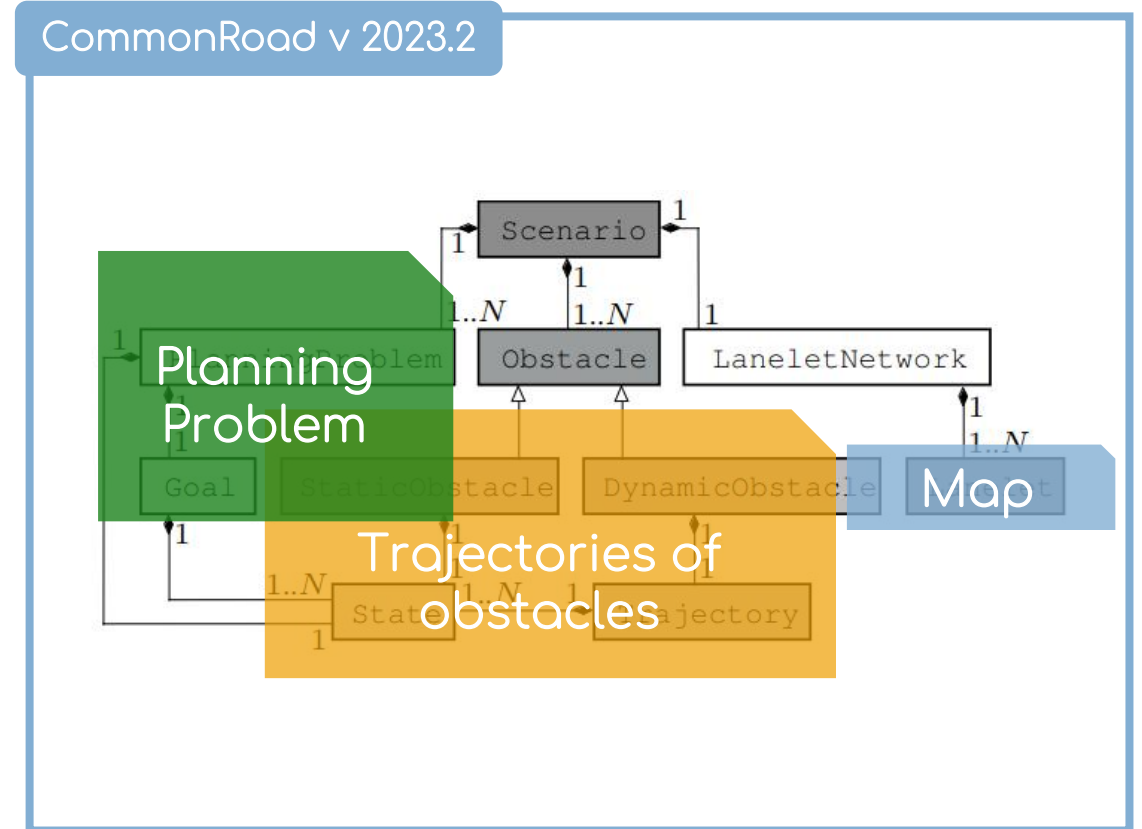
[3] Fremont, D.J., Dreossi, T., Ghosh, S., Yue, X., Sangiovanni-Vincentelli, A.L. and Seshia, S.A.. "Scenic: a language for scenario specification and scene generation". SIGPLAN 2019

OpenSCENARIO to CommonRoad

Both cover the design and implementation of a traffic scenario



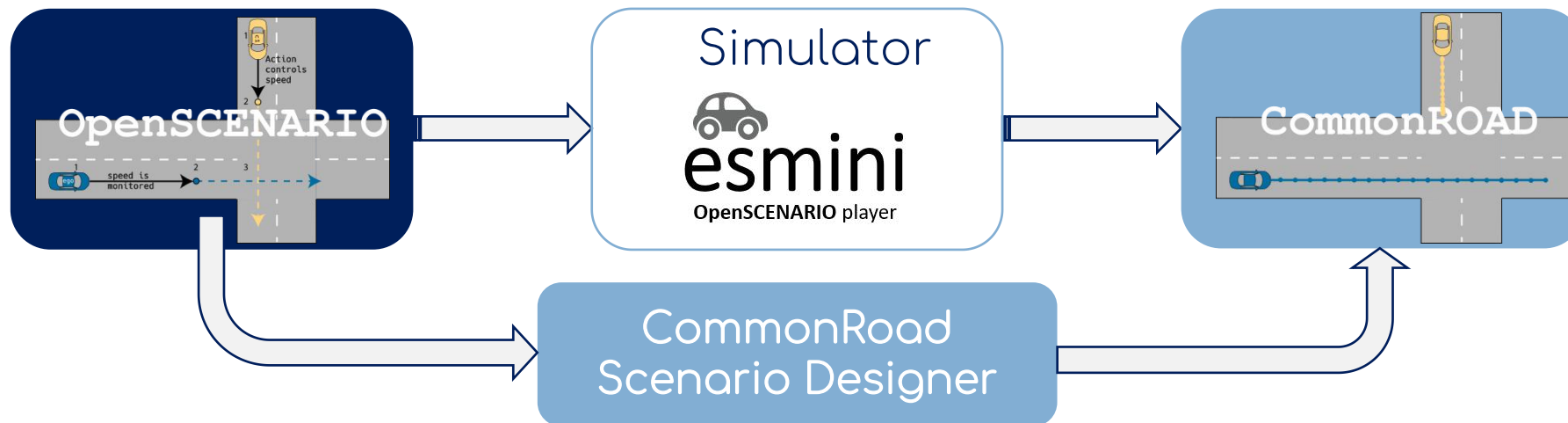
Logical Scenario



Concrete Scenario

Toolbox Overview

- Map Conversion: Convert OpenDRIVE To Lanelets [4] [5]
- Storyboard Conversion: OpenSCENARIO player - esmini [6]
- Planning Problem Construction: based on ego vehicle's trajectory

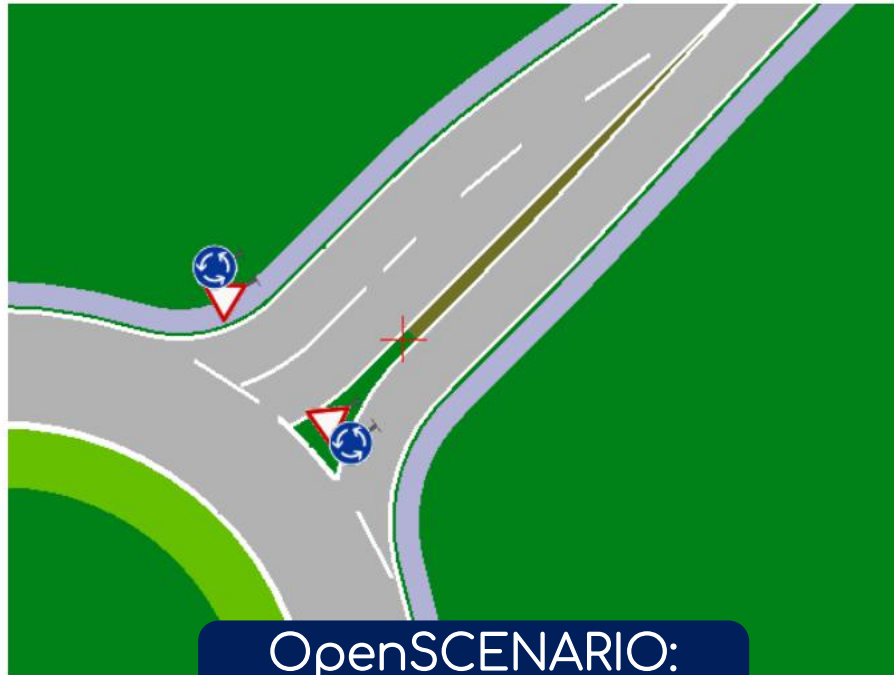


[4] M. Althoff, S. Urban, and M. Koschi, "Automatic conversion of road networks from OpenDRIVE to lanelets," SOLI 2018.

[5] S. Maierhofer, M. Klischat, and M. Althoff, "Commonroad scenario designer: An open-source toolbox for map conversion and scenario creation for autonomous vehicles." ITSC 2021

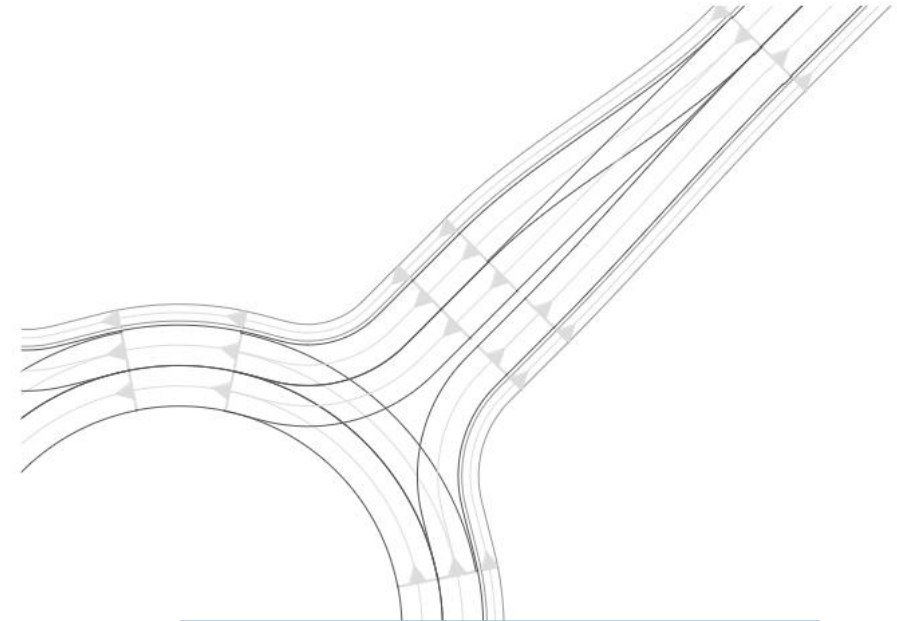
[6] <https://github.com/esmini/esmini>

Map Conversion



OpenSCENARIO:
OpenDRIVE

Lanes built from reference lines using clothoids or polynomials



common
ROAD Lanelets

atomic, interconnected, and drivable road segment

Storyboard Conversion

Esmini: orchestrate and execute the dynamic elements defined by OpenSCENARIO

OpenSCENARIO:
Storyboard

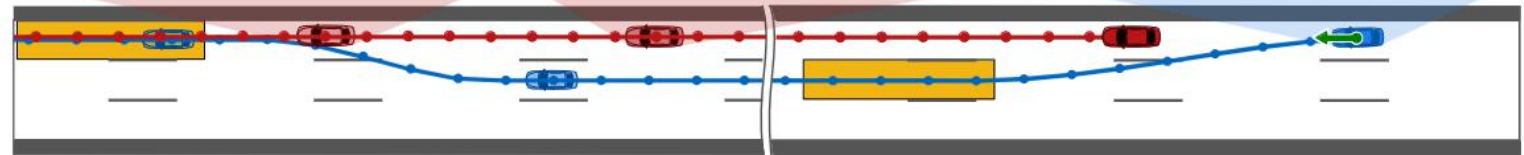


common
ROAD Trajectories

An overtaking story

Legend for the overtaking story:

- vehicle A (blue car icon)
- vehicle B (red car icon)
- initial state (green arrow icon)
- goal region (yellow square icon)
- driving direction (black arrow icon)
- trajectory (blue line with dots icon)



Evaluation

1. OpenSCENARIO standard examples
2. the esmini demonstration package
3. automated lane keeping scenarios

Source	Success Rate	Avg. Conversion Time	Avg. Scenario Duration
I	100.0% (13/13)	10.68s	53.61s
II	100.0% (26/26)	18.20s	30.96s
III	100.0% (15/15)	66.34s	40.64s

[7] <https://github.com/asam-oss/OSC-ALKS-scenarios>

common ROAD Universe

CommonRoad Input-Output Motion Planning Utilities

- scenario representation
- visualization

- CommonRoad-Drivability-Checker
- CommonRoad-Reach
- CommonRoad-CriMe

- CommonRoad-Route-Planner
- SPOT: Set-based Prediction
- Vehicle Models and Cost Functions

Deep Learning

- CommonRoad-Geometric
- CommonRoad-RL

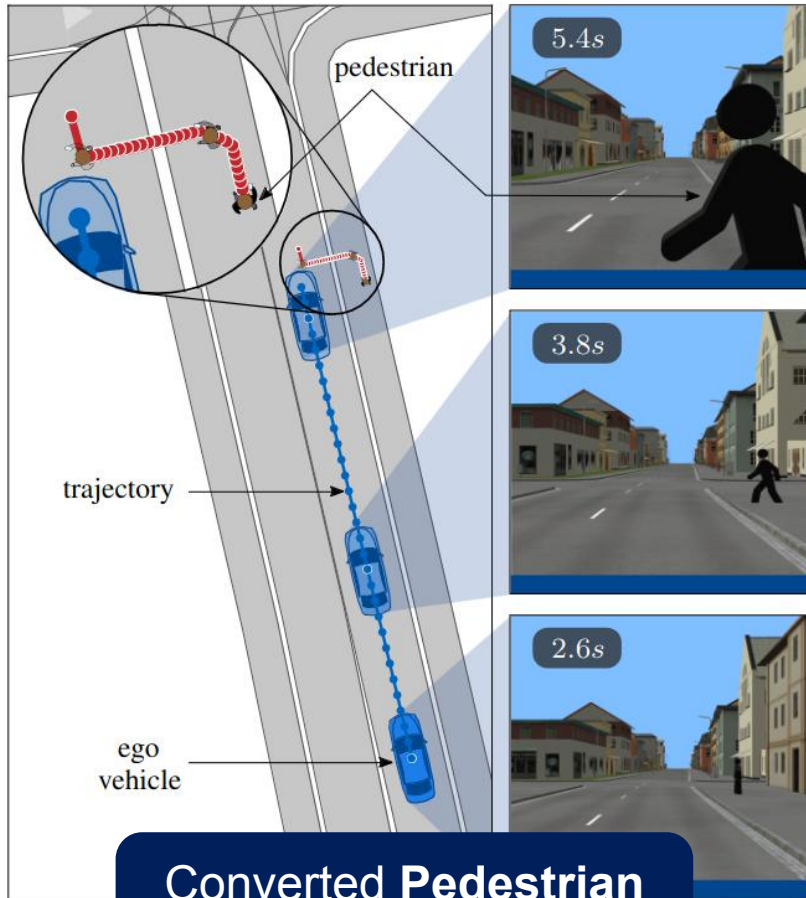
Scenario Creation & Conversion and more ...

- CommonRoad Scenario Designer
- CommonRoad-OpenSCENARIO-Converter
- Dataset Converter

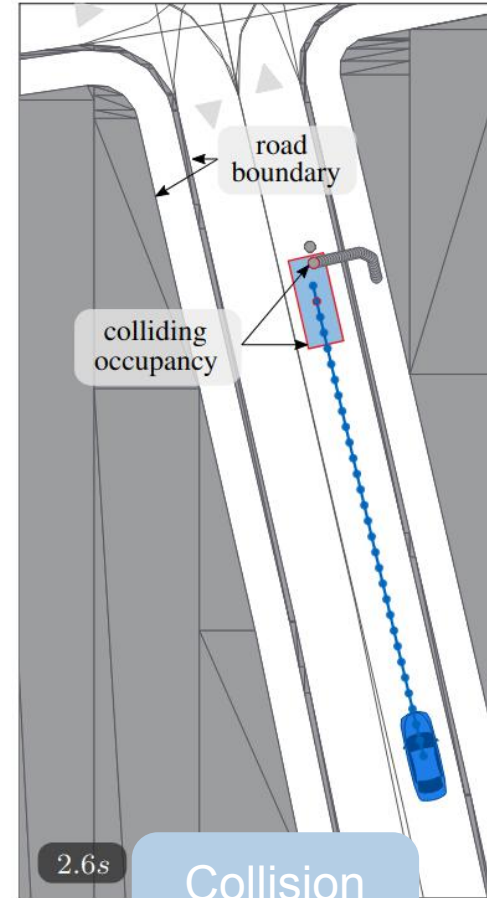
- CommonRoad-Apollo Interface
- CommonRoad-Autoware Interface
- CommonRoad-Carla Interface

commonroad.in.tum.de | `pip install commonroad-all`

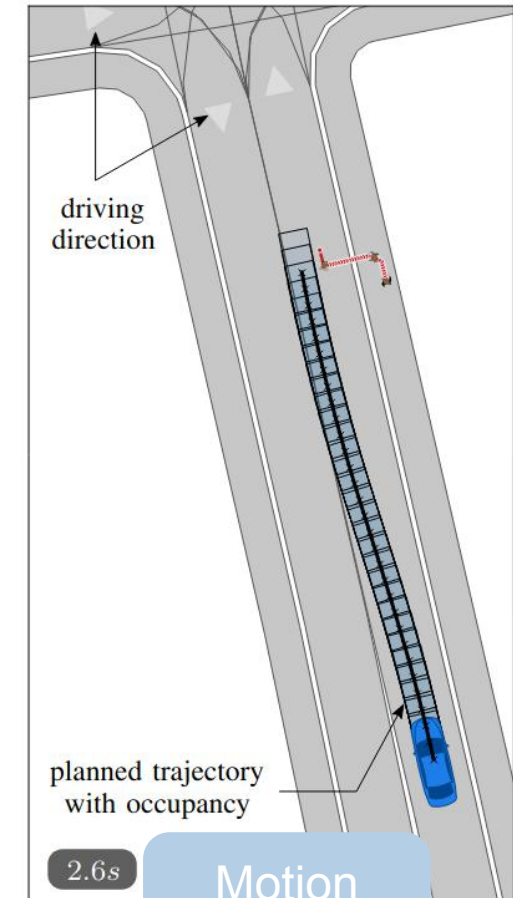
OpenSCENAIO Evaluation



Converted Pedestrian Collision Scenario

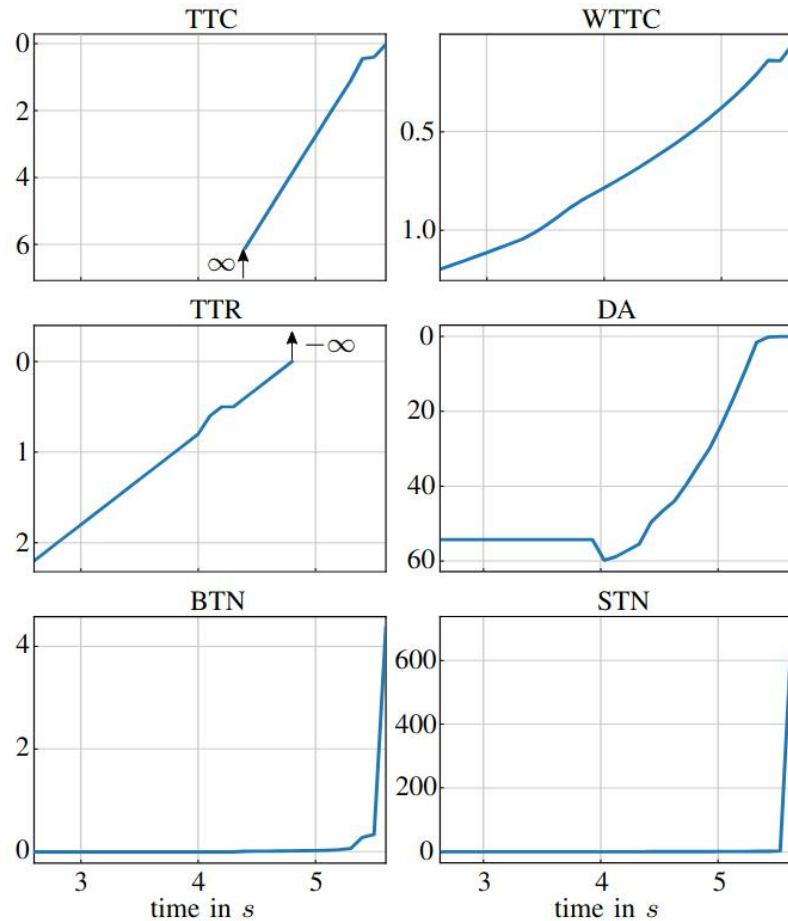


Collision Checking

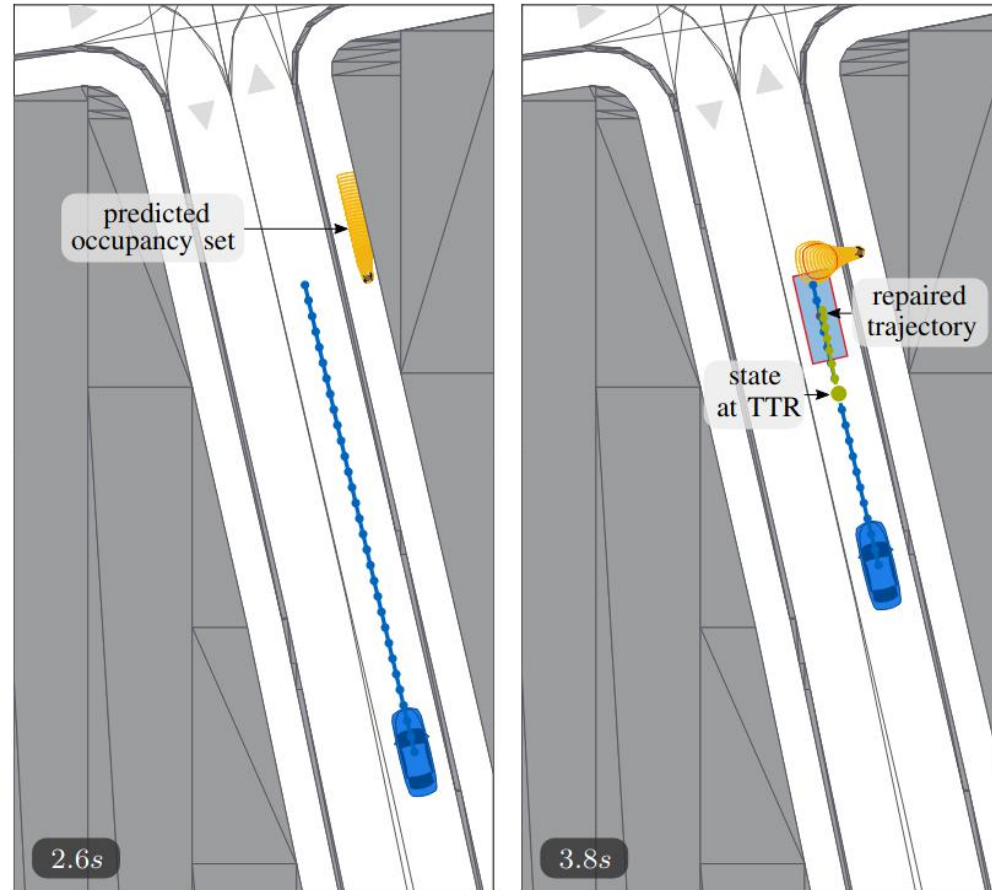


Motion Planning

OpenSCENAIO Evaluation



Criticality Measures



Safety Verification and Trajectory Repair



Key Takeaways

first publicly available converter from OpenSCENARIO to CommonRoad
[pip install commonroad-openscenario-converter](#)

Available at

commonroad.in.tum.de

