REQUIREMENTS AND CONDITIONS – Booth No. 08

CRITICAL SCENARIOS FOR HUMAN DRIVERS – CRITICALITY METRIC

PEGASUS

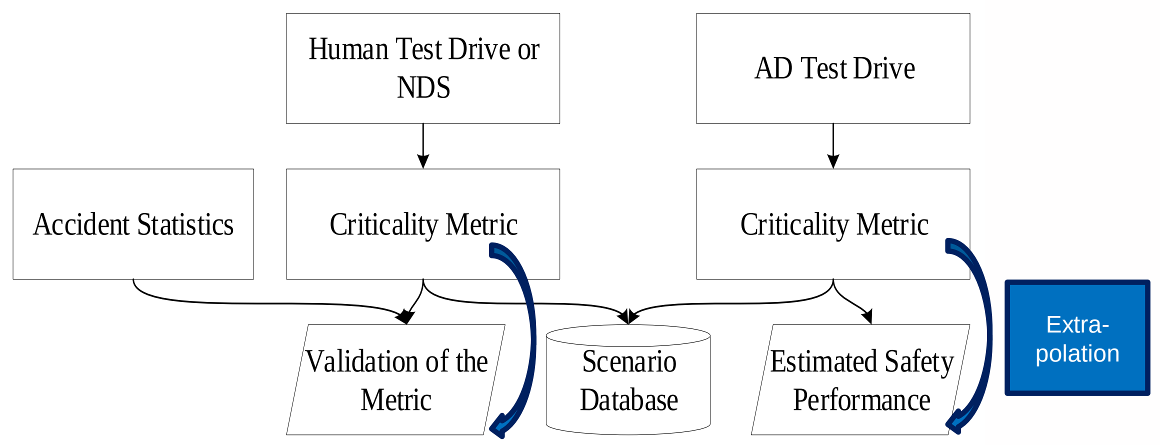
Concept and Application of a Criticality Metric for two Purposes

Identify Critical Situations

- Derive Critical Situations from **recorded data (such as BMW Euro FOT and other sources)**
- Mark Scenarios in the PEGASUS **database** as critical and important for **test case derivation**
- Determine **relevant features and feature distributions** in individual scenarios
- **Efficient** preselection of critical scenarios that might be critical using **machine learning** with several (simple) metrics as feature (WTTC, TTB, THW, CI)
- Assess potentially critical scenarios with **advanced metric** based on trajectory optimization

Estimate Safety Performance

- Determine the **frequency of certain situations (such as approaching traffic jam)** e.g. by using BMW Euro FOT data and **assessing driver behavior**
- Metric needs to be designed to be applicable **on all kinds of situations** linking criticality to crash likelihood
- Extrapolate the **Safety Performance** using **statistical** methods (not developed in PEGASUS, see References)
- Human traffic can be used as **validation** because the **accident statistics** are known assuming that the metric is valid for both “drivers“ (human and HAD)



Two purposes for criticality metric

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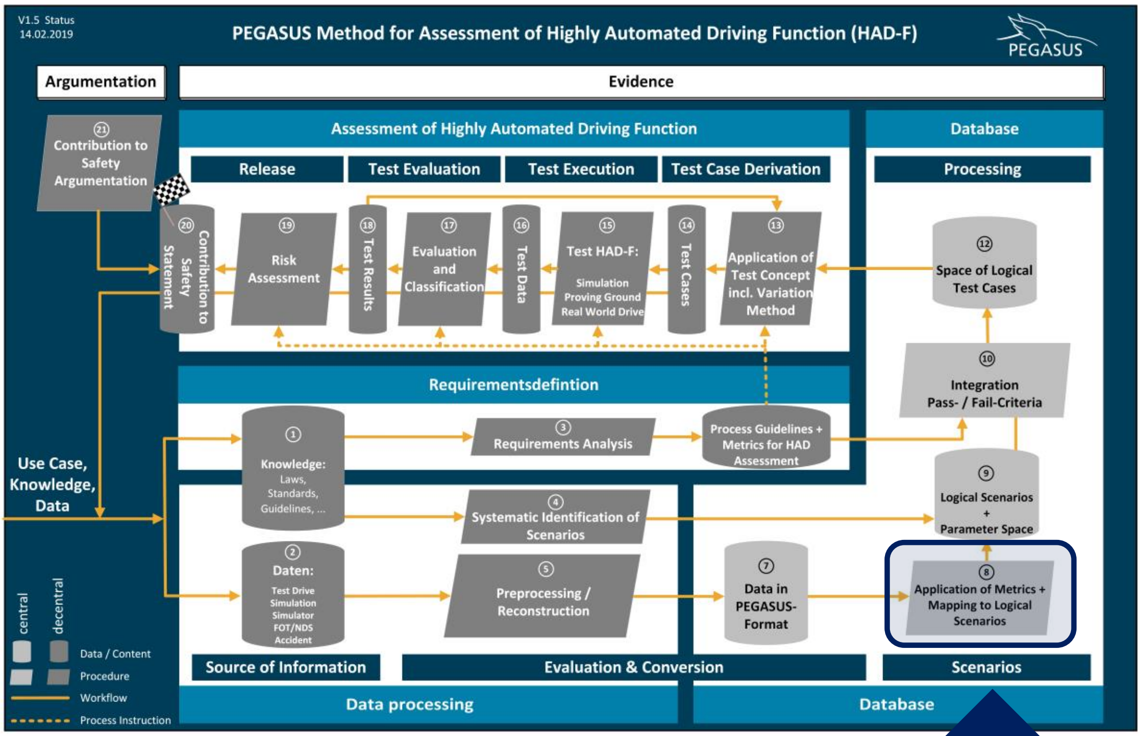
Integration into PEGASUS Method

Application

The metrics are applied inside the mechanics of the **PEGASUS database** after the available data is transformed into a **unifying data format**.

The metrics are applicable on **all kinds of motorway scenarios**.

BMW Euro FOT and other source data with potentially critical scenarios has **been loaded to the PEGASUS database**.



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Concept of the Metric

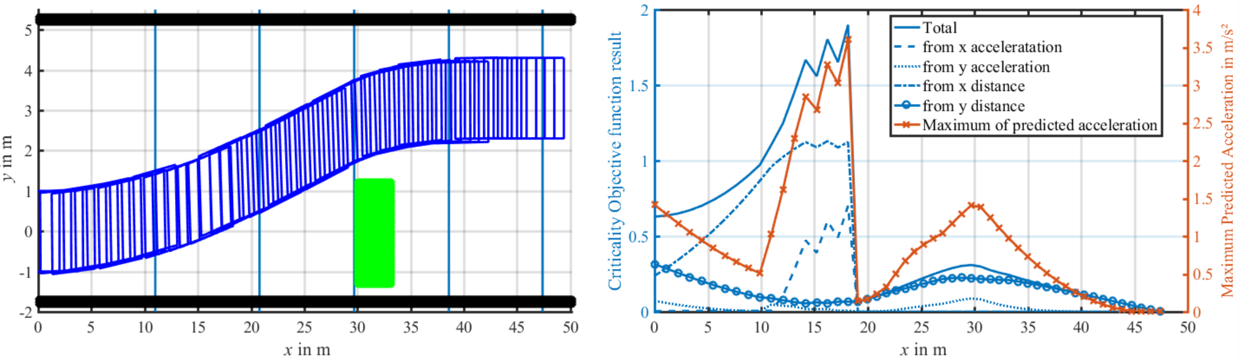
Computation of Criticality

- Optimization problem to find the trajectory with minimal criticality

$$\min_u J = \sum_{k=1}^{N-1} w_x R_x(k) + \sum_{k=1}^{N-1} \mathrm{w}_y R_y^2(k) + \sum_{k=1}^{N-1} w_{ax} \frac{a_x^2(k)}{(\mu_{\max} g)^2} + \sum_{k=1}^{N-1} w_{ay} \frac{a_y^2(k)}{(\mu_{\max} g)^2}$$

Long. Margin | Lat. Margin | Long. Accel. | Lat. Accel.

- Margins are dependent on the environment information
- The final Criticality is derived from the maximum of the required accelerations in this trajectory
- For more information see the publication in IEEE ITSC 2018: Junietz, P.; Bonakdar, F.; Klamann, B.; Winner, H.: Criticality Metric for the Safety Validation of Automated Driving using Model Predictive Trajectory Optimization



Obstacle Scenario

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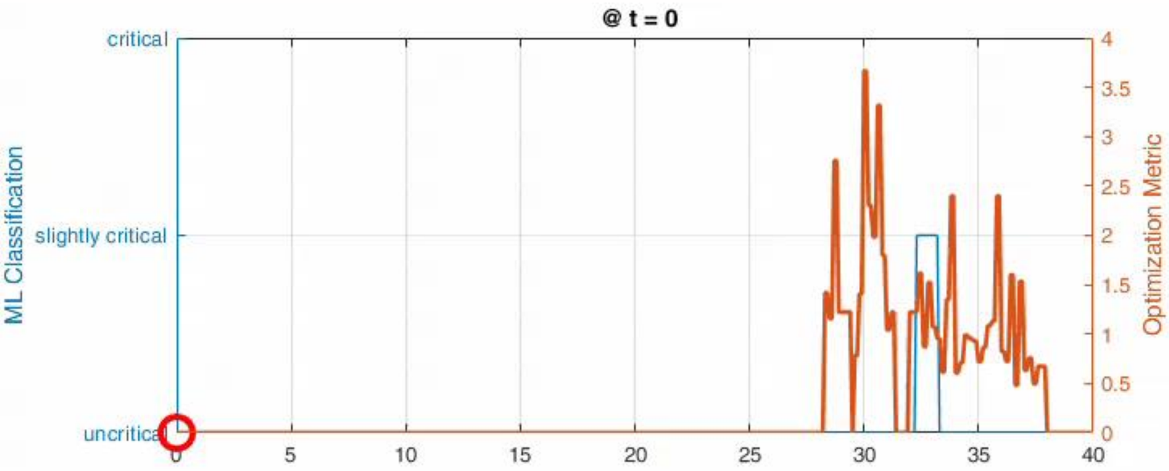
Application on Recorded Data on BMW FOT/NDS Drives



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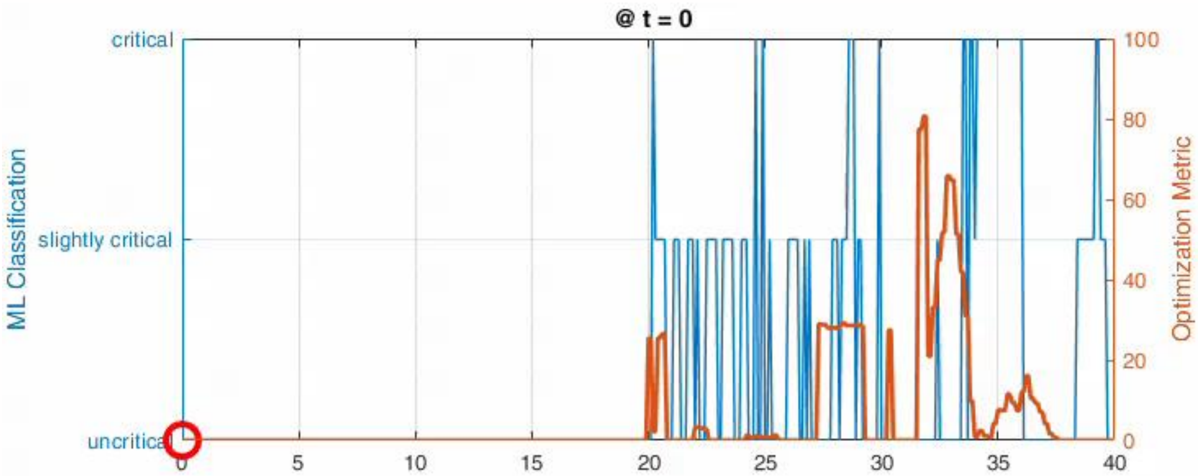

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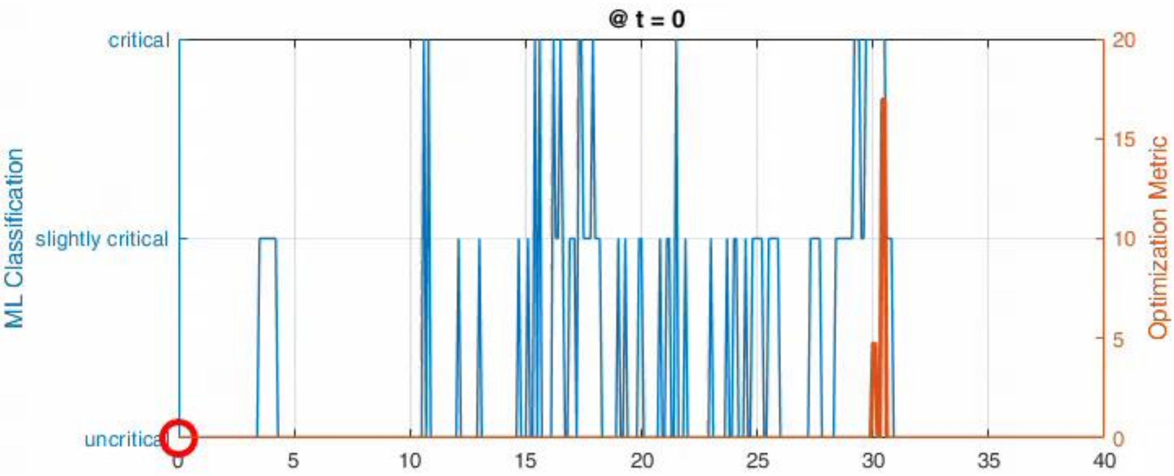

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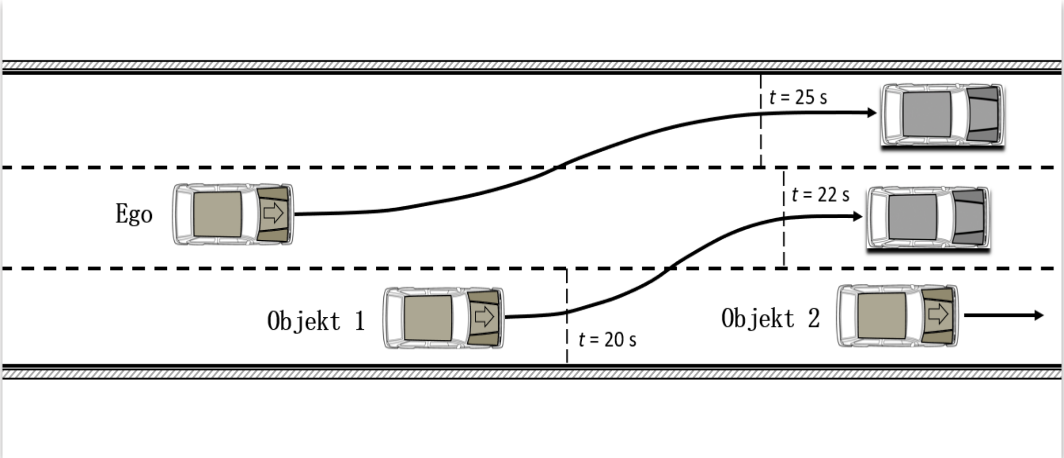
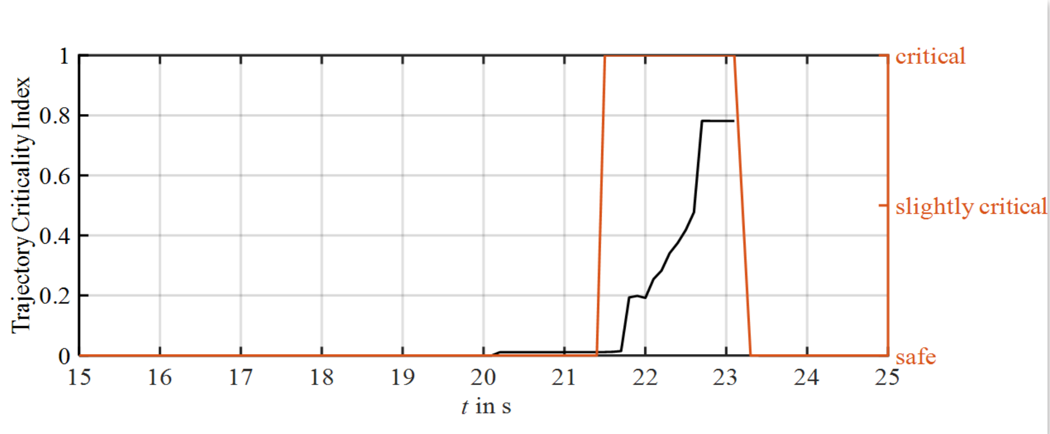
Application on Simulation





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Other relevant Literature

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