



Benoit Vanholme (BMW)



Verification & Validation Expert



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THE USE OF EDGE CASES FOR THE DEVELOPMENT OF AUTOMATED DRIVING.

EDGE CASES: A CHALLENGE AND AN OPPORTUNITY.



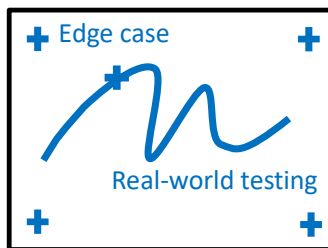
Dr. Benoit Vanholme
Verification & Validation Department
Division of Driving Experience, Automated Driving



EDGE CASES: A CHALLENGE & AN OPPORTUNITY FOR THE V&V OF AUTOMATED DRIVING SYSTEMS.

Why a challenge?

- **Extremely rarity** of safety-critical cases during real-world test driving: a fatal accident happens every 226 million km, material damage every 300 000 km (Destatis 2016).
- **Importance** to demonstrate system behavior for these rare cases, both from a societal, as from a safety point-of-view (White paper SaFAD / ISO TR 4804 / ISO TS 5083).

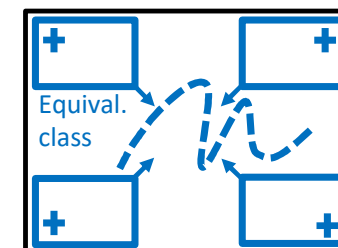


Test space

Why an opportunity?

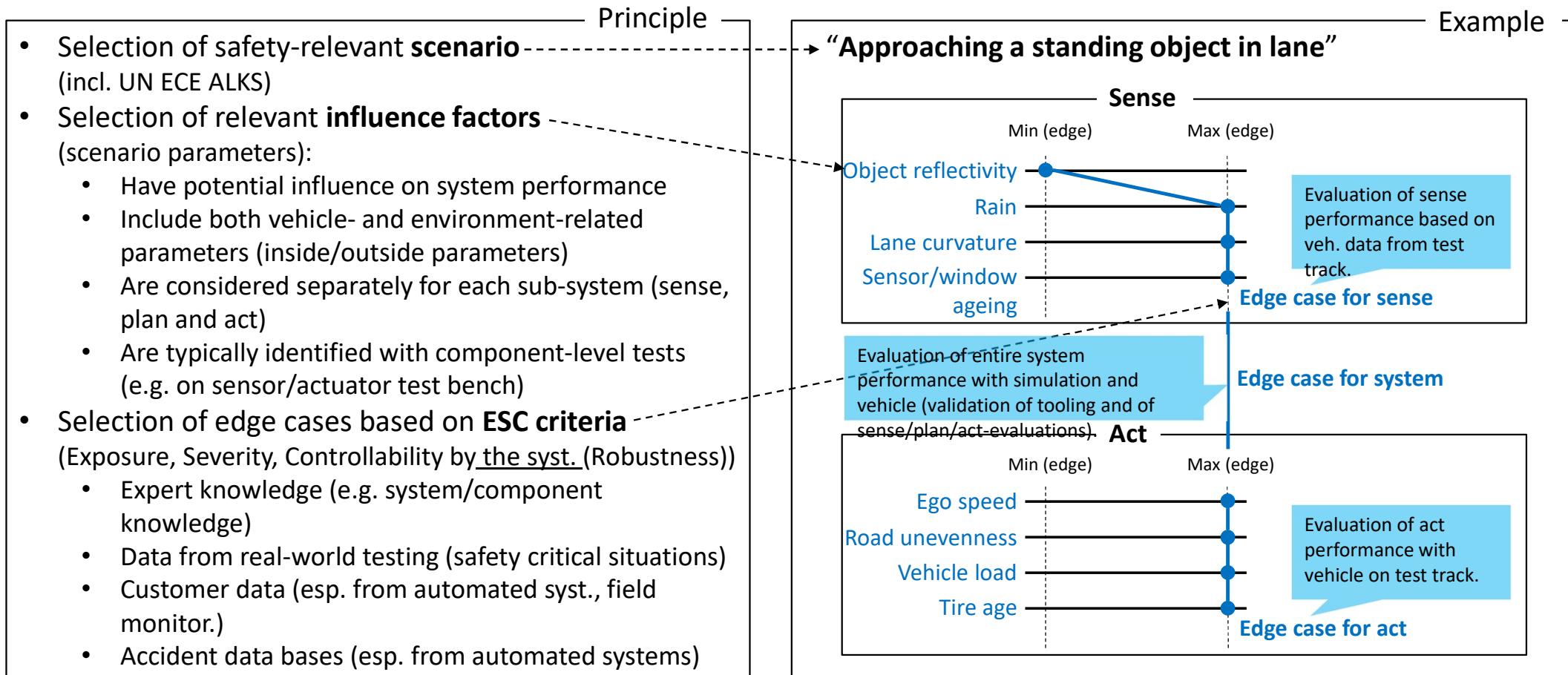
- Investigation of system behavior with scenario-based testing of edge cases brings potentially **more knowledge** about the safety of the system than other test cases.
- Transferability of results of edge cases to other cases, based on equivalence classes, potentially leads to a **reduction of the test effort**.

Research question



The investigation of edge cases is **essential for the verification & validation** of automated driving systems.

THE IDENTIFICATION OF EDGE CASES.



Test catalogue with edge cases is created based on **knowledge of influence factors** that are challenging for system.

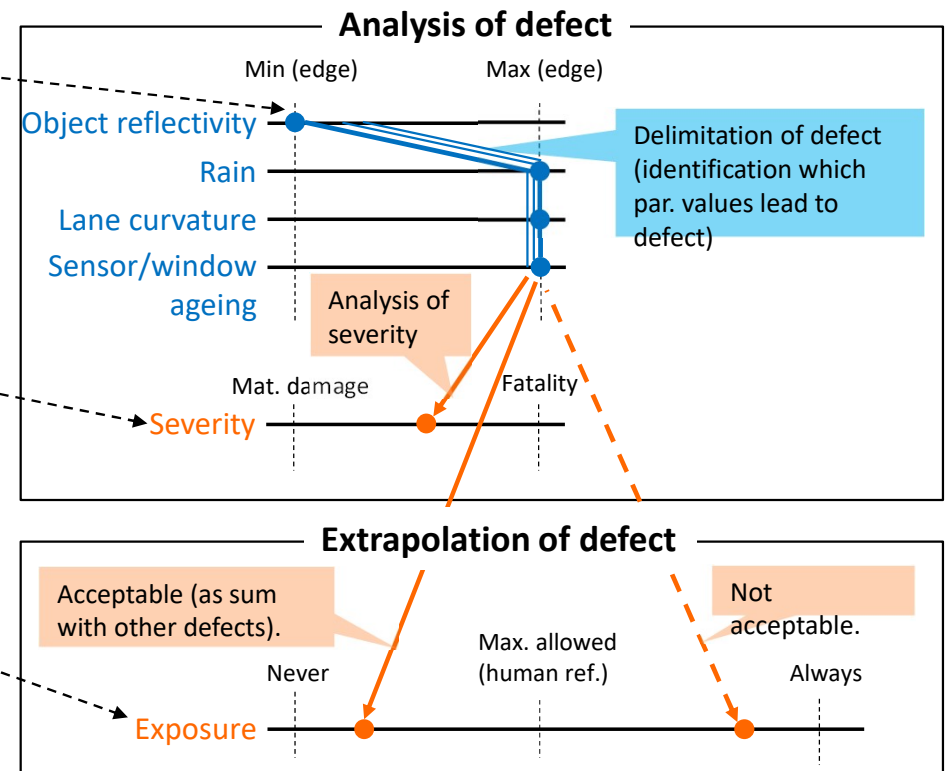
USE OF EDGE CASE RESULTS IN SYSTEM VALIDATION.

Principle

- Identification of an edge case that leads to a **defect of the system** (from previous step)
- **Delimitation** of defect
 - Analysis of extent of the defect (investigation which parameter value ranges lead to this defect)
 - Based on equivalence classes and/or additional tests in neighborhood of the edge case
- Analysis of **severity**
 - Distinction between material damage, injuries, fatalities
 - Based on accident data bases
- Analysis of **exposure**
 - Comparison with human reference
 - Based on customer data and other sources for scenario statistics

Example

“Approaching a standing object in lane”



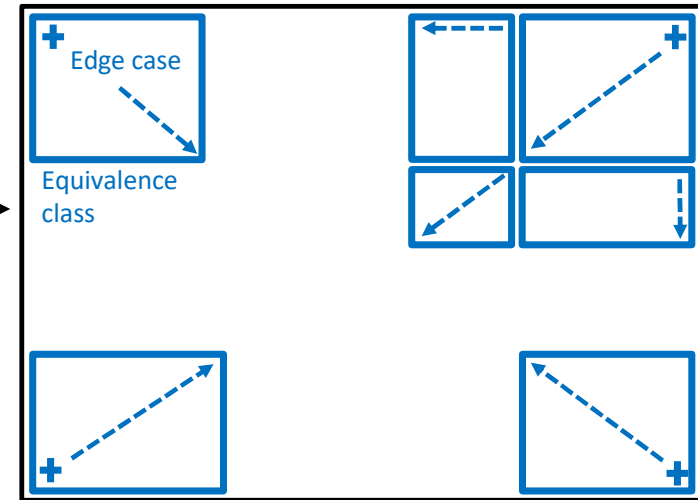
➔ Interpretation of system defects for edge cases is based on analysis of **severity and exposure**.

RESEARCH QUESTIONS.

Research questions

- **Validity:** is the design of edge cases an efficient means to find safety-relevant defects of automated driving systems? In the other way, are safety-relevant defects caused by specific influence factors, or do they occur randomly?
- **Transferability:** does a safe system behavior for edge cases imply a safe system behavior for easier cases? Does the investigation of edge cases allow reducing the number of tests?
- **Sharing:** which knowledge on edge cases can be shared between companies: methodical, abstract, concrete?
- **Other sectors:** how are edge cases dealt with in medicine, aviation and other safety-relevant sectors?

Test space



THANK YOU.

Dr. Benoit Vanholme, Verification & Validation expert
BMW - Division of Driving Experience, Automated Driving
benoit.Vanholme@bmw.de