

CALIBRATING NON-INVASIVE IMPAIRMENT DETECTION WITHOUT INTOXICATION GROUND TRUTH: An indirect application approach



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MOTIVATION

DUI AS A ROAD SAFETY PROBLEM

Alcohol, illicit drugs etc. increase crash and injury risk
Euro NCAP includes DUI/non-fatigue impairment in driver monitoring

LIMITED AVAILABILITY OF GROUND TRUTH DATA

Collecting and testing intoxication-based data involves increased risks for study participants, particularly for illicit drugs and medications
DUI studies are practically and ethically difficult

ENGINEERING QUESTION

How can a DUI function be implemented without conducting own controlled DUI studies?

Requirement

Constraint

Research question

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METHODOLOGY

RECOGNITION

Literature provides the basis

Which behavioral dimensions are relevant?

Which substance-associated differences exist?

- Selection of a suitable method (driver observation, driving behavior)
- Selection and calculation of suitable indicators

- Selection of relevant categories, i.e., substance classes (alcohol, drugs, medications)
- Assignment of indicators to categories including direction and significance

DUI functionality = literature-supported

ASSESSMENT & PARAMETERIZATION

Must be calibrated in the target vehicle system

Coverage and generalization
The study must be sufficiently large to avoid overfitting

Transfer gap
Study setups ≠ vehicle

System/hardware gap
Laboratory camera ≠ target-system camera

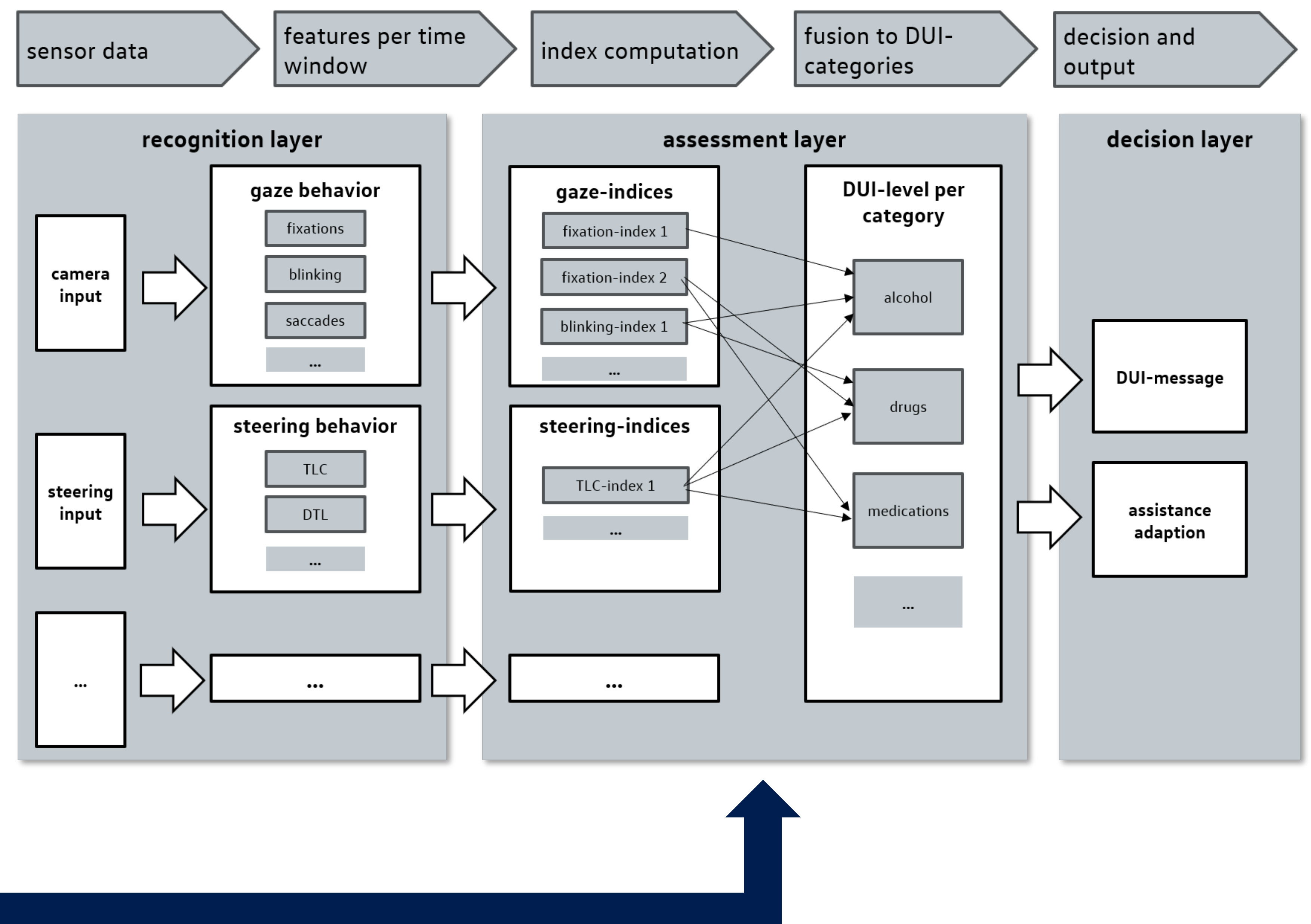
Application challenges

Data availability
DUI studies are difficult to conduct, especially for drugs

Simulator gap
Simulation ≠ Real Driving (limited transferability)

Category gap
No direct transfer to other substances (alcohol ≠ drugs)

DUI-Application = Based on target vehicle system



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INDIRECT APPROACH

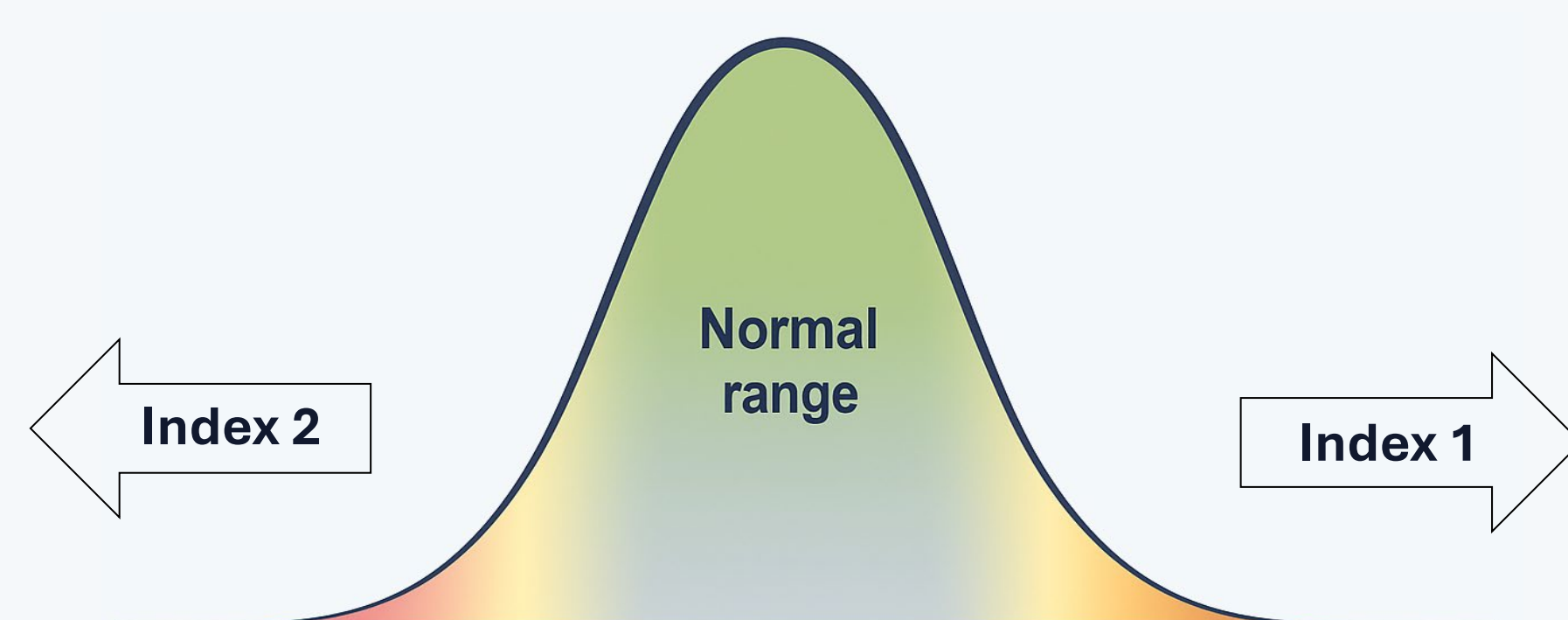
BASIC IDEA

Target-System Reference

Non-impaired reference drives define the normal feature range.

Literature Evidence

Impairment can manifest as deviations from normal behavior.



LOGICAL CONCLUSION

Deviation from normal behavior → impairment

RESULT

Step 1: Data Collection

Use reference drives from broad vehicle testing, including long drives with distinctive characteristics.

DATASET	Speed range / drive szenario	Total	Regular drives	Long drives
Number of drives		1513	1407	106
Distance in km	Total	94888	68658	26230
	< 50 km/h	11936	11454	482
	50 - 130 km/h	77636	53043	24593
	> 130 km/h	5317	4162	1155
Travel time in hours	Total	1792	1519	273
	< 50 km/h	880	852	27
	50 - 130 km/h	876	638	237
	> 130 km/h	37	28	9

Step 2: Configuration Optimization

Simultaneous calibration of the interdependent parameters considering different acceptance criteria.

