Technische Universität Braunschweig

Institut für Regelungstechnik

Knowledge-Based Scenario Generation Using Ontologies

Till Menzel

Motivation: Scenario-based release process

PEGASUS contributed to answer two questions:

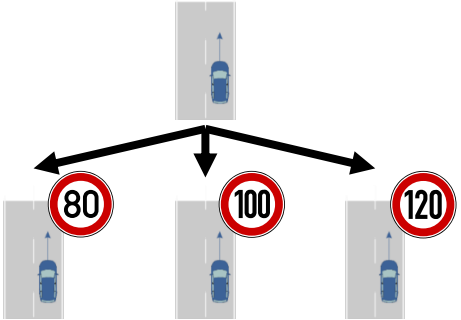
1. How safe is safe enough?
2. How can we verify that the automated driving function achieves the desired performance consistently?

[Lipinski 2019]

For that, PEGASUS examined a

Scenario-based method to assess highly automated driving functions

→ Purposeful generation of operating scenarios



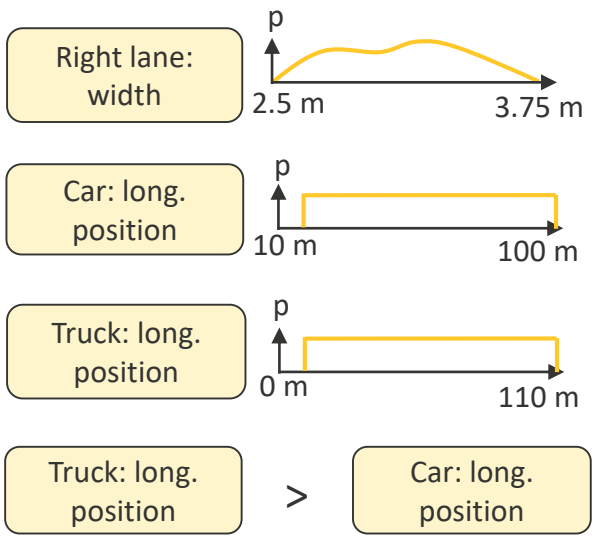
Daniel Lipinski, “Introduction and Overview of 3.5 Years of PEGASUS,” Pegasus Symposium, 2019.

Terminology: Levels of abstraction for scenario representation

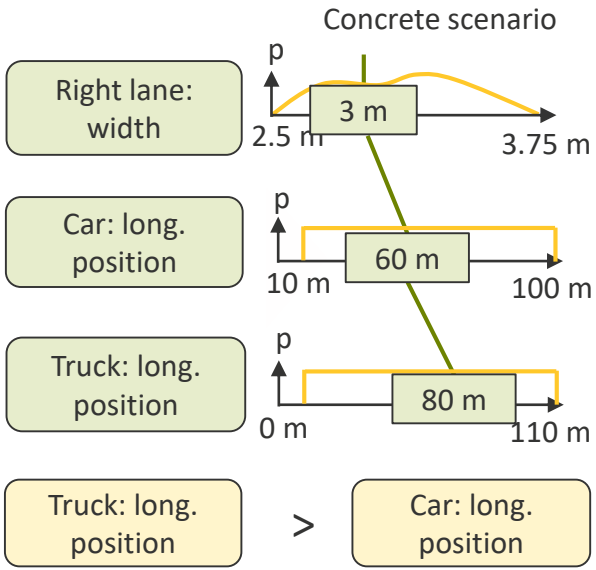
Functional scenario "Follow"

Road	has layout	two-lane motorway
Car	has position on	right lane
Truck	has position on	right lane
Car	follows	truck

Logical scenario "Follow"

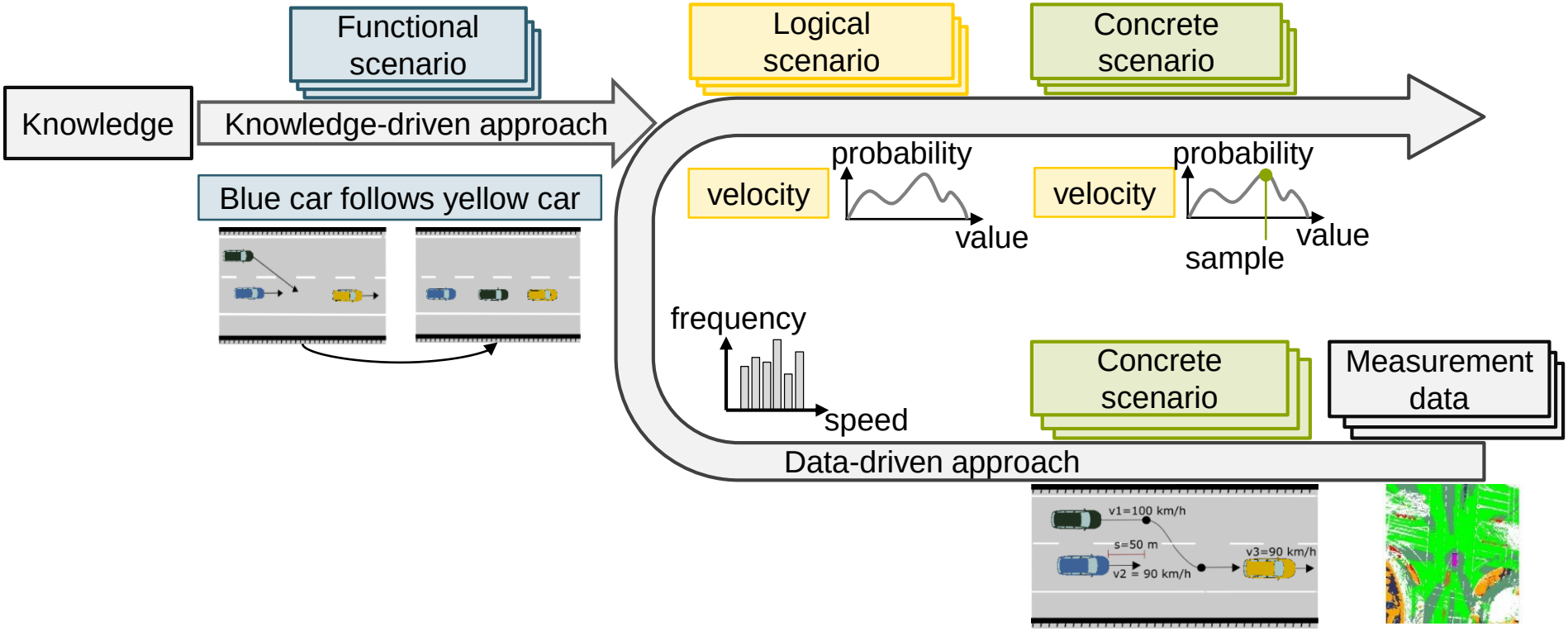


Concrete scenario "Follow"

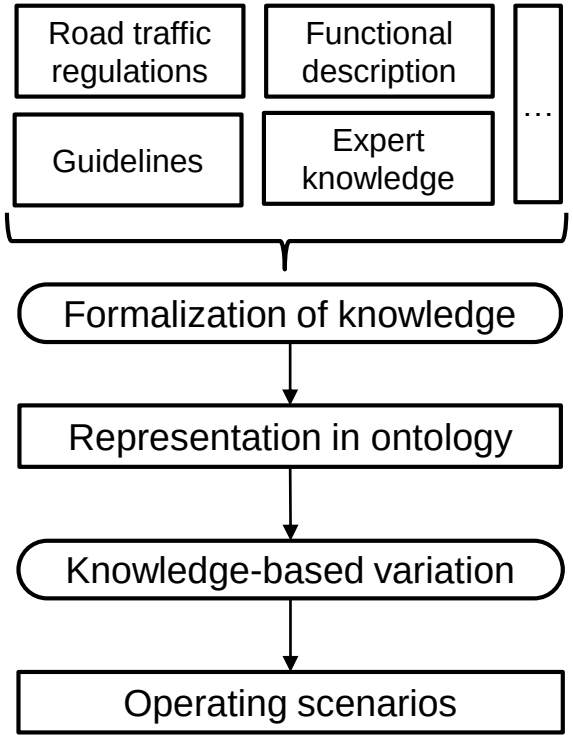


T. Menzel, G. Bagschik, and M. Maurer, "Scenarios for Development, Test and Validation of Automated Vehicles," in 2018 IEEE Intelligent Vehicle Symposium (IV), Changshu, 2018, pp. 1821–1827.

Knowledge-based scenario generation



Process for generating functional scenarios



G. Bagschik, T. Menzel, C. Körner, and M. Maurer, “Wissensbasierte Szenariengenerierung für Betriebsszenarien auf deutschen Autobahnen,” in Workshop Fahrerassistenzsysteme und automatisiertes Fahren Bd. 12, Walting, 2018.

Process for generating functional scenarios

Road traffic regulations

Functional description

Guidelines

Expert knowledge

…

Formalization of knowledge

↓

Representation in ontology

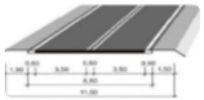
↓

Knowledge-based variation

↓

Operating scenarios

5-layer-model to structure scenarios



Road-level (L1)

- Geometry and topology
- Quality, boundaries (surface)

Traffic infrastructure (L2)

- Construction barriers
- Traffic signs

Temporary manipulation of L1 and L2 (L3)

- Geometry and topology (overlaid)
- Time frame > 1 day

Objects (L4)

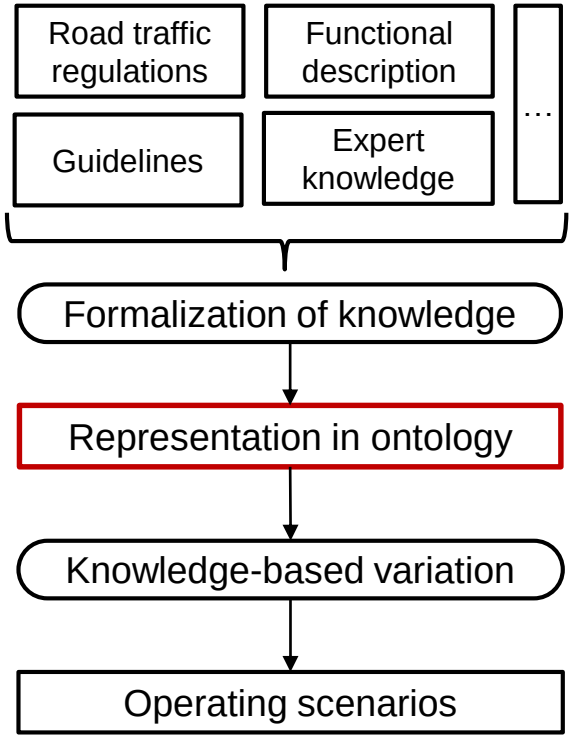
- Dynamic and movable
- Interactions and maneuvers

Environment (L5)

- Weather
- Lighting

G. Bagschik, T. Menzel, and M. Maurer,
“Ontology based Scene Creation for the Development of Automated Vehicles,”
in 2018 IEEE Intelligent Vehicle Symposium (IV), Changshu, 2018, pp. 1813–1820.

Process for generating functional scenarios



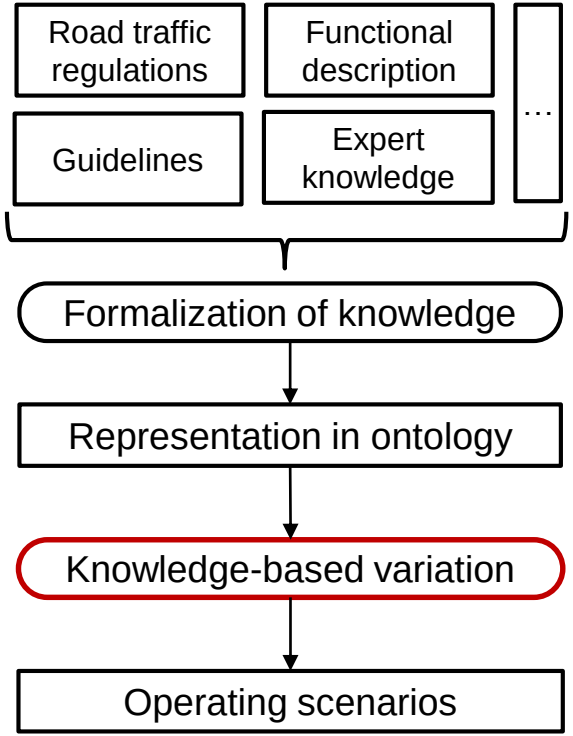
Cross section RQ 36

RQ 36 is subclass of

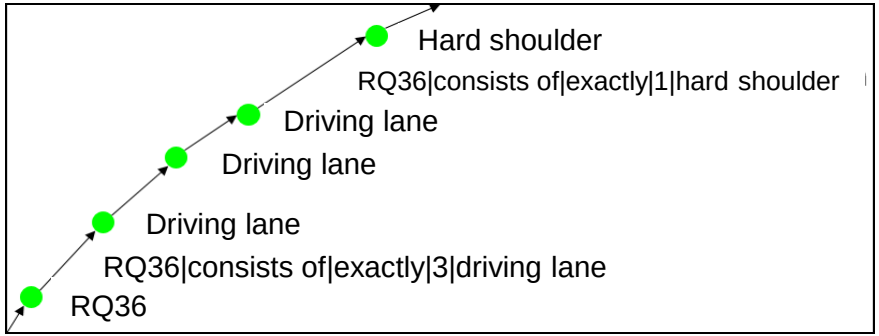
- Design class 1
- Consists of | exactly | 1 | embankment
- Consists of | exactly | 1 | hard shoulder
- Consists of | exactly | 3 | driving lanes
- Has optional | exactly | 1 | crash barrier or wildlife fence
- Has level of abstraction | some | AL 2

G. Bagschik, T. Menzel, C. Körner, and M. Maurer, “Wissensbasierte Szenariengenerierung für Betriebsszenarien auf deutschen Autobahnen,” in Workshop Fahrerassistenzsysteme und automatisiertes Fahren Bd. 12, Walting, 2018.

Process for generating functional scenarios



- Variation of the scenery by tree traversal
  - Generation of an infrastructure graph
  - → Each path through the tree represents one scenery
- Variation of traffic participants and maneuvers based on a position grid



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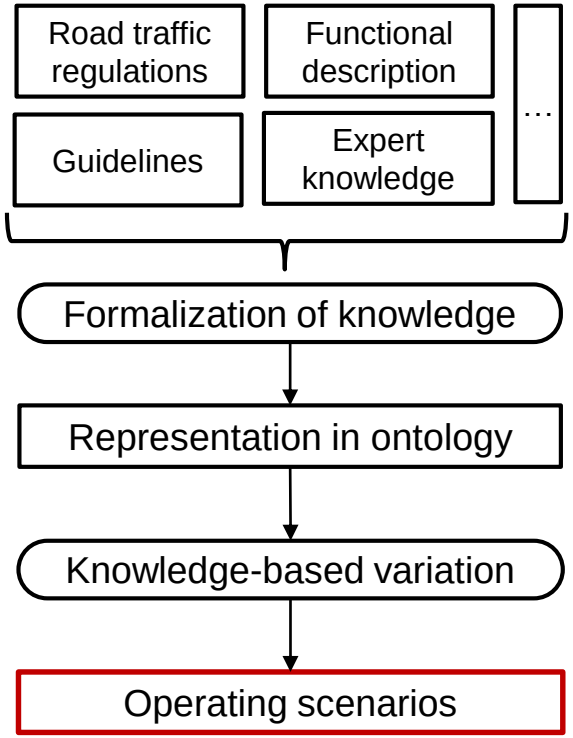
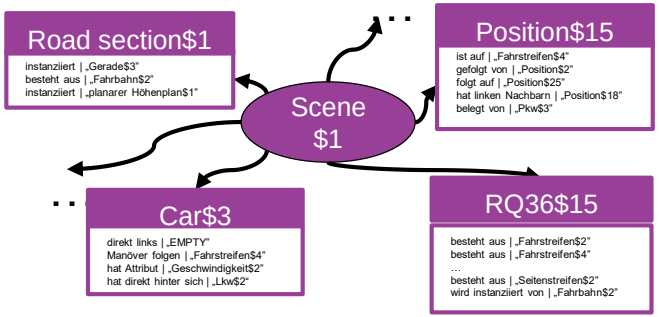
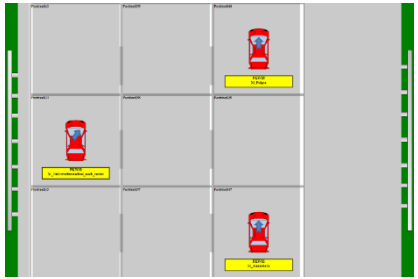
Process for generating functional scenarios



Computer readable presentation

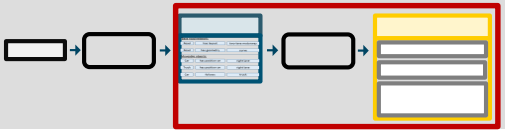


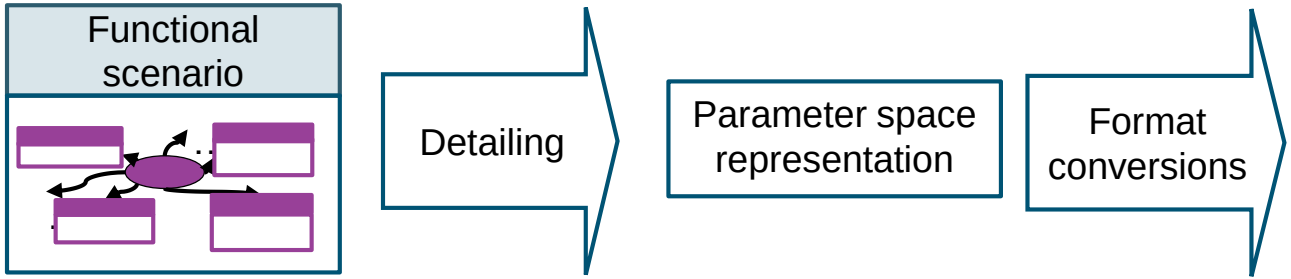
Human readable representation



G. Bagschik, T. Menzel, C. Körner, and M. Maurer, "Wissensbasierte Szenariengenerierung für Betriebsszenarien auf deutschen Autobahnen," in Workshop Fahrerassistenzsysteme und automatisiertes Fahren Bd. 12, Walting, 2018.

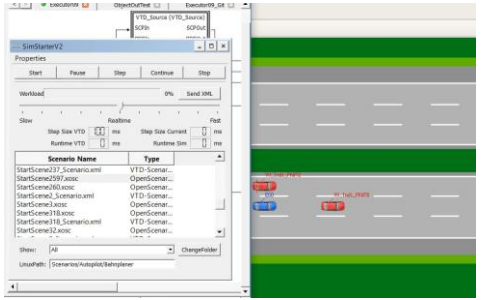
From functional to logical scenarios





OpenDRIVE

OpenSCENARIO



Set of rules [2]

Wed May 30 09:47:23 CEST 2018

Regel Nr.	Parameterabhängigkeit
0	$V0_Indi_PKW78_startPositionOffset > $V0_Indi_PKW72_startPositionOffset
1	$V0_Indi_PKW78_startPositionOffset > $V0_Indi_PKW711_startPositionOffset
2	$V0_Indi_PKW75_startPositionOffset > $V0_Indi_PKW78_startPositionOffset
3	$V0_Indi_PKW72_related_actual_Lane = $V0_Indi_PKW75_related_actual_Lane
4	$V0_Indi_PKW72_related_actual_Road = $V0_Indi_PKW75_related_actual_Road

Detailing:

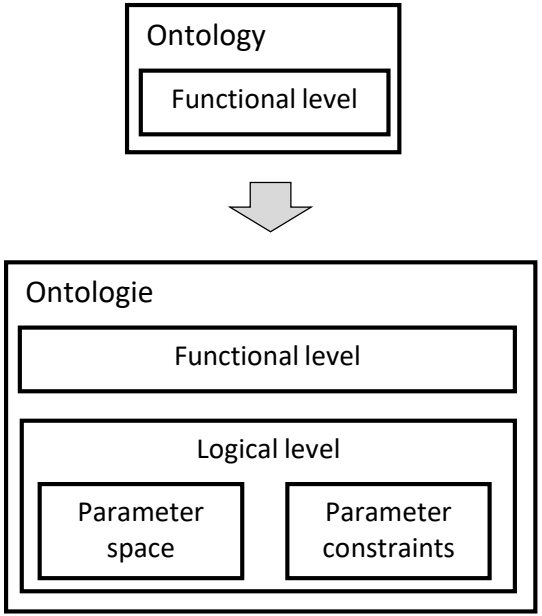
- Specification of parameters for each term
- Identification of parameter constraints
- Calculation of a default value for each parameter considering constraints

T. Menzel, G. Bagschik, L. Isensee, A. Schomburg, and M. Maurer,
“From Functional to Logical Scenarios: Detailing a Keyword-Based Scenario Description for Execution in a Simulation Environment,”
in 2019 IEEE Intelligent Vehicle Symposium (IV), Paris, 2019, pp. 2383-2390.

Current work

1. Transferring the approach to urban areas

2. Expanding ontology by a logical level



Contact

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