REQUIREMENTS AND CONDITIONS – Booth No. 05

SCENARIO DESCRIPTION AND KNOWLEDGE-BASED SCENARIO GENERATION

PEGASUS

Scenarios have to be described on multiple levels of abstraction

➡ Different applications of scenarios in each development phase of a V-model-based development process result in contradicting requirements for scenario representation.

Concept phase	System development phase	Test phase
Human experts shall be able to formulate scenarios in the fields terminology in **natural language.**	Scenarios shall include the **parameter ranges** of the **state values** used for scenario representation.	Scenarios shall be modeled via a **single representative** for each state value to ensure reproducibility.

➡ Multiple levels of abstraction for scenarios can help to support a structured scenario generation along a V-model-based development process.

Functional scenario "Follow"

Base road network:

Road	has layout	two-lane motorway
Road	has geometry	curve

Moveable objects:

Car	has position on	right lane
Truck	has position on	right lane
Car	follows	truck

Logical scenario "Follow"

Base road network:

Right lane: width	2.5 m	3.75 m
Left lane: width	2.5 m	3.75 m
Curve: radius	300 m	900 m

Moveable objects:

Truck: long. position	0 m	110 m
Car: long. position	10 m	100 m
Truck: long. position	>	Car: long. position

Concrete scenario "Follow"

Base road network: Concrete scenario

Right lane: width	2.5 m	3 m	3.75 m
Left lane: width	2.5 m	3 m	3.75 m
Curve: radius	300 m	500 m	900 m

Moveable objects:

Truck: long. position	0 m	80 m	110 m
Car: long. position	10 m	60 m	100 m
Truck: long. position	>	Car: long. position	

Level of abstraction

Number of scenarios

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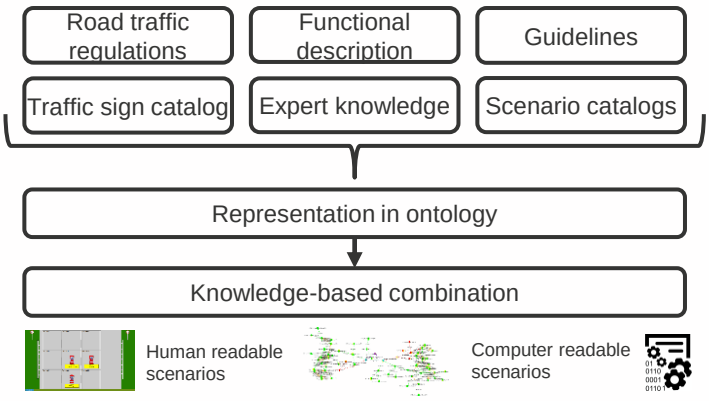
Generation of functional scenarios:
A wide variety of functional scenarios can be generated with a knowledge-based approach in a traceable way

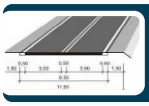
Motivation:
- Development and systems safety can be supported by **traceable** scenario generation
- **Creative** processes by humans are **unable** to generate high **variety** of scenarios

Approach:
- Formalize knowledge with an **ontology**
- Knowledge is structured according to a **6-layer-model**
- Scenario export to HTML-based visualization and scenario graph

Results:
- Generation of more than **10,000 functional scenarios**
- Manual **verification of 700 scenarios** regarding correctness and completeness



Process for knowledge-based generation of functional scenarios



Road level (L1)
- Geometry and topology
- Condition, boundaries

Traffic infrastructure (L2)
- Construction barriers
- Signs, traffic guidance

Temporal modifications L1 und L2 (L3)
- Geometry and topology overlay
- Time dependent > 1 day

Objects (L4)
- Dynamic, movable
- Interactions, maneuvers

Environment (L5)
- Weather
- Lighting

Digital Information (L6)
- V2X-Information
- Digital Map

6-layer-model to structure scenarios based on Schuldt (2017), Bagschik et al. (2018) and Bock et al. (2018)

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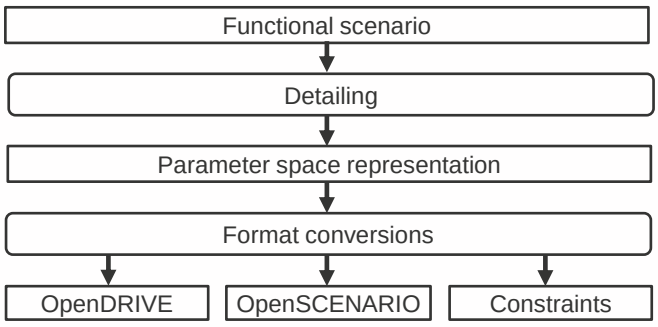
From functional to logical scenarios:
Functional scenarios can automatically be transformed into the formats for simulation and build the basis for test case generation.

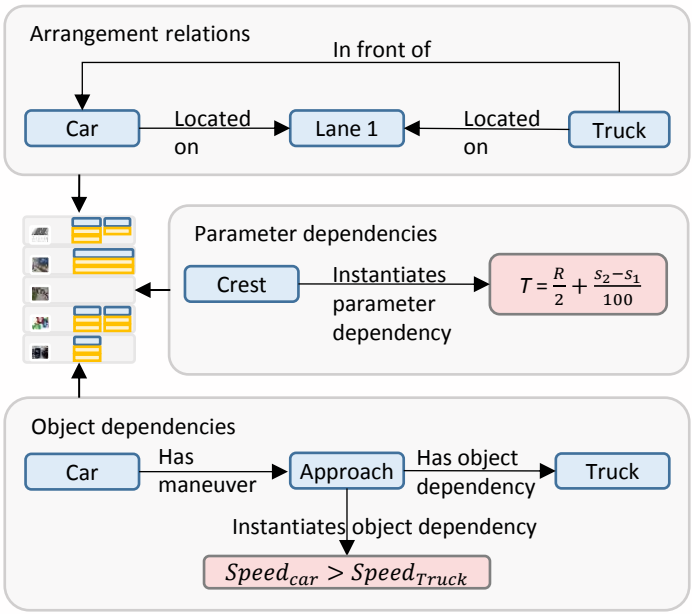
Motivation:
- Conversion of functional scenarios into the **data formats for simulation** takes considerable **manual effort**
- A **standardized interpretation** of linguistically described scenarios is not guaranteed

Approach:
- Each keyword in the respective functional scenario is **specified in detail through parameters**
- Dependencies of the parameters as well as **constraints for choosing parameter values** are modeled and documented
- Parameter space representation is converted into **OpenDRIVE** and **OpenSCENARIO**

Results:
- Generation of more than **10,000 OpenDRIVE- and OpenSCENARIO-files**
- Examination of selected OpenDRIVE-files through OpenDRIVE-Viewer
- Examination of selected OpenSCENARIO-files through execution in simulation



Process for transformation from functional to logical scenarios. Rectangles represent working products, rounded corners represent process steps.



Augmentation of the parameter space with arrangement relations as well as object and parameter dependencies. The tangent length T of a crest has to be calculated based on the radius R as well as the initial tilt s_1 and the final tilt s_2.

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