KI WISSEN
Automotive AI Powered by Knowledge

3.12 Runtime Monitoring Using TSC-Based Knowledge Building Blocks

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Motivation

We want to employ runtime conformity checks of AI driving functions against integrated knowledge to reduce the training duration, trigger safety mechanisms and increase the AI's confidence. In the project KI Wissen, our goal was to develop a method for runtime monitoring of knowledge-infused AI driving functions based on formalized multi-stakeholder Knowledge Building Blocks (KBBs) based on the specification language Traffic Sequence Charts (TSCs).

Concept and Realization

In Figure 1, the monitorable, normative knowledge of the German traffic rule §20 is specified as TSC. In detail, the specified knowledge is the maximum allowed velocity and minimum distances while passing-by a bus, stopping at a bus stop. TSCs allow to specify spatio-temporal knowledge, especially those that are frequently found in traffic scenarios.
Based on rigorous semantics, the visual specification can be made machine-readable using e.g., temporal logics. Our concept of TSC runtime monitoring [1] exploits the separation of the spatial properties (Spatial Views: visual, spatial relation of objects) and temporal properties (Temporal Evolution: chart structure and timing constraints) of TSCs.

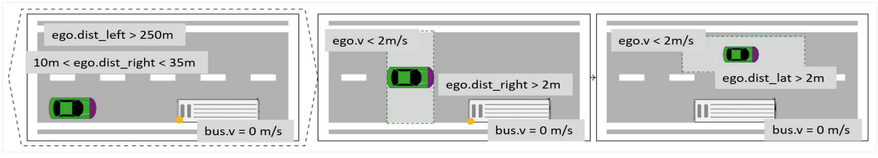

Figure 1: Knowledge Building Block (KBB) on normative knowledge of German traffic rule §20 specified as TSC. (© DLR e.V.)

Spatial View Recognition

- Receiving signals from simulation or real world sensors
- Dynamic mapping of relevant traffic objects
- Mapping from signals to logical attributes
- Calculating missing information, which are not provided by received data
- Provides information about Spatial View satisfaction

Temporal Evolution Recognition

- Receiving information about Spatial View satisfaction with time stamps
- Considering temporal order and timing of the Spatial View satisfaction by utilizing timed automata

Final Verdict

- Satisfied → increased confidence
- Violated → activation of countermeasures
- Inconclusive → manual inspection

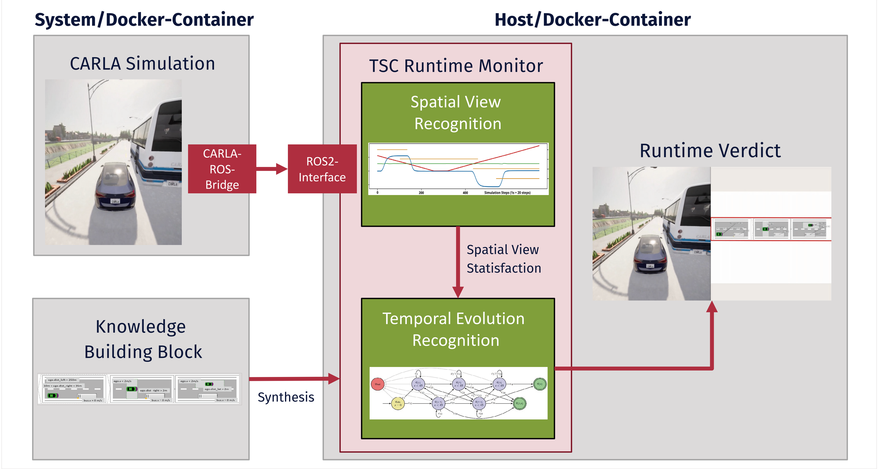

Figure 2: TSC Runtime Monitoring Realization with CARLA-Simulation (© DLR e.V.)

References

[1] Dominik Grundt et al., (2022), *Towards Runtime Monitoring of Complex System Requirements for Autonomous Driving Functions*. In: Proceedings Fourth International Workshop on Formal Methods for Autonomous Systems (FMAS)

Partners

External partners

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