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Title: “Best practices for simulation-based critical scenario identification”

Abstract: Verification and Validation (V&V) processes play a vital role in ensuring the safety and reliability of automated driving applications. Scenario-based testing has emerged as an effective approach for identifying critical scenarios that challenge the capabilities of automated driving systems. This presentation aims to explore the methodology of scenario-based testing and its application to automatically find unknown critical test cases and to derive critical influence factors by analyzing data produced by simulation. The influence factors can range from parameters of the dynamic behavior of the actors, the roadway characteristics, or environmental conditions.

Due to the potentially infinite number of scenario instances and the abundance of influence factors and scenario parameters - even in a constrained operational design domain, uncovering unknown critical scenarios efficiently at a high coverage is still challenging. However, achieving a high coverage of the critical scenarios is essential to validate the safety of the automated system. This talk targets at efficient methods to uncover unknown critical scenarios for automated driving functions using scenario-based testing. Inspired by the ISO 21448 SOTIF standard, we illustrate how elements from the safety domain can be mapped to the activity of critical scenario identification. The mapping is helpful in various ways. It identifies the different sources of the unknown and opens the potential for directing the search by shaping the criticality metrics. Based on these high-level insights, we will derive a workflow for critical scenario identification using simulation-based testing. The workflow takes as input an abstract scenario and a criticality metric. By applying Blackbox-optimization techniques, the algorithm iteratively drives the search within the abstract scenario towards a critical test case related to the criticality metric. The workflow will eventually output critical concrete test cases, that can be used for further analysis or for consideration in the automated driving function development.

Throughout the presentation, we will share our experiences and best practices that we have been found from various R&D activities on critical scenario identification. As such, we discuss different non-proprietary scenario formats with different levels of abstractions and evaluate them against their utility for identifying unknown critical scenarios. Moreover, we delve into the question of how to find good trade-offs between exploration and exploitation in terms of the design of the scenario space, criticality metric, and the Blackbox optimization search methods in use. For the latter, we show some insights on the nature of these optimization techniques. Finally, we give an outlook on how to increase the effectiveness of critical scenario identification to fully explore the diversity of critical factors, while keeping the search space at a manageable level.