Fraunhofer IESE

Fraunhofer-Institut für Experimentelles
Software Engineering IESE

Runtime Scenario Identification for Autonomous Vehicles

Problem: Autonomous vehicles are engineered for specific scenarios. The use in an open world may exhibit new and unforeseen characteristics. Field observations are required to **identify new scenarios at runtime**. This means to observe the actual traffic on actual road segments. The observation should identify if new characteristics are relevant within a certain scenario. Due to the high dimensional observation space, it is likely that many new combinations of characteristics are recorded. Test vehicles or of in-use vehicle fleets use limited storage and bandwidth of recordings so a **filtering of runtime records** is required to determine if a combination of characteristics maps to a known case of if new edge case has been found, which should be feedback to development and testing.

Idea: At the safety department of the Fraunhofer IESE, we employ the use of auto-encoders to **distinguish in between relevant and irrelevant new scenarios**. The unsupervised learning allows to implement engineering agnostic detection capabilities, which require no explicit feature engineering. The identification of cause-effect relations goes beyond a pure anomaly detection. It enables an **automated reasoning** if the observation of a new combination of characteristics maps to a known cause-effect or not.

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Benefit: The manufacturer of autonomous vehicles can fulfill its **product monitoring obligation** and automatically determine unexpected scenarios during the runtime of the autonomous vehicles using AI. Implementation takes place without feature engineering and requires no prior knowledge of the system architecture.

Our solution: The safety department of the Fraunhofer IESE developed the **tool AutoTestReduction to identify automatically new driving scenarios**. The system uses the available natural driving data of the development cycle as a reference and compares at runtime new driving scenarios against it. The learned representation incorporates for each scenario the set of characteristics that must, may or must not occur.

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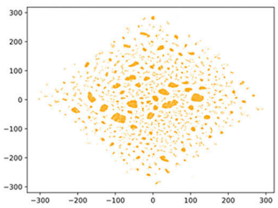
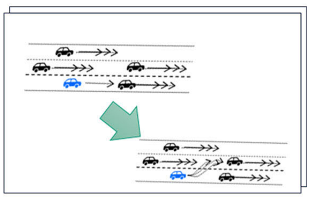
Real-World recordings
or simulator based recordings



Cluster recordings based on
the learnt Auto-Encoder
representation



Logical Scenarios with
parameter ranges
(one per cluster)

Clustering of traffic scenarios based on unsupervised learning with an auto-encoder. If new records are determined to be outliers and not to belonging to existing clusters, then a new relevant case has been identified.

We provide:

- The Tool **AutoTestReduction** to identify cause-effect relations based on natural driving data
- Support in the integration of **field observations** into the safety argumentation
- The integration of **dynamic risk management** into field operations