Fraunhofer IESE

Fraunhofer-Institut für Experimentelles Software Engineering IESE

Street design comparison for Operation Design Domain (ODD) compliance

Problem: The definition of an **Operational Design Domain (ODD)** determines the set of scenarios for which an autonomous vehicle is designed and tested for. The definition of **abstract street designs** for ODDs enables the design of autonomous vehicles for a large range of **real-world scenarios**. This approach implies that an autonomous vehicle that should be employed with a certain area, like a city, requires the prove that all actual street designs match the abstract street designs of the ODD. This also includes the expectable behavior of traffic participants matches to the expectations made during ODD design. Depending on the actual street design and the possible emergent interactions the space of potential state combinations is very high, which impedes the need for sophisticated comparison methods.

Idea: At the safety department of the Fraunhofer IESE, we employ the use of **auto-encoders** to identify automatically which behavior interactions are possible within a certain street design. The unsupervised learning allows to implement engineering agnostic models, which require no explicit feature engineering. The comparison of possible interactions at two different street designs allows to identify overlapping behaviors as well as to identify different interaction behaviors.

Benefit: The results can be employed by Autonomous vehicle Manufactures as well as by street designers. Autonomous vehicle Manufactures are enabled to prove that the **real-world area is consistent with the designed ODD**. This safety evidence contributes to the safety argumentation and is a prerequisite for the product release. Street designers are enabled to examine different behavior interactions to optimize the street design and find potential causes of unexpected behaviors.

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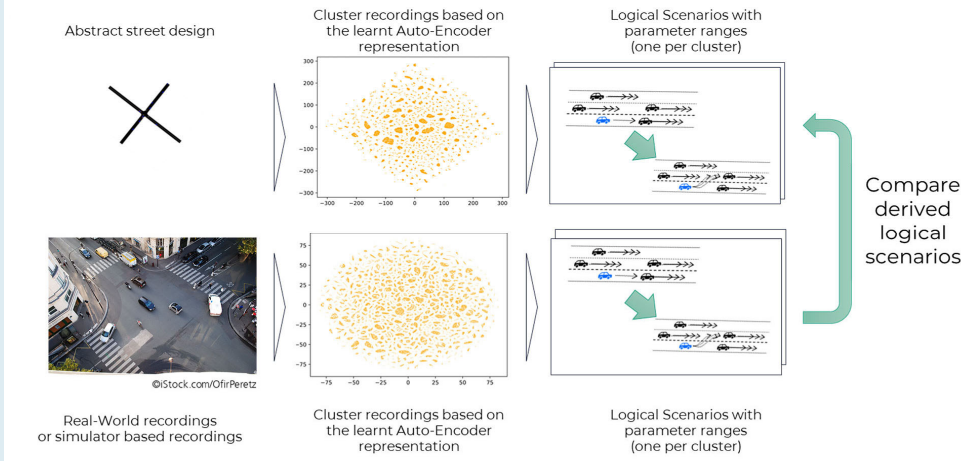
Our solution: The safety department of the Fraunhofer IESE developed the AutoTestReduction tool to **identify automatically new driving scenarios for street designs**. The system uses either available natural driving data or simulation data of the actual street design and for an abstract street design. The learned representation for each street design incorporates for each scenario the set of characteristics that must, may or must not occur. By comparing the characteristics of scenarios of different street designs a match can be identified; unmatched scenarios denote different behavior interactions.



Clustering of traffic scenarios based on unsupervised learning with an auto-encoder for two intersections. the clusters that cannot be matched from one intersection to the other determine the missing or additional behavior interaction possibilities. In case of clusters would match both intersections exhibit the same traffic participant behavior interactions.

We provide:

- The Tool **AutoTestReduction** to identify cause-effect relations for **specific street designs**
- Comparison of street designs to assure **ODD compliance**
- Support in the safety argumentation in between **abstract world design** and **real-world design**