SAFIR: Kundengerechte Erprobungssystematik für pilotiertes Fahren

Vorhaben: Sicherheit für Alle – Forschungs- und Innovationspartnerschaft in der Region für globale Fahrzeugsicherheit
Impulsprojekt 2; Förderkennzeichen (FKZ): 03FH7I02IA

Motivation

- Field tests during the development phase ensure that
  - The system performs according to the intended specifications
  - Unexpected reactions of the system are eradicated
- The efforts caused by the testing of integrated safety functions are high
- Costs are expected to grow dramatically considering automated driving

Objective

- Contribute towards a reduction of kilometers driven for validation
- Automated identification, analysis and assessment of traffic scenarios
  - Generic representation of traffic scenarios
  - Feature definition to analyze traffic scenarios with machine learning
  - Group scenarios and extract representatives for template generation

Cluster Analysis

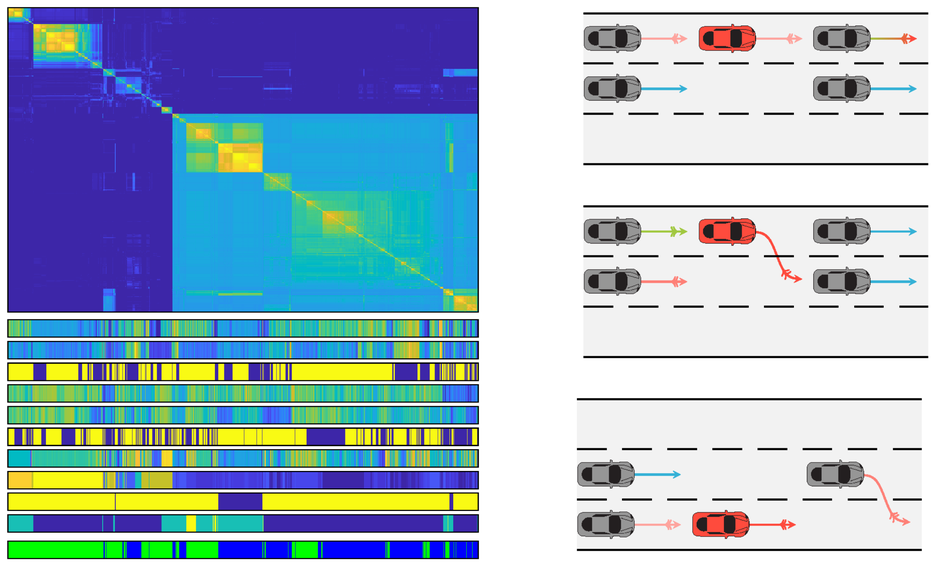

Figure 3: Clustering results with normalized feature value representation (left) and representative scenarios derived from clusters (right)

Scenario extraction

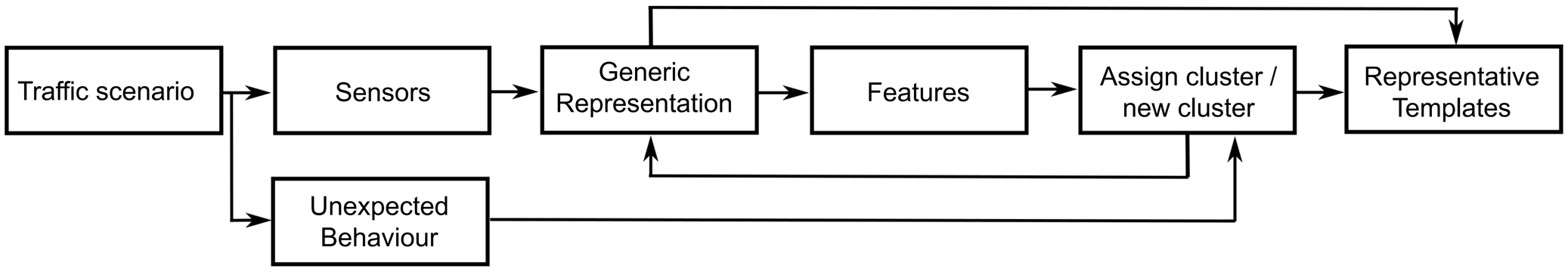

Figure 1: The overall process of scenario extraction for automated identification, analysis and assessment of traffic scenarios

Architecture

- Data driven approach: data structure determines the scenario description and feature selection
- Feature set is provided to the clustering process, which delivers the similarity matrix
- Assigning classes according to similarity matrix and train supervised model in order to assign new traffic scenarios

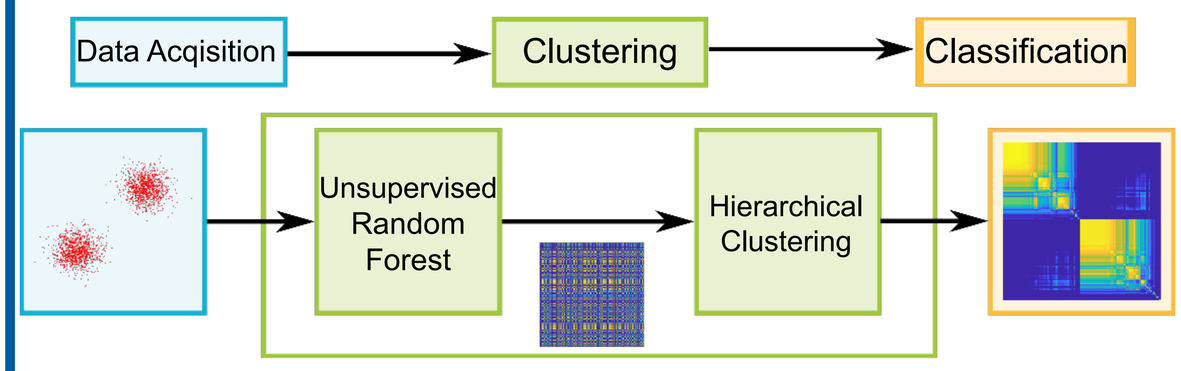

Figure 2: Unsupervised and supervised machine learning architecture for scenario categorization

Data Acquisition

- Generic scenario description allows data import from various data source
- Simulation framework built up on Open-Source tool SUMO [1]
- House developed simulation tool CARMOS
- Public available data set (highD [2]: real world highway traffic)
- Replicate representative traffic scenarios on test facility (planned)

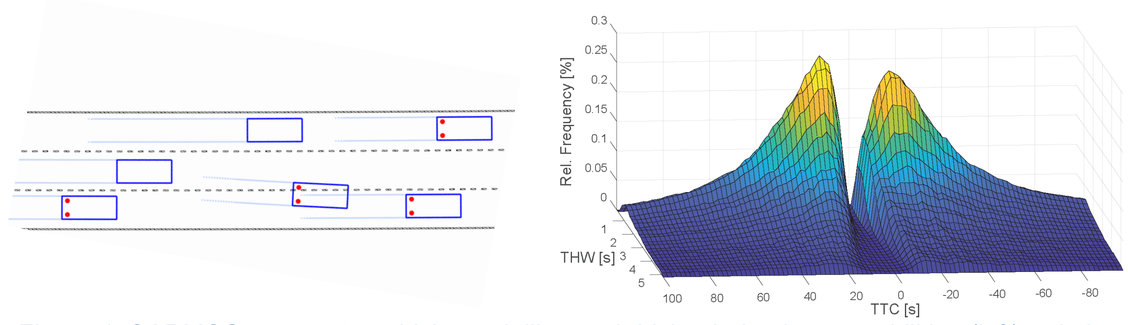

Figure 4: CARMOS - accurate vehicle modelling and driving behaviour capabilities (left), relative frequency of the criticality measures Time-To-Collision and Time-Headway, computed from 45.000 km real word driving on German highways obtained from [2] (right)

Publications

- An Unsupervised Random Forest Clustering Technique for Automatic Traffic Scenario Categorization
  in 21st IEEE International Conference on Intelligent Transportation Systems, 2018
- Unsupervised and Supervised Learning with the Random Forest Algorithm for Traffic Scenario Clustering and Classification
  in 30th IEEE Intelligent Vehicles Symposium, 2019
- Highway traffic data - macroscopic, microscopic and criticality analysis for capturing relevant traffic scenarios and traffic modeling based on the highD data set
  in arxiv.org (open access platform), 2019

References

[1] Daniel Krajzewicz, Jakob Erdmann, Michael Behrisch, and Laura Bieker. “Recent Development and Applications of SUMO - Simulation of Urban Mobility”, in International Journal On Advances in Systems and Measurements, 2012
[2] R. Krajewski, J. Bock, L. Kloeker, and L. Eckstein, “The highD Dataset: A Drone Dataset of Naturalistic Vehicle Trajectories on German Highways for Validation of Highly Automated Driving Systems,” in IEEE 21st International Conference on Intelligent Transportation Systems (ITSC), 2018.

Conclusion and Outlook

- Clustering method for automated categorization developed, validated on
  - Simulated data
  - Real world highway traffic data set [2]
- Data generation frameworks developed
  - CARMOS for highway traffic
  - Open source simulation
- Main results published
- Driver or market specific clustering
- Replicate representative driving scenarios on the CARISSMA test track

Figure 5: CARISSMA test facility

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