KI DELTA LEARNING
Scalable AI for Automated Driving

Knowledge Transfer for Multi-Sensor Data Fusion

Viviane Benzin, Richard Schulz, Simon Doll

SP 3
WP 3.4

Use Case for Delta Learning

Autonomous vehicles are usually equipped with both complementary and redundant sensing modalities including camera, LiDAR and radar sensors. By combining the information of the different sensors, data fusion aims at obtaining a consistent representation of the surrounding of an autonomous vehicle. Speaking in terms of *Delta Learning* this entails dealing with manifold inter-sensor deltas concerning sensing abilities, measurement spaces, field of views and temporal offsets.

output for given input data, probabilistic filters provide means to naturally deal with unseen scenes in a robust manner. But, knowledge transfer methods implementing the simple principle of equal output for equal input are limited in their ability to transfer this robustness and can only restore it from the available training data up the margin that can be accomplished by targeted design of the network`s architecture and training setup. On top of that, the difficulty of comprehending the knowledge that a neural network has learned poses a problem for

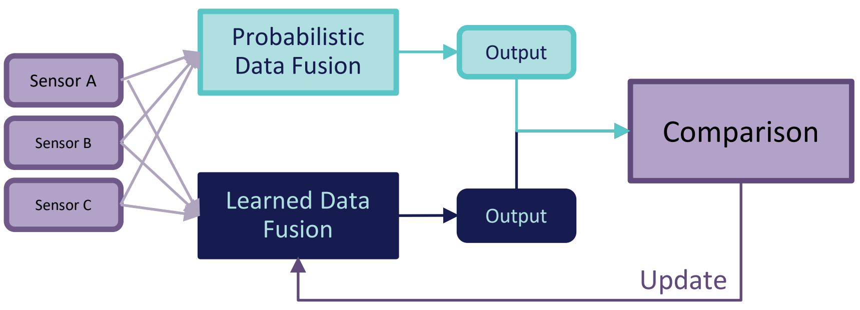

Figure 1: General concept for knowledge transfer from probabilistic to learned multi-sensor data fusion (left). Data generation with CARLA [2]. Non-overlapping training and validation routes (right).

Technical Problem

To this point, architecture design for multi-sensor data fusion is often guided by intuition and empirical observation. While classic data fusion approaches employ probabilistic filters using intermediate, handcrafted feature representations, recent works are motivated by the large success of neural networks for single-sensor object detection and investigate their efficacy in multi-sensor setups. Due to their adaptability to unknown correlations, learned models hold great promise for improving the performance of a multi-sensor data fusion system in real-world scenarios where a-priori models for process and measurement noise are not sufficiently accurate.

Knowledge transfer from a probabilistic to a learned approach is not straightforward, because widely used knowledge transfer methods such as teacher-student learning are not easily applicable to data fusion for several reasons. While probabilistic approaches are characterized by a tight coupling of object detection and tracking operating on asynchronous single-sensor inputs, machine-learning based methods often employ the so-called “tracking-by-detection” paradigm expecting the sensor inputs to be temporally aligned. Moreover, in addition to the knowledge comprised in the evaluating the effectiveness of knowledge transfer.

Technical Solution

Despite extensive research in the field of multi-sensor data fusion, it remains unclear how to best possibly combine the strengths of learning-based and classic methods for scalable highly automated driving. Our research primarily focuses on multi-sensor object detection. In a first step, we explore strengths and weaknesses of existing approaches with special emphasis on robustness, modularity and traceability. For an objective comparison, we investigate suitable evaluation strategies and metrics. We also discuss the requirements for suitable benchmark datasets since existing multi-sensor datasets are too limited with respect to the variety in sensor setups and combinations, driving scenarios as well as object classes to draw conclusions on the performance under real-world conditions [1]. We, therefore, explore the possibilities of open-source simulators for autonomous driving such as CARLA [2].

References

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Sensors

Mercedes-Benz

For more information contact:
viviane.benzin@daimler.com,
richard.schulz@daimler.com

Partners

External partners

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