KI DATA TOOLING
The Data Kit for Automotive AI

Conceptualization of Corner Cases

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What is a Corner Case?

Corner cases are new or very rarely occurring situations, object classes, pedestrian movements, and more that cannot be reliably detected, classified, etc. by machine learning models. An example of a corner case is shown in Figure 1: It shows a winter scene with an icy, slippery, reflective road, low winter sun and people on cross-country skis crossing the road. Something that is hard to find in current datasets but is very important for developing and validating machine learning models.

Figure 1: Corner Case Example

	Sensor Layer		Content Layer			Temporal Layer
	Hardware Level	Physical Level	Domain Level	Object Level	Scene Level	Scenario Level
LiDAR-based corner cases	Laser Error • *Broken mirror* • *Misaligned actuator*	Beam-Based Corner Case • *Black cars disappear* • ...	Domain Shift on Single Point Cloud • *Shape of Road markings*	Single-Point Anomaly on Single Point Cloud • *Dust cloud* • ...	Contextual/Collective Anomaly on Single Point Cloud • *Sweeper cleaning the sidewalk*	Corner Cases on Multiple Point Clouds and Frames • *Person breaks traffic rule* • *Overtaking a cyclist* • *Car accident* • ...
Camera-based corner cases	Pixel Error • *Dead pixel* • *Broken lense*	Pixel-Based Corner Case • *Dirt on lense* • *Overexposure*	Domain Shift on Single Frame • *Location (EU-U.S.A.)* • ...	Single-Point Anomaly on Single Frame • *Animal* • ...	Contextual/Collective Anomaly on Single Frame • *People on a billboard* • ...	
RADAR-based corner cases	Impulse Error • *Low voltage* • *Low temperature*	Impulse-Based Corner Case • *Interference* • ...	Domain Shift on Single Point Cloud • *Weather, e.g., snow, rain, etc.*	Single-Point Anomaly on Single Point Cloud • *Lost objects* • ...	Contextual/Collective Anomaly on Single Point Cloud • *Demonstration* • *Tree on street*	

Figure 2: Categorization of Camera-, LiDAR-, and RADAR-based Corner Cases [1]

Categorization of Camera-, LiDAR-, and RADAR-based Corner Cases

Based on a sensor data processing toolchain consisting of data preprocessing, machine learning, data fusion, and driving function, our research [1] categorized corner cases into several layers and levels, see Figure 2. The sensor, content and temporal layer are ordered by the theoretical complexity of the detection and are subdivided into several levels. Figure 2 illustrates the individual corner case layers and levels and provides examples of corner cases resulting from a single sensor and referred to as a single-source corner case. In addition, multi-source corner cases arise during data fusion due to data mismatches and ambiguity. The fusion can also detect these inconsistencies as a corner case detector.

Method Layer Corner Cases

Method layer [1] corner cases are not sensor- but method-specific. These types of corner cases are not necessarily perceptible by sensors or a human driver, making this layer more abstract. Method layer corner cases are caused by the applied architecture or machine learning model and the uncertainty in the methodology. For example, we aim to detect unknown objects by a high model uncertainty [2] but also typical „normal“ objects can spark a high uncertainty and lead to a method layer corner case. Adversarial samples are another example of method layer corner cases that humans cannot perceive, but for the model, even small changes in model input can lead to drastic changes in model output.

References:

[1] Heidecker, F., Breitenstein, J., Rösch, K., Löhdefink, J., Bieshaar, M., Stiller, C., Fingscheidt, T., Sick, B.: An Application-Driven Conceptualization of Corner Cases for Perception in Highly Automated Driving, In Proc. of the IV, Nagoya, Japan, 2021

[2] Heidecker, F., Hannan, A., Bieshaar, M., Sick, B.: Towards Corner Case Detection by Modeling the Uncertainty of Instance Segmentation Networks. ICPR Workshop on Integrated Artificial Intelligence in Data Science., Milan, Italy, 2021

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KI Data Tooling is a project of the KI Familie. It was initiated and developed by the VDA Leitinitiative autonomous and connected driving and is funded by the Federal Ministry for Economic Affairs and Climate Action.

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag