KI DELTA LEARNING
Scalable AI for Automated Driving

# Lidar Sensor Domain Shift Based on Mounting Position Changes

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WP 2.3

Sensors

## Use-Case in Delta Learning

This Working Package considers the Domain shift between Lidar sensors in different mounting positions.
We specifically are interested in the changes this Domain shift introduces on the input data for Neural networks.
Thus, we aim to quantify the influence that this shift induces on other traffic participants on 3D point cloud level.
For this task we are mainly focusing on cars as the target type of interest. We further aim to train a model on this data which allows us to compare new point clouds to the available model and determine which sensor setup it is more likely to originate from.

## Technical Problem

The problem we are facing is the general quantification of differences in point clouds. This quantification shall be performed for our selected target type: Cars.
Given a dataset that provides data from differently mounted lidar sensors. We are facing a problem composed of the extraction of data for this target type, the accumulation of this data in a shared space over all instances of the target type and a general description of the differences in this space.

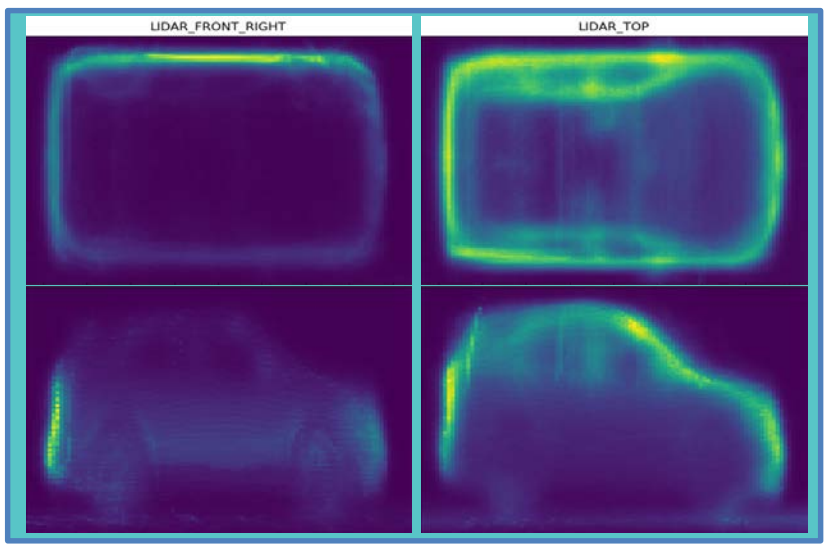


*Figure 1: Histogram accumulation of measurements in scaled coordinates for a lider mounted on the bumper height (leftside) and a lidar mounted on the roof from the lyft level 5 dataset. Shown are birdseye and side perspective*

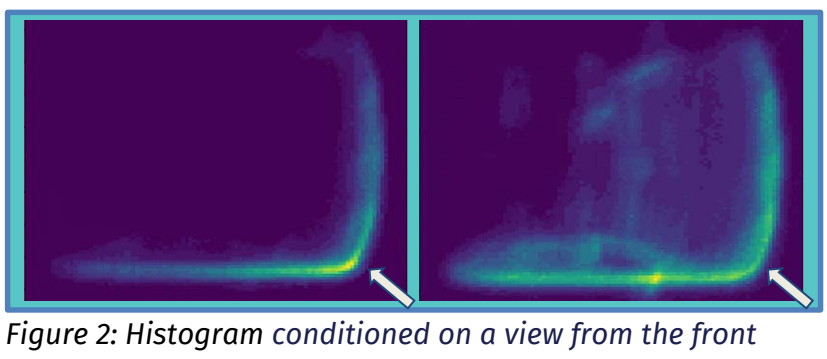

*Figure 2: Histogram conditioned on a view from the front right in birdseye coordinates.*

## Technical Solution

We use data from the *Lyft level 5 [1]* dataset. It provides 3 Lidar sensors in different mounting positions. One on the roof of the target and tow in the front bumper. For the extraction of data from we use a annotation bounding box based extraction scheme including ground removal. To provide a common space we use the unit coordinate space proposed in *Tracking Multiple Vehicles Using a Variational Radar Model [2]* which scales the data by the bounding boxes length, width and height to provide a common space over all sizes of cars. Based on which we are able to generate a statistical distribution over the measurements. A histogram over the accumulated data is shown in *Figure 1.* This model was additionally conditioned on the aspect angle, the relative angle from the cars orientation to the sensors line of sight to the vehicles to remove biases in the accumulation and provide insights into the different self occlusion and visibility with respect to the sensors point of view. A histogram over the conditional is shown in *Figure 2.* We further use this distribution to train Gaussian mixture models as a likelihood function for new data as a measure for comparison. Trained conditional Mixture models are shown in *Figure 2.*

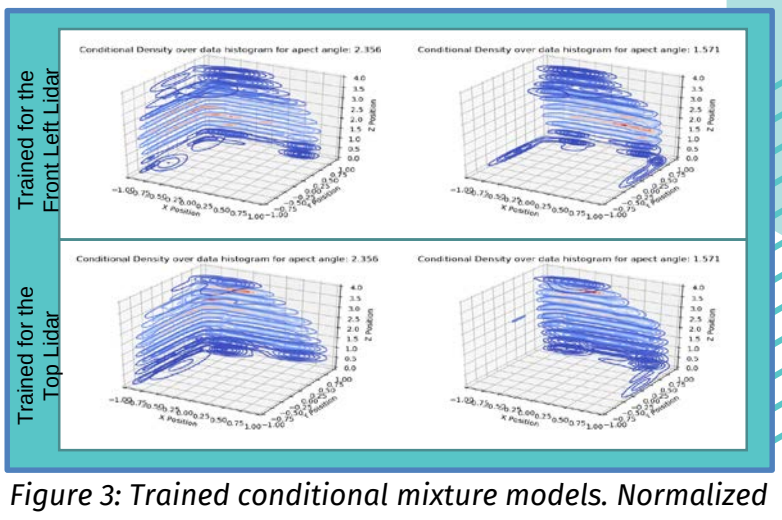


*Figure 3: Trained conditional mixture models. Normalized equidistant slices over the height are provided from the 3d mixture for 2 of the aspect conditionals.*

## Evaluation

Quantitative differences in the detections can directly be seen as the upper part of the geometry is significantly stronger represented. Which is the major difference the domain shift implicates. The conditionals for this WP are trained and show significant differences in the likelihood but the full evaluation as a classification is still pending.

[1] R. Kesten, M. Usman, J. Houston, T. Pandya, K. Nadhamuni, A. Ferreira, M. Yuan, B. Low, A. Jain, P. Ondruska, S. Omari, S. Shah, A. Kulkarni, A. Kazakova, C. Tao, L. Platinsky, W. Jiang, and V. Shet. Lyft Level 5 AV Dataset 2019. https://level5.lyft.com/ dataset/, 2019. Accessed: 2019-10-24.
[2] Scheel, A. and Dietmayer, K., 2018. Tracking multiple vehicles using a variational radar model. *IEEE Transactions on Intelligent Transportation Systems*, *20*(10), pp.3721-3736.

Valeo

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**External partners**

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