KI ABSICHERUNG
Safe AI for Automated Driving

Systematic Testing of DNNs Against Multiple Performance Limiting Factors (PLFs)

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Performance Limiting Factors (PLFs):

Any factors that contribute to limiting the detection performance of a model can be considered as PLFs. A PLF can be numeric or categorical, and can stem from different sources such the overall environment condition, arrangement of the objects, sensors and other hardware artifacts, etc. Based on that, we have extracted 21 PLFs as follows:

01. Boundary edge strength*
02. Background edge strength*
03. Crowdedness*
04. Contrast to background*
05. Brightness
06. Contrast
07. Edge Strength
08. Fog intensity
09. Lens flare intensity
10. Vignette intensity
11. Daytime type
12. Sky type
13. Wetness type
14. Bbox height
15. Bbox aspect ratio
16. Visible instance pixels
17. Occlusion ratio
18. Distance
19. Foreground brightness
20. Entropy
21. Truncated

* We have introduced four novel PLFs and annotated the total KI-A test data-set for these PLFs, which include the following:

- **Boundary edge strength:** the edge strength of the pedestrian boundary as an indication of visibility.
- **Background edge strength:** to detect the cases where the background has salient features that could cause detection issues.
- **Crowdedness:** an aggregated distance-based metric to detect if one object is in a crowded area.
- **Contrast to background:** the contrast of the object w.r.t. its background.
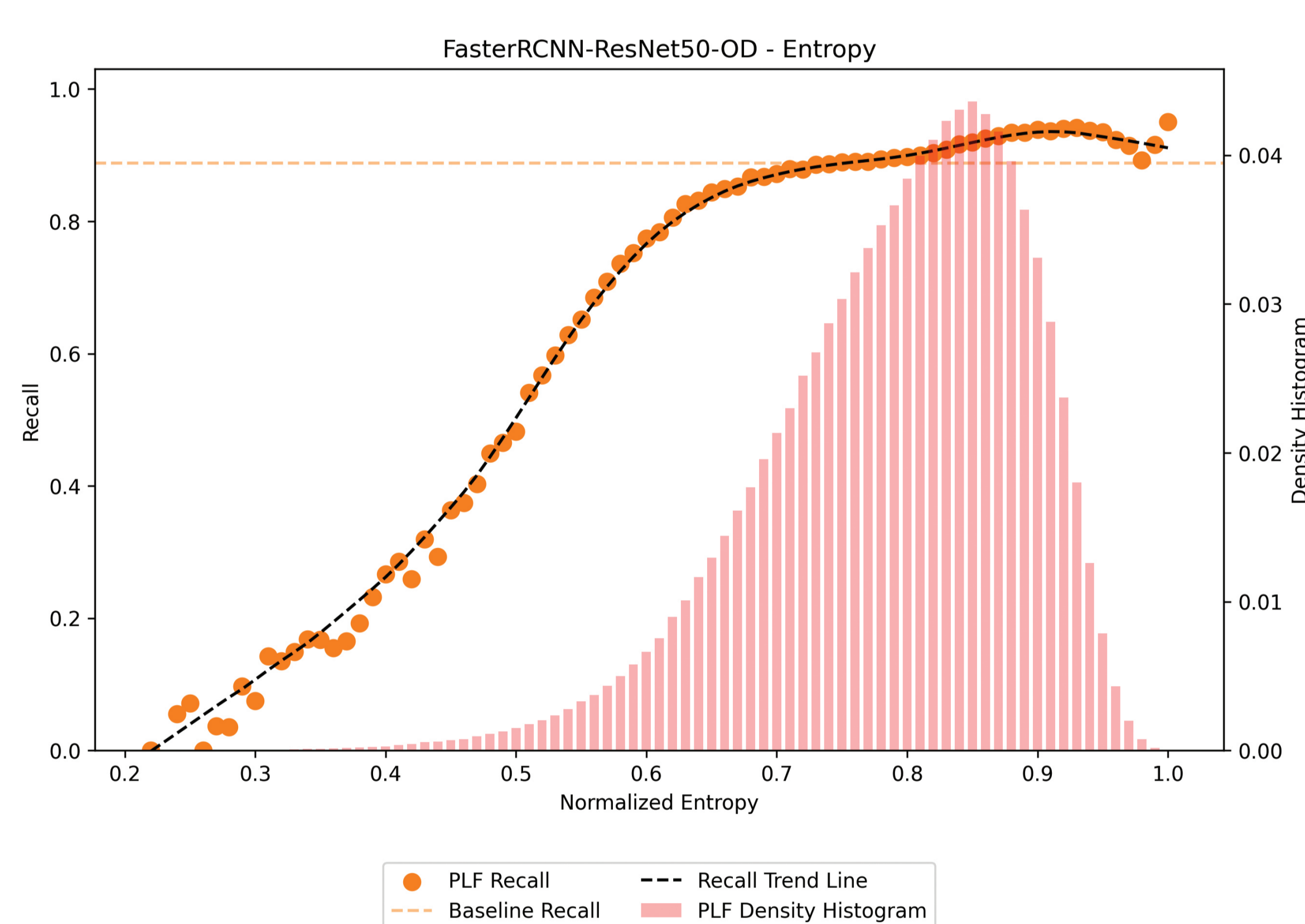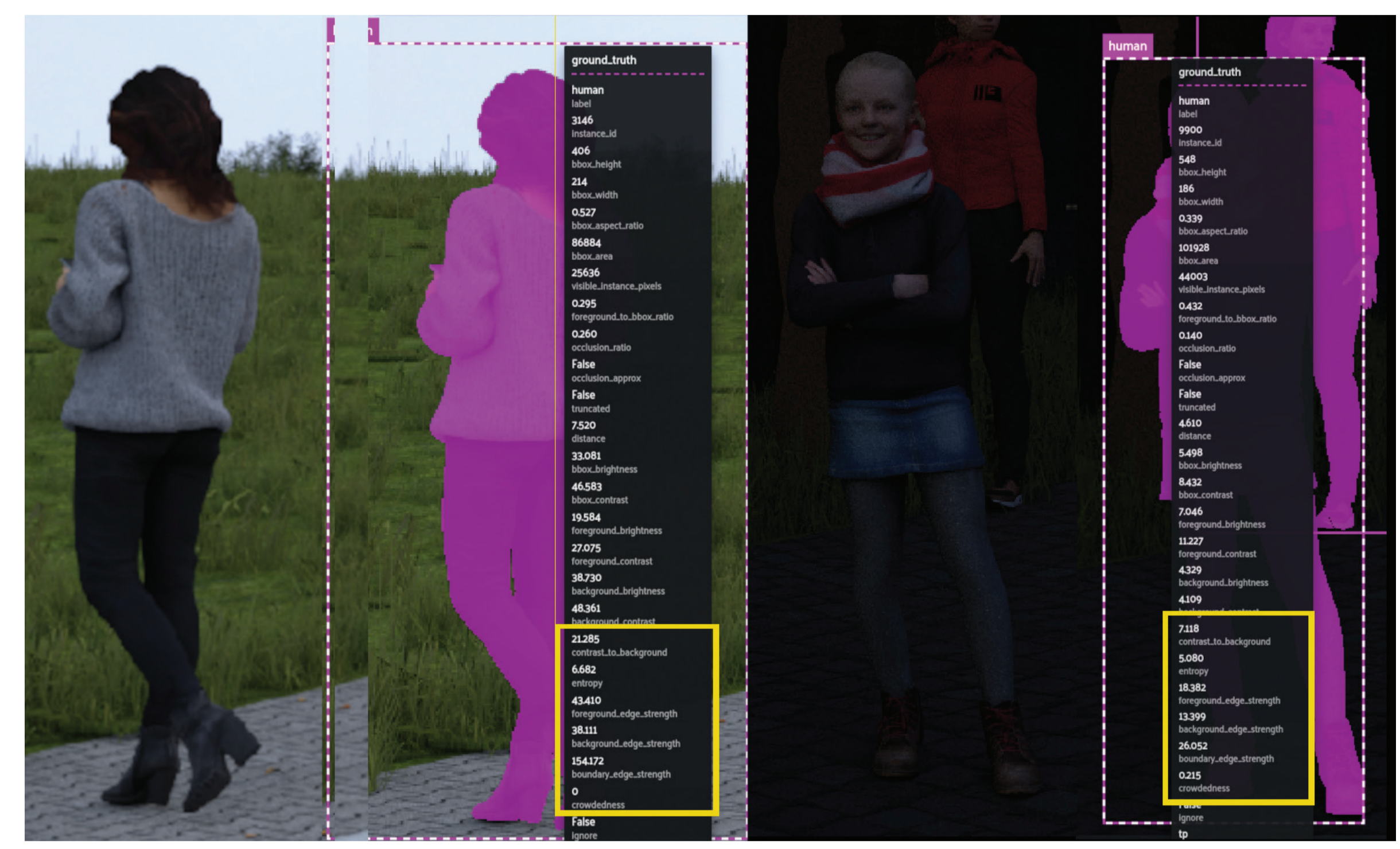

Figure 1: Two pedestrian instance examples which have different PLFs compared to each others. The highlighted PLFs are the ones which have a more significant difference

Effectiveness of PLFs:

An indication of effectiveness for a PLF is its correlation with the DNN performance. This way one could extract the data aspects that are under-represented to enrich the training data-set.

Trained and Analyzed Models:

- FasterRCNN- 2D Object Detection
- RetinaNet- 2D Object Detection
- SSD300- 2D Object Detection
- FCOS- 2D Object Detection
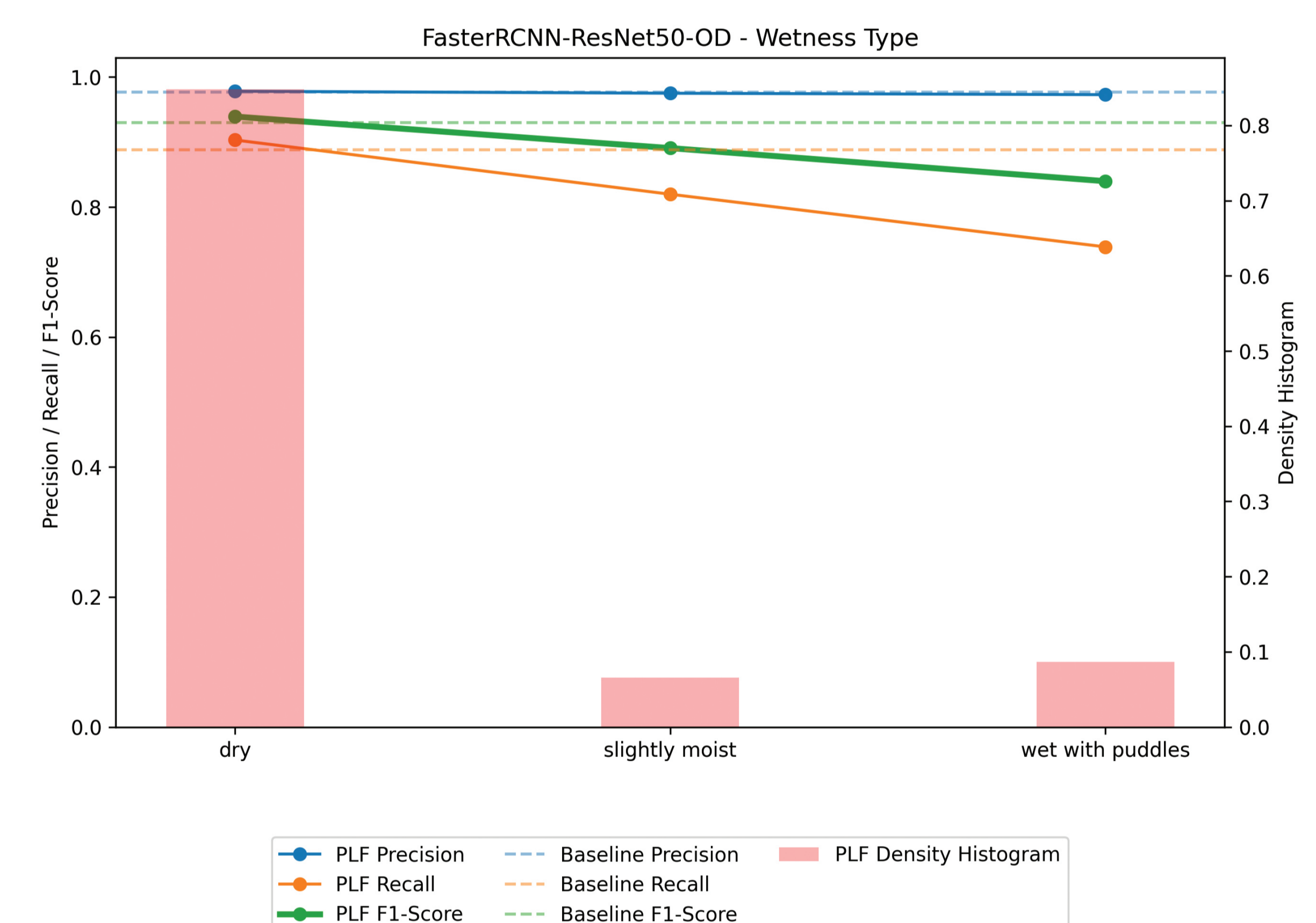- KeypointRCNN- Keypoint Detection
- MaskRCNN- Instance Segmentation

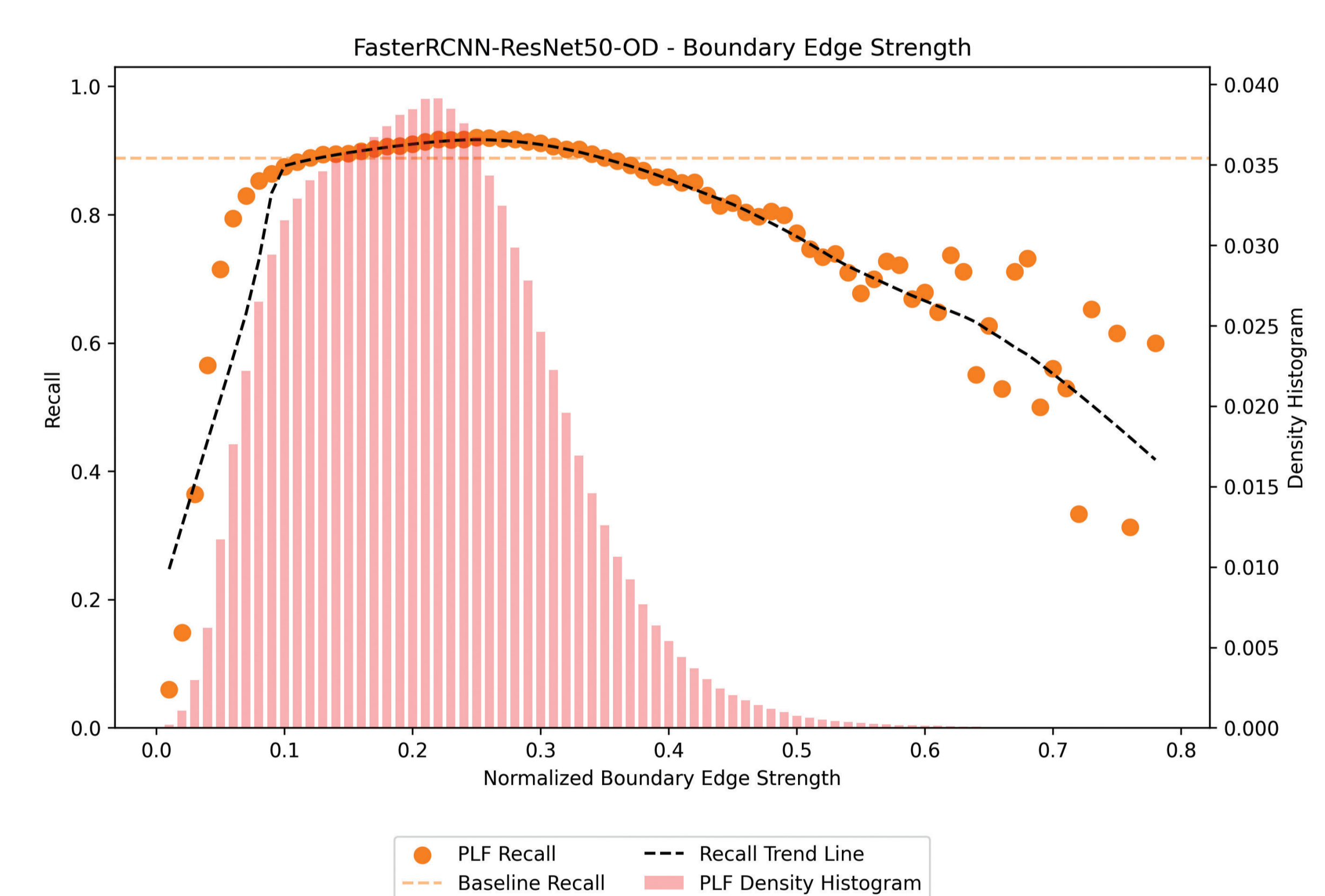Figure 3: The correlation and histogram analysis of the scene wetness as a PLF.

Figure 2: The correlation and histogram analysis of the object entropy as a PLF.

Figure 4: The correlation and histogram analysis of the object boundary edge strength as a PLF.

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Image sources:
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