

3D Object Detection

Results from all steps of the project

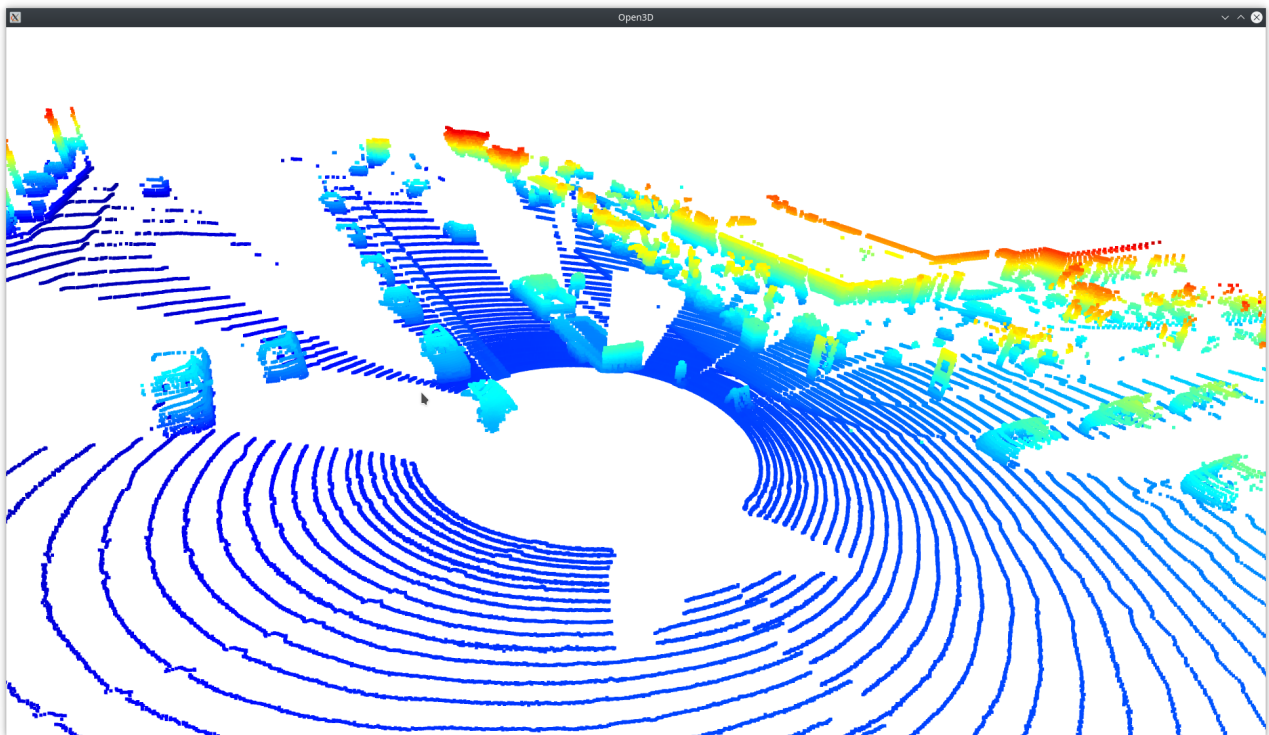
ID_S1_EX1

Screenshot from the stacked range/intensity image (cropped to $\pm 90^\circ$)



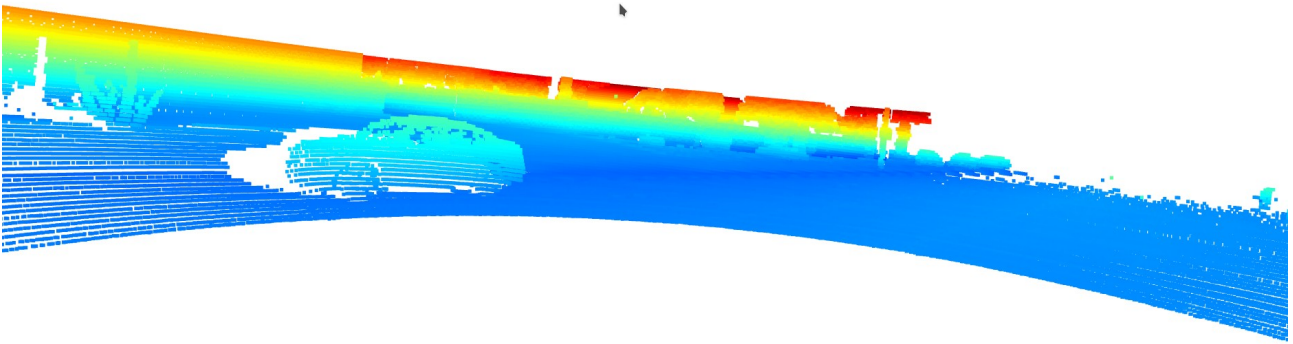
ID_S1_EX2

Screenshot of a point cloud visualization

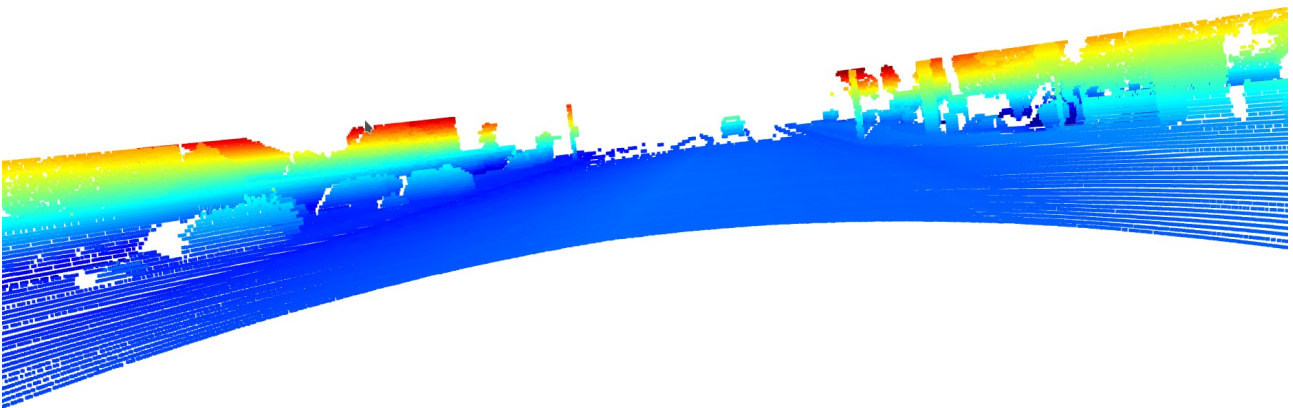


and further examples from this exercise:

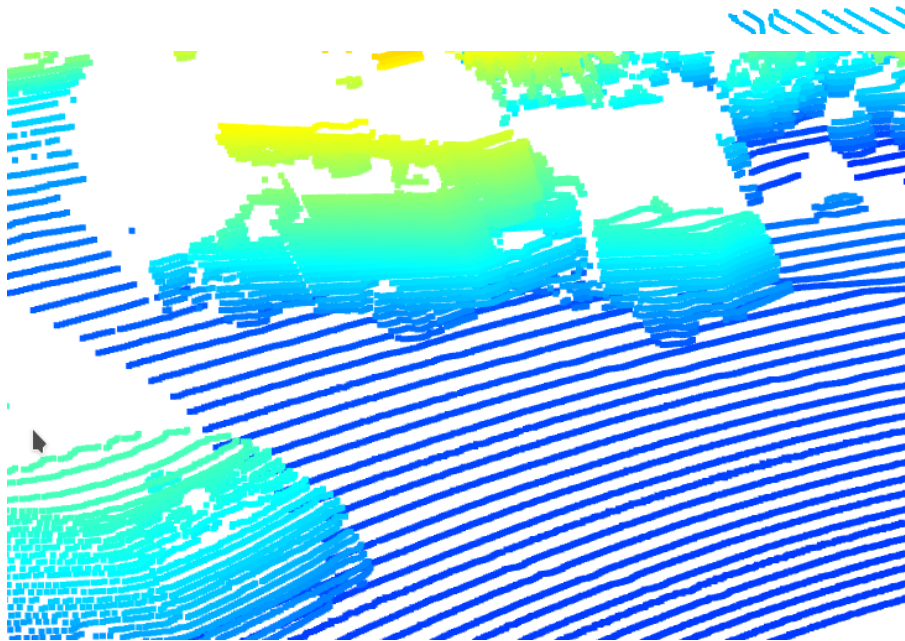
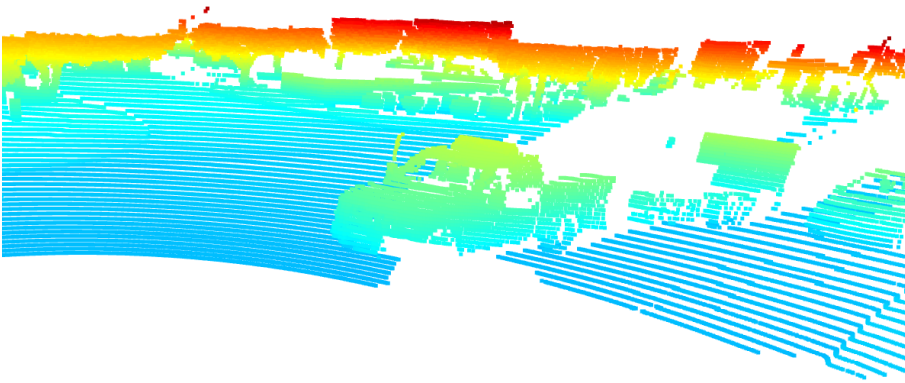
Vehicle to the side of the ego vehicle with low distance



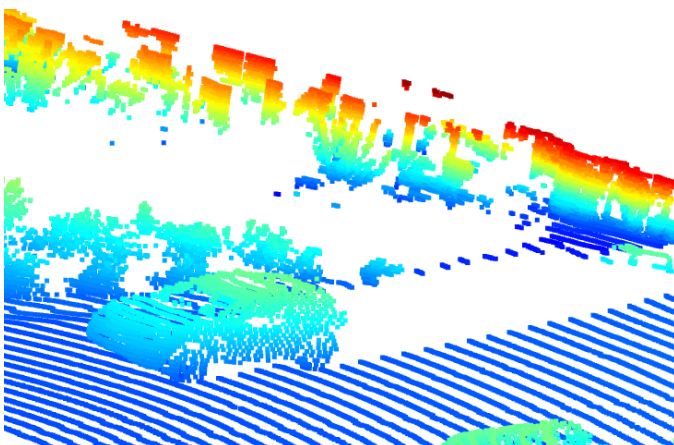
vehicle far ahead of the ego

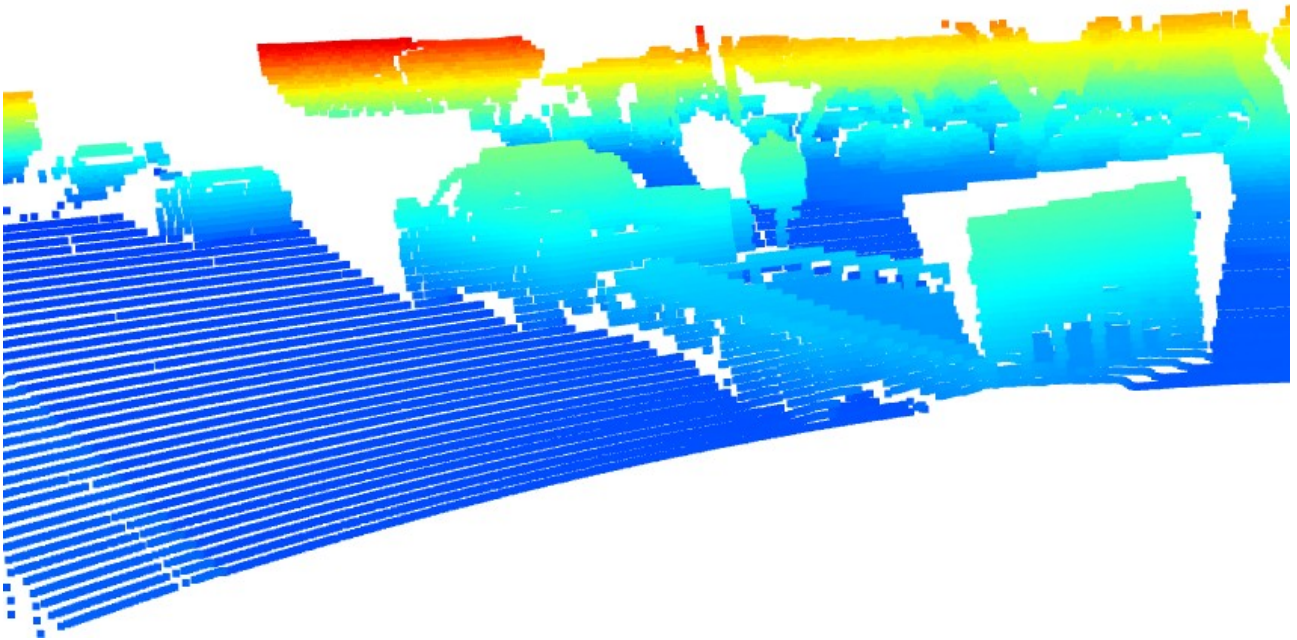


vehicle with trailer



vehicles to the side



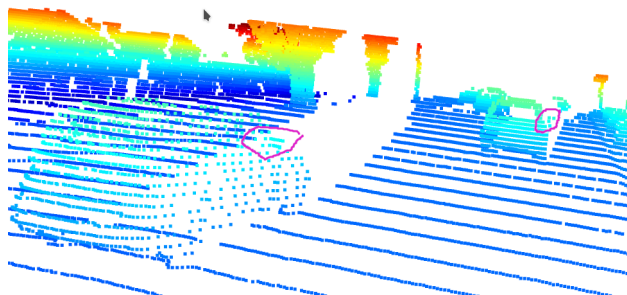


Stable features on most vehicles:

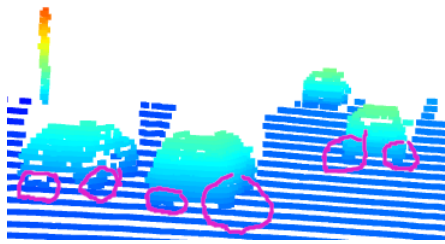
The license plate is clearly visible in the intensity image due to it's high reflectivity which is intended by law



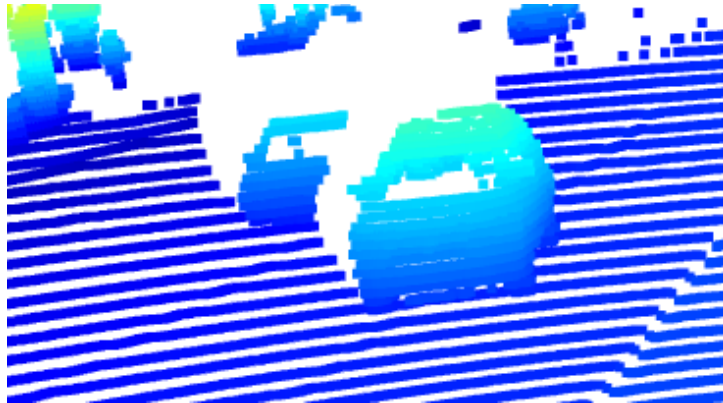
The side mirror is visible as an overhanging geometry in the point cloud



The same applies to the tires

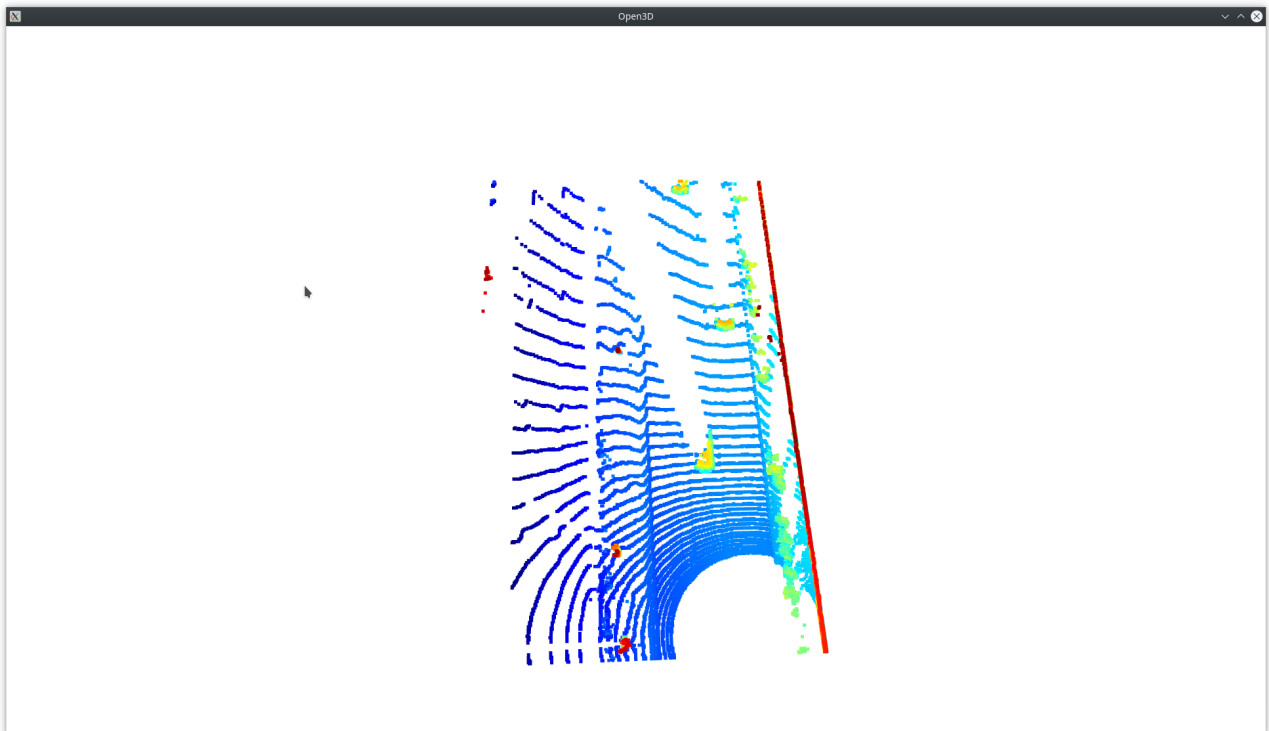


the front window also has a distinct lidar signatur because often no points can be measured on it.



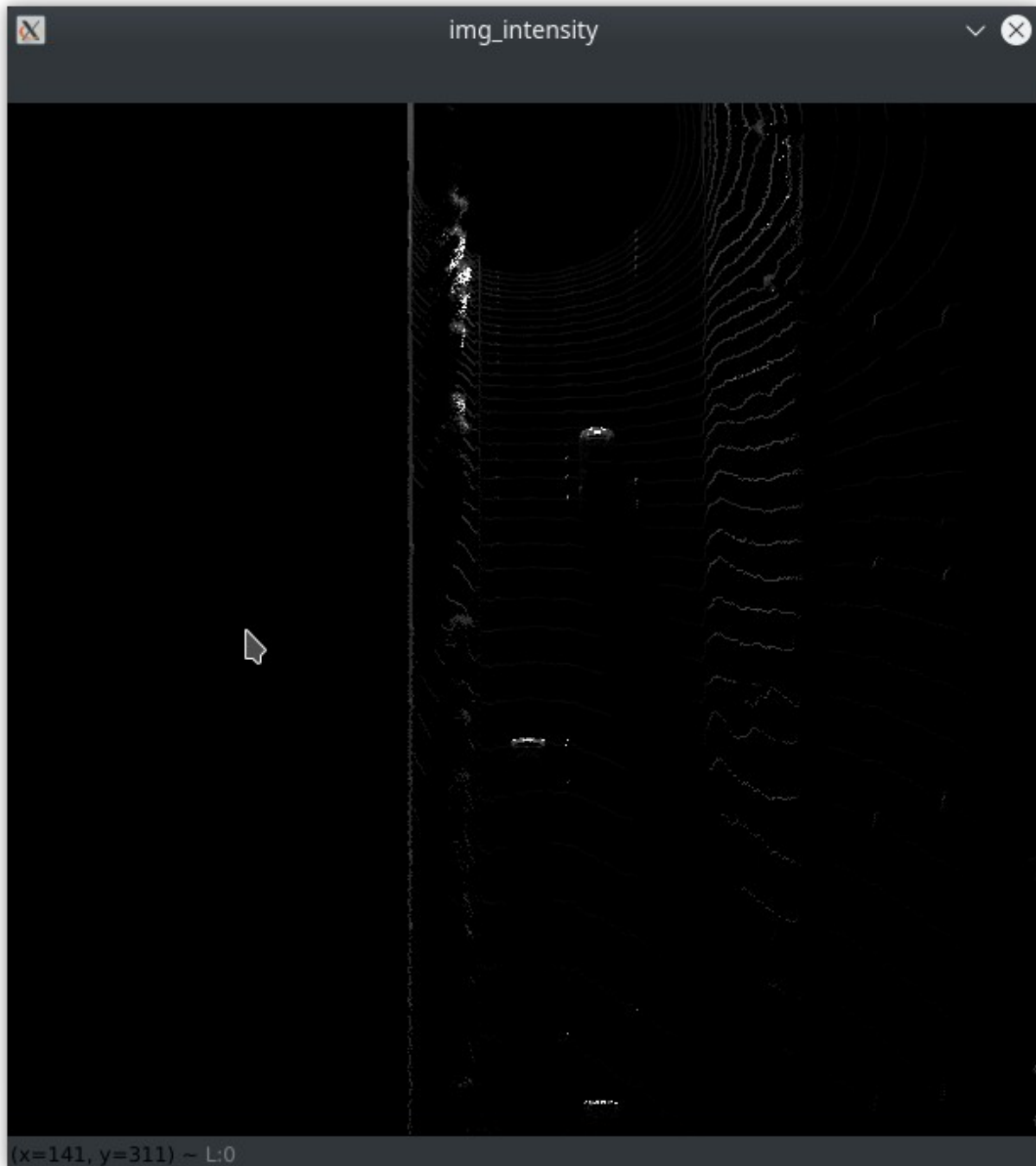
ID_S2_EX1

Birds-eye view from the Lidar point cloud



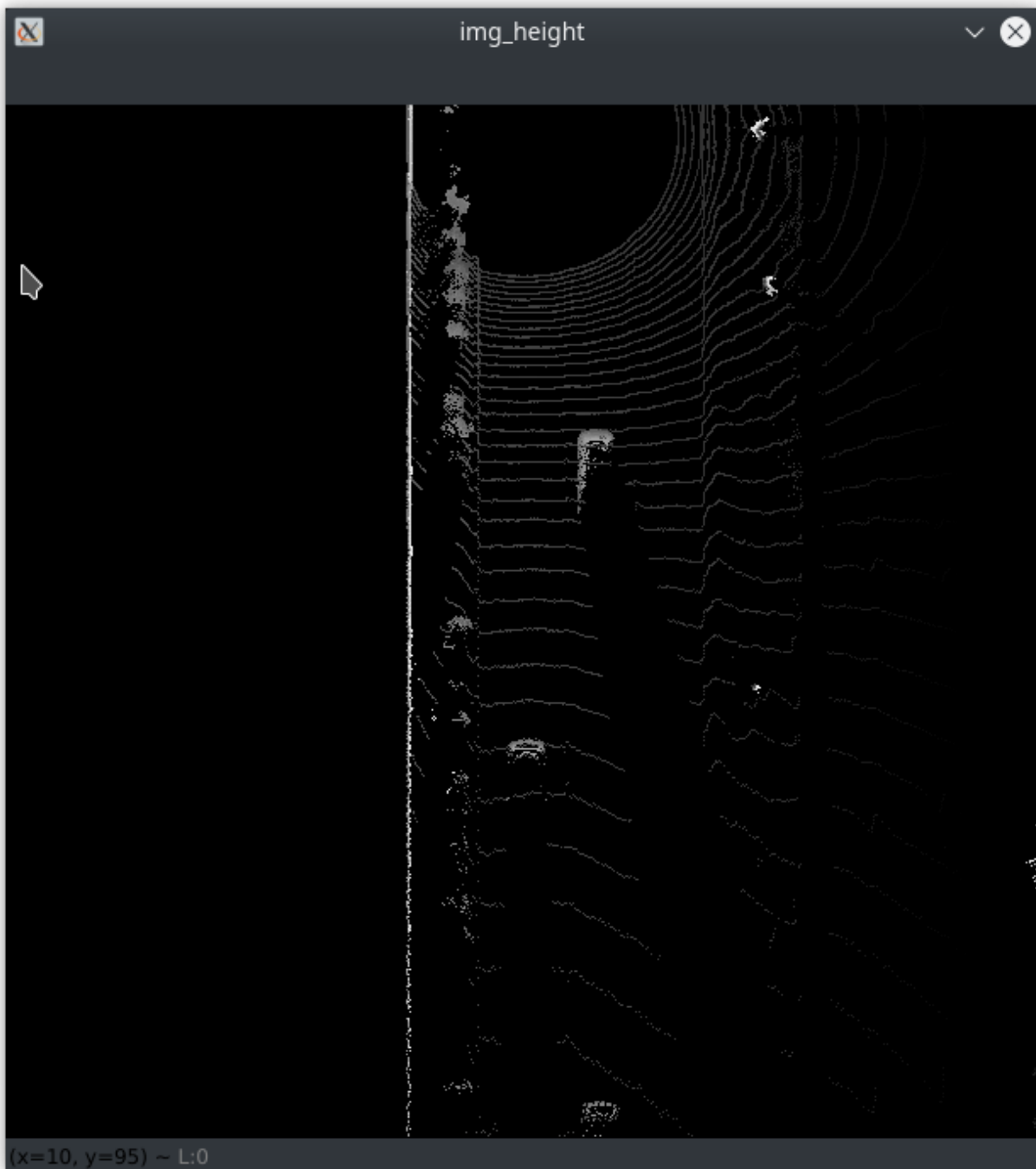
ID_S2_EX2

Plot of the intensity map



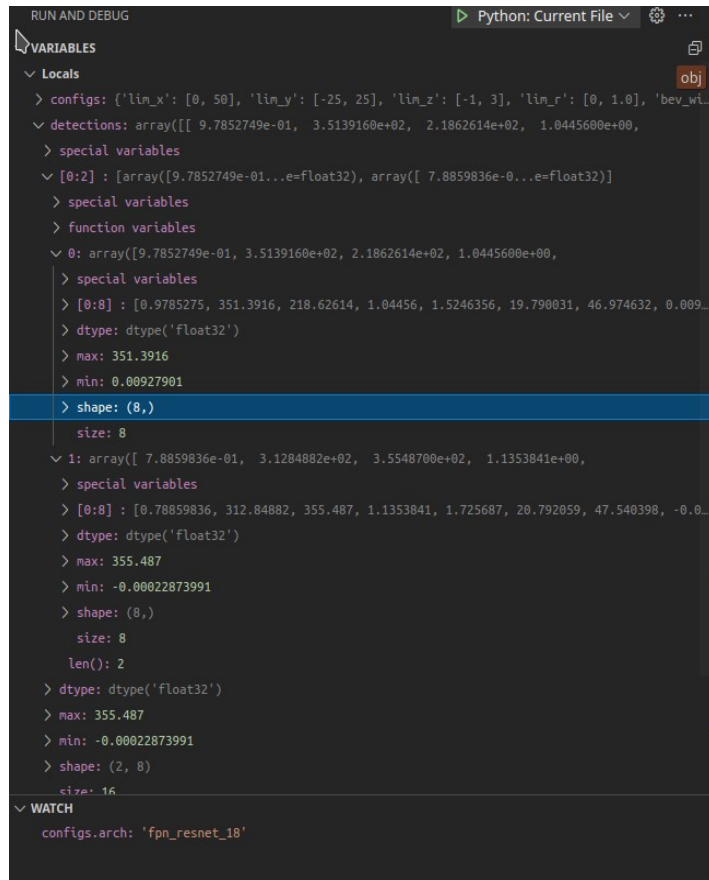
ID_S2_EX3

Plot of the height map



ID_S3_EX1

Detection results from fpn_resnet



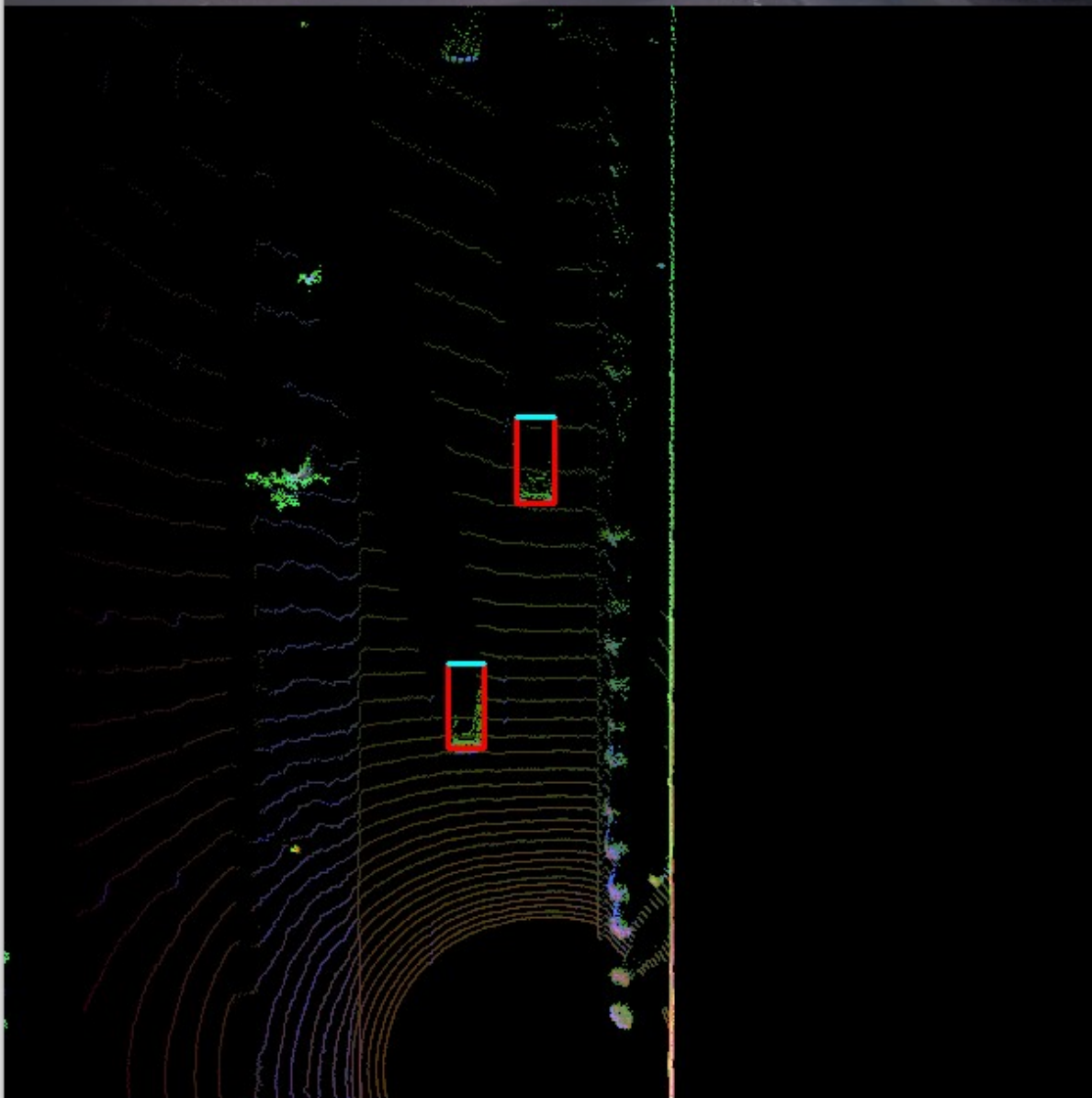
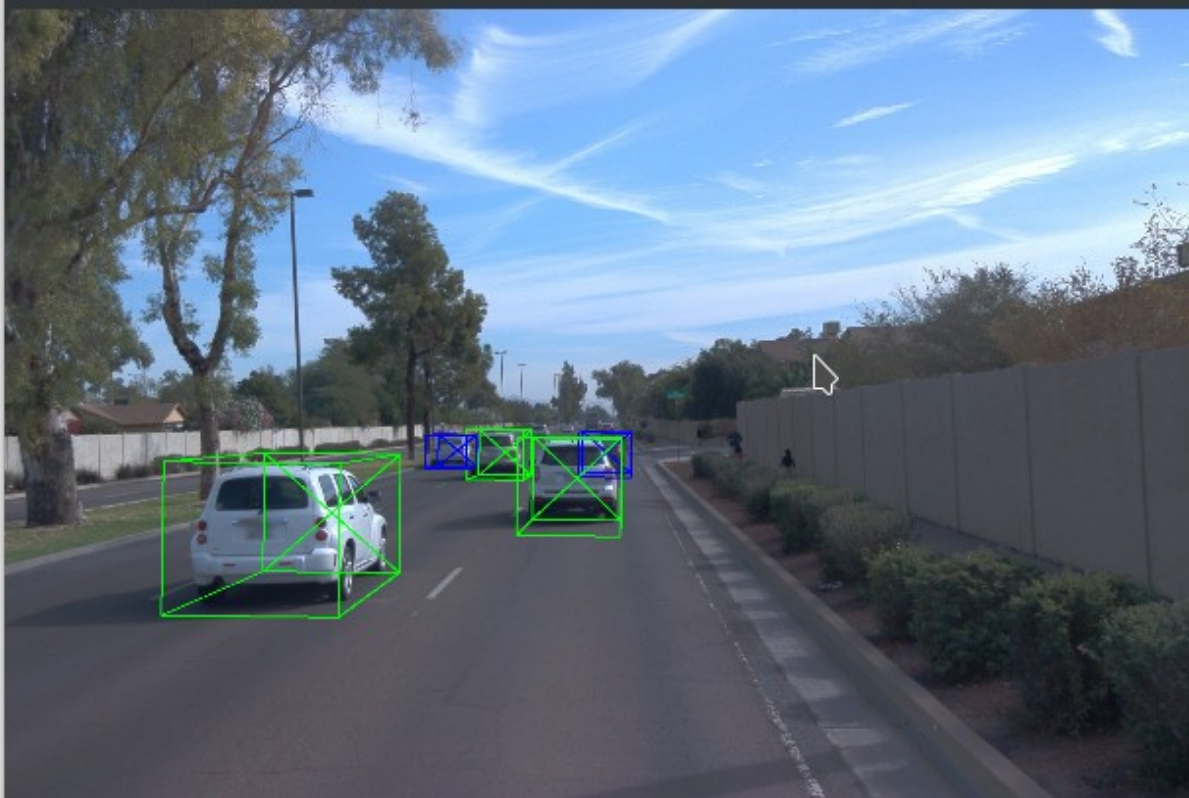
```
RUN AND DEBUG Python: Current File
VARIABLES
  Locals
    > configs: {'lin_x': [0, 50], 'lin_y': [-25, 25], 'lin_z': [-1, 3], 'lin_r': [0, 1.0], 'bev_wi...
    > detections: array([[ 9.7852749e-01,  3.5139160e+02,  2.1862614e+02,  1.0445600e+00,
    > special variables
    > [0:2] : [array([9.7852749e-01...=float32), array([ 7.8859836e-0...=float32)]
    > special variables
    > function variables
    > 0: array([9.7852749e-01,  3.5139160e+02,  2.1862614e+02,  1.0445600e+00,
    > special variables
    > [0:8] : [0.9785275, 351.3916, 218.62614, 1.04456, 1.5246356, 19.790031, 46.974632, 0.009...
    > dtype: dtype('float32')
    > max: 351.3916
    > min: 0.00927901
    > shape: (8,)
    size: 8
    > 1: array([ 7.8859836e-01,  3.1284882e+02,  3.5548700e+02,  1.1353841e+00,
    > special variables
    > [0:8] : [0.78859836, 312.84882, 355.487, 1.1353841, 1.725687, 20.792059, 47.540398, -0.0...
    > dtype: dtype('float32')
    > max: 355.487
    > min: -0.00022873991
    > shape: (8,)
    size: 8
    len(): 2
    > dtype: dtype('float32')
    > max: 355.487
    > min: -0.00022873991
    > shape: (2, 8)
    size: 16
  WATCH
    configs.arch: 'fpn_resnet_18'
```

ID_S3_EX2

Create 3D bounding boxes from bev detection



labels vs. detected objects



(x=413, y=177) - R:71 G:77 B:71

ID_S4_EX1

Calculate intersection over union and center point deviation for detected objects

```
RUN AND DEBUG Python: Current File
VARIABLES
Locals
obj
> best_match: [0.7966157121043681, 0.14627647399902344, -0.028125226497650146, 1.8929607095304...
> center_devs: [[0.2877540588378906, -0.09154129028320312, 2.0292643213596193], [-0.0819072723...
> special variables
> function variables
> 0: [0.2877540588378906, -0.09154129028320312, 2.0292643213596193]
> 1: [-0.08190727233886719, 0.013139963150024414, 1.8291298942401681]
> 2: [0.14627647399902344, -0.028125226497650146, 1.8929607095304846]
len(): 3
> detection_box: [(tensor(48.3975), tensor(6.2150)), (tensor(48.2462), tensor(2.1183)), (tenso...
> detections: [[1, tensor(29.0276), tensor(0.7716), -1.0, 1.5, tensor(1.9871), tensor(3.9524)]...
dist_x: -20.113563537597656
dist_y: -3.3874545097351074
dist_z: 1.8929607095304846
intersection: 0.0
iou: 0.0
> ious: [0.6844300641342204, 0.9125634400478836, 0.7966157121043681]
> special variables
> function variables
0: 0.6844300641342204
1: 0.9125634400478836
2: 0.7966157121043681
len(): 3
> l: tensor(4.0995)
> label: box {
> label_box: [(28.17953882067741, 2.9083779909680008), (28.132932237523885, -1.399325953041435...
> labels: [box {
> labels_valid: array([False, False, False, False, False, True, False, True, False,
> matches_lab_det: []
```

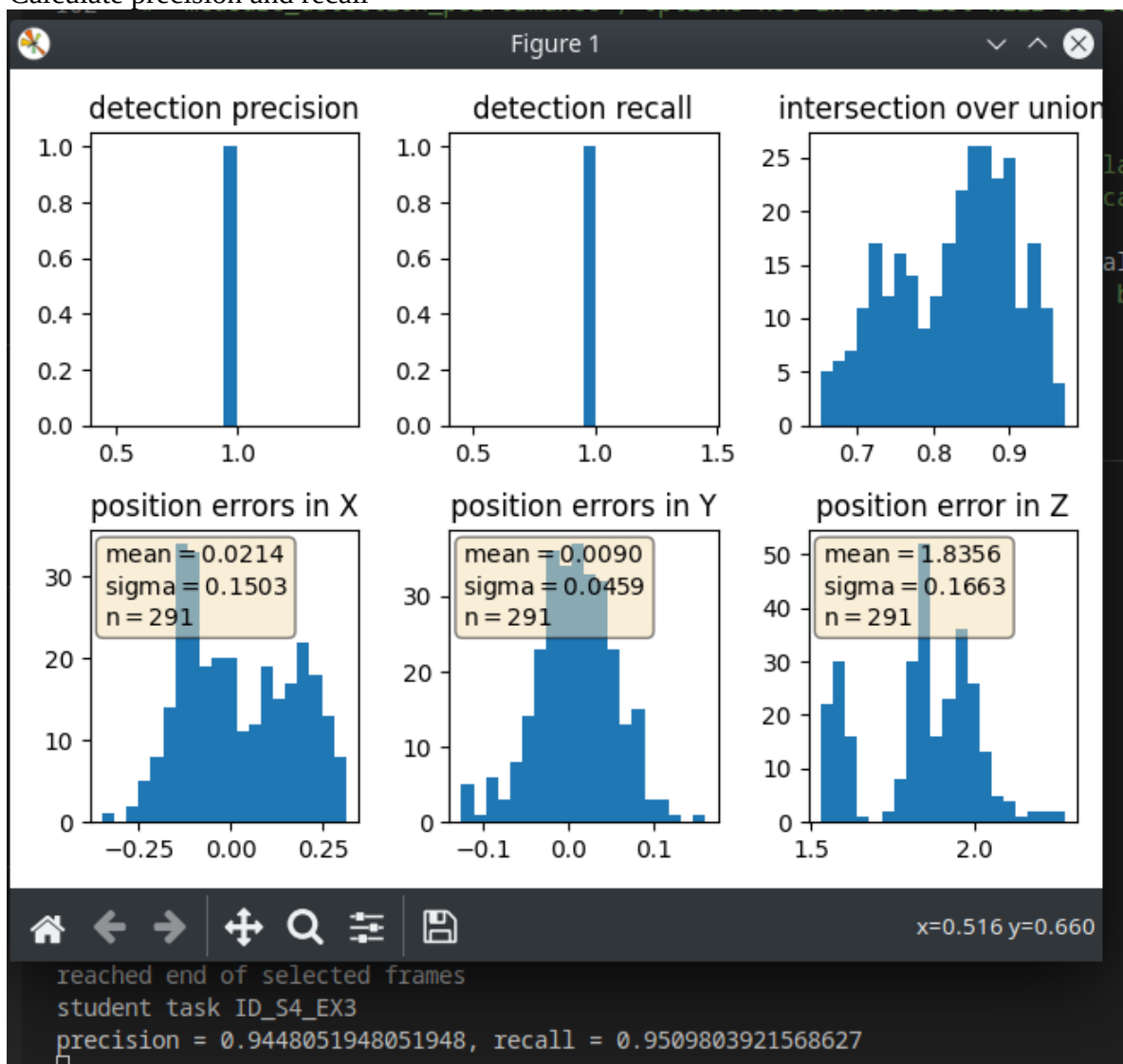
ID_S4_EX2

Calculate FP and FN

```
RUN AND DEBUG Python: Current File
VARIABLES
  Locals
    all_positives: 3
    > best_match: [0.7966157121043681, 0.14627647399902344, -0.028125226497650146, 1.8929607095304...
    > center_devs: [[0.2877540588378906, -0.09154129028320312, 2.0292643213596193], [-0.0819072723...
    > det_performance: [[0.6844300641342204, 0.9125634400478836, 0.7966157121043681], [...], [...
    > special variables
    > function variables
    > 0: [0.6844300641342204, 0.9125634400478836, 0.7966157121043681]
    > 1: [[0.2877540588378906, -0.09154129028320312, 2.0292643213596193], [-0.08190727233886719,...
    > 2: [3, 3, 0, 0]
    len(): 3
```

ID_S4_EX3

Calculate precision and recall



Validate by using labels as objects

