



Hochschule  
Bonn-Rhein-Sieg  
University of Applied Sciences



# Out-of-distribution detection in 3D semantic segmentation models

Master thesis

September 10, 2021

Lokesh Veeramacheneni

# Content

1. RandLA-Net Semantic3D flipout performance
2. RandLA-Net Semantic3D ensemble performance
3. Triangular detections in S3DIS datasets
4. What thresholds to be used?
5. Out-of-distribution (OOD) dataset - Toronto3D
6. Next steps

# RandLA-Net Semantic3D flipout performance

#Passes	MeanIOU	IoU per class								Accuracy
		C1	C2	C3	C4	C5	C6	C7	C8	
1	69.95	94.24	80.09	86.16	22.48	88.70	39.41	57.42	91.12	90.71
5	69.83	94.38	80.21	84.10	23.32	87.80	39.68	57.75	91.43	90.43
10	69.84	94.38	80.16	83.90	23.46	87.73	39.75	57.83	91.47	90.40
15	69.86	94.38	80.17	83.80	23.48	87.73	39.82	57.96	91.57	90.40
20	69.87	94.38	80.18	83.80	23.57	87.72	39.84	57.92	91.57	90.40

**Table 1:** Illustration of performance of RandLA-Net on Semantic3D over flipout initialized with variance 1. meanIOU and IOU per class and overall accuracy are represented here. C1 to C8 are the classes of Semantic3D which are Manmadeterrain, Naturalterrain, Highvegetation, Lowvegetation, Buildings, Hardscapes, Scanningartifacts, and Cars.

# RandLA-Net Semantic3D ensemble performance

#Ensembles	MeanIOU	IoU per class								Accuracy
		C1	C2	C3	C4	C5	C6	C7	C8	
1	68.19	94.55	81.19	84.67	29.43	81.37	18.85	64.74	90.74	88.78
5	69.51	94.73	81.92	84.42	28.05	<b>86.41</b>	28.50	61.03	91.03	90.04
10	69.97	95.25	83.73	86.63	30.36	84.13	18.60	<b>66.01</b>	92.61	89.94
15	70.32	95.27	83.54	<b>88.22</b>	<b>32.19</b>	84.82	26.17	61.67	90.75	<b>90.57</b>
20	<b>70.80</b>	<b>95.55</b>	<b>84.11</b>	86.65	29.60	85.41	<b>29.58</b>	62.47	<b>93.06</b>	90.56

**Table 2:** Illustration of performance of RandLA-Net on Semantic3D over number of ensembles. meanIOU and IOU per class and overall accuracy are represented here. C1 to C8 are the classes of Semantic3D which are Manmadeterrain, Naturalterrain, Highvegetation, Lowvegetation, Buildings, Hardscapes, Scanningartifacts, and Cars.

# RandLA-Net Semantic3D ensemble performance

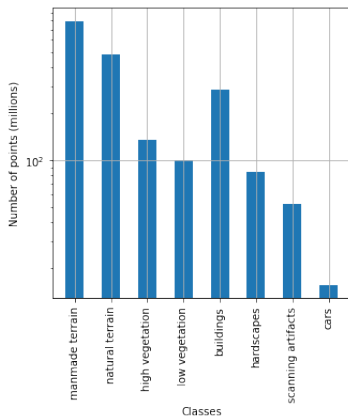


Figure 1: Distribution of training points in million per class in Semantic3D dataset.

- Triangle detections of the rectangular spaces - PNG images
- What thresholds to be used? - ipynb file
- Toronto3D dataset study

# Out-of-distribution (OOD) dataset - Toronto3D

Indoor dataset

Classes are:

Semantic3D(ID)	Toronto3D (OOD)
Manmade terrain	Road
Natural terrain	Road marking
High vegetation	Natural
Low vegetation	Building
Buildings	Utility line
Hardscapes	Pole
Scanning artifacts	Car
Cars	Fence

**Table 3:** Classes in both the datasets, In-distribution (ID) dataset is Semantic3D and OOD dataset is Toronto3D

# Next steps

- Toronto3D evaluation using deep ensembles
- Semantic3D Vs S3DIS (outdoor vs indoor) evaluation using flipout