



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

Master thesis

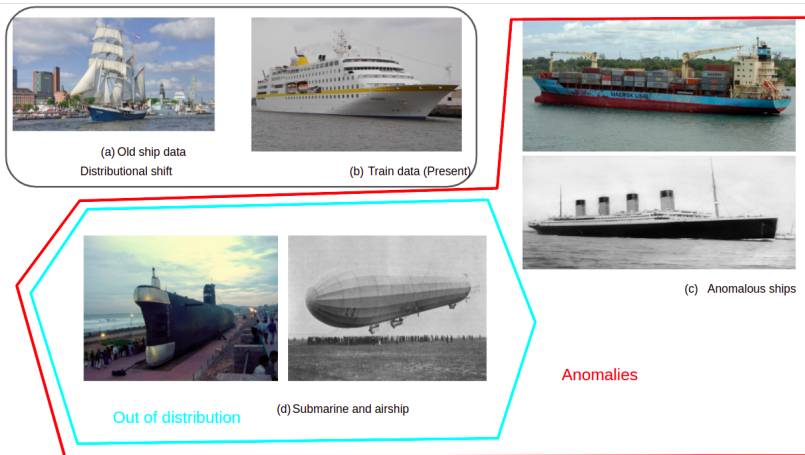
September 10, 2021

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Content

1. Recap
2. RandLA-Net Semantic3D ensemble performance
3. Out-of-distribution (OOD) dataset - S3DIS
4. Next Steps

Recap-OOD Vs Anomaly



Recap-RandLA-Net

- RandLA-Net is chosen because of
 - architectural advantage-extract complex structures efficiently
 - lower parameters-ease of training
 - No preprocessing-random point sampling
 - State of the art performance on point based methods

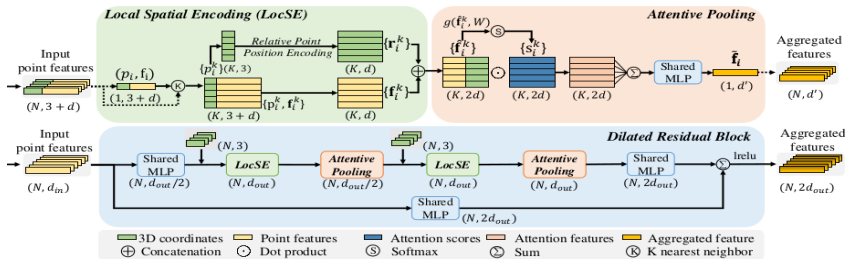


Figure 2: Local feature aggregation module for efficient feature extraction.

Recap-Dataset

- Semantic3D as in-distribution (ID) dataset because
 - Dense point clouds - static dataset
 - Rich features per point such as x,y,z,r,g,b and intensity
 - c.a 4 billion points
 - Less number of classes
 - Highest scene diversity in dataset compared to other datasets
- Chosen ensemble technique for uncertainty quantification because of better performance

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	86.41	28.50	61.03	91.03	90.04
10	69.97	95.25	83.73	86.63	30.36	84.13	18.60	66.01	92.61	89.94
15	70.32	95.27	83.54	88.22	32.19	84.82	26.17	61.67	90.75	90.57
20	70.80	95.55	84.11	86.65	29.60	85.41	29.58	62.47	93.06	90.56

Table 1: 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

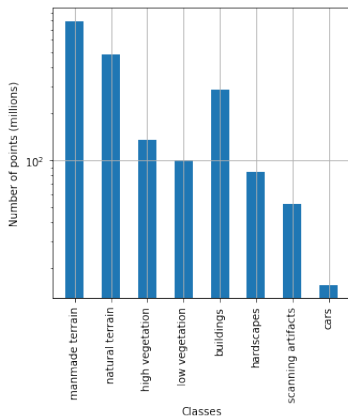


Figure 3: Distribution of training points in million per class in Semantic3D dataset.

RandLA-Net Semantic3D ensemble performance

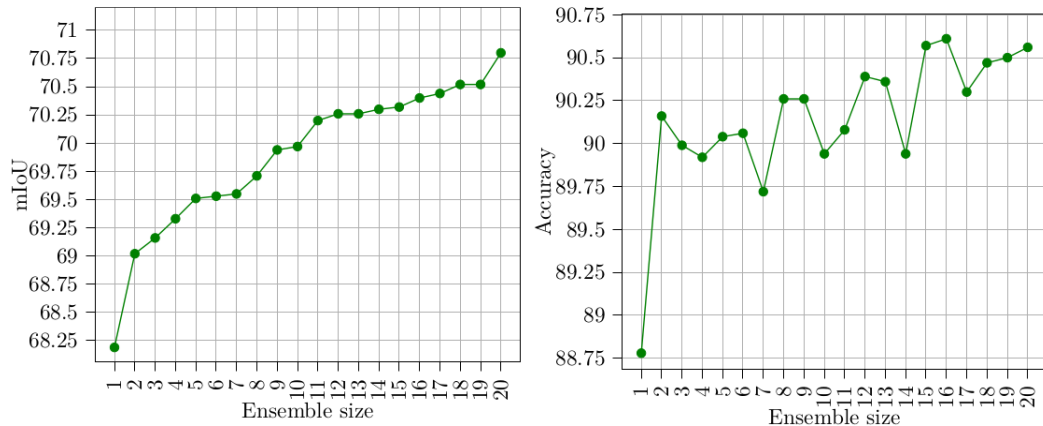


Figure 4: Detailed performance metrics such as mean IOU and Accuracy with ensemble size.

RandLA-Net Semantic3D ensemble performance

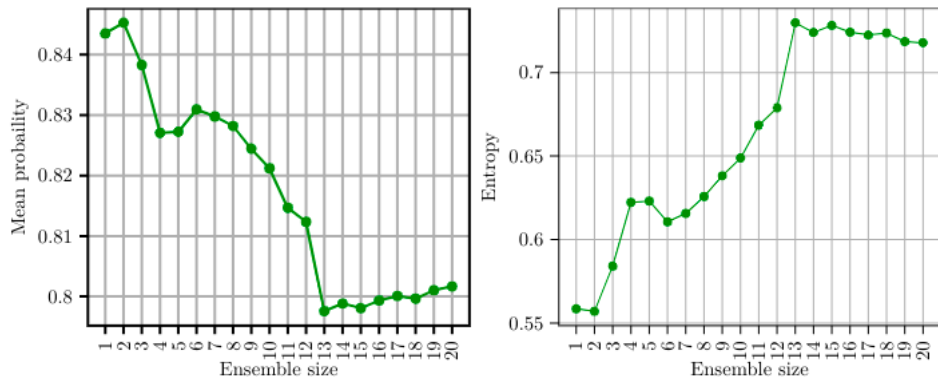


Figure 5: Illustration of change in mean probability and entropy with ensemble size.

Out-of-distribution (OOD) dataset - S3DIS

Indoor dataset

Classes are:

Semantic3D(ID)	S3DIS(OOD)
Manmade terrain	Ceiling
Natural terrain	Floor
High vegetation	Wall
Low vegetation	Beam
Buildings	Column
Hardscapes	Window
Scanning artifacts	Door
Cars	Chair
	table
	bookcase
	sofa
	board

Table 2: Classes in both the datasets, In-distribution (ID) dataset is Semantic3D and OOD dataset is S3DIS

Next steps

- Uncertainty score on OOD dataset using deep ensembles
- Threshold based classifier for OOD Vs ID
- Is table for related work models scientifically acceptable?