Hochschule
Bonn-Rhein-Sieg
University of Applied Sciences

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

Master thesis

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Lokesh Veeramacheneni

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Recap

- RandLA-Net as model because of architectural advantage
- 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 becuase of better performance

RandLA-Net Semantic3D ensemble performance

#Ensembles	MeanIOU	Accuracy	IOU-Manmadeterrain	IOU-Naturalterrain	IOU-Highvegetation	IOU-Lowvegetation	IOU-Buildings	IOU-Hardscapes	IOU-Scanningartifacts	IOU-Cars
1	69.53	90.06	95.18	83.34	87.46	31.83	83.76	20.47	62.98	91.27
5	70.20	90.08	95.26	83.86	**88.95**	32.02	83.61	20.66	**64.36**	92.94
10	70.52	90.47	95.08	83.3	86.52	27.81	**85.77**	**32.43**	62.22	91.06
15	70.40	**90.61**	95.26	84.13	88.16	31.41	85.43	26.24	59.62	**92.98**
20	**70.52**	90.50	**95.38**	**84.27**	86.94	**33.7**	85.16	26.89	61.78	90.05

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.

RandLA-Net Semantic3D ensemble performance

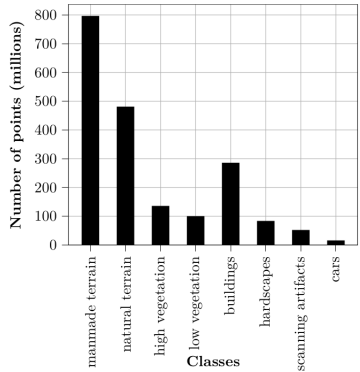
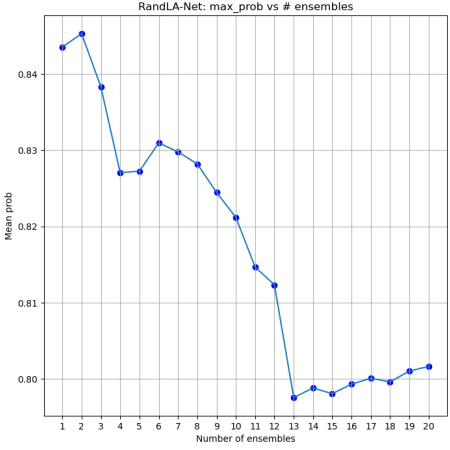
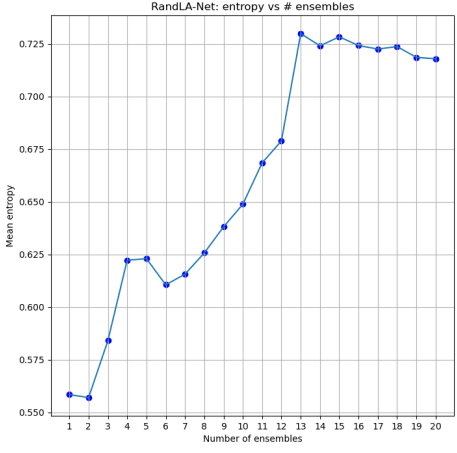


Figure 1: Distribution of training points in million per class in Semantic3D dataset.

RandLA-Net Semantic3D ensemble performance





Out-of-distribution (OOD) dataset - S3DIS

Indoor dataset

Classes are:

Semantic3D	S3DIS
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, ID dataset is Semantic3D and OOD dataset is S3DIS

Max prediction probabilities distribution (ID-OOD)

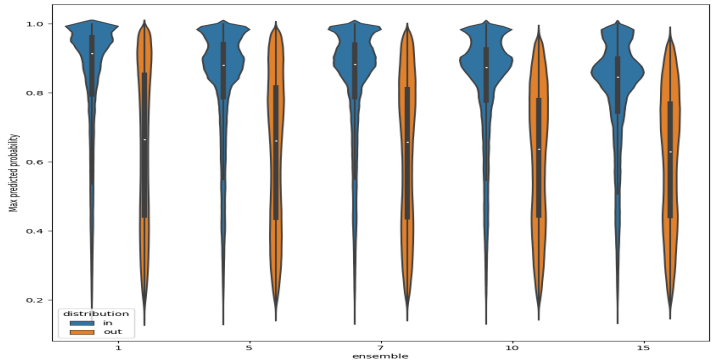


Figure 2: Violin plot depicting the median and distribution of predicted max probabilities for ID and OOD datasets.

Entropy distribution (ID-OOD)

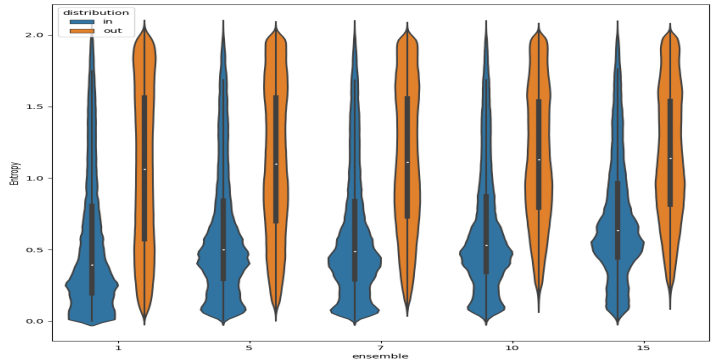


Figure 3: Violin plot depicting the median and distribution of entropies for ID and OOD datasets.

Next Steps

- Threshold based detector for probability and entropy
- Related work section of the report
- Other uncertainty techniques