

## Domain Generalization



Fig 1. Domain shift.

### Domain Shift:

- Clean and ordered v.s. complex and cluttered layouts
- Different point patterns

### Contributions:

- A practical yet challenging setting of domain generalized 3D indoor point cloud segmentation.
- A novel data augmentation technique: clustering instance mix.
- A non-parametric multi-prototypes based classifier to deal with intra-class variance.

## Clustering Instance Mix

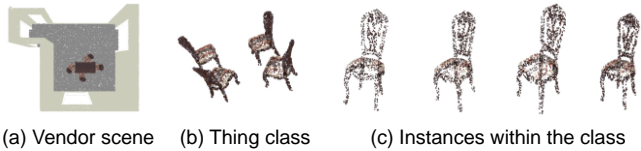


Fig 2. Visualization of one thing class.

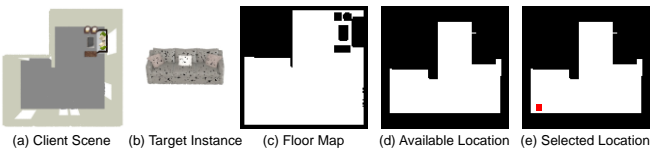
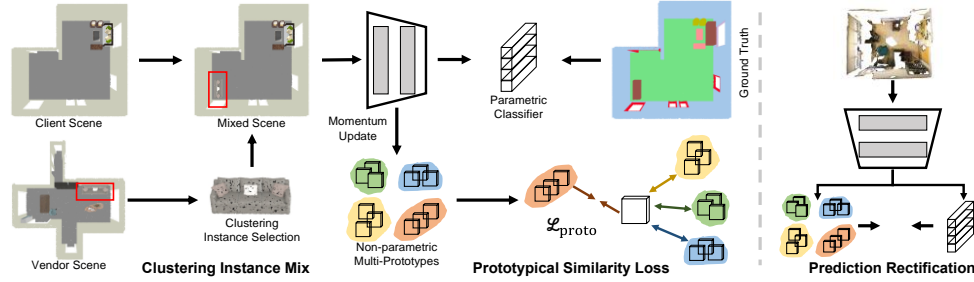


Fig 3. Geometry constrained mixing.

## Methodology



### Multi-prototypes Initialization

$$\bar{f}_c^i = \frac{\sum_{j=1}^n f(x_j^i) * \mathbb{1}(y_j^i == c)}{\sum_{j=1}^n \mathbb{1}(y_j^i == c)}$$

### Prototypical Similarity Loss

$$\mathcal{L}_{\text{proto}}(x, y) = -\frac{1}{n} \sum_{j=1}^n y_j \log \frac{\exp(s(x_j, c_j))}{\sum_{k=1}^{N_C} \exp(s(x_j, c_k))}$$

### Prediction Rectification

$$w(x_j, c) = \frac{\exp(s(x_j, c))}{\sum_{k=1}^{N_C} \exp(s(x_j, c_k))} \quad p(x_j, c) = w(x_j, c) * \Phi(f(x_j), c)$$

## Qualitative Results

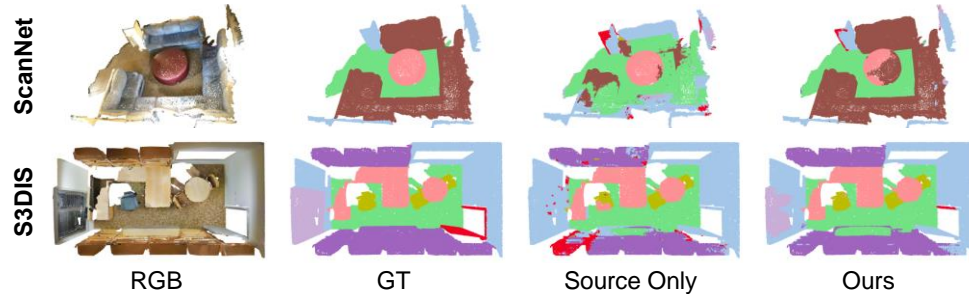


Fig 4. Qualitative results.

## Experiments

Tab 1. 3D-FRONT -> ScanNet and S3DIS benchmarks.

Target	Method	wall	floor	chair	sofa	table	door	wind.	bksf.	mIoU
ScanNet	Source Only	70.24	86.41	61.53	31.90	50.95	6.60	3.02	31.93	42.82
	ClassMix [12]	68.52	80.54	52.40	42.67	28.94	7.20	8.36	39.28	40.99
	Cuboid Mixing [8]	73.02	89.04	62.56	36.87	45.89	7.22	0.36	37.59	44.07
	Mix3D [13]	71.87	87.23	60.68	<b>48.15</b>	43.15	<b>8.56</b>	0.65	27.83	43.52
	VSS [9]	68.80	89.05	57.91	45.49	47.22	8.47	10.09	36.42	45.43
	DODA-S [6]	71.65	<b>89.23</b>	60.72	41.78	48.13	8.33	6.76	39.48	45.76
Ours	<b>73.42</b>	88.07	<b>62.72</b>	43.56	<b>52.14</b>	7.71	<b>14.20</b>	<b>44.44</b>	<b>48.28</b>	
S3DIS	Source Only	68.94	92.63	50.86	16.61	47.50	9.00	0.87	22.74	38.64
	ClassMix [12]	70.53	93.68	56.04	7.89	34.25	10.51	0.20	35.52	38.58
	Cuboid Mixing [8]	69.18	88.41	56.83	9.43	34.36	11.47	0.23	24.96	36.86
	Mix3D [13]	70.73	92.64	53.17	9.04	50.51	7.97	1.17	25.88	38.89
	VSS [9]	69.71	94.52	58.11	<b>26.43</b>	40.83	<b>21.16</b>	23.14	49.24	47.89
	DODA-S [6]	71.33	92.11	59.32	20.02	36.24	13.47	7.63	38.75	42.36
Ours	<b>76.00</b>	<b>94.66</b>	<b>66.22</b>	17.79	<b>53.20</b>	21.12	<b>29.84</b>	<b>51.14</b>	<b>51.25</b>	

Tab 2. Ablation studies.

No.	CINMix	Para.	N-Para. T	N-Para. I	ScanNet	S3DIS	Mean
1	✗	✓	✗	✗	45.43	47.89	46.66
2	✓	✓	✗	✗	46.23	48.92	47.58
3	✗	✓	✓	✗	46.63	48.29	47.46
4	✗	✓	✓	✓	46.78	49.06	47.92
5	✓	✗	✓	✗	46.88	46.26	46.57
6	✓	✓	✓	✗	48.00	50.02	49.01
7	✓	✓	✓	✓	<b>48.28</b>	<b>51.25</b>	<b>49.77</b>

Tab 3. Augmentations.

Augmentation	ScanNet	S3DIS	Mean
VSS+N-Para.	46.78	49.06	47.92
+ClassMix [12]	46.63	45.74	46.19
+Cuboid Mixing [8]	47.74	45.58	46.66
+Mix3D [13]	47.99	48.22	48.11
+CINMix	<b>48.28</b>	<b>51.25</b>	<b>49.77</b>

Tab 4. Clustering constrains.

Degree of constraints	ScanNet	S3DIS	Mean
Strict	45.47	47.41	46.44
Loose	48.11	50.92	49.52
Appropriate	<b>48.28</b>	<b>51.25</b>	<b>49.77</b>

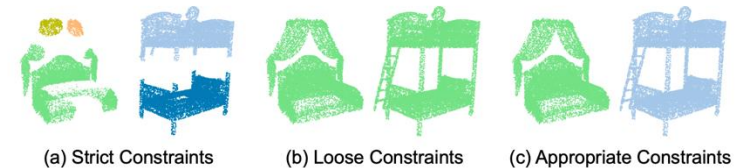


Fig 5. Visualization of different clustering constraints.