





Average kNN distance: 
$$d_{i} = \frac{1}{k} \sum_{\mathbf{x}_{j} \in knn(\mathbf{X}, \mathbf{x}_{i}, k)} \left\| \mathbf{x}_{i} - \mathbf{x}_{j} \right\|_{2}, \qquad i = 1,$$
$$\bar{d} = \frac{1}{n} \sum_{i}^{n} d_{i} \qquad \sigma = \sqrt{\frac{1}{n} \sum_{i}^{n} (d_{i} - \bar{d})^{2}}$$
$$\mathbf{X}' = \{\mathbf{x}_{i} | d_{i} < \bar{d} + \alpha \cdot \sigma\}, \qquad i = 1, \dots, n$$
Upsampler network:

$$\mathcal{L}(\mathbf{X}, \widehat{\mathbf{X}}) = \mathcal{L}_{rec}(\mathbf{X}, \widehat{\mathbf{X}}) + \beta \mathcal{L}_{rep}(\mathbf{X}, \widehat{\mathbf{X}}) + \gamma \|\boldsymbol{\theta}\|_{2}^{2}$$
$$\mathcal{L}_{rec}(\mathbf{X}, \widehat{\mathbf{X}}) = D(\mathbf{X}, \widehat{\mathbf{X}}) = \frac{1}{\|\widehat{\mathbf{X}}\|_{0}} \sum_{\mathbf{x}' \in \widehat{\mathbf{X}}} \min_{\mathbf{x} \in \mathbf{X}} \|\mathbf{x} - \mathbf{x}'\|_{2}^{2}$$
$$\mathcal{L}_{rep}(\mathbf{X}, \widehat{\mathbf{X}}) = \sum_{\mathbf{x} \in \mathbf{X}} \sum_{\mathbf{x}' \in knn(\mathbf{x})} \eta(\|\mathbf{x} - \mathbf{x}'\|_{2}^{2}) w(\|\mathbf{x} - \mathbf{x}'\|_{2}^{2})$$



<b>7</b> 11	Defense	Defense (SOR)	<b>Defense (PU-Net)</b>	Defense (DUP-Net)
±IJ	(SRS)	(ours)	(ours)	(ours)
	83.0%	86.5%	87.5%	86.3%
	64.7%	81.4%	23.9%	84.5%
	58.8%	59.8%	17.6%	62.7%
	59.5%	59.1%	18.0%	61.4%
	92.0%	-	-	87.6%
	92.4%	-	-	68.4%
	68.1%	71.3%	76.1%	73.9%
	56.4%	60.0%	67.7%	64.3%
	45.0%	48.6%	57.7%	54.4%
	35.1%	36.8%	48.1%	43.7%