A Learnable Self-supervised Task for Unsupervised Domain Adaptation on Point Cloud Classification and Segmentation

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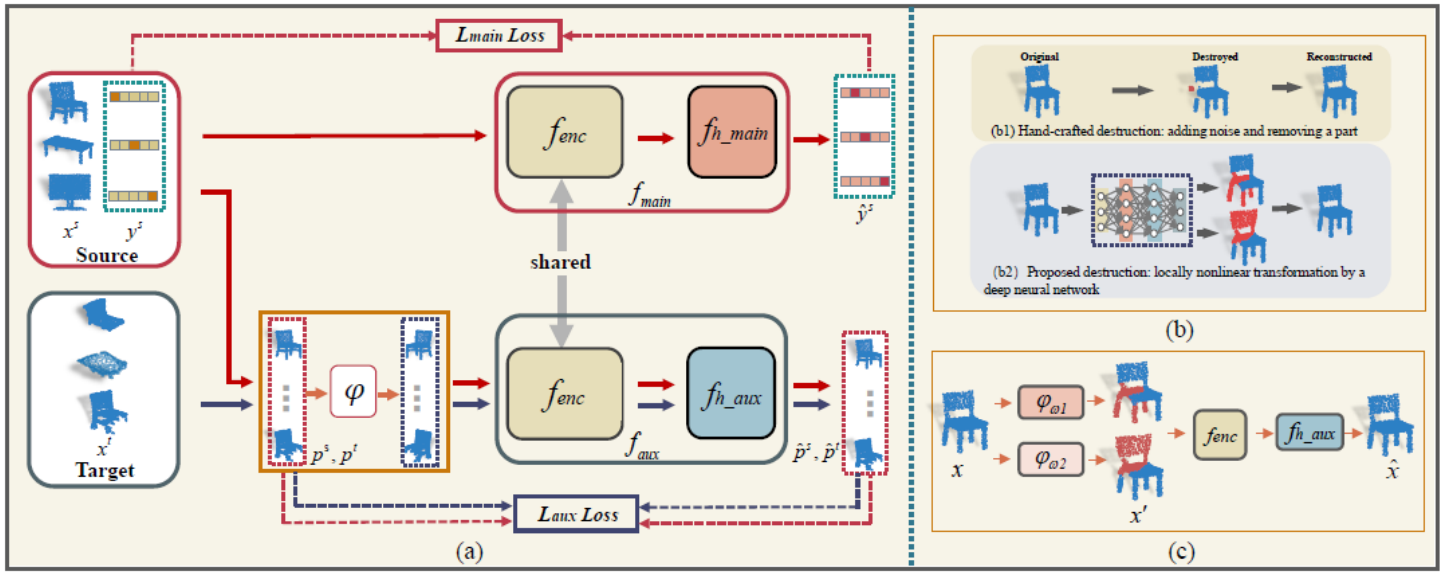
Problems & Ideas

- Problems of conventional self-supervised tasks:
  - Need human design self-supervised tasks.
  - All existing deconstruction-construction self-supervised task are unlearnable.
- Ideas: propose a learnable transformation based on a deep neural network, which destroys a point cloud by applying nonlinear transformation on a part of it.



The proposed point cloud UDA framework. (a) The framework of the domain adaptation network based on self-supervised learning, where the red and blue arrows represent data flows from the source and target domains, respectively. (b) A learnable point cloud transformation network. (c) A self-supervised point cloud reconstruction task based on multi-region transformation.

Main Contributions

- Contributions:
  - we propose a learnable transformation based on a deep neural network, which destroys a point cloud by applying nonlinear transformation on a part of it;
  - We train the network through adversarial training and the trained network is able to learn a continuous nonlinear transformation to generate highly abundant and complicated point clouds while retaining the semantic information;
  - We tested our method on multiple datasets and achieved new state-of-the-art performance on both point cloud classification and segmentation UDA, respectively .

Method	M → S	M → Sc	S → M	S → Sc	Sc → M	Sc → M	Avg.
w/o Adapt	81.7	42.9	72.2	44.2	67.3	65.1	62.2
Rotate	83.0	51.6	72.5	41.0	67.1	70.3	64.3
PointDAN	83.9	44.8	63.3	45.7	43.6	56.4	56.3
RS	81.5	35.2	71.9	39.8	61.0	63.6	58.8
DefRec	81.7	51.8	78.6	54.5	73.7	71.1	68.6
GAST	84.8	**59.8**	80.8	56.7	**81.8**	74.9	73.0
Ours	**85.8**	56.3	**81.7**	**59.8**	77.9	**79.7**	**73.5**

SSL	Multi	Crop	DGCNN	M → S	M → Sc	S → M	S → Sc	Sc → M	Sc → M	Avg.
				80.2	43.1	75.8	40.7	63.2	67.2	61.7
√				82.6	48.8	74.0	44.7	63.1	67.9	63.5
√	√			82.5	47.8	73.8	46.2	67.4	69.0	64.5
√	√	√		82.5	52.7	73.8	53.8	67.4	69.0	66.5
√	√		√	82.8	46.7	**81.7**	51.3	72.9	71.7	67.9
√		√	√	80.6	52.2	72.1	50.5	63.1	68.4	64.5
√	√	√	√	**85.8**	56.3	**81.7**	**59.8**	77.9	**79.7**	**73.5**

Left: The classification accuracy (%) on the PointDA-10 dataset; Right: Ablation study on different training strategies.