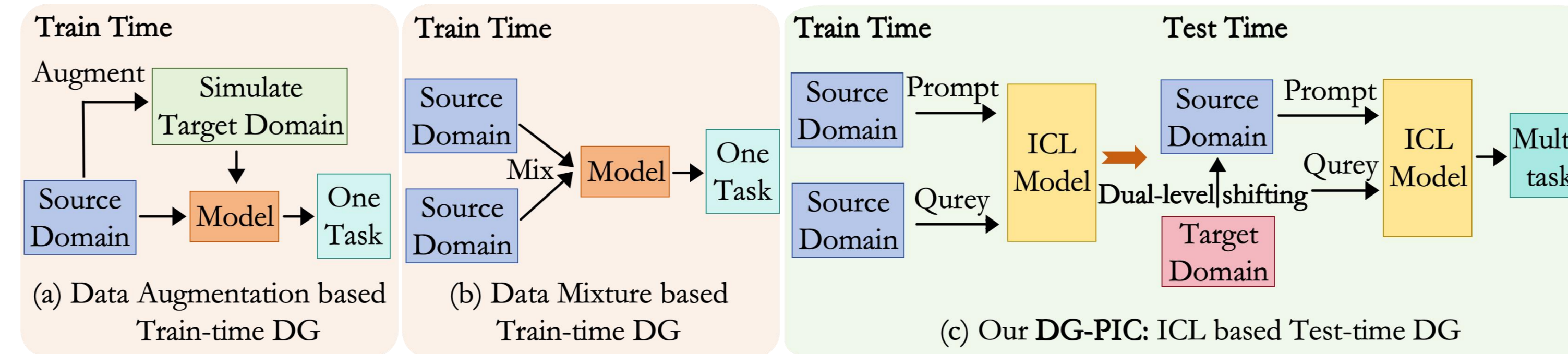


Contributions

- The first network to tackle a novel and practical **multi-domain, multi-task setting** in a unified model for **test-time Domain Generalization** in point cloud understanding.
- **Dual-level Source Prototype Estimation** captures global-level shapes and local-level geometry, and **Dual-level Test-time Feature Shifting** aligns target data with macro-level domain information and micro-level patch relationships.
- DG-PIC achieves **state-of-the-art performance** on our new benchmark across three different tasks.

Motivation

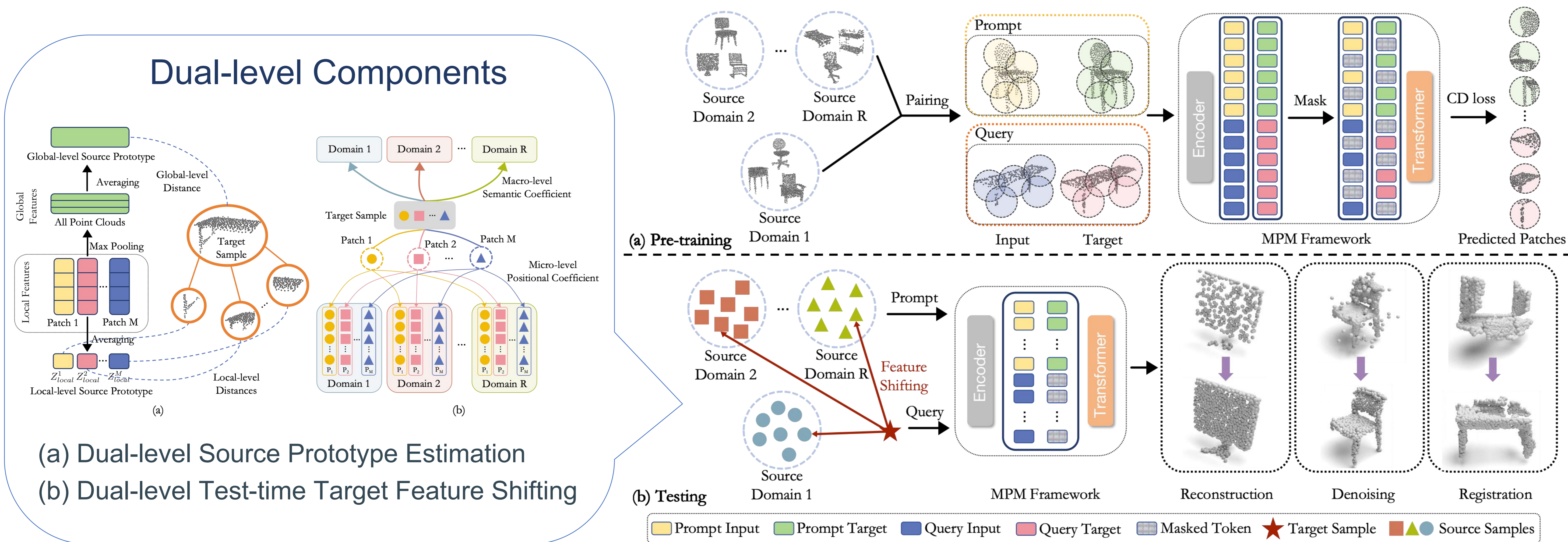


- Previous train-time DG techniques focus on a single task and learn domain-invariant features during training, ignoring the role of test data.
- In-Context Learning (ICL) is tied to the training data and struggles to mitigate domain gaps between diverse datasets.
- DG-PIC aligns test data to sources at dual levels without test-time model updates, excelling in multi-domain and multi-task setting.

Experimental Results

Methods	Venue	Setting	Recon.	Denoi.	Regis.
Task-specific Models					
PointNet [32]	CVPR 2017	Fully Supervised Learning	41.1	41.9	43.5
PointNet++ [33]	NeurIPS 2017	Fully Supervised Learning	40.3	38.5	41.9
DGCNN [49]	TOG 2019	Fully Supervised Learning	39.0	37.9	39.8
PCT [12]	CVM 2021	Fully Supervised Learning	30.8	35.8	32.5
Point-MAE [30]	ECCV 2022	Fully Supervised Learning	30.4	36.0	31.2
Pointmixup [5]	ECCV 2020	Train-time Domain Generalization	40.5	42.3	41.7
PointCutMix [64]	Neuro. 2022	Train-time Domain Generalization	44.8	43.5	41.3
Multi-task Models					
PointNet [32]	CVPR 2017	Fully Supervised Learning	41.3	43.6	45.6
PointNet++ [33]	NeurIPS 2017	Fully Supervised Learning	40.9	39.6	43.2
DGCNN [49]	TOG 2019	Fully Supervised Learning	40.7	38.2	41.6
PCT [12]	CVM 2021	Fully Supervised Learning	31.5	36.5	34.9
Point-MAE [30]	ECCV 2022	Fully Supervised Learning	30.7	36.3	31.0
Pointmixup [5]	ECCV 2020	Train-time Domain Generalization	40.9	44.2	43.0
PointCutMix [64]	Neuro. 2022	Train-time Domain Generalization	45.9	47.5	43.6
In-Context Learning Models					
Baseline		Fully Supervised Learning	156.2	127.1	83.6
PIC [10]	NeurIPS 2023	Fully Supervised Learning	72.9	80.0	12.7
Our DG-PIC	ECCV 2024	Test-time Domain Generalization	4.1	15.2	5.8

Framework of DG-PIC



Pre-training:

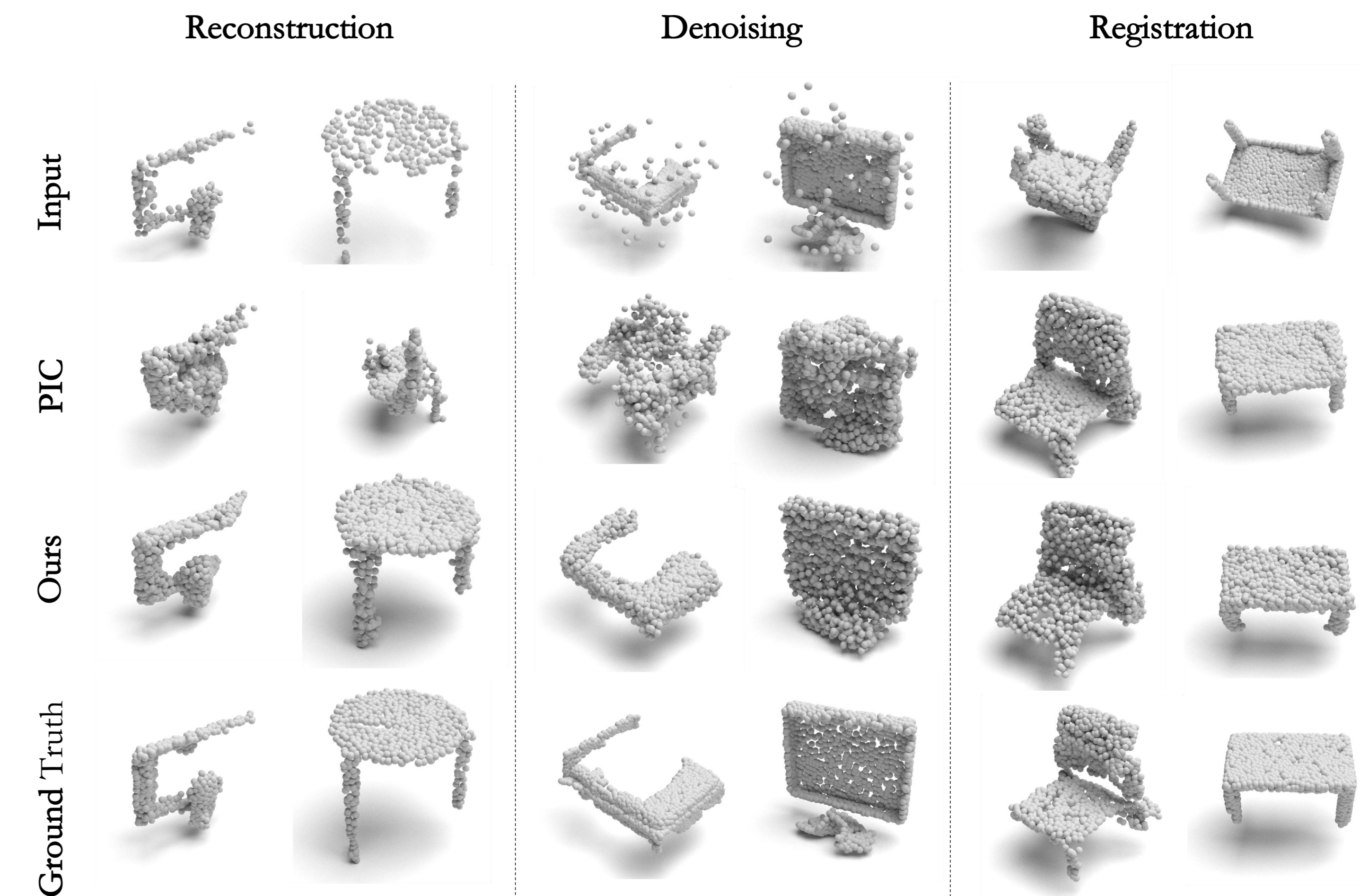
- Select source samples to form a query-prompt pair for the same task.
- Mask patches and reconstruct them using the MPM framework.

Test-time DG

Testing:

- Freeze the pre-trained model and shift unseen target toward sources.
- Choose the closest source sample as prompt, and output query target.

Comparison of three point cloud tasks on our benchmark



Visualization of three different point cloud understanding tasks

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