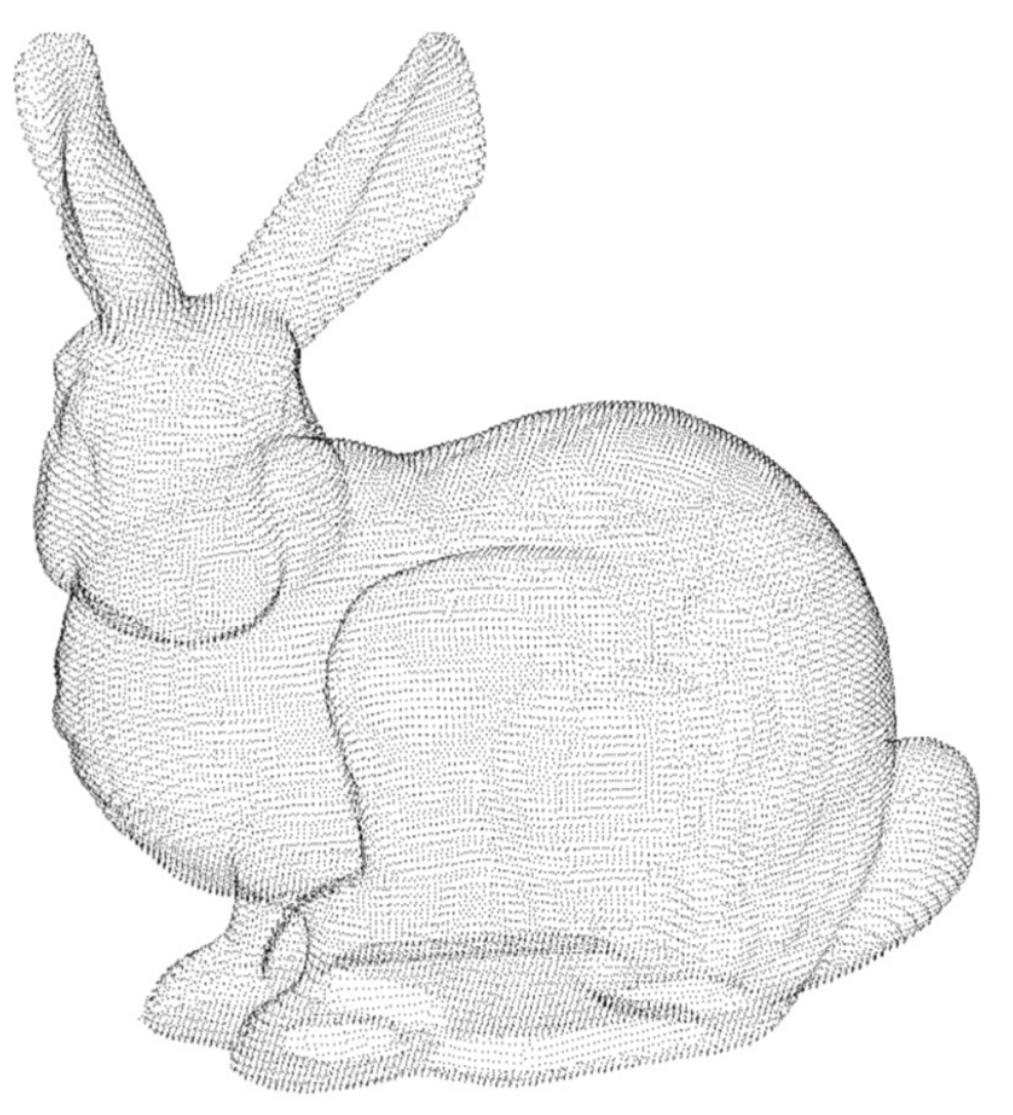


# Shape Completion with Meso-Skeleton Learning

## Dongyue Lu, Zhisheng Zheng

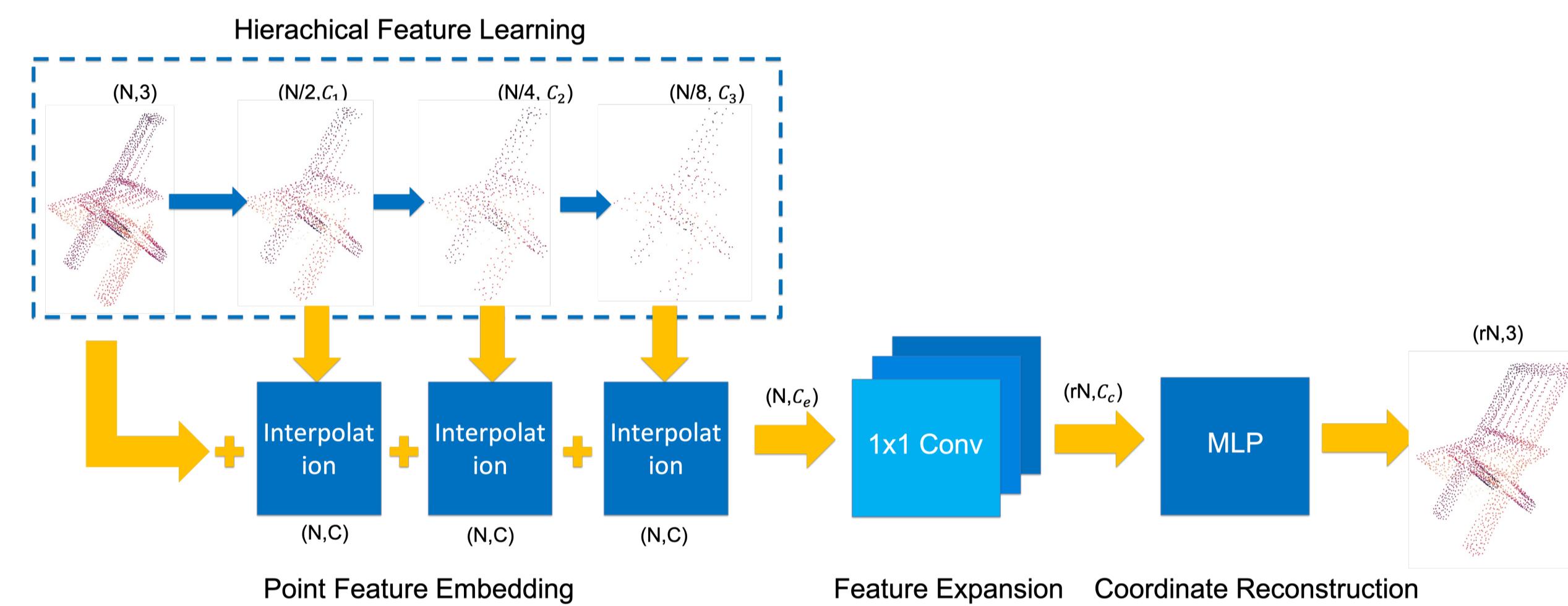


### Motivation

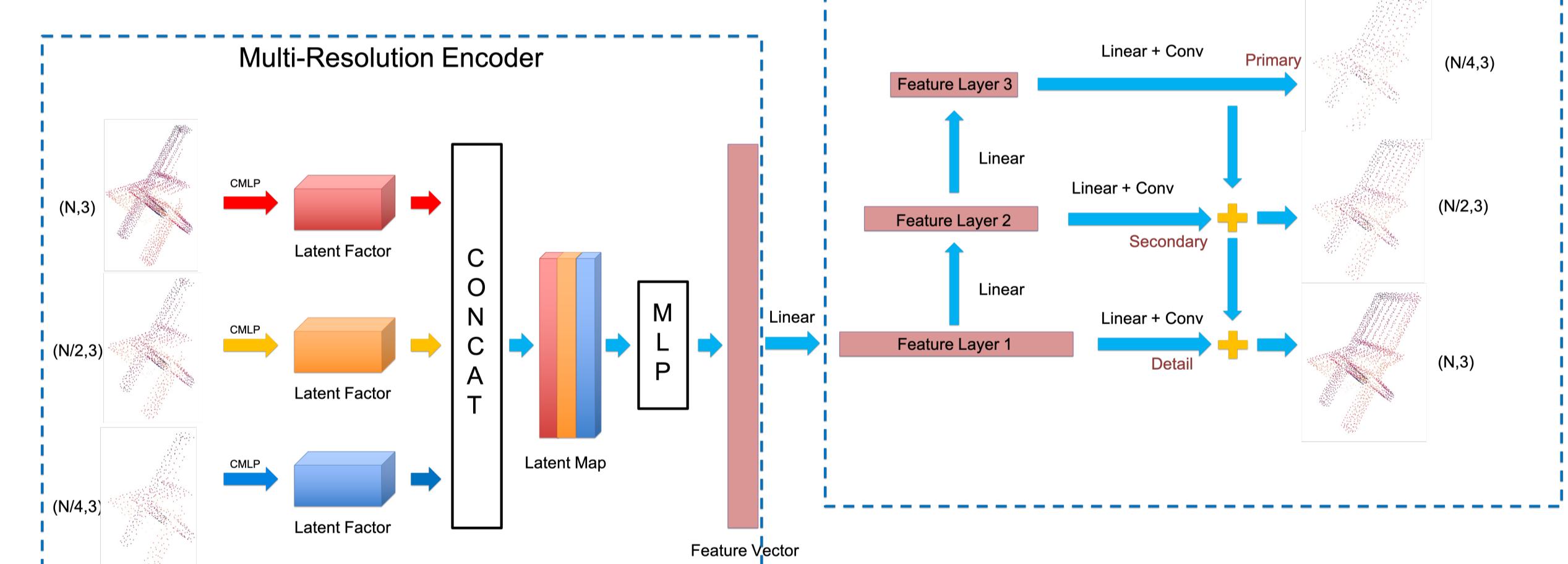
- Due to the limitation of view angles or occlusions of devices, a 3D point cloud completion is needed for downstream applications.
- Most of existing methods is built under the autoencoder framework.
- The unordered nature of point cloud make it hard to keep the shape topology.
- A meso-skeleton of point cloud may be beneficial for capturing the information of objects

### Related Model

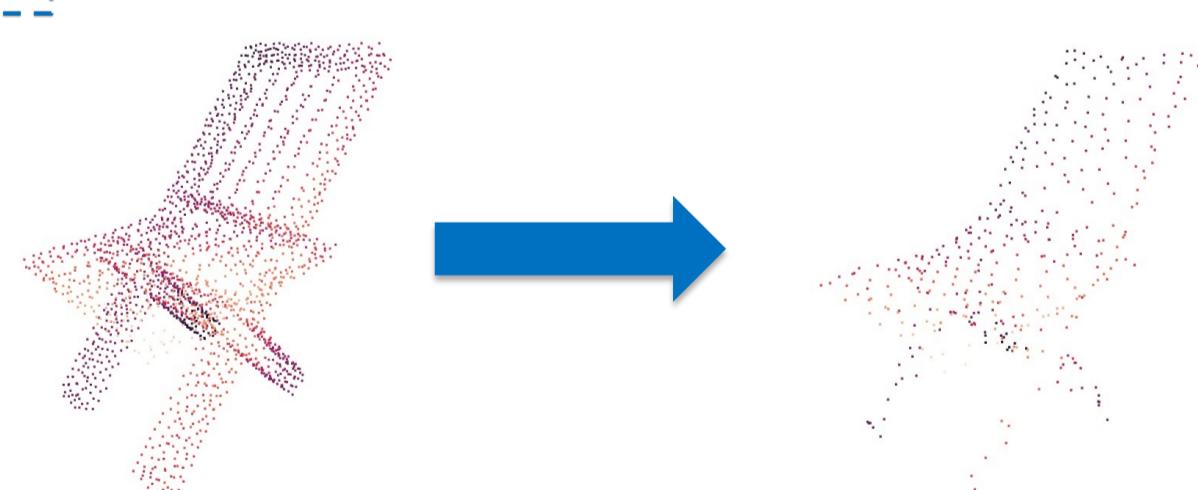
#### • PU-Net



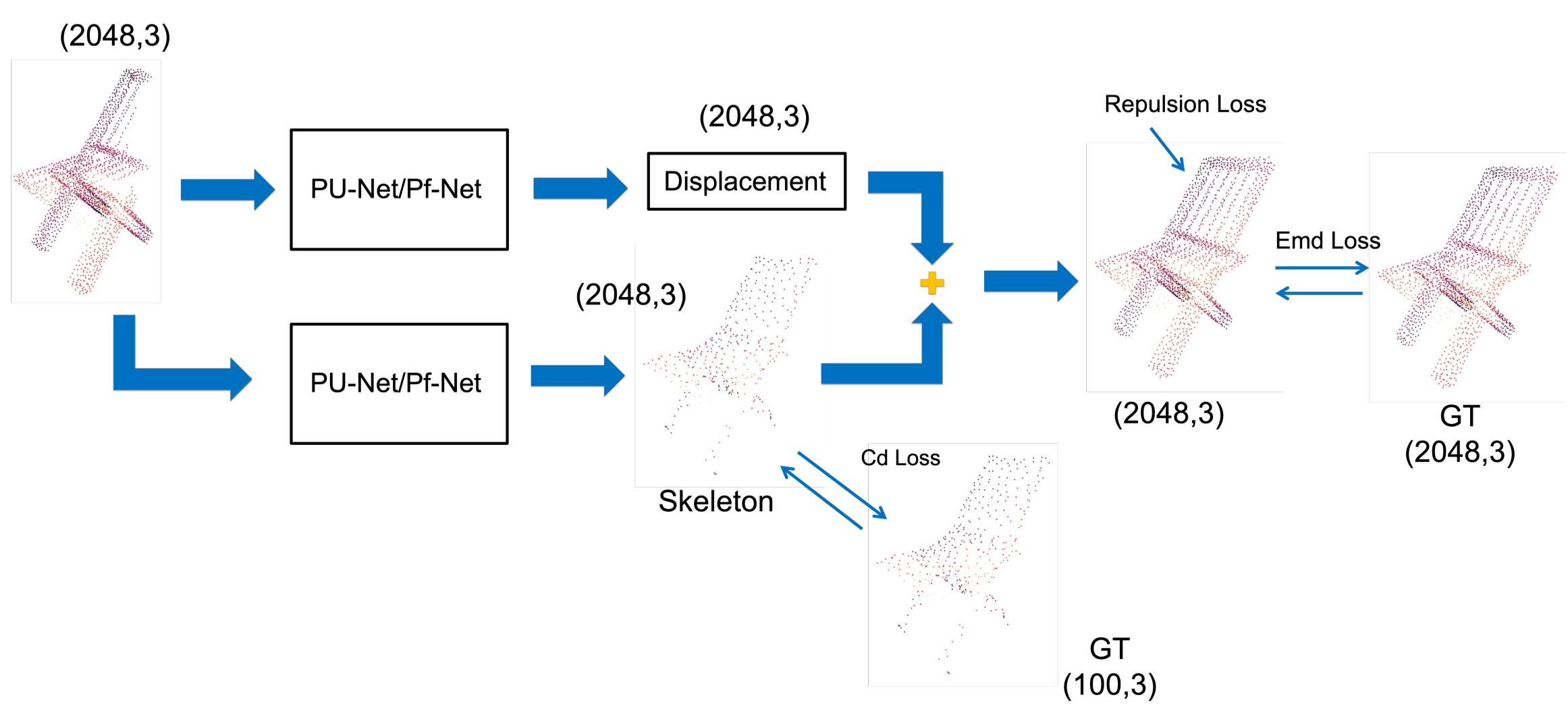
#### • PF-Net



#### • Point2Skeleton



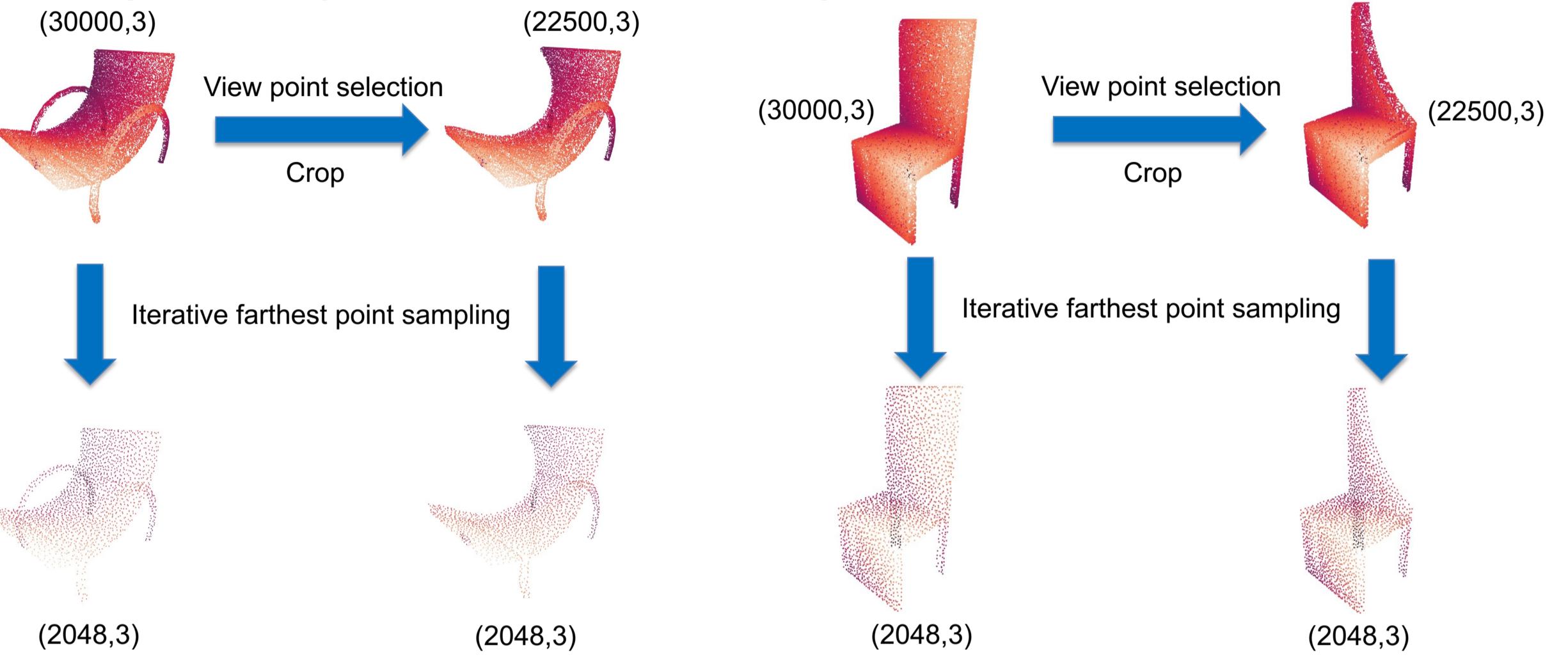
### Proposed Architecture



### Experiments and Results

#### Dataset

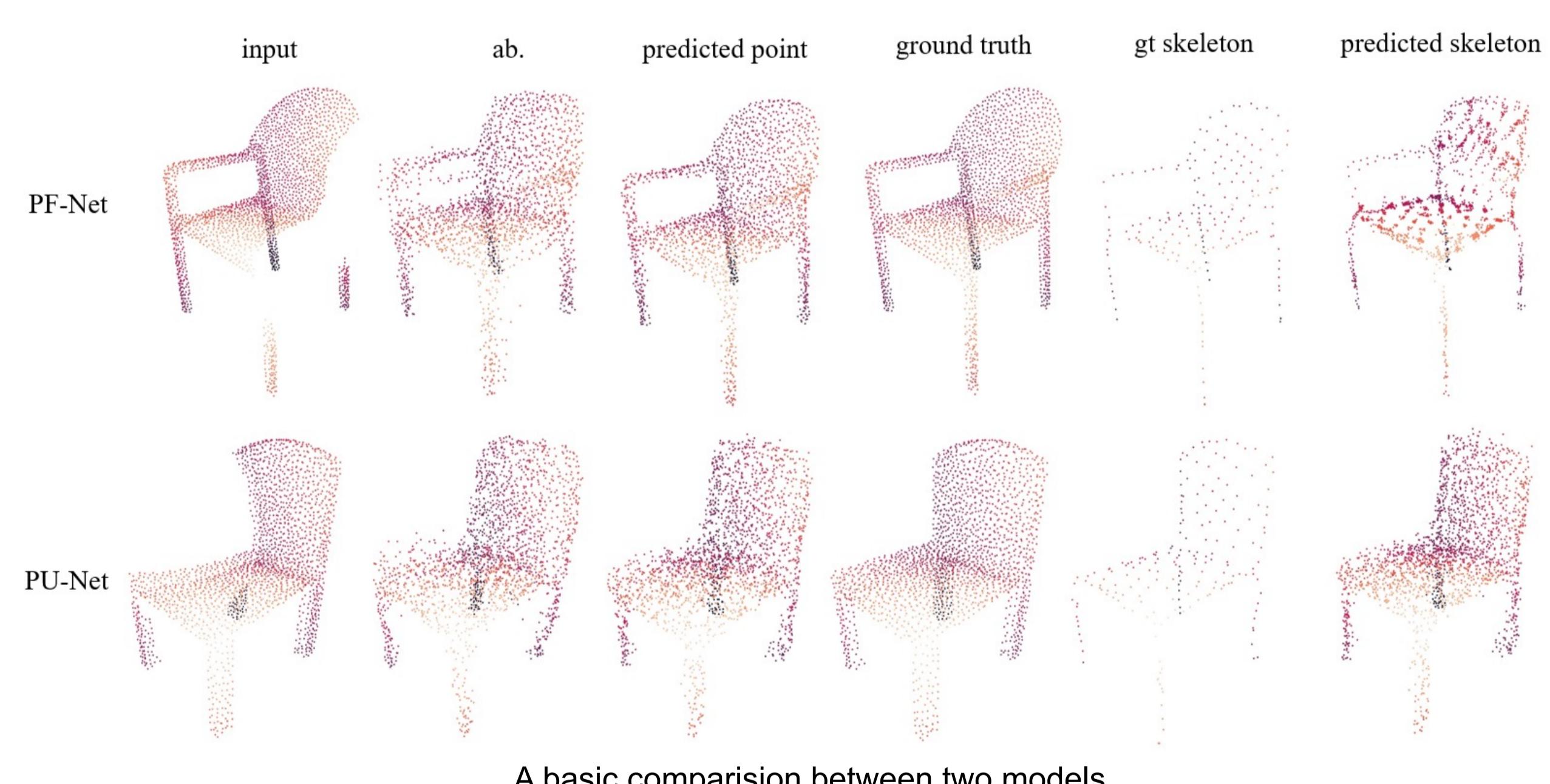
- 2000 pairs of point cloud from ShapeNet



#### Loss Function

- $\mathcal{L}_{CD} = \frac{\sum_{x \in P} \min_{y \in Q} \|x - y\|_2}{|P|} + \frac{\sum_{y \in Q} \min_{x \in P} \|y - x\|_2}{|Q|}$
- $\mathcal{L}_{EMD} = \min_{\emptyset: P \rightarrow Q} \sum_{x \in P} \|x - \emptyset(x)\|_2$
- $\mathcal{L}_{Repulsion} = \sum_{i=0}^N \sum_{i' \in K(i)} \eta(\|x_{i'} - x_i\|_2) \omega(\|x_{i'} - x_i\|_2)$
- $\mathcal{L} = \alpha \mathcal{L}_{CD} + \beta \mathcal{L}_{EMD} + \gamma \mathcal{L}_{Repulsion}$

#### Experiments Results



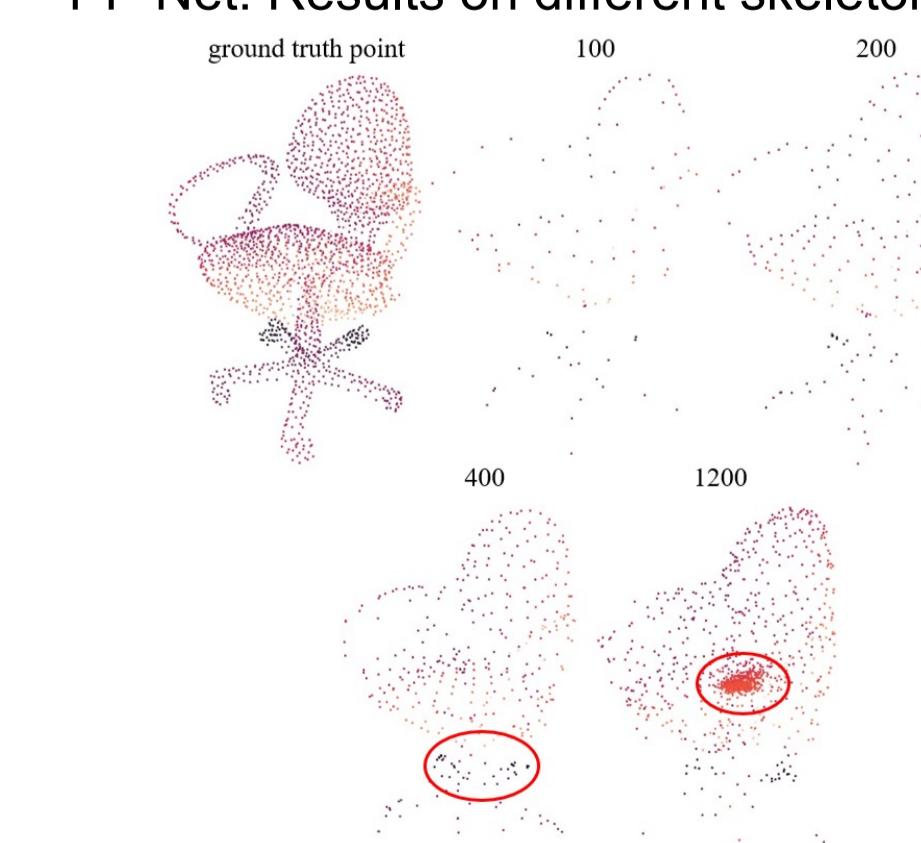
ratio	0	0.1	0.3	0.5	0.7	0.9
loss	2.950	<b>2.554</b>	2.920	3.201	3.225	3.598

PU-Net: Results on different skeleton weights

Skeleton number	100	200	400	1200
PU-Net full point loss	2.554	<b>2.472</b>	2.684	3.236
PF-Net full point loss	1.629	<b>1.603</b>	1.650	1.655
PU-Net skeleton loss	0.803	<b>0.756</b>	0.890	1.260
PF-Net skeleton loss	0.325	<b>0.210</b>	0.364	0.388

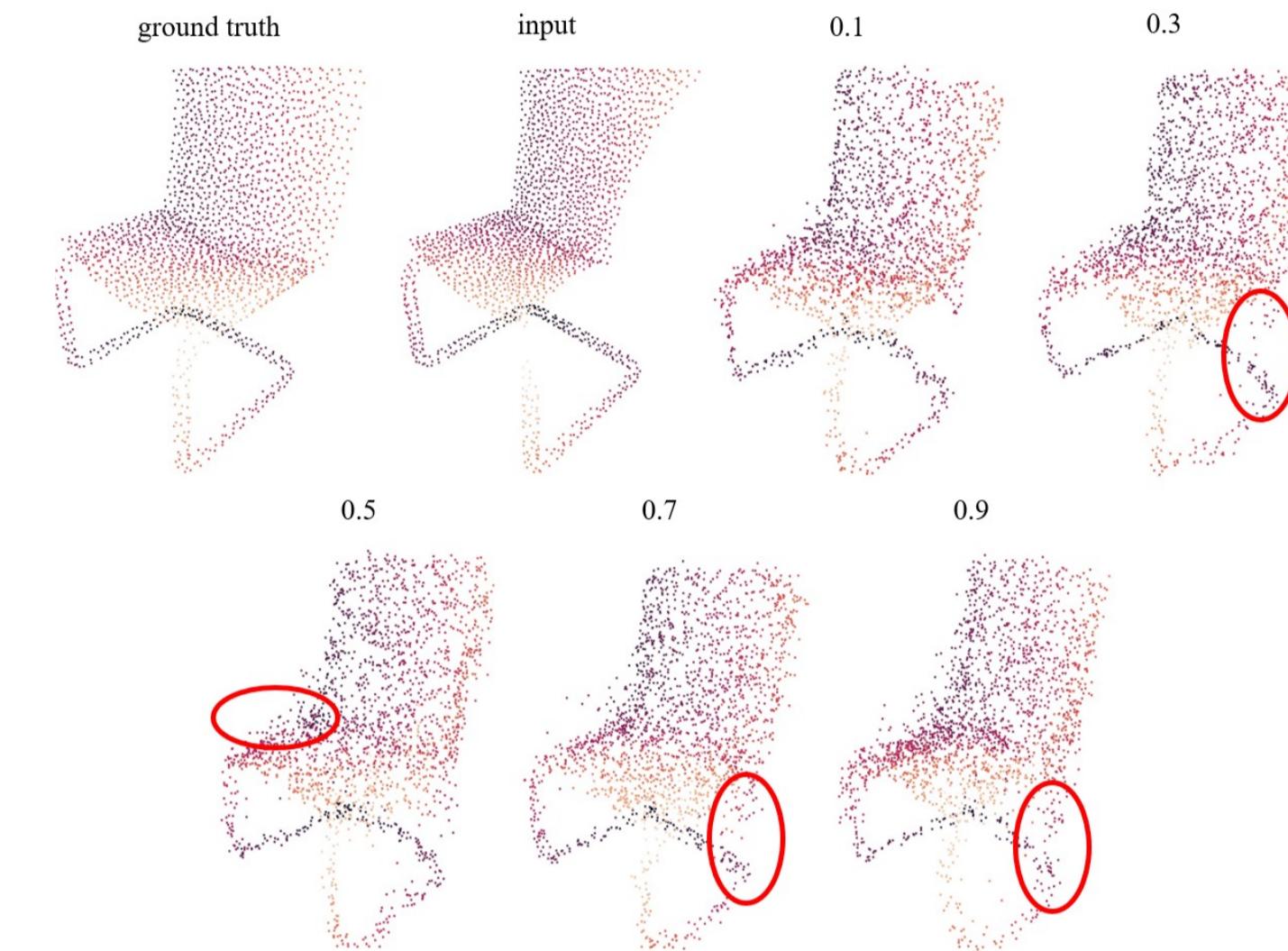
Results on different skeleton point numbers

PF-Net: Results on different skeleton weights



Different skeleton generated by Point2Skeleton

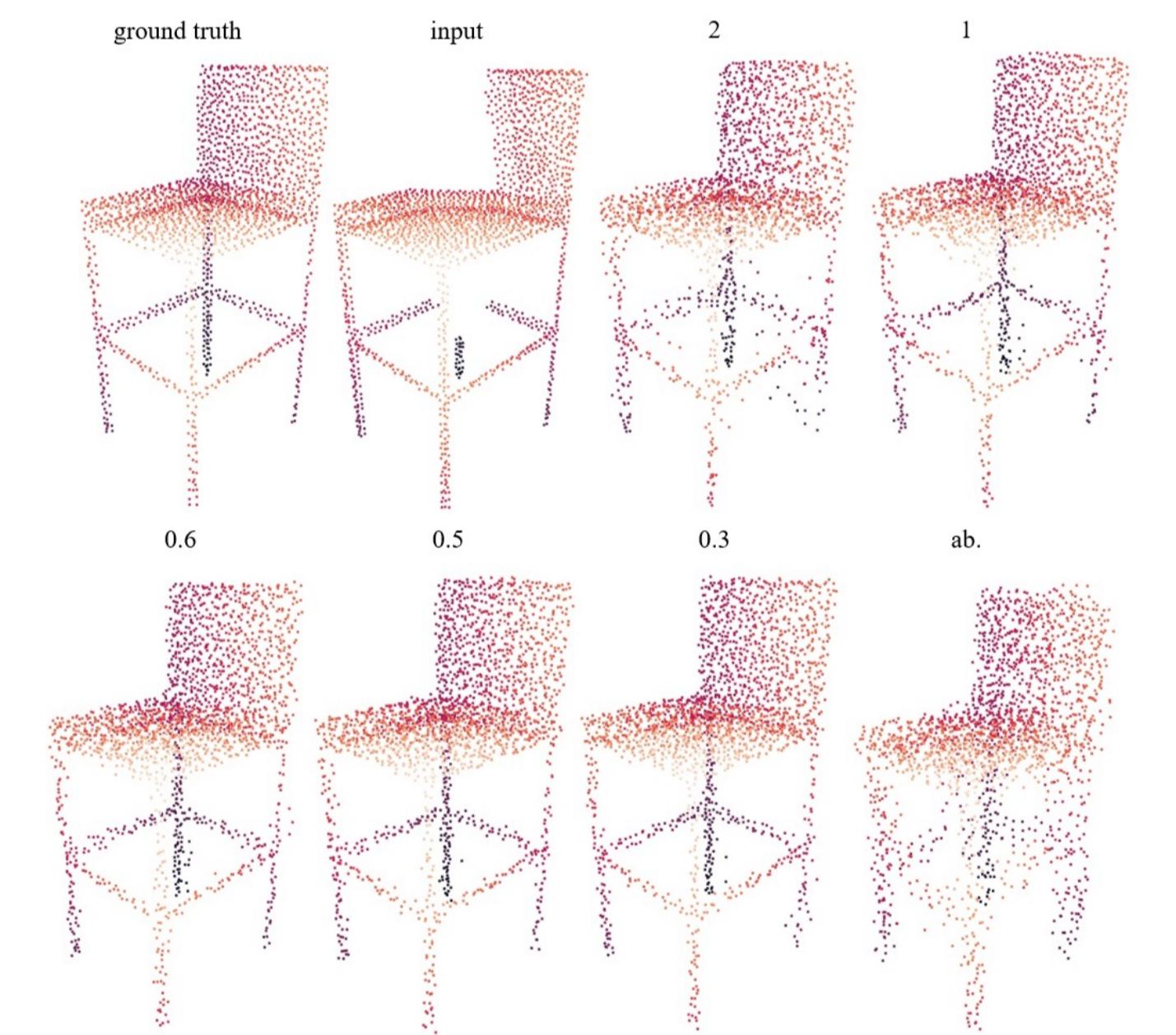
#### • PU-Net-Basis



PU-Net experiments on different skeleton weights

PU-Net experiments on different skeleton numbers

#### • PF-Net-Basis



PF-Net experiments on different skeleton weights

PF-Net experiments on different skeleton numbers

### Conclusion and Review

We built two model based on PU-Net and PF-Net to study the effect of Meso-Skeleton Learning in 3D point cloud completion.

- Meso-Skeleton is capable of capturing additional information for 3D point cloud completion task compared to traditional auto-encoder framework model.
- The quality of skeleton has great influence on the final completion results, noisy or corrupted skeleton can even lead to worse results.
- The dataset and the categories are not big enough due to the limite of devices.
- Our work can be further developed by improving the quality and applicability of skeleton generation, and adding more rigorous skeleton generation quality evaluation.