Point Completion By Unsupervised Skeleton Learning

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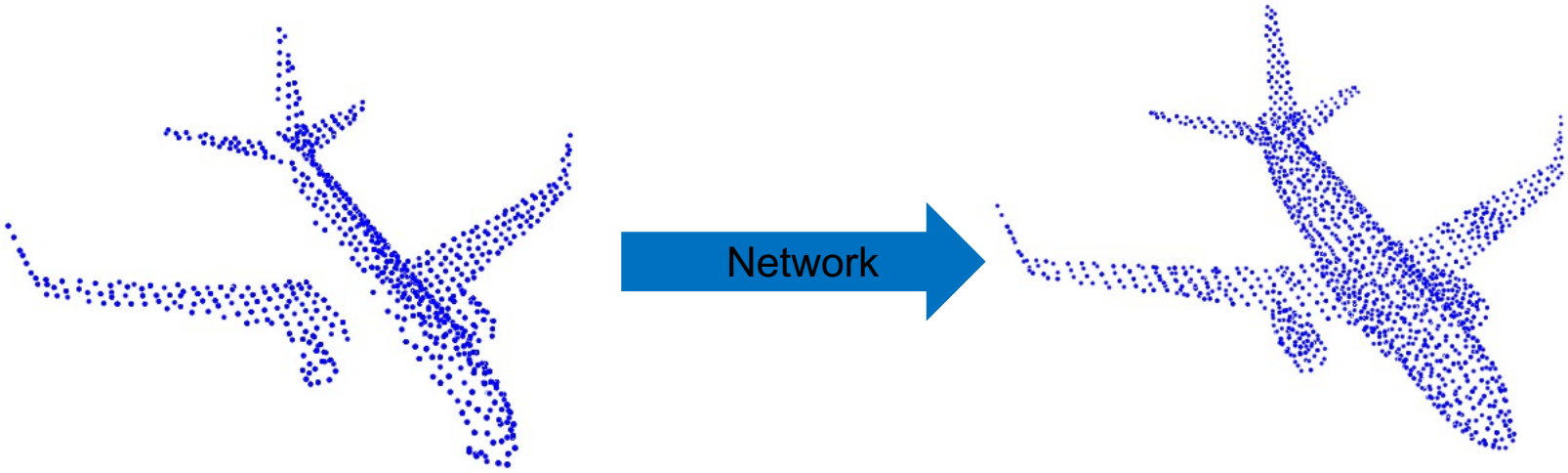
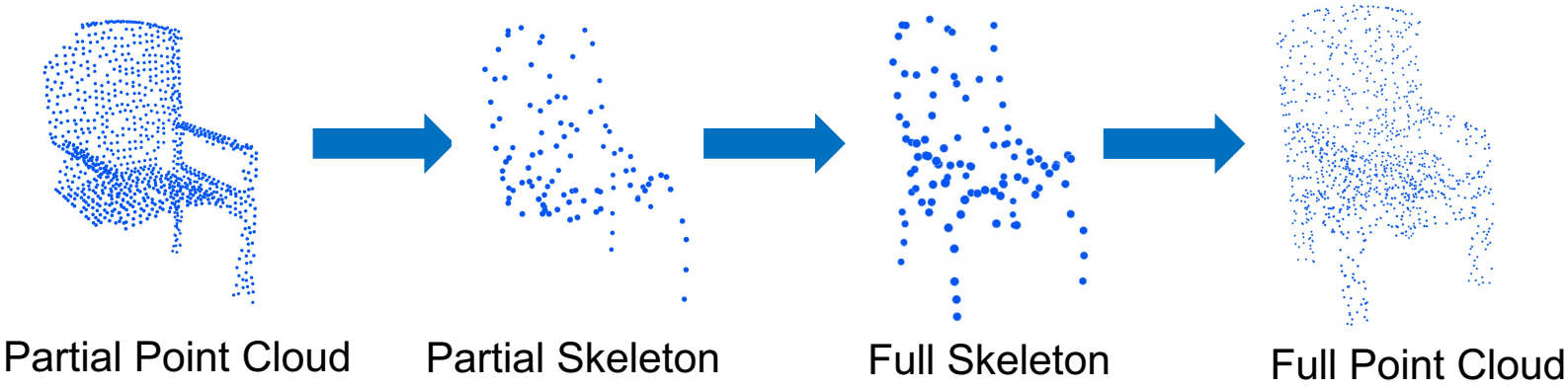
Recall: Point Clouds Completion



Partial Point Cloud

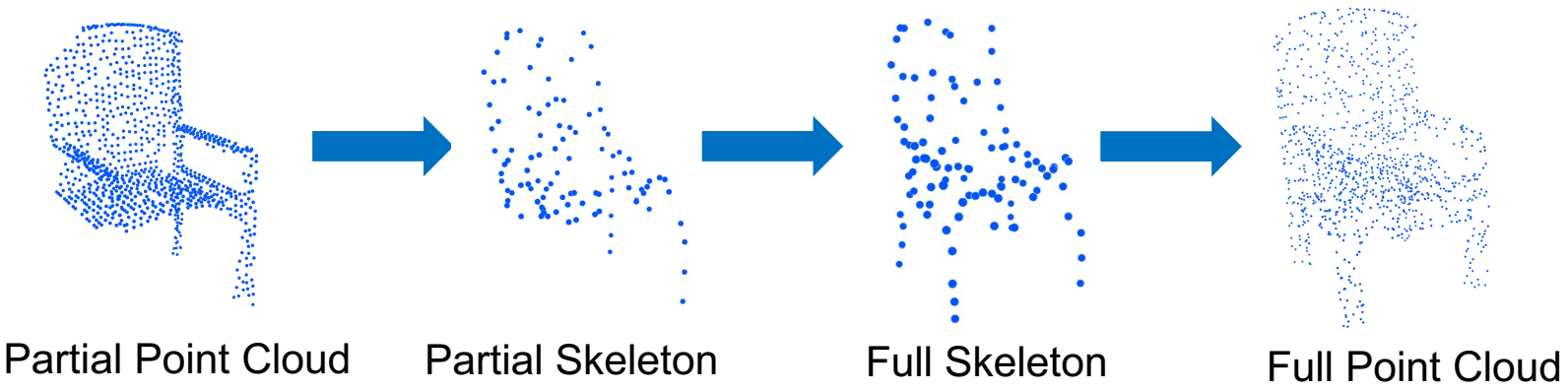
Full Point Cloud

Recall: Shape Completion with Meso-Skeleton Learning



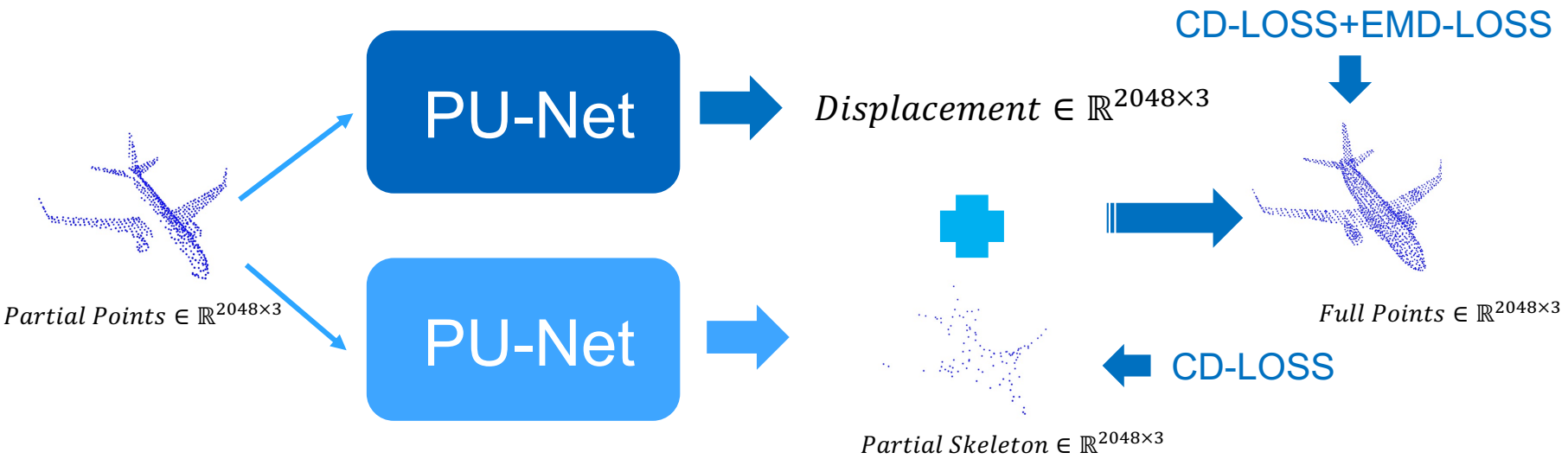
- **Point2Skeleton**: generate partial and full skeletons
- **Intermediate module**: supervised learning from partial skeleton to full skeleton base on PU-Net
- **P2P-net**: learning from full skeleton and partial points to full points.

Encountered Difficulties



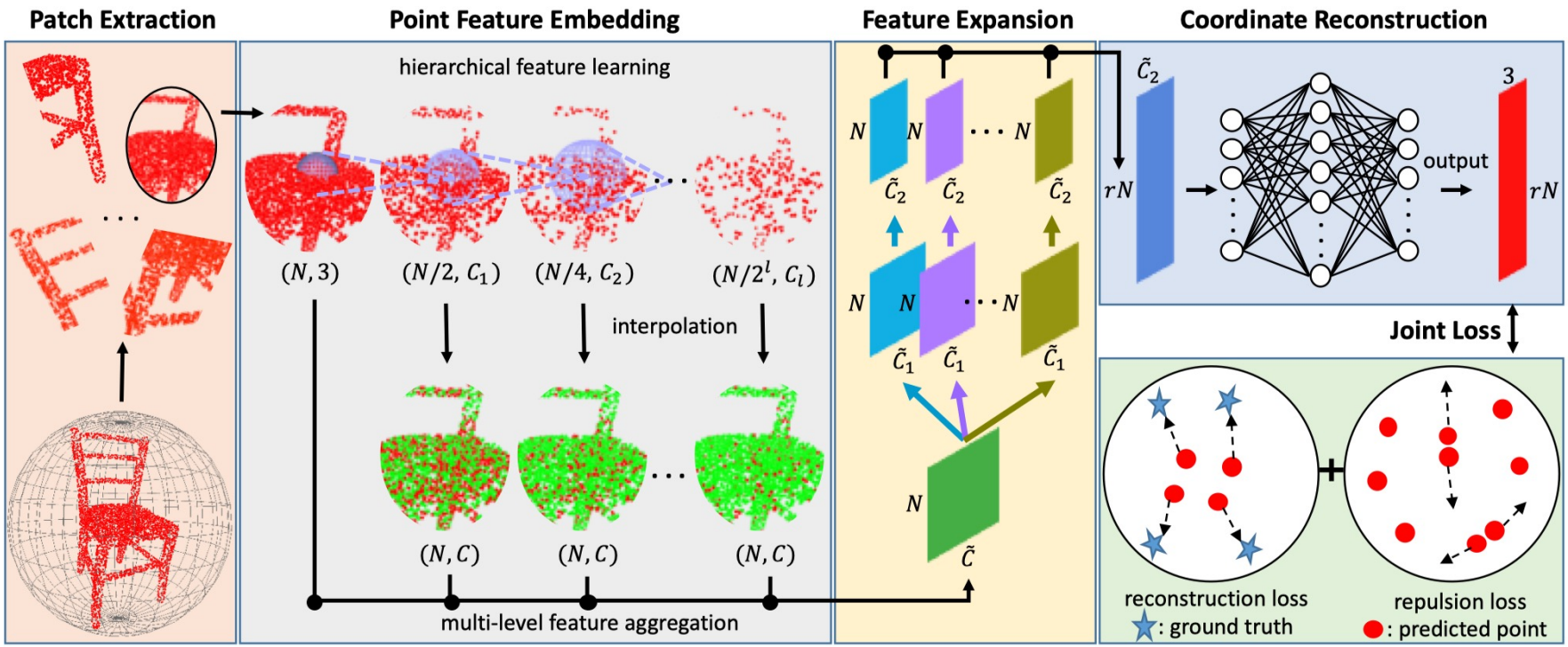
- Sparse skeleton points and limited hardware conditions
- Bad performance on Skeleton Completion
- Difficult and extremely laborious to combine all three networks: different versions of CUDA, tensorflow and pytorch

End-To-End Model



- **First network**: take partial points as input to generate partial skeleton for global information, supervised by partial skeleton
- **Second network:** produce displacement from partial points for local information
- Sum the outputs of two networks to obtain full points, supervised by full points.

PU-Net



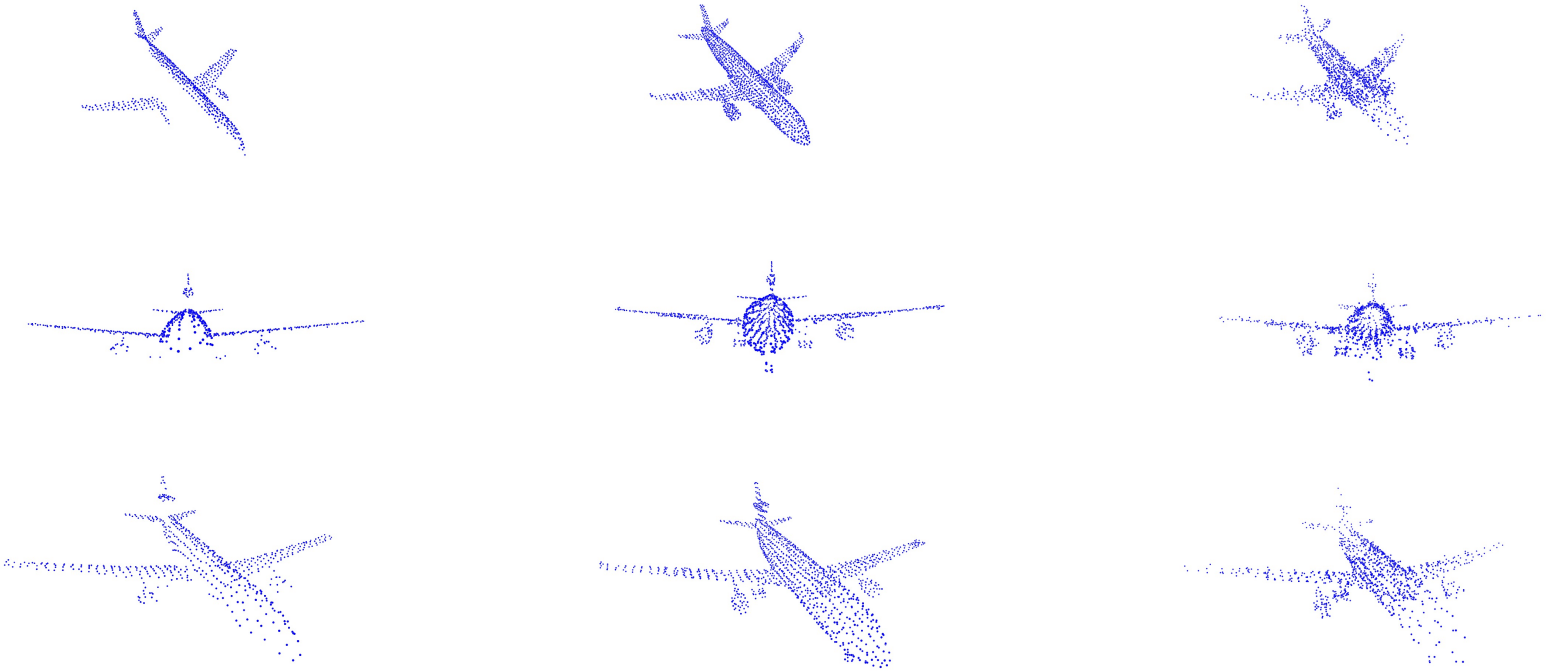
Workflow of PU-Net

Implementation details

- **Dataset:**
  - ShapeNet: 3730 pairs of *air plane* and 5750 pairs of *table*, with the shape of (2048,3) for each example
  - Skeleton number: applying Point2Skeleton to generate skeletons with 100, 200 and 400 points for comparison
- **Loss:**
  - Reconstruction loss: CD loss for skeleton generation, CD, EMD loss for full point generation
  - $\mathcal{L}_{\mathrm{CD}} = \frac{\sum_{x \in P} \min_{y \in Q} ||x-y||_2}{|P|} + \frac{\sum_{y \in P} \min_{x \in P} ||y-x||_2}{|Q|}$
  - $\mathcal{L}_{\mathrm{EMD}} = \min_{\emptyset: P \to Q} \sum_{x \in P} ||x - \emptyset(x)||_2$
  - Repulsion loss: Improve the uniformity of point cloud distribution (to be done)

Current progress

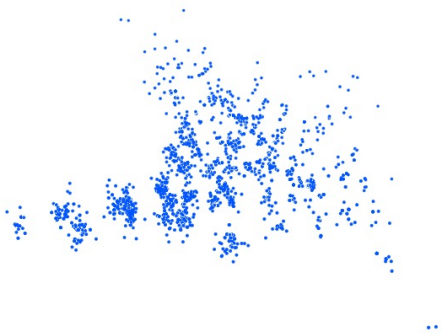
- Completed the model building
- Conducted preliminary training on a small number of examples.
- Model Tuning



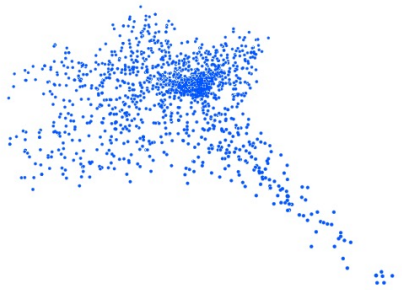
Partial Point CLoud | Full Point CLoud | Predicted Point CLoud

Current problems

- **Poor skeleton generation results**
  - Adjust the weight of joint loss
  - Adjust the parameters of Point2Skeleon to improve the quality of ground truth skeleton
  - Adjust the inner parameters of PU-Net



Skeleton generated from our model

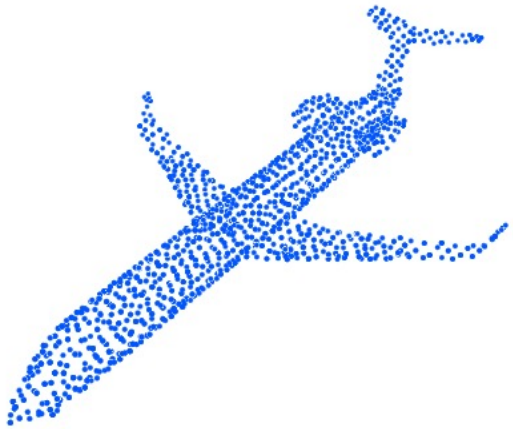


Skeleton generated from single PU-Net

Current problems

- **Poor training results for large number of samples**
  - uneven training set
  - inappropriate hyper parameters

Full point cloud generated by our model



Ground-truth full point cloud

- **Long training time**

Works to be done

- Tackle the problems we didn’t solve yet
- Study the impact of skeleton with different points (100,200,400)
- Ablation Study
- Model comparison
- Final report and presentation

Thank You!

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