# Unsupervised Feature Learning for Point Cloud by Contrasting and Clustering


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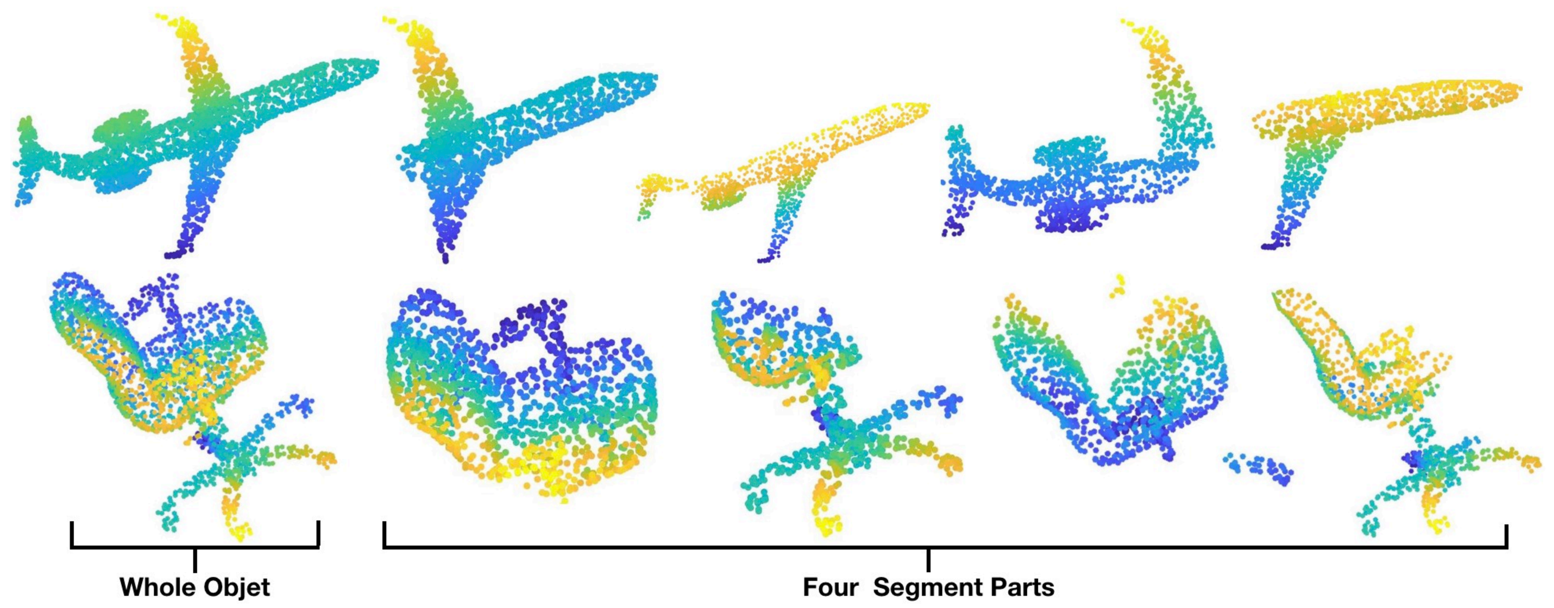
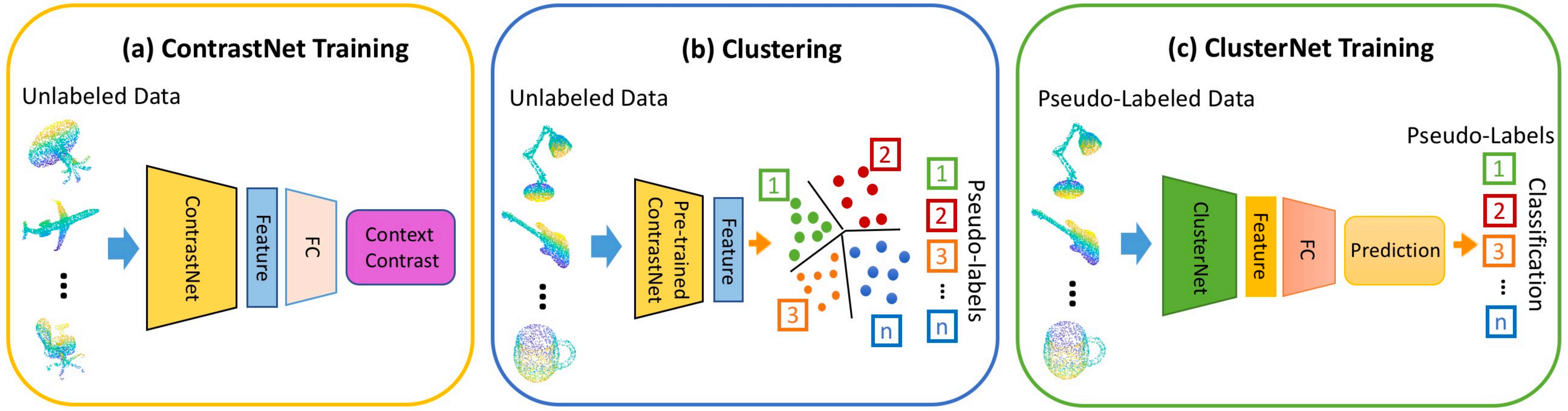
## Motivation




- Human can easily recognize the object and the locations of the segments in the object.
- We train GNNs to learn features from unlabeled dataset by recognizing whether two segments are from the same object.

## Unsupervised Feature Learning Pipeline




a) ContrastNet to verify whether two point cloud cuts belong to the same object;
b) Cluster samples of 3D objects and assign cluster IDs by Kmeans++, using the features learned from ContrastNet;
c) ClusterNet for object clustering learning, by training the network with the labels assigned by the clustering step.

## Results for ContrastNet and ClusterNet

| Training | Testing | ContrastNet(%) | ClusterNet(%) |
|---|---|---|---|
| ShapeNet | ModelNet40 | 84.1 | 86.8 (**+2.7**) |
| ShapeNet | ModelNet10 | 91.0 | 93.8 (**+2.8**) |
| ModelNet40 | ModelNet40 | 85.7 | 88.6 (**+2.9**) |

| Clusters | ShapeNet ModelNet40 | ShapeNet ModelNet10 | ModelNet40 ModelNet40 |
|---|---|---|---|
| 100 | 86.2% | 93.5% | 87.7% |
| 200 | 86.4% | 93.6% | 88.2% |
| 300 | **86.8%** | **93.8%** | **88.6%** |
| 400 | 86.5% | 93.2% | 87.8% |

| Pre-training | Clusters | Clustering Acc. | Testing Acc. |
|---|---|---|---|
| ShapeNet | 16 | 83.4% | 86.1% |
| ModelNet40 | 40 | 64.2% | 87.4% |

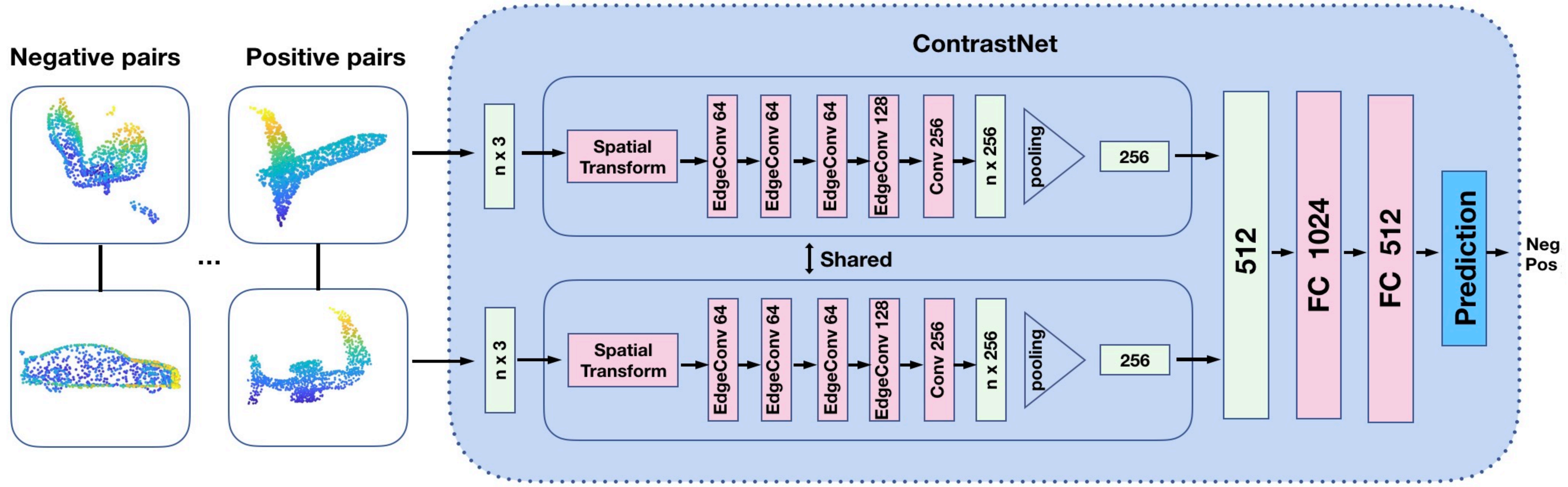
## Achievements

- An unsupervised feature learning framework is proposed for point cloud data to learn semantic features.
- Our proposed approach outperforms most of the state-of-the-art unsupervised learning methods.

Several perspective views of 3D point cloud of an object. The views from different perspectives might be totally different.

- Experiments show that our proposed approaches generate results that are practically useful by simulating occlusions and perspective views.

## Architecture of ContrastNet




- The positive pairs are generated by randomly sampling two segments from the same point cloud sample, while the negative pairs are generated by randomly sampling two segments from two different samples.
- A dynamic graph convolutional neural network (DGCNN) is used as the backbone network.
- The part contrast learning does not require any data annotations by humans.

## Results for Occlusions and Perspective Views

| Model | Acc. Full | Acc. Part | Acc. Perspective |
|---|---|---|---|
| ContrastNet | 85.7% | 79.4% | 72.0% |
| ClusterNet | 88.6% | 82.4% | 75.8% |

## Compare With Others

| Models | ModelNet40 (%) | ModelNet10 (%) |
|---|---|---|
| SPH [15] | 68.2 | 79.8 |
| LFD [7] | 75.5 | 79.9 |
| T-L Network [9] | 74.4 | - |
| VConv-DAE [30] | 75.5 | 80.5 |
| 3D-GAN [36] | 83.3 | 91.0 |
| Latent-GAN [1] | 85.7 | **95.3** |
| FoldingNet [38] | **88.4** | 94.4 |
| ***ClusterNet (Ours)*** | ***86.8*** | ***93.8*** |

| Models | Acc.(%) | Models | Acc.(%) |
|---|---|---|---|
| PointNet [23] | 89.2 | DGCNN [35] | **92.2** |
| PointNet++ [25] | 90.7 | | |
| PointCNN [17] | **92.2** | ***ClusterNet(Ours)*** | ***88.6*** |