

PointSpherical: Deep Shape Context for Point Cloud Learning in Spherical Coordinates

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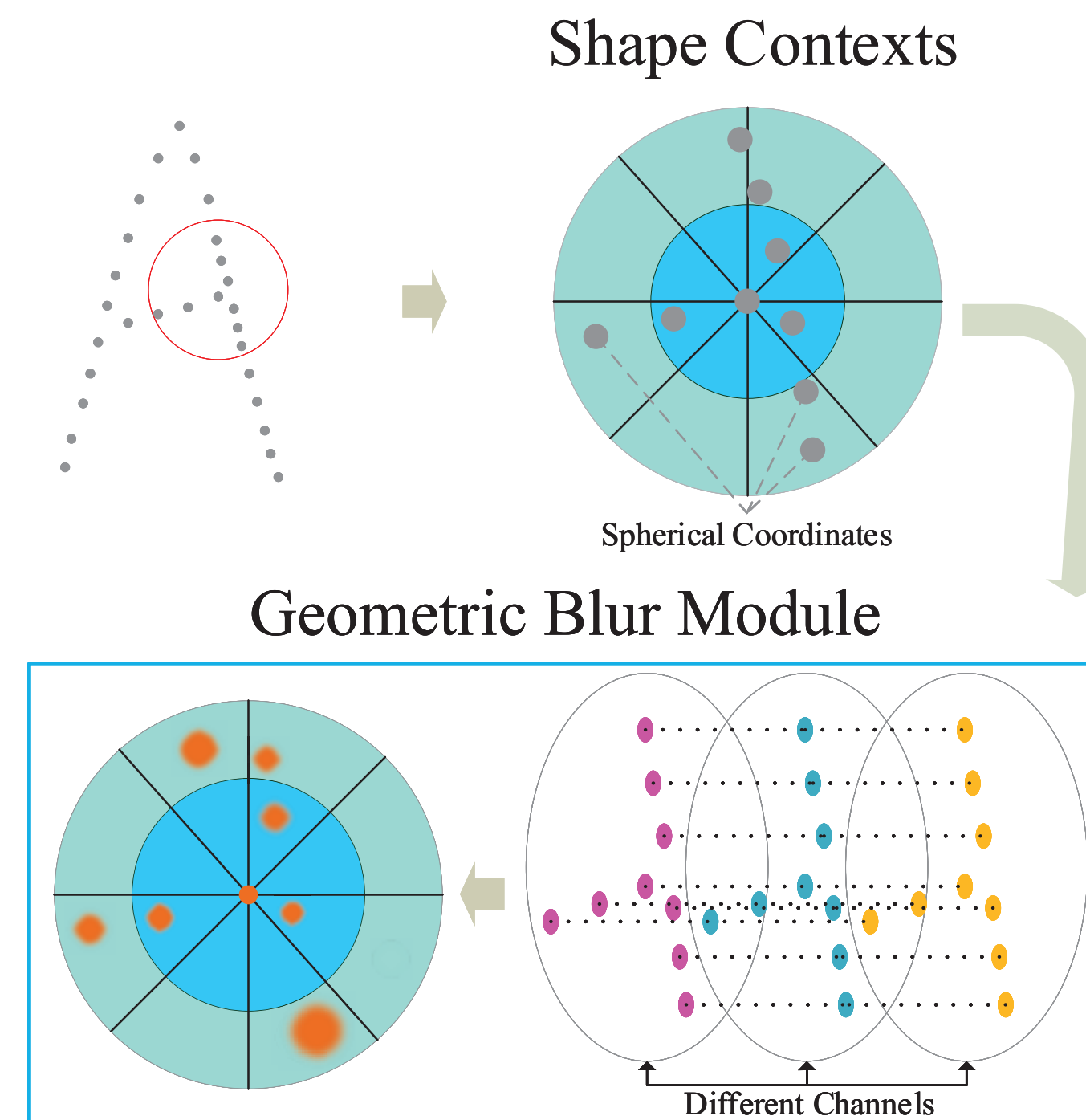


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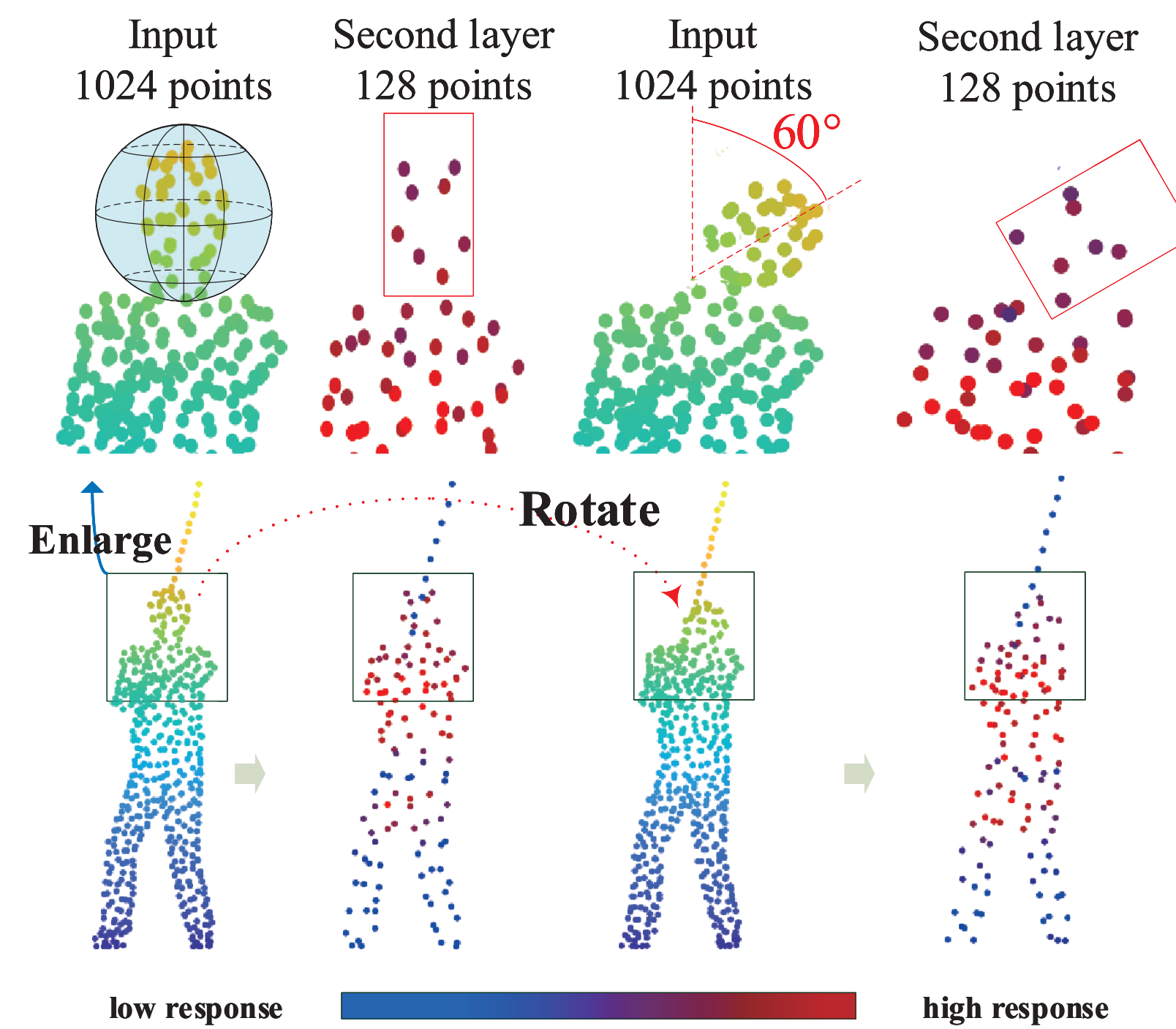
Introduction

- Overview of Pointspherical



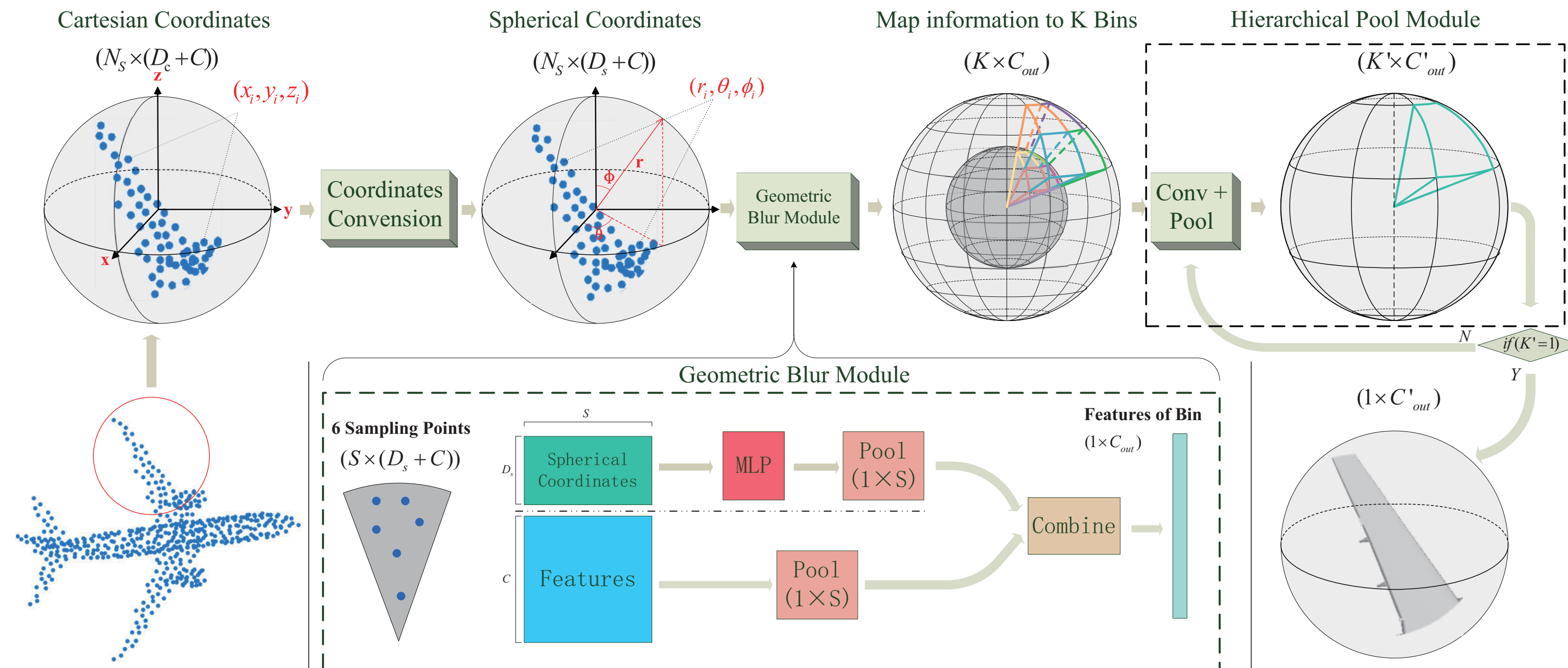
Introduction

- Semi-rotational invariance



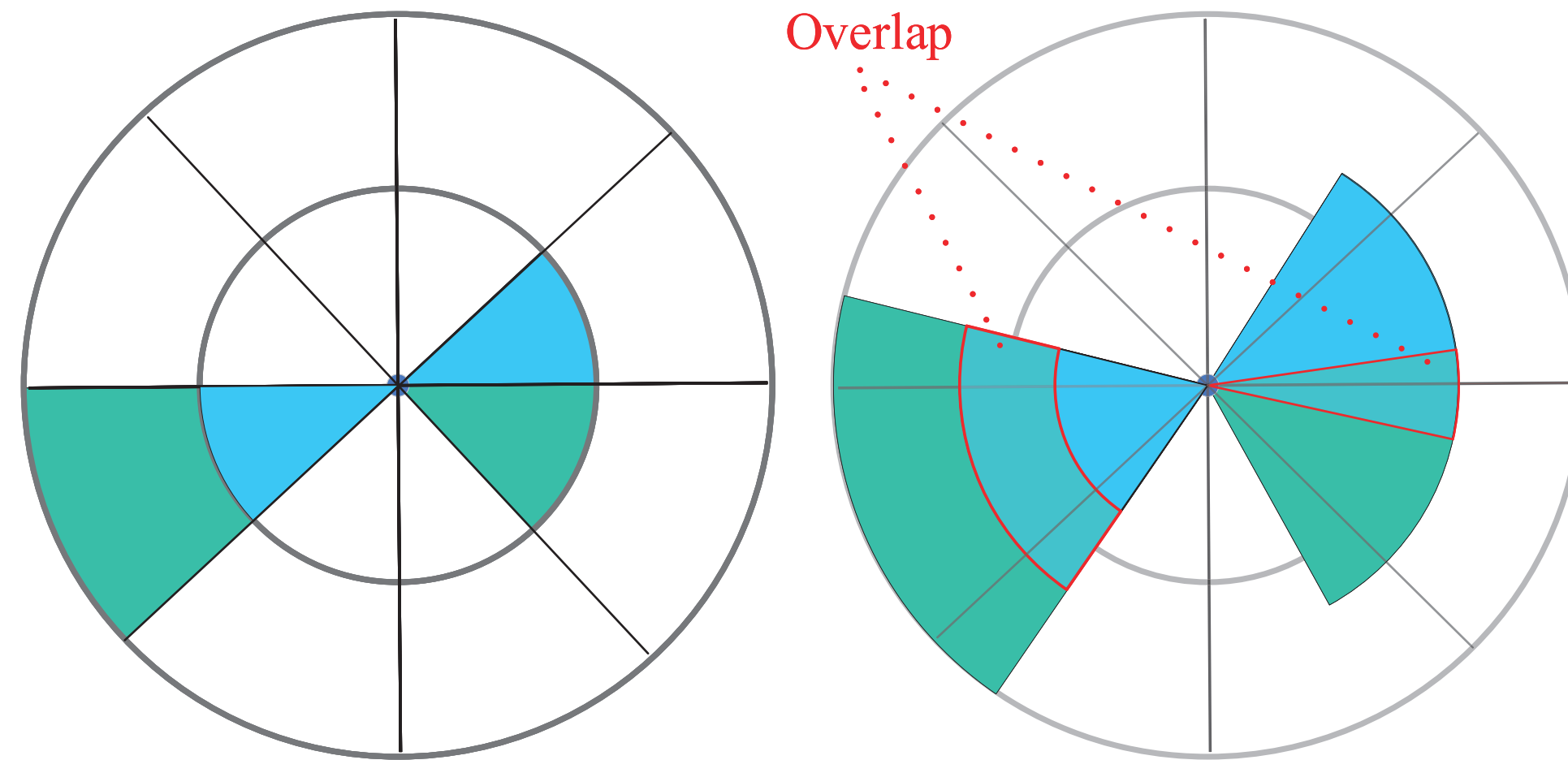
Method

- Spherical Hierarchical Pool



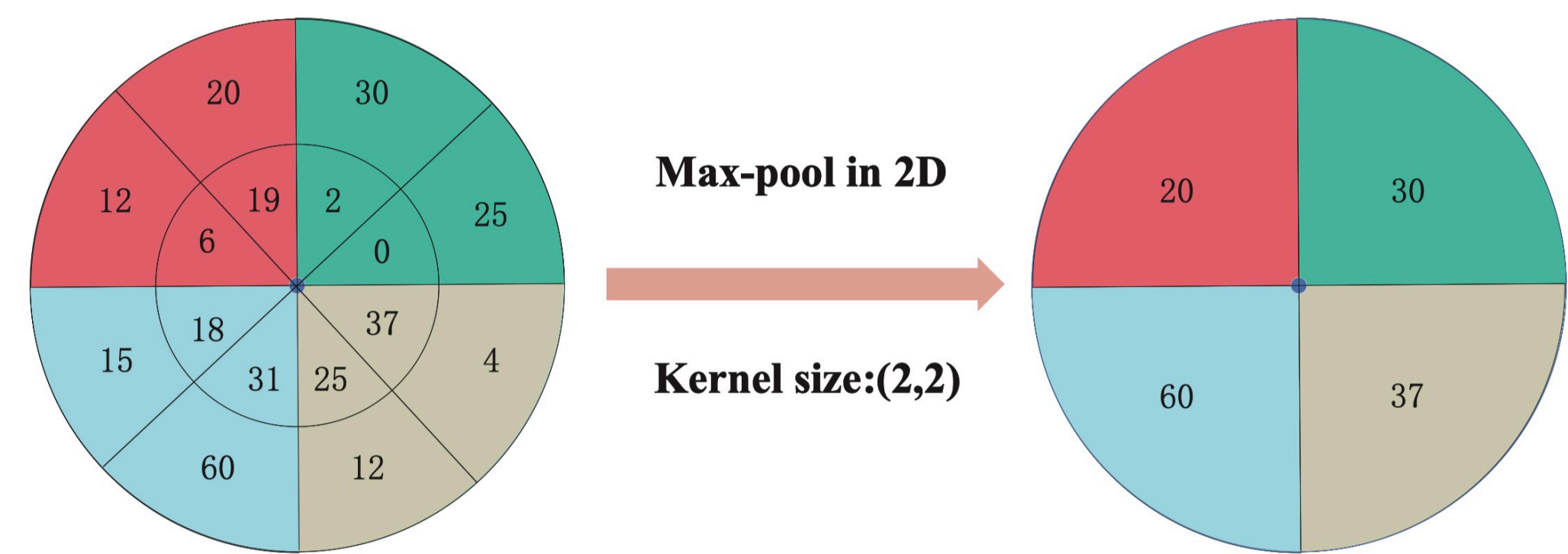
Method

- Shape Context Module



Method

- Geometric Blur Module



$$G_1(x) = \int_{T \in \mathcal{T}} I(T(x)) \, dT,$$

$$F_{b_{ik}} = MLP^1(\mathcal{A}(g(MLP^2(D_{x_{ij}})), g(F_{x_{ij}}))), \\ \forall x_{ij} \in \mathcal{N}(b_{ik}),$$

Results

- 2D Shape Classification

2D SHAPE CLASSIFICATION ON MNIST BENCHMARK.

Method	Accuracy(%)
LeNet [11]	99.20
Network in Network [25]	99.53
PointNet [1]	99.22
ShapeContextNet [7]	99.40
PointNet++ [13]	99.49
PointCNN [17]	99.54
PointSpherical	99.60

Results

- State-of-the-result

3D SHAPE CLASSIFICATION AND 3D SEMANTIC SEGMENTATION ON
MODELNET40 BENCHMARK AND SCANNET BENCHMARK,
RESPECTIVELY. “mAcc” AND “Acc” INDICATE CLASS-AVERAGED AND
INSTANCE-AVERAGED ACCURACY.

Method	ModelNet				ScanNet v1 accuracy(%)
	Input	Point	mAcc(%)	Acc(%)	
VoxNet [12]	voxel	-	83.0	85.9	-
MVCNN [2]	image	-	-	90.1	-
PointNet [1]	xyz	1k	86.2	89.2	73.9
ShapeContextNet [7]	xyz	1k	87.6	90.0	-
Kd-Net(depth=10) [28]	xyz	1k	-	90.6	-
PointNet++ [13]	xyz	1k	-	90.7	84.5
Ψ -CNN [29]	xyz	1k	88.7	92.0	-
PointCNN [17]	xyz	1k	88.1	92.2	85.1
DGCNN [30]	xyz	1k	90.2	92.2	-
PointWeb [27]	xyz	1k	89.4	92.3	85.9
A-CNN [31]	xyz	1k	90.3	92.6	85.4
RS-CNN [32]	xyz	1k	-	92.9	-
ShellNet [33]	xyz	1k	-	93.1	85.2
PointSpherical	xyz	1k	90.7	93.2	86.54
SO-Net [26]	xyz	2k	-	90.9	-
Kd-Net(depth=15) [28]	xyz	32k	-	91.8	-
PointConv [34]	xyz, nor	-	-	92.5	-
Geo-CNN [35]	xyz, nor	1k	-	93.9	-
PointNet++ [13]	xyz, nor	5k	-	91.9	-
SpiderCNN [36]	xyz, nor	5k	-	92.4	-
SO-Net [26]	xyz, nor	5k	-	93.4	-

Results

- State-of-the-result

3D SEMANTIC SEGMENTATION RESULTS ON THE S3DIS BENCHMARK IN AREA 5 (%).

Method	OA	mAcc	mIoU	ceiling	floor	wall	beam	column	window	door	table	chair	sofa	bookcase	board	clutter
PointNet [1]	-	48.98	41.09	88.80	97.33	69.80	0.05	3.92	46.26	10.76	58.93	52.61	5.85	40.28	26.38	33.22
SegCloud [37]	-	57.35	48.92	90.06	96.05	69.86	0.00	18.37	38.35	23.12	70.40	75.89	40.88	58.42	12.96	41.60
PointCNN [17]	85.91	63.86	57.26	92.31	98.24	79.41	0.00	17.60	22.77	62.09	74.39	80.59	31.67	66.67	62.05	56.74
SPGraph [16]	86.38	66.50	58.04	89.35	96.87	78.12	0.00	42.81	48.93	61.58	84.66	75.41	69.84	52.60	2.10	52.22
PCCN [38]	-	67.01	58.27	92.26	96.20	75.89	0.27	5.98	69.49	63.45	66.87	65.63	47.28	68.91	59.10	46.22
PAT [39]	-	70.83	60.07	93.04	98.51	72.28	1.00	41.52	85.05	38.22	57.66	83.64	48.12	67.00	61.28	33.64
PointWeb [27]	86.97	66.64	60.28	91.95	98.48	79.39	0.00	21.11	59.72	34.81	76.33	88.27	46.89	69.30	64.91	52.46
PointSpherical	87.58	70.43	62.68	92.20	97.96	80.55	00.00	12.93	62.95	54.46	79.37	87.12	57.96	70.30	67.42	51.64

Results

- Ablation Study

ABLATION STUDY OF THE PROPOSED POINTSPHERICAL ON MODELNET40 AND S3DIS AREA 5 (%).

	Baseline	Baseline + different modules				
Cartesian Coordinates	✓		✓	✓		✓
Spherical Coordinates		✓	✓		✓	✓
Spherical Hierarchical Pool				✓	✓	✓
ModelNet (accuracy)	92.0	92.5	92.6	92.9	93.1	93.2
S3DIS Area 5 (mIoU)	58.2	60.9	60.8	60.99	62.68	62.12

Results

- Robustness

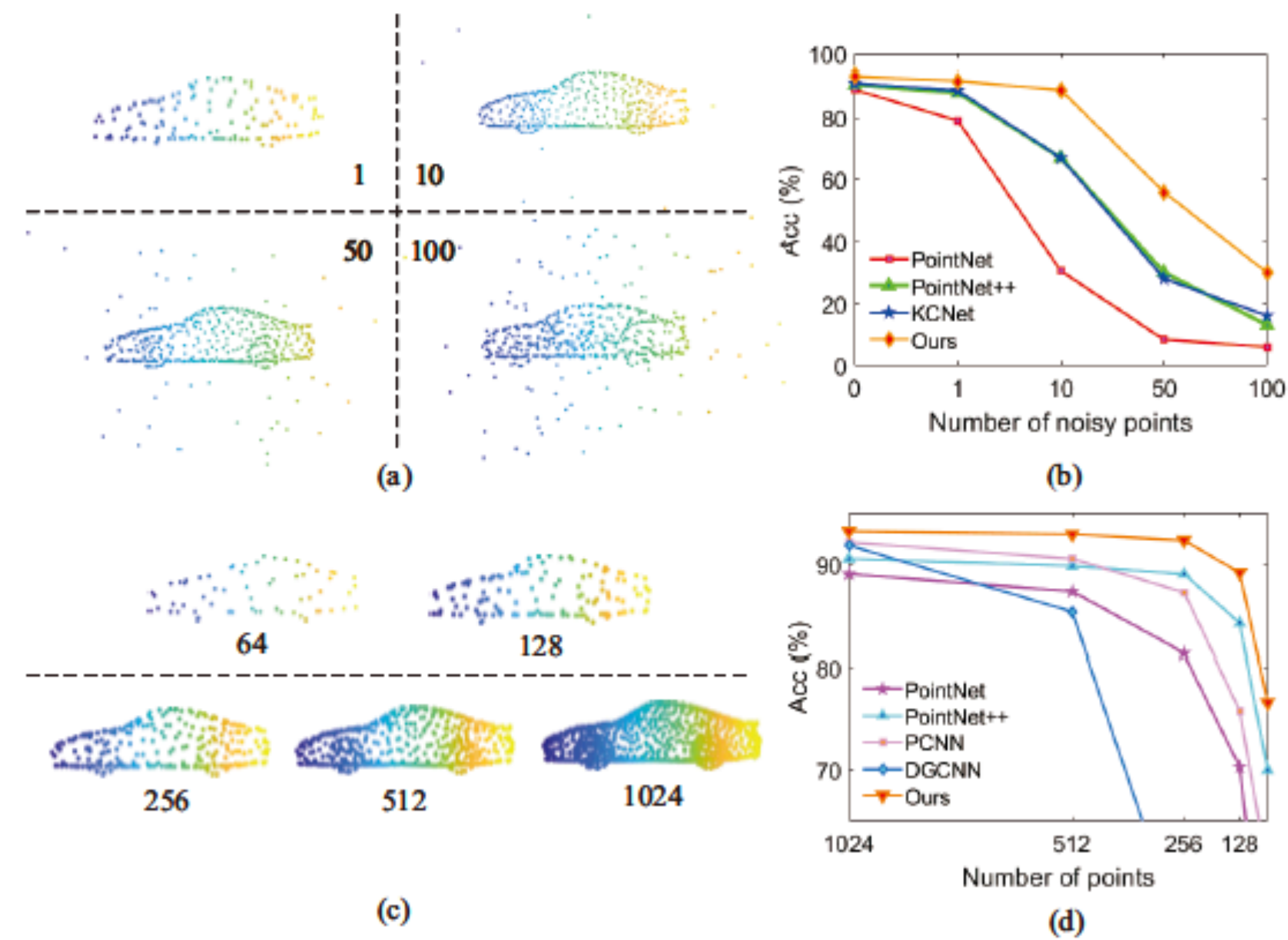


Fig. 6. Robustness of Noise and Sampling Density. The upper is the visualization of noise and the upper for sample density.

Results

- Visualization

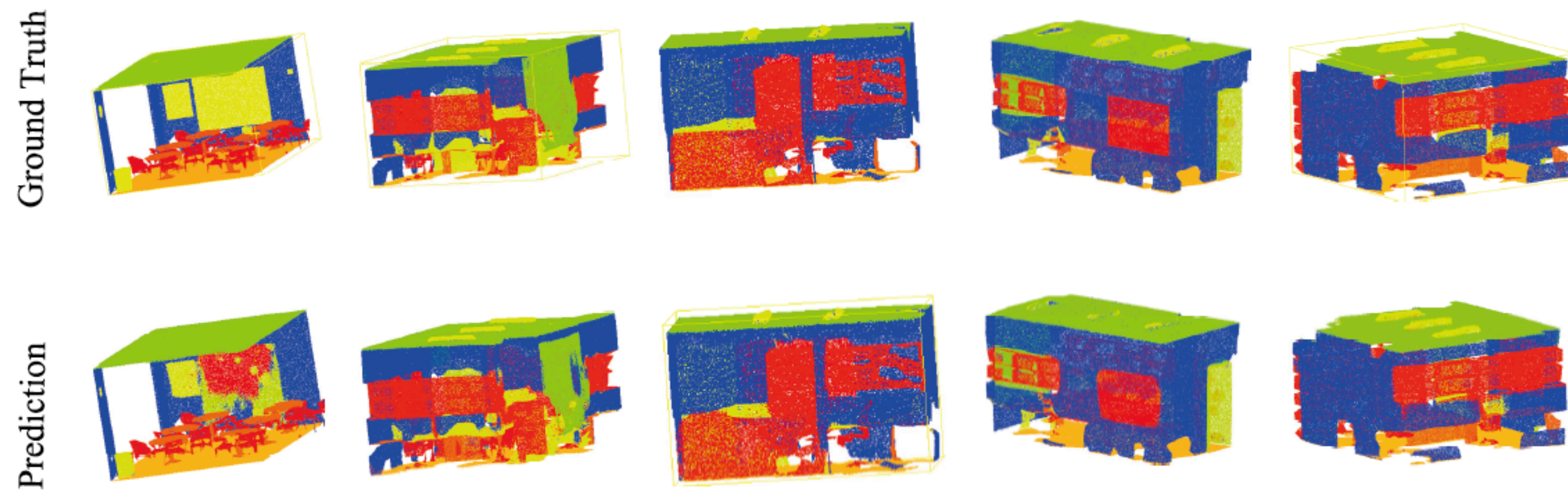


Fig. 7. Semantic segmentation for indoor scenes in the S3DIS dataset [23]

Thanks for Listening!

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