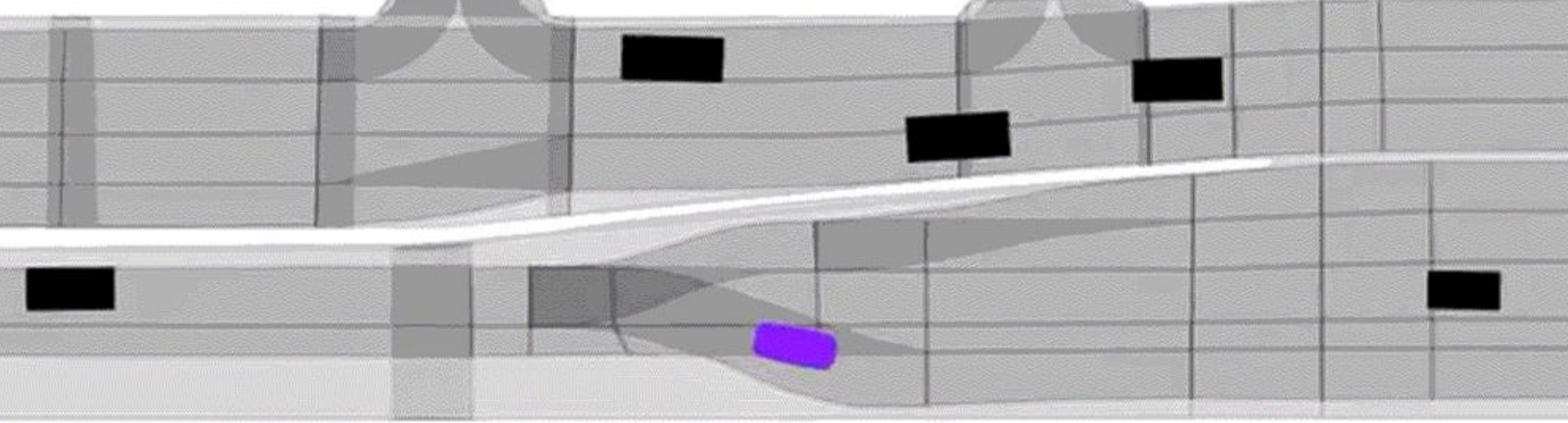


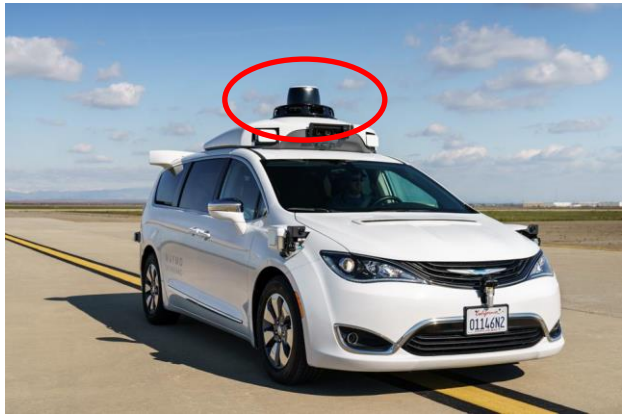
UltraLiDAR: Learning Compact Representations for LiDAR Completion and Generation

Yuwen Xiong, Wei-Chiu Ma, Jingkang Wang, Raquel Urtasun

UNIVERSITY OF TORONTO
Massachusetts Institute of Technology
Waabi

Motivation

- Robust autonomous system relies on LiDAR to perceive 3D surroundings
  - Data collection is hard to scale up due to costly LiDAR

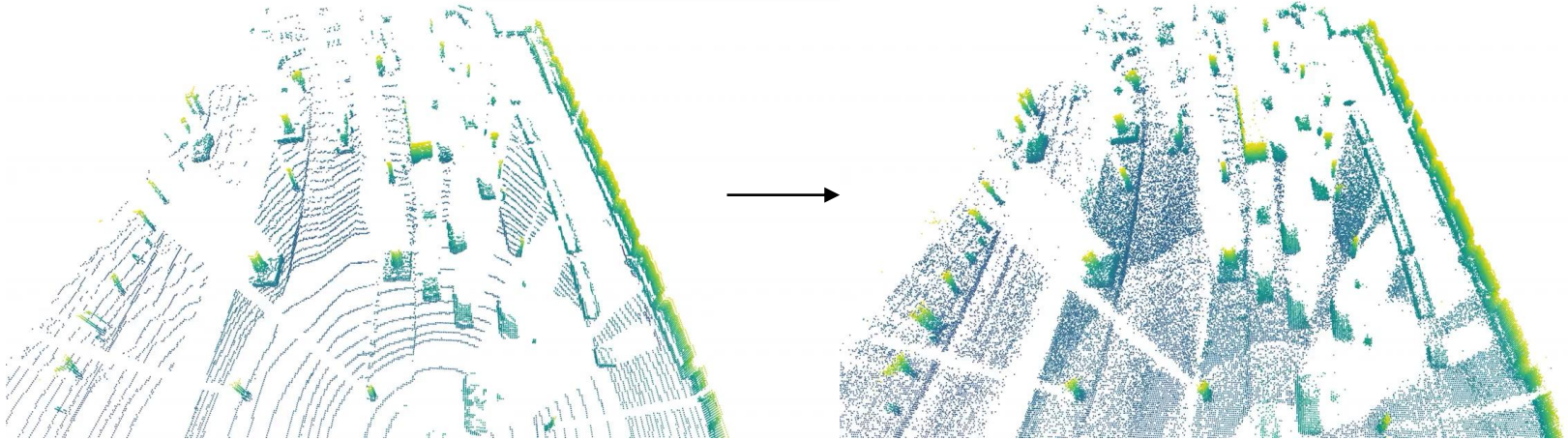


Motivation

- Robust autonomous system relies on LiDAR to perceive 3D surroundings
  - Data collection is hard to scale up due to costly LiDAR
  - Modern 64-beam LiDAR is still “sparse”

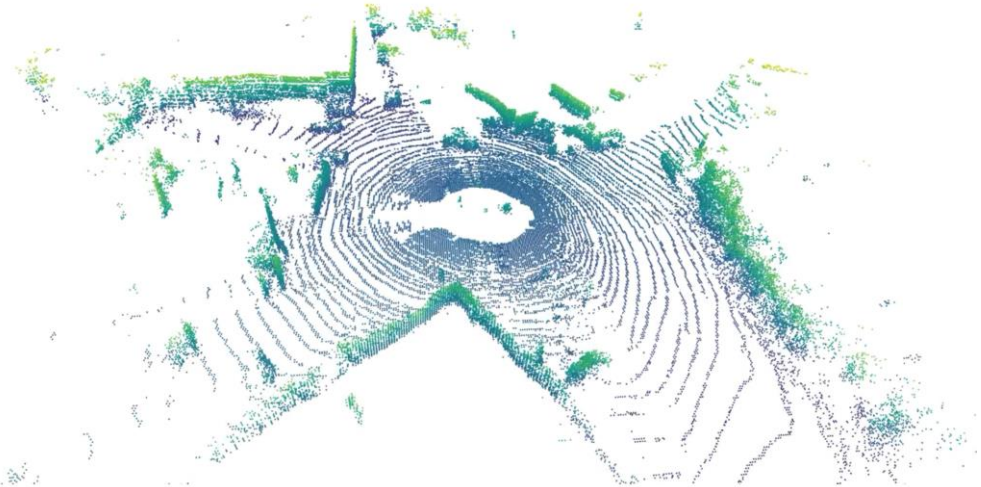
Our solution

- We present UltraLiDAR, which learns compact representations for:
  - Sparse-to-dense completion (64 -> 512 beam)



Our solution

- We present UltraLiDAR, which learns compact representations for:
  - Sparse-to-dense completion (64 -> 512 beam)
  - Realistic LiDAR generation



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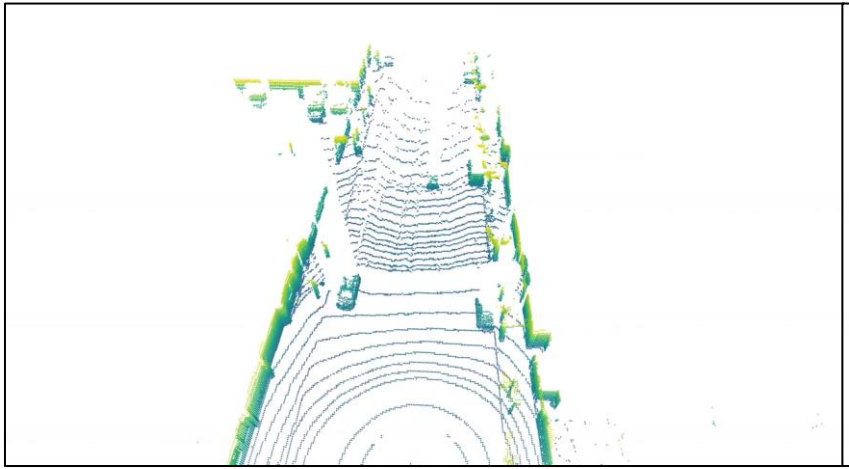
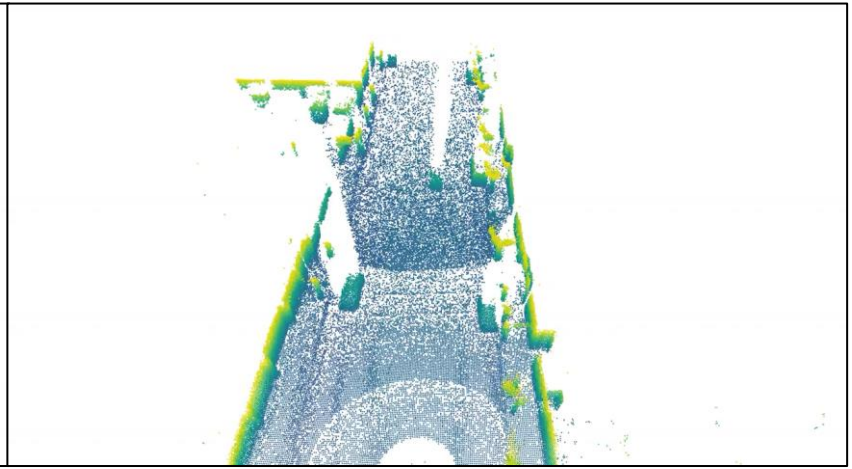
Sparse-to-Dense for 3D detection

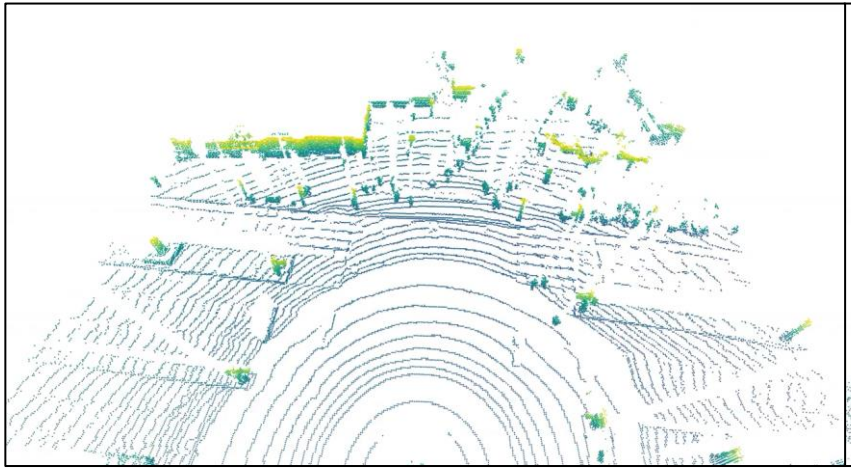


Real 64-beam data

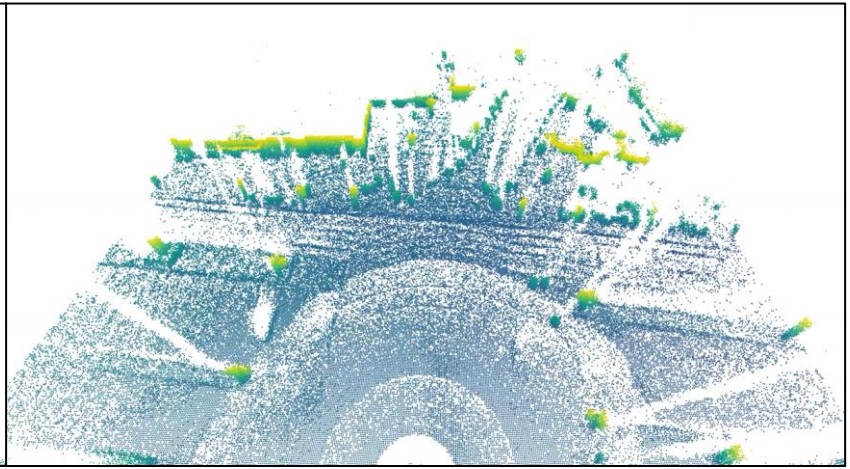


Our sparse-to-dense
512-beam data

Sparse-to-Dense for 3D detection

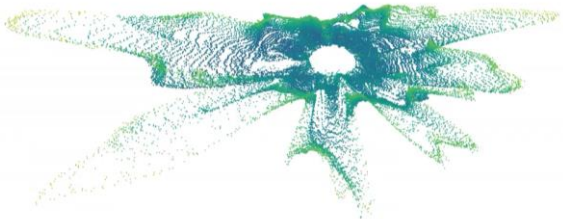


Real 64-beam data

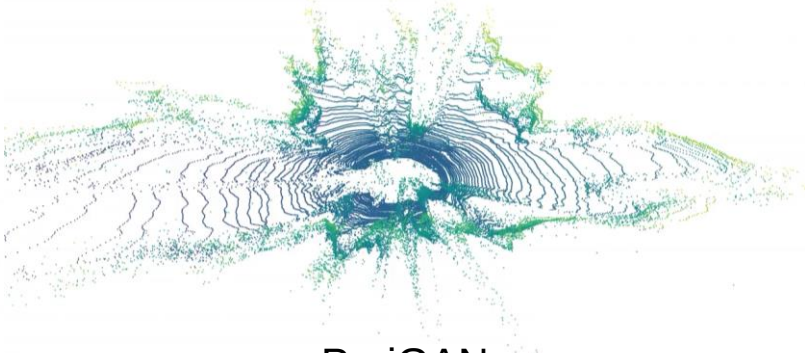


Our sparse-to-dense
512-beam data

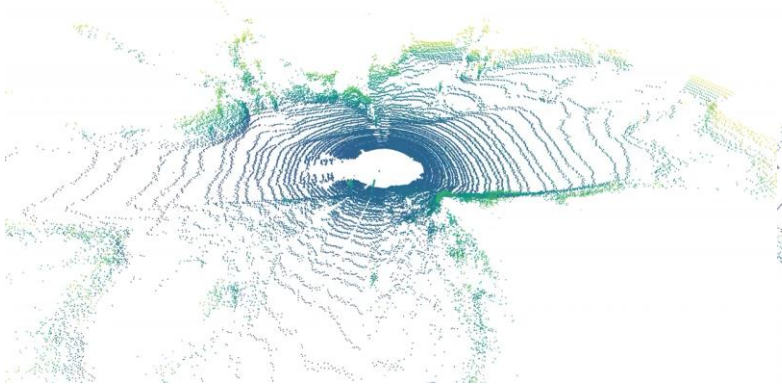
Unconditional generation results on KITTI-360



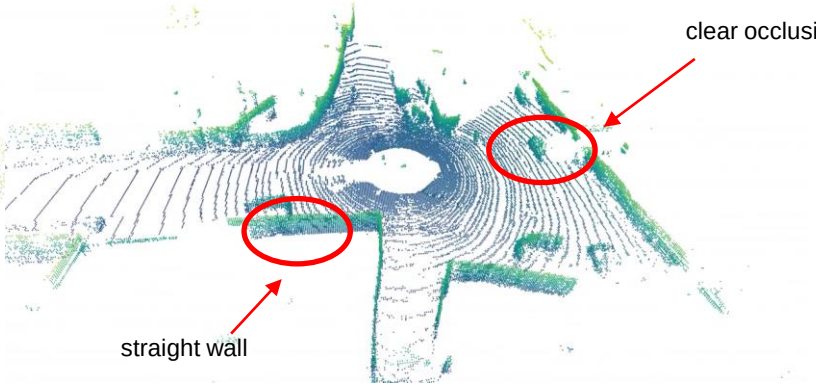
LiDAR VAE



ProjGAN

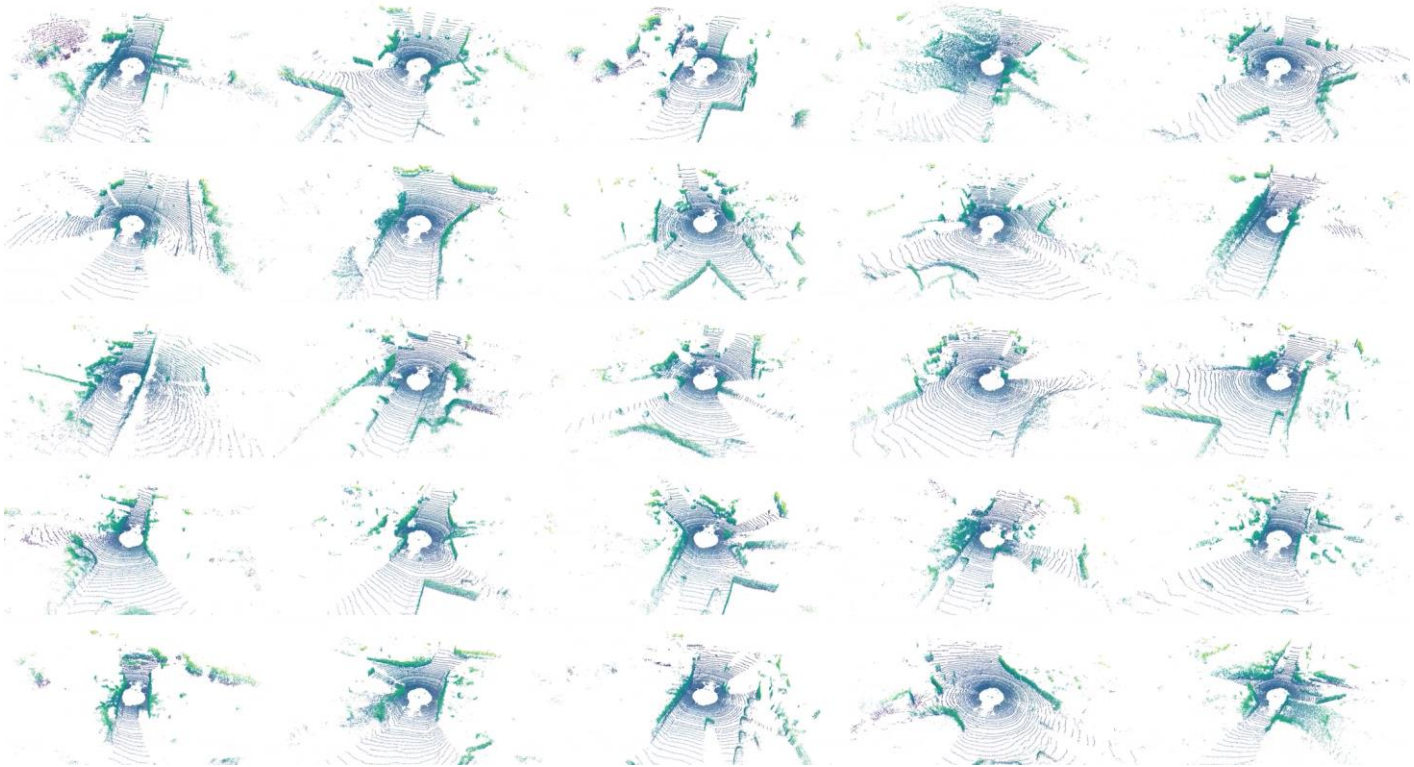


LiDARGen



Ours

Unconditional generation results on KITTI-360



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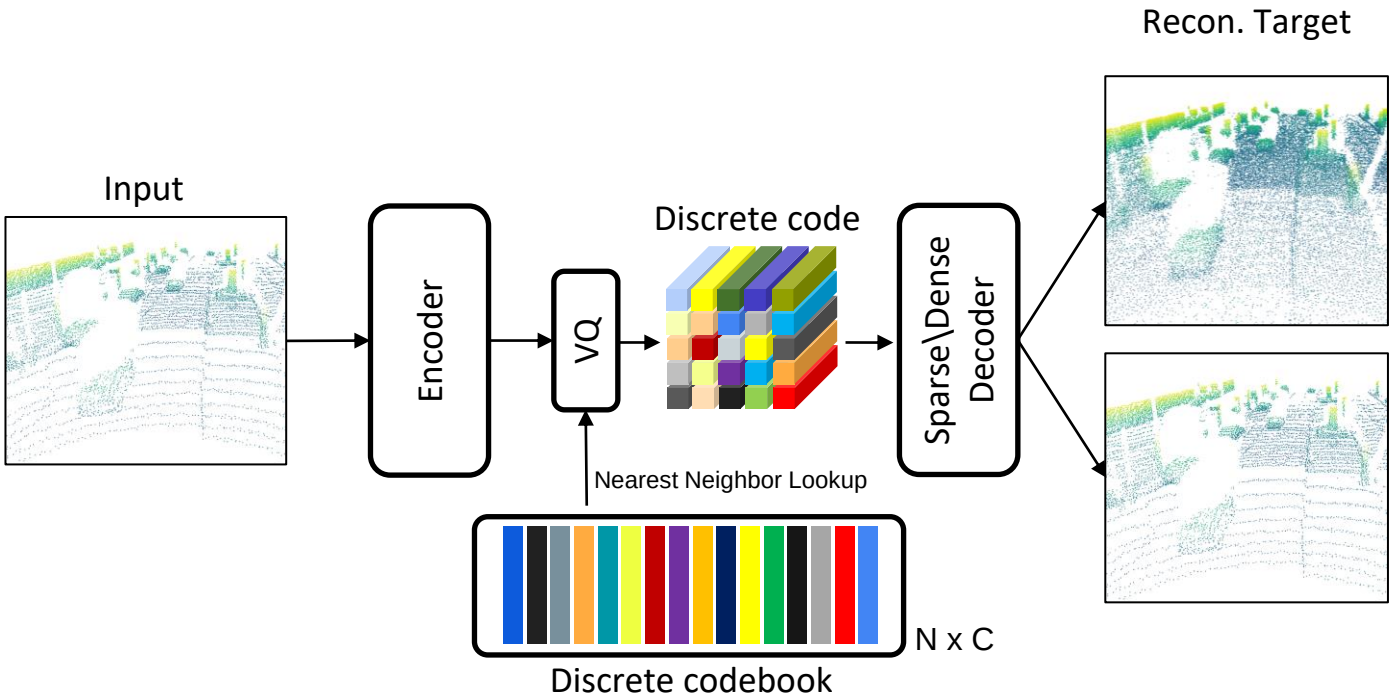
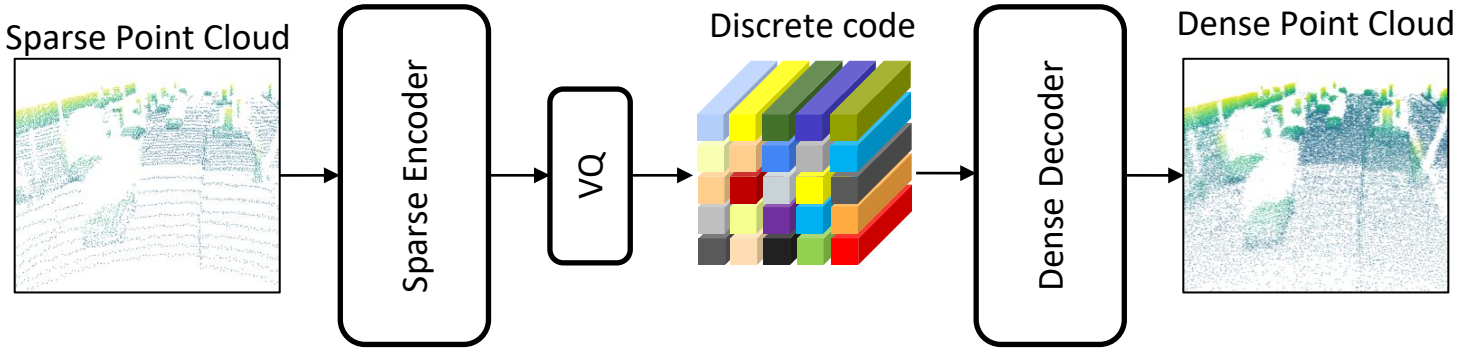
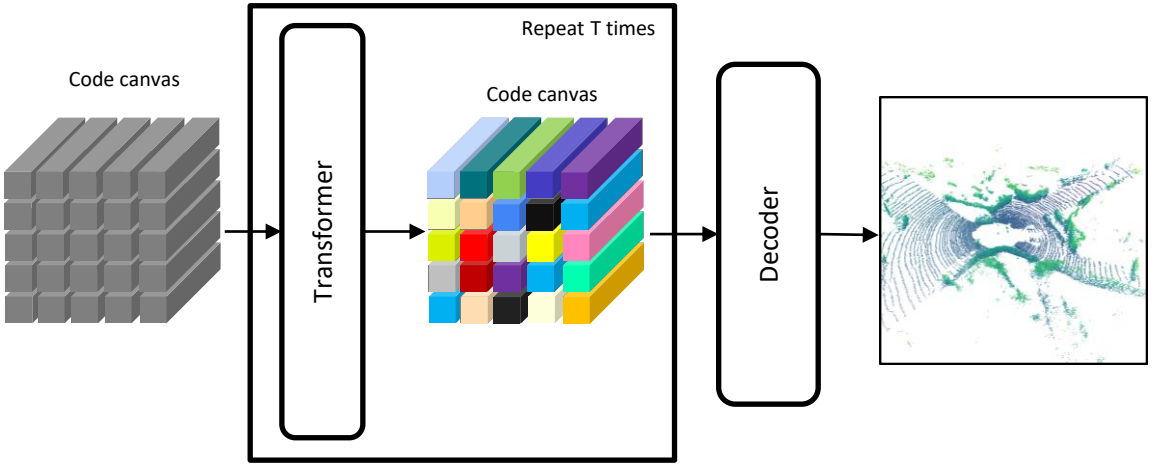
Discrete Codebook Learning



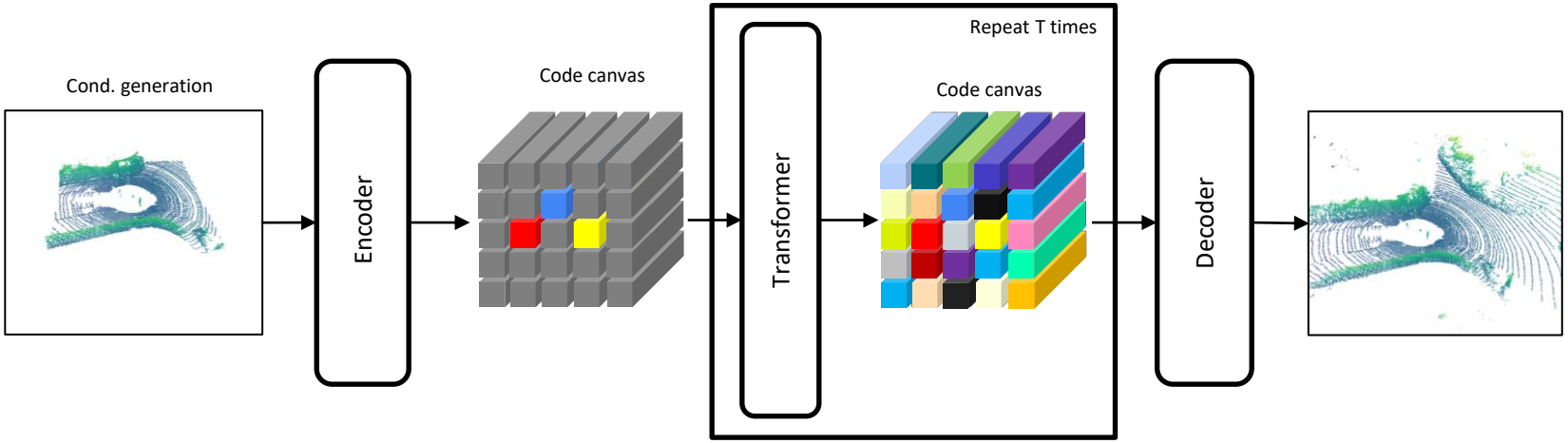
Sparse to Dense Point Cloud Completion



Point Cloud Generation



Conditional Point Cloud Generation



Sparse-to-Dense for 3D detection

Model	Sparse to Dense	Two-stage PIXOR		PointPillar	
		AP_{BEV}	AP_{3D}	AP_{BEV}	AP_{3D}
Real / 64	-	79.3	62.2	75.5	62.3
Sim / 512	-	78.1	57.7	70.0	55.5
Sim / 512	ContComp	79.7	62.4	75.1	59.8
Sim / 512	Ours	**80.3**	**64.3**	**76.0**	**62.8**

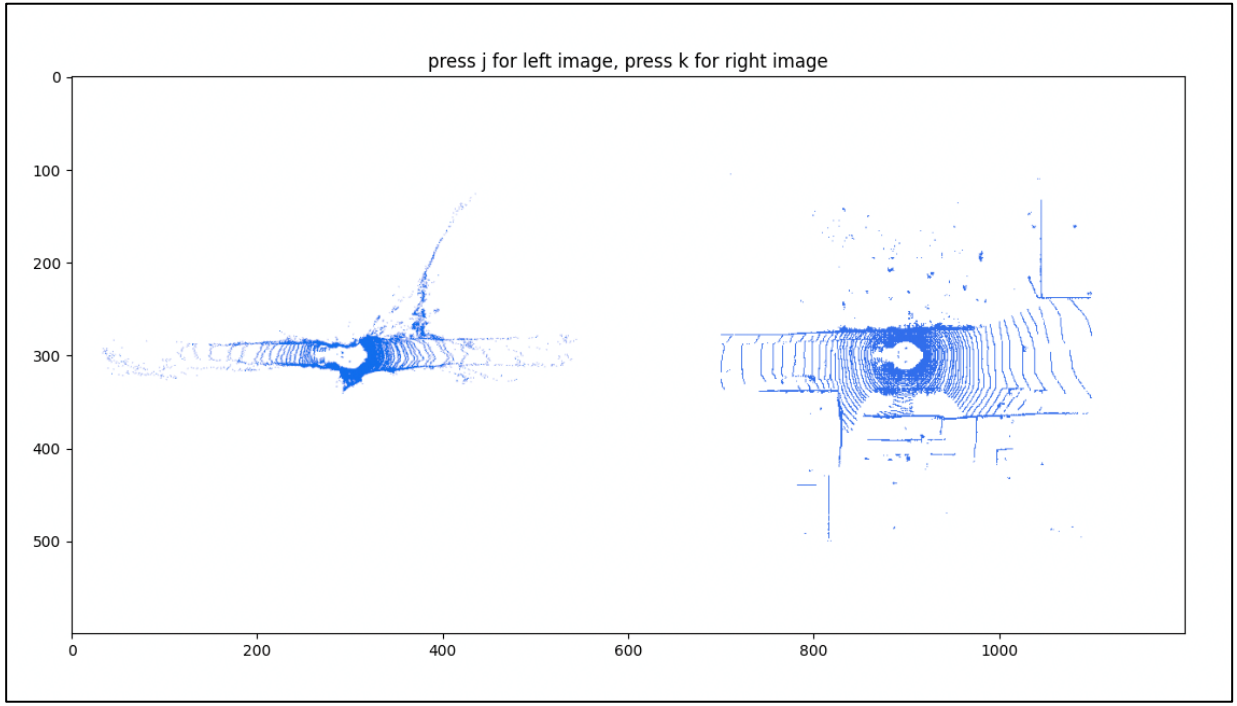
PandaSet results

Sparse-to-Dense for 3D detection

Model	Sparse to Dense	Two-stage PIXOR		PointPillar	
		AP_{BEV}	AP_{3D}	AP_{BEV}	AP_{3D}
Real / 64	-	71.7	32.8	60.9	28.1
Sim / 512	-	66.9	33.2	58.5	28.0
Sim / 512	ContComp	74.9	41.5	67.7	36.9
Sim / 512	Ours	**76.7**	**46.3**	**73.0**	**40.9**

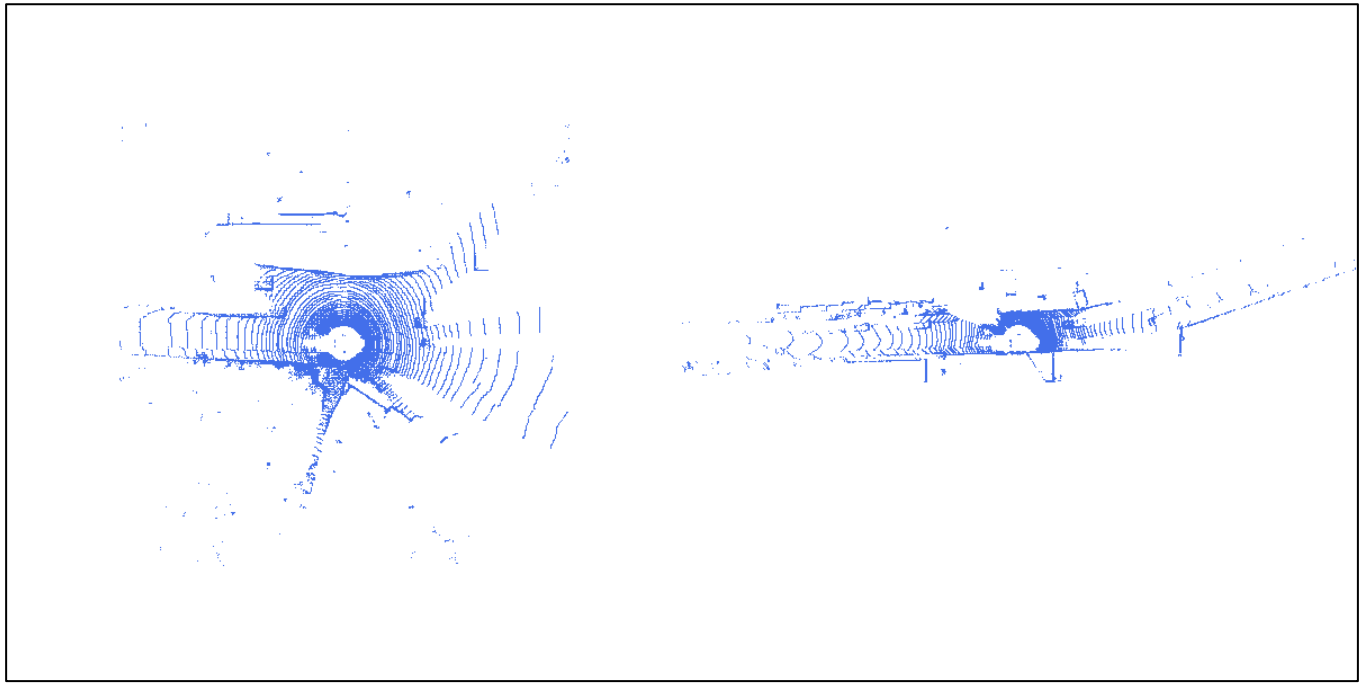
PandaSet -> KITTI cross-dataset evaluation

Realistic LiDAR generation

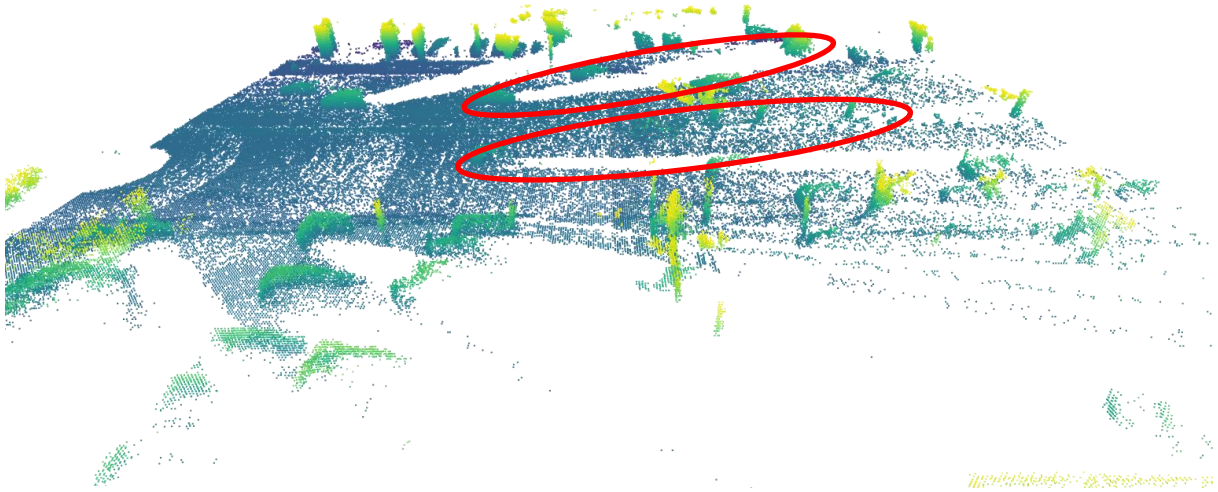


A/B test GUI

Realistic LiDAR generation



Conditional generation results on PandaSet



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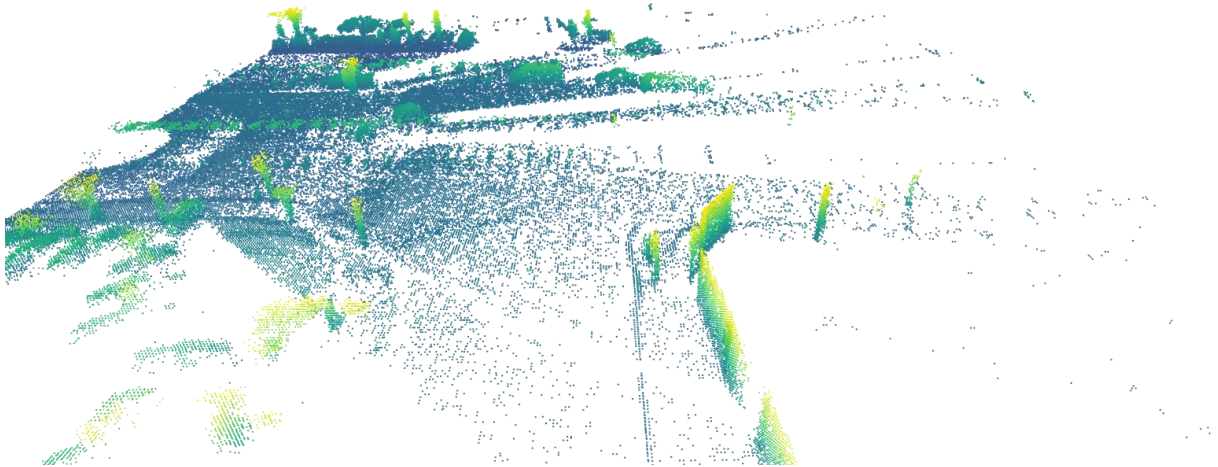
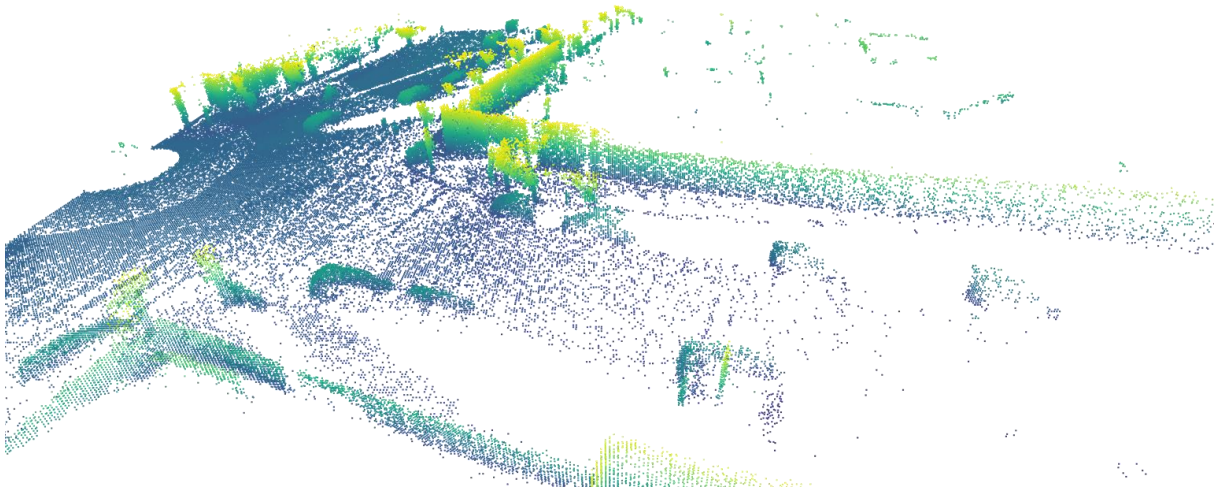
Conditional generation results on PandaSet



Conditional generation results on PandaSet



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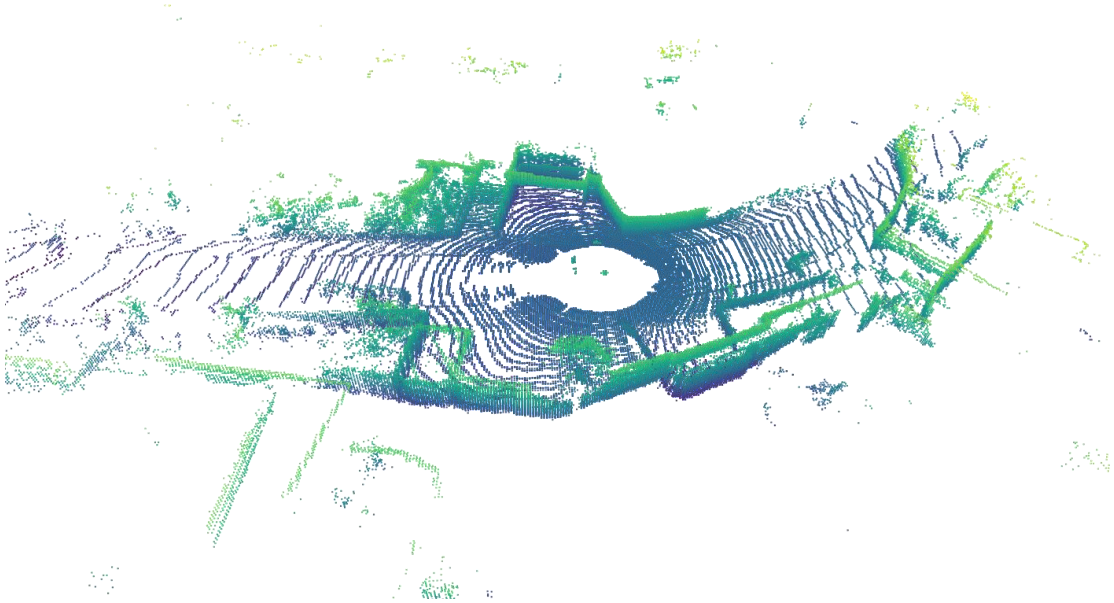
Conditional generation results on KITTI-360



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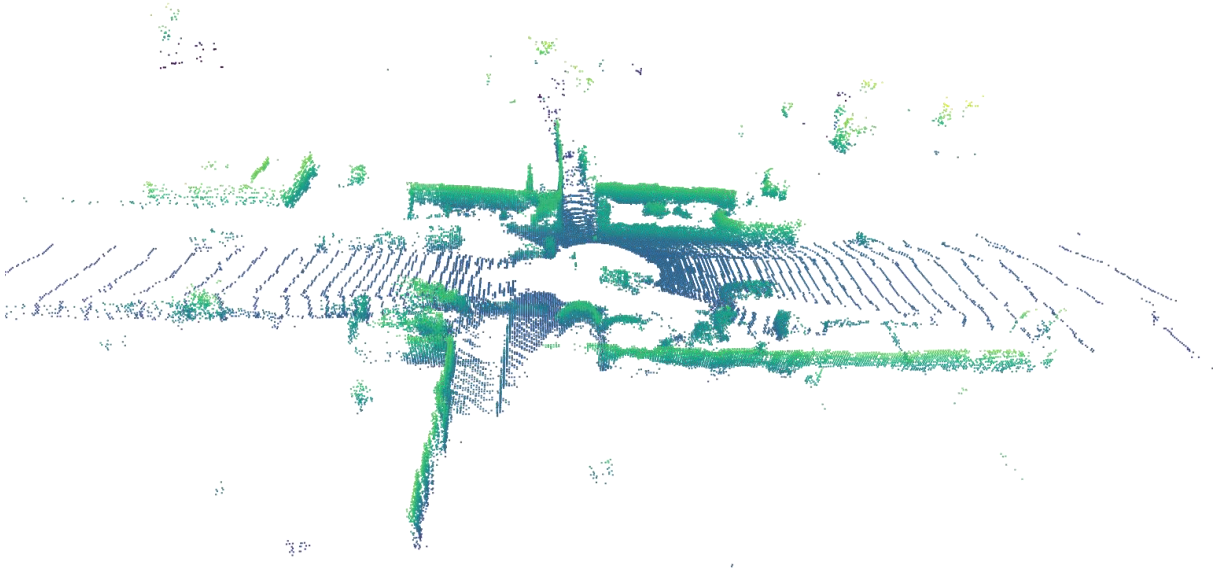
Conditional generation results on KITTI-360



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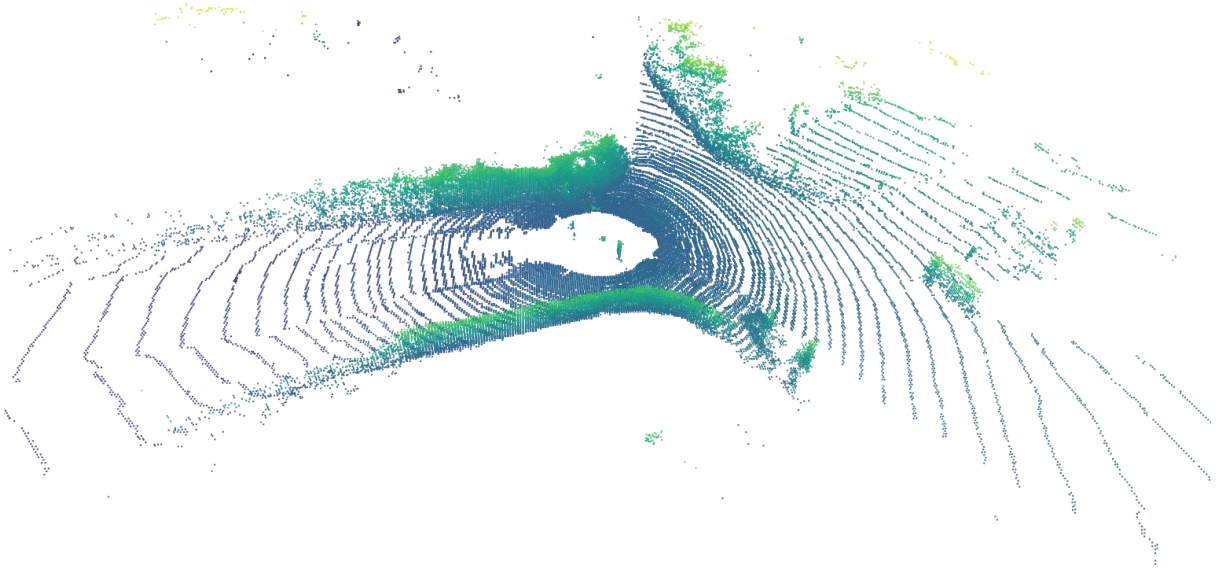
Conditional generation results on KITTI-360



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Conclusion

- We present UltraLiDAR to perform sparse-to-dense LiDAR completion and LiDAR generation.
- Results on 3D detection task show that with our sparse-to-dense module, the detector performance can be further improved.
- Our model can also generate realistic LiDAR sweeps at scale and outperform all previous LiDAR generation baselines.