

UltraLiDAR: Learning Compact Representations for LiDAR Completion and Generation

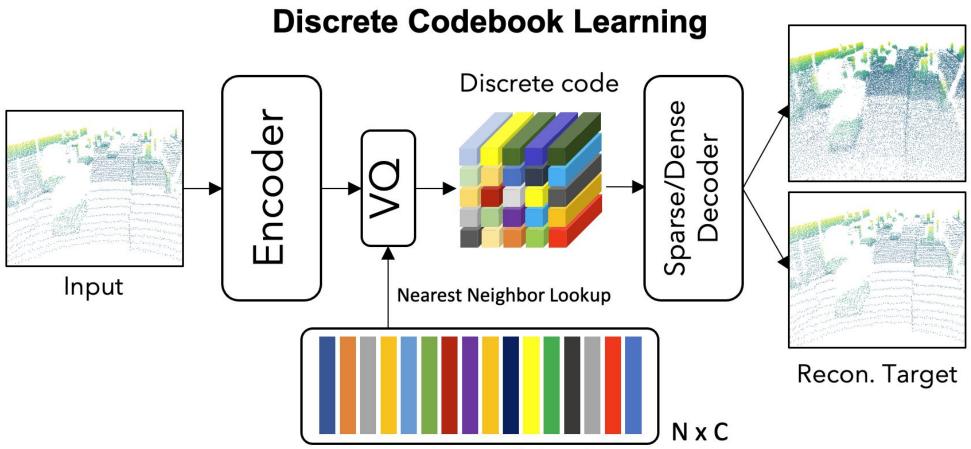
Overview

- Robust autonomous system relies on LiDAR to perceive 3D surroundings, however:
 - Modern 64-beam LiDAR is still "sparse"
 - Data collection is hard to scale up due to costly LiDAR
- We present **UltraLiDAR** that learns a compact representation codebook for:
 - Sparse-to-dense completion (e.g. 64 beam -> 512 beam)
 - Realistic data-driven LiDAR generation

Learning codebook by reconstruction

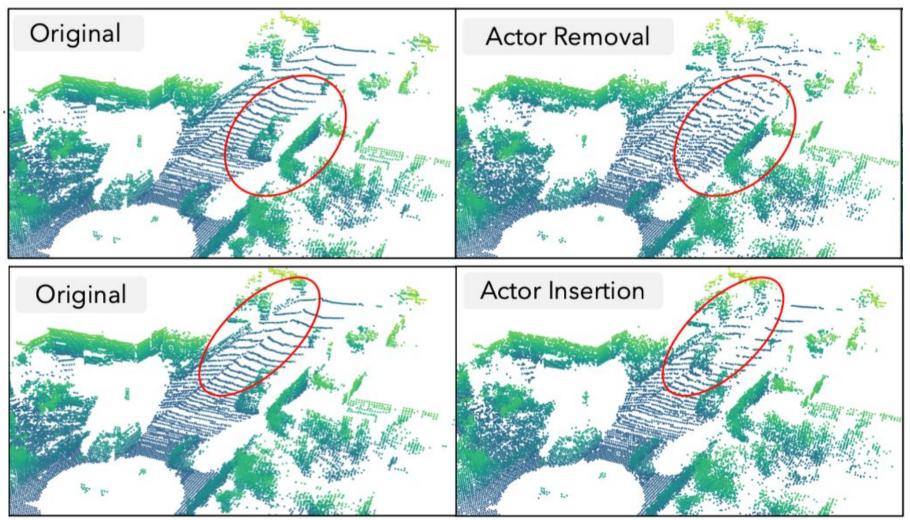
Why discrete code?

- **Robustness**: quantization makes representations robust to noise and domain shift
- **Explainability**: code can be back-traced to understand its semantic meaning
- **Controllability**: edit the scene by editing the code

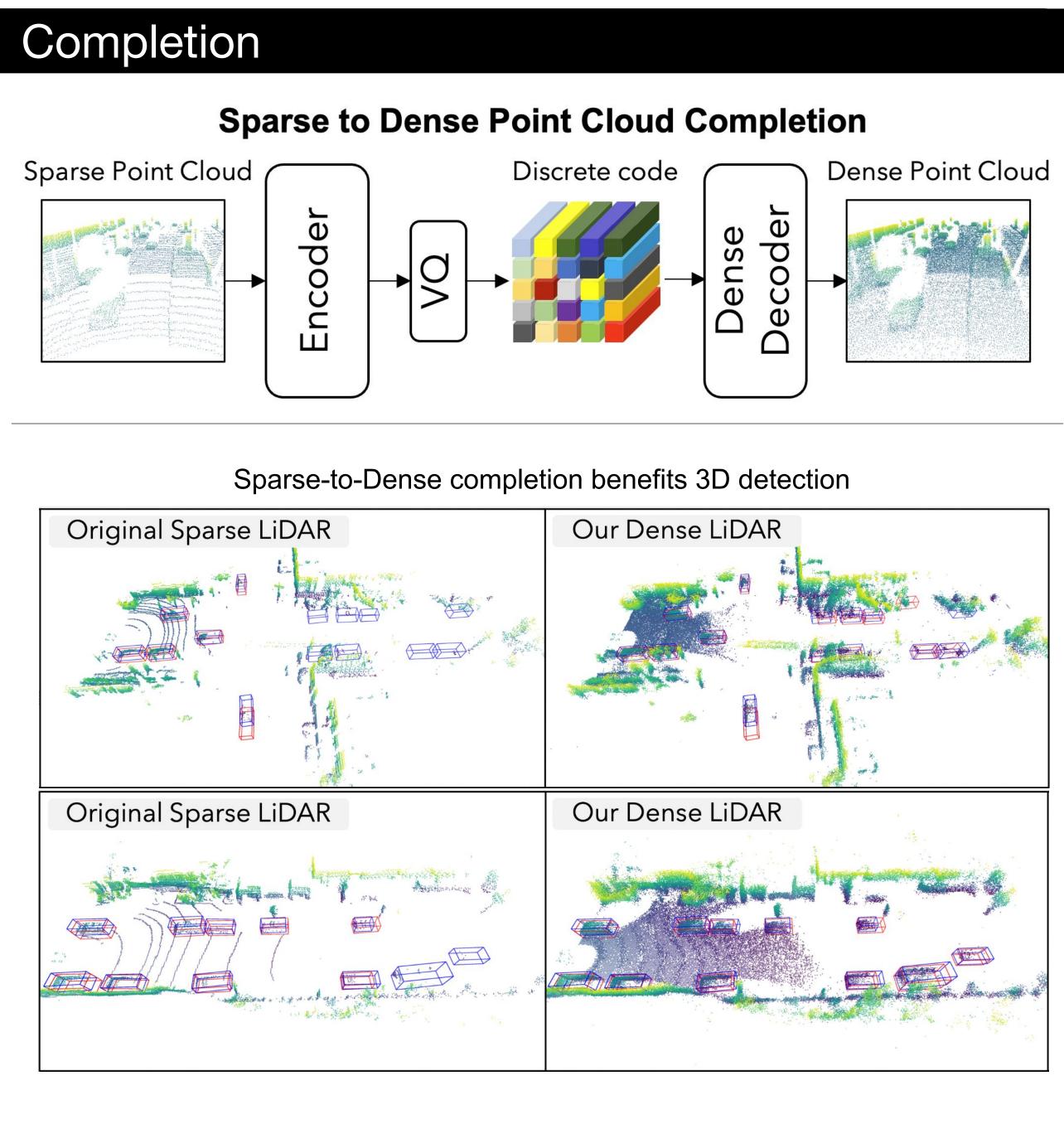


Discrete codebook

Manipulate scenes by editing codes on the code canvas



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Lifting the real 64-beam data to 512 beams achieves **better performance**

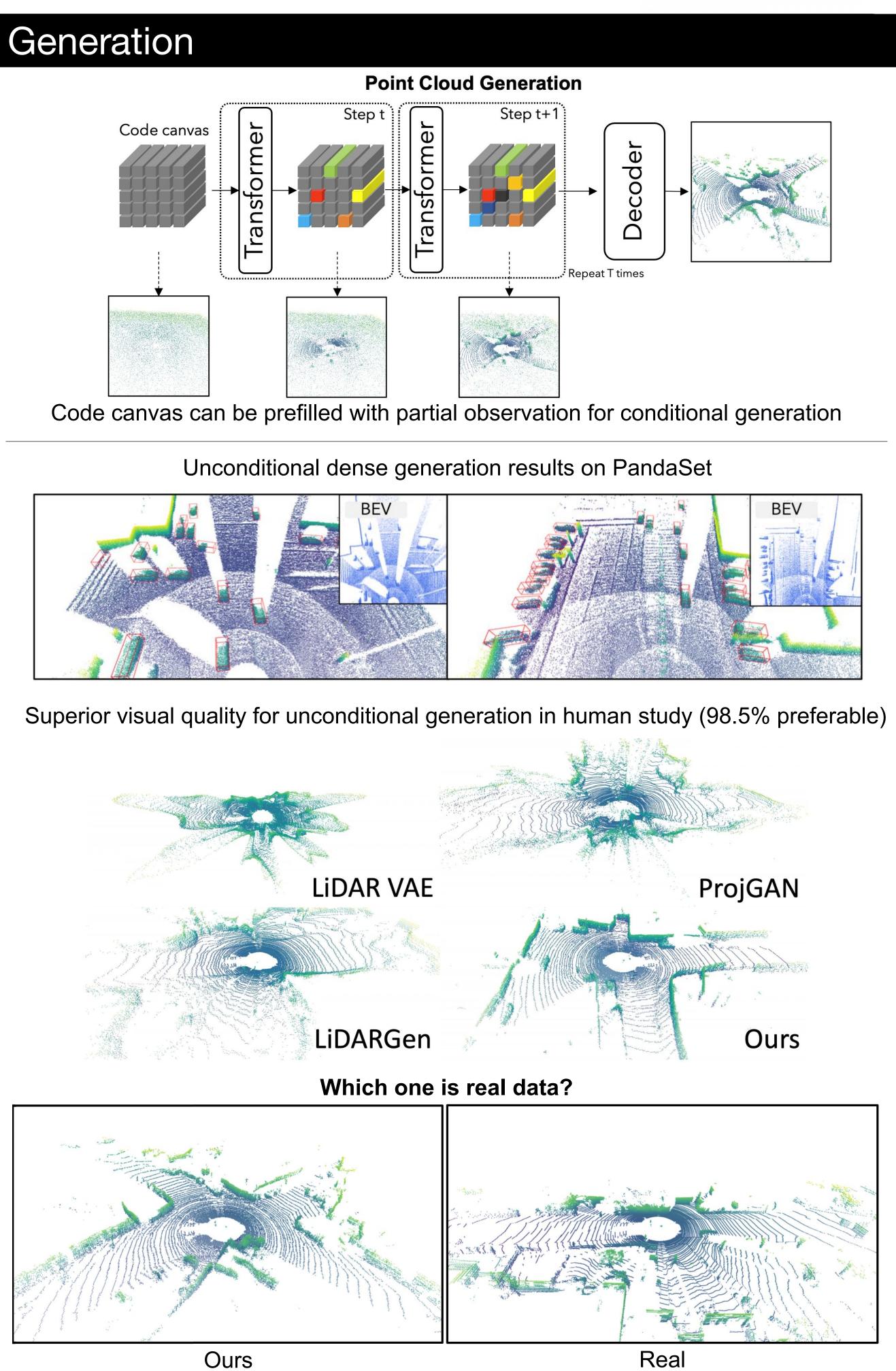
Model	Sparse to	Two-stage PIXOR		PointPillar	
	Dense	AP_{BEV}	AP_{3D}	AP_{BEV}	AP_{3D}
Real / 64	-	79.3	62.2	75.5	62.3
Sim / 512	-	78.1	57.7	70.0	55.5
Sim / 512	ContComp	79.7	62.4	75.1	59.8
Sim / 512	Ours	80.3	64.3	76.0	62.8

The codebook generalize well in PandaSet->KITTI cross-dataset setting

Model	Sparse to	Two-stage PIXOR		PointPillar	
	Dense	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







Real