

LiDPM: Rethinking Point Diffusion for Lidar Scene Completion

Tetiana Martyniuk

Gilles Puy

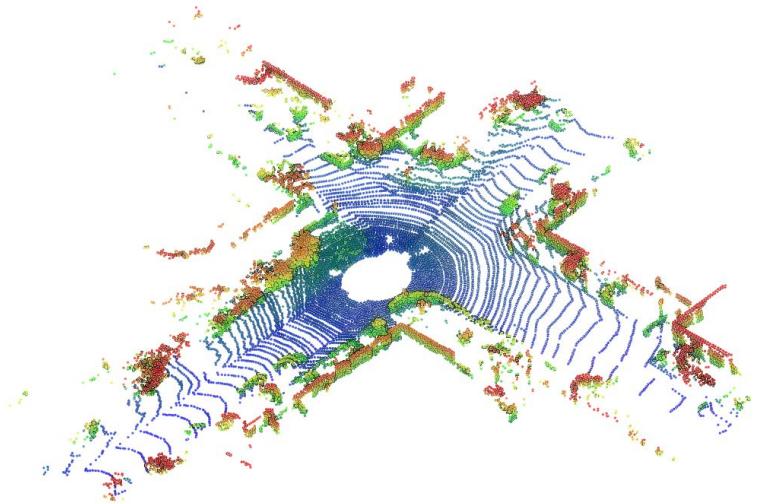
Alexandre Boulch

Renaud Marlet

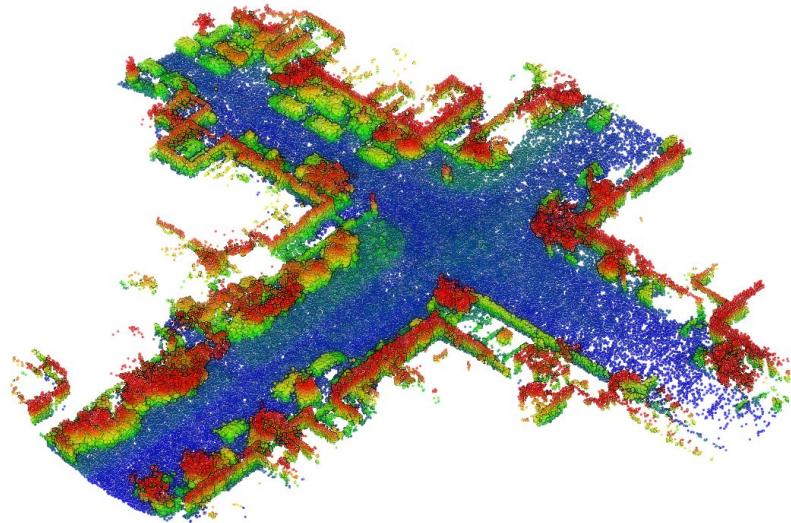
Raoul de Charette



Task: lidar scene completion

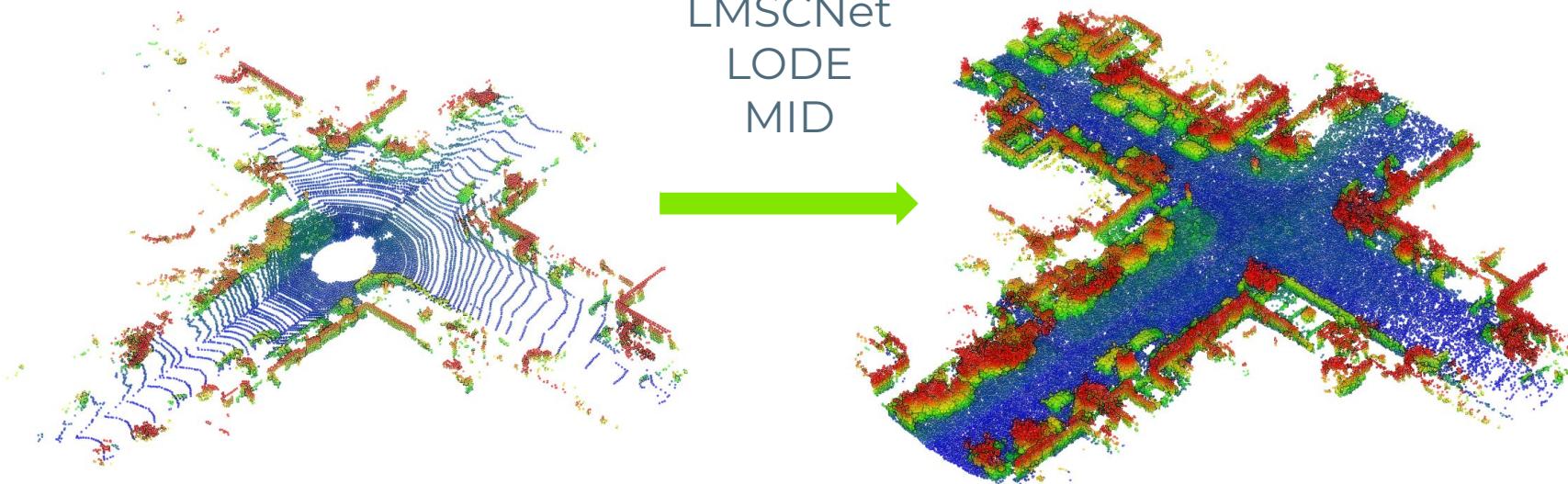


Sparse lidar
point cloud



Dense scene

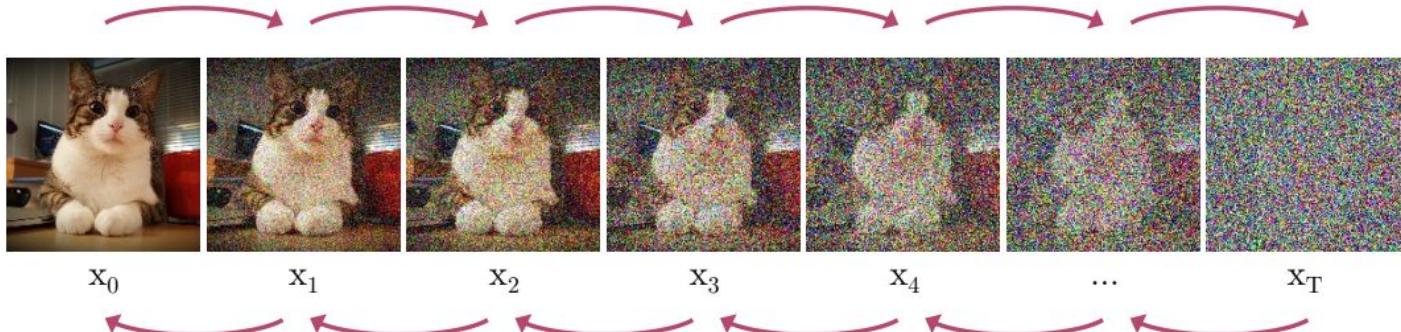
Scene completion. Prior work



Diffusion

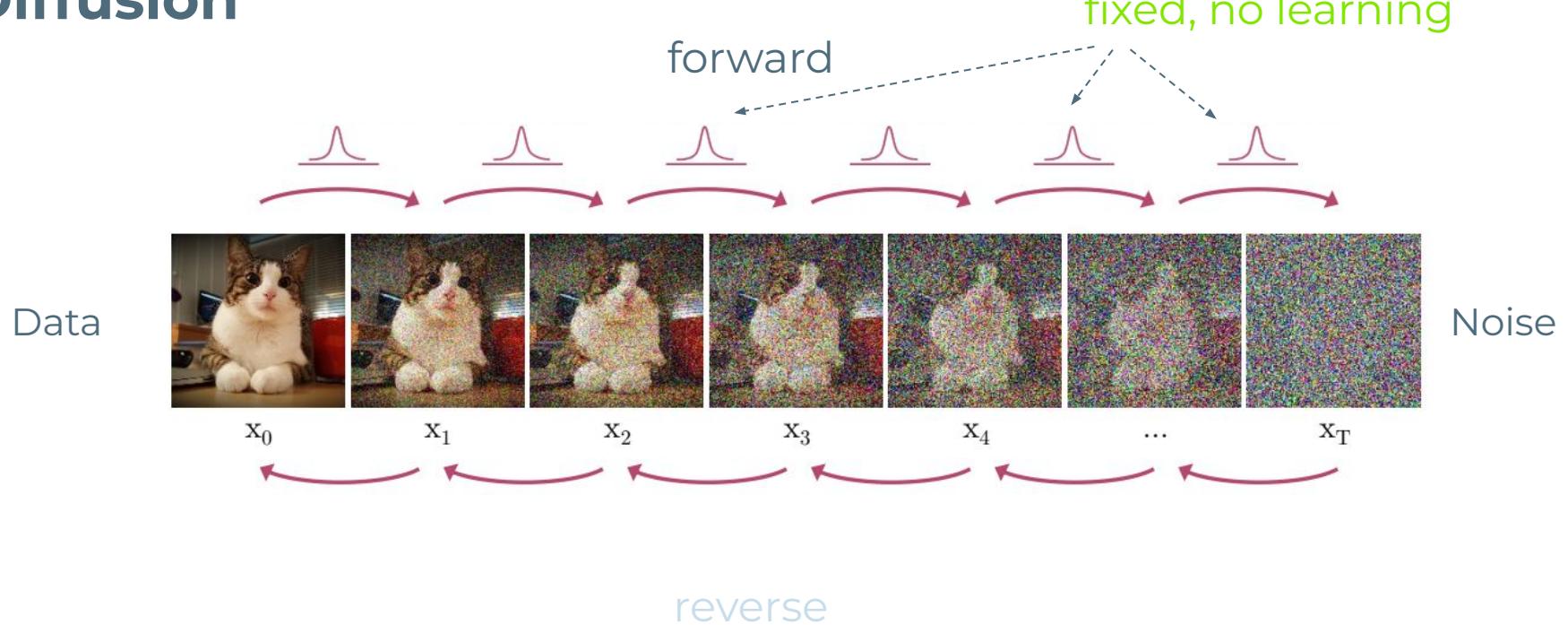
forward

Data



reverse

Diffusion



Diffusion

fixed, no learning

Data



Noise

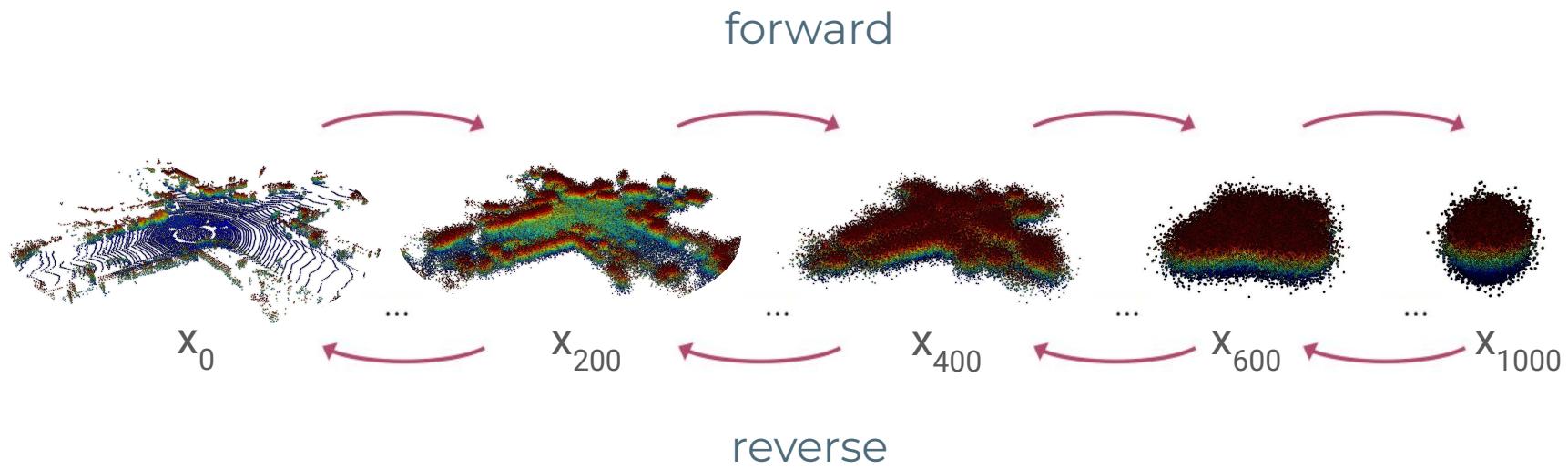
$x_0 \quad x_1 \quad x_2 \quad x_3 \quad x_4 \quad \dots \quad x_T$



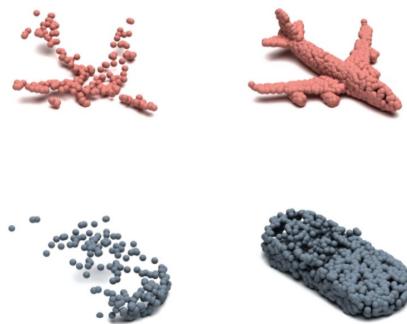
reverse

learnt by
a network

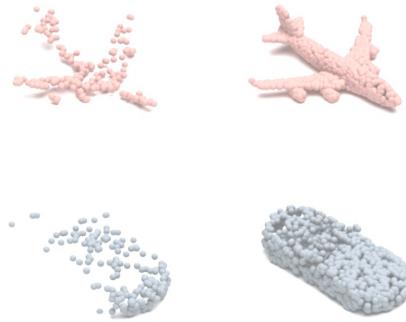
Diffusion on points



Prior work



Prior work



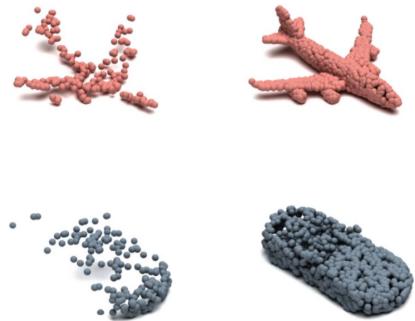
Challenge

object-level architectures don't scale up to the scene level!

Prior work. Challenges

Object level

architectures don't scale
up to the scene level



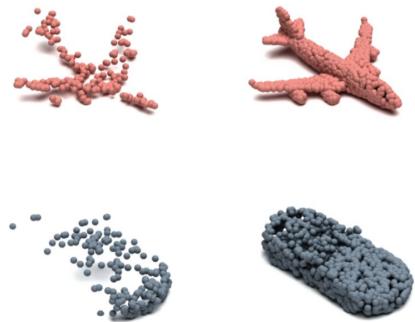
Scene level



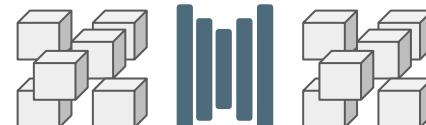
Prior work. Challenges

Object level

architectures don't scale
up to the scene level



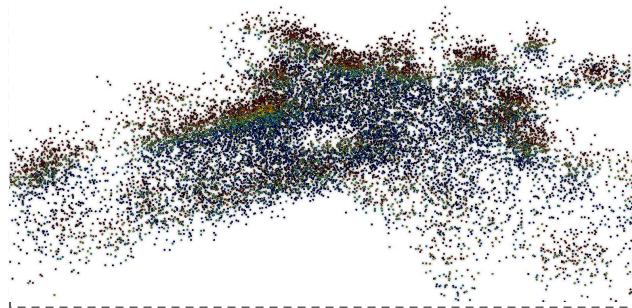
Scene level



Sparse CNN

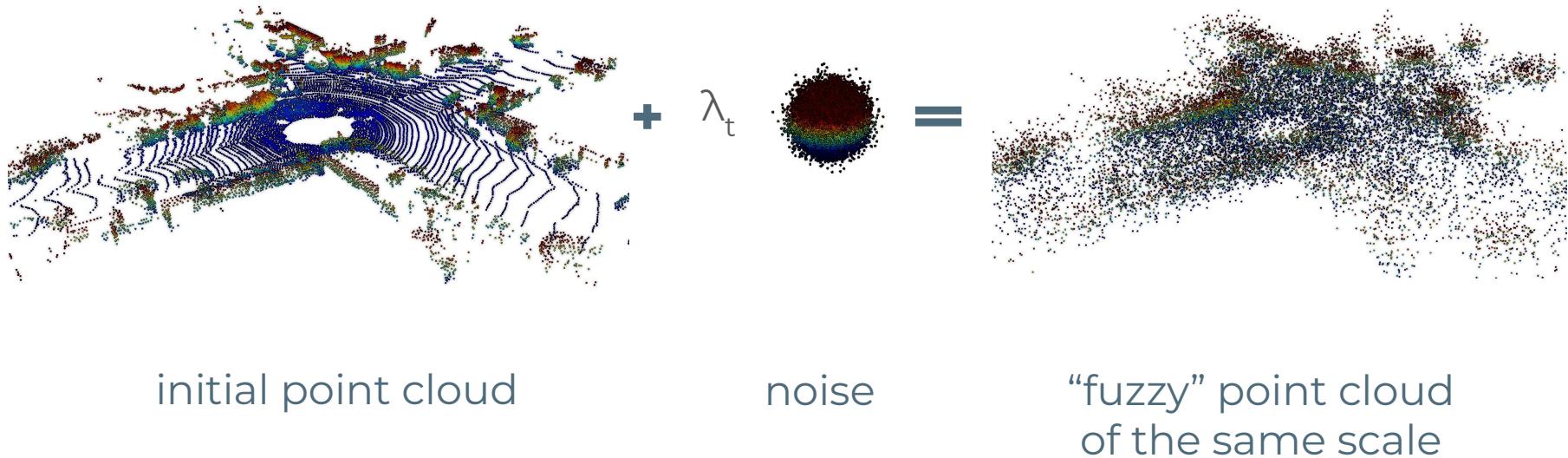


“local” diffusion

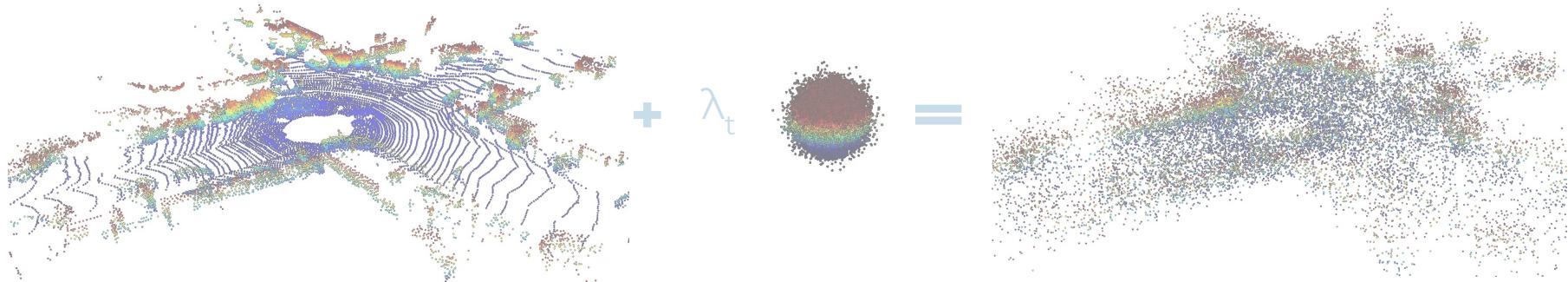


3D Shape Generation and Completion through Point-Voxel Diffusion, Zhou et al., 2021;
Scaling Diffusion Models to Real-World 3D LiDAR Scene Completion, Nunes et al, 2024

“Local” diffusion



“Local” diffusion



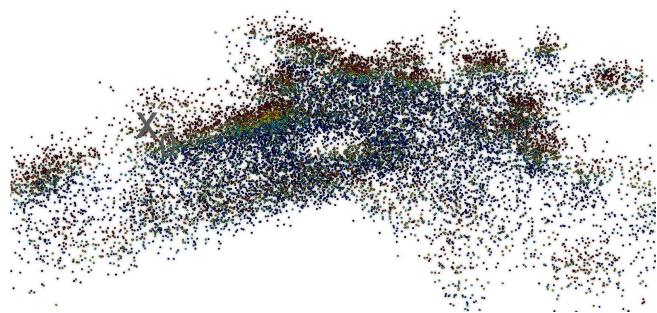
Challenges

- requires regularization,
- does not naturally extend to scene generation.

Prior work. Challenges

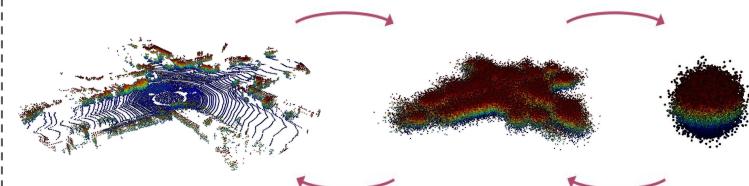
“Local” diffusion

- regularization needed
- only scene completion



LiDPM

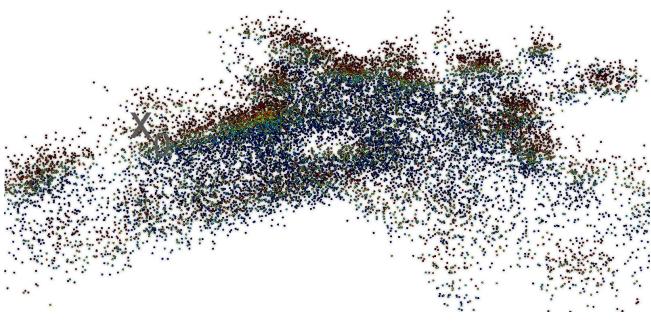
“vanilla” diffusion



Prior work. Challenges

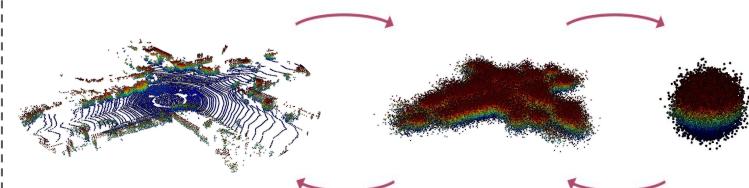
“Local” diffusion

- regularization needed
- only scene completion



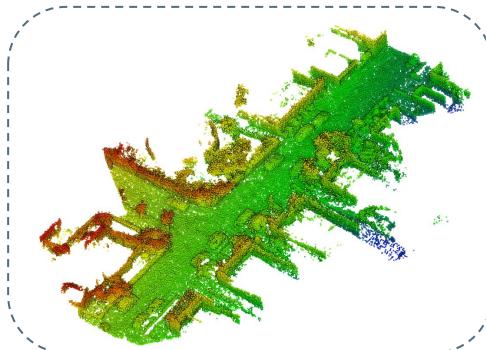
LiDPM

- **no** regularization needed
- scene completion **and** generation



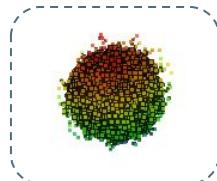
LiDPM. Training

Dense GT point cloud



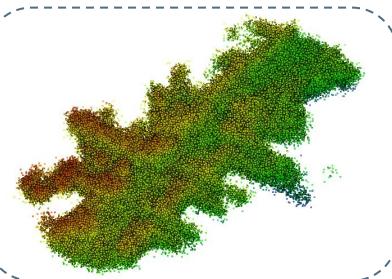
timestep t

noise &
scale



Gaussian noise

Noisy point cloud



LiDPM. Training

Dense GT point cloud



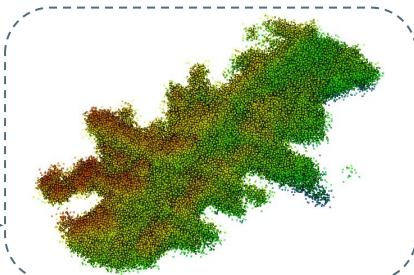
timestep t



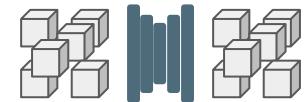
Gaussian noise

noise & scale

Noisy point cloud



Conditioning



Sparse CNN



Predicted noise

LiDPM. Training

Dense GT point cloud



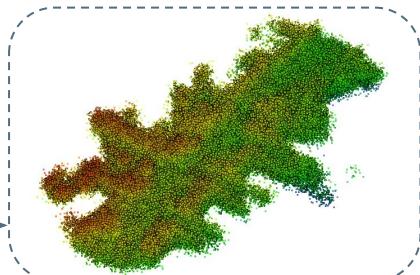
timestep t

noise & scale



Gaussian noise

Noisy point cloud



Loss

Conditioning



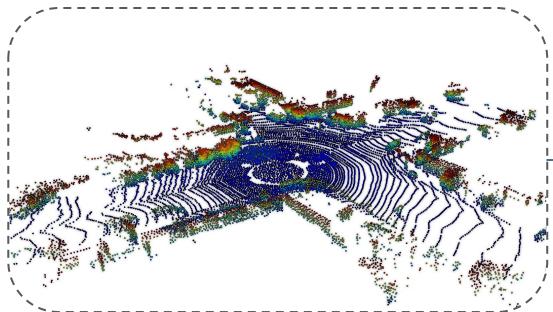
Sparse CNN



Predicted noise

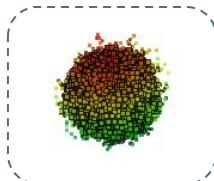
LiDPM. Inference

Input point cloud

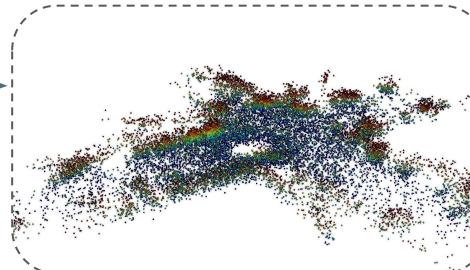


timestep t^*

noise &
scale



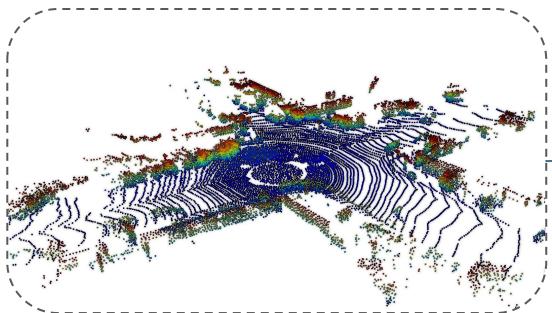
Gaussian noise



Noisy point cloud

LiDPM. Inference

Input point cloud



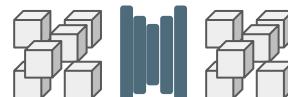
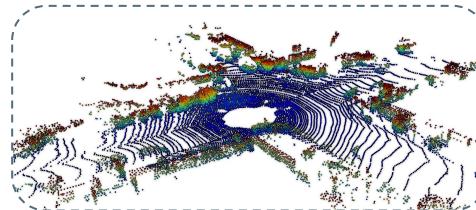
timestep t^*



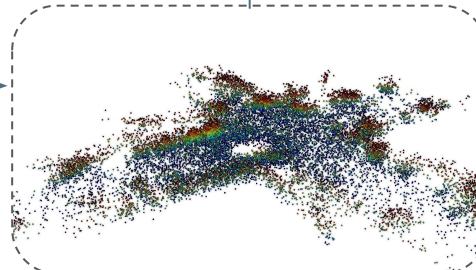
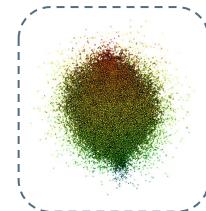
Gaussian noise

noise &
scale

Conditioning



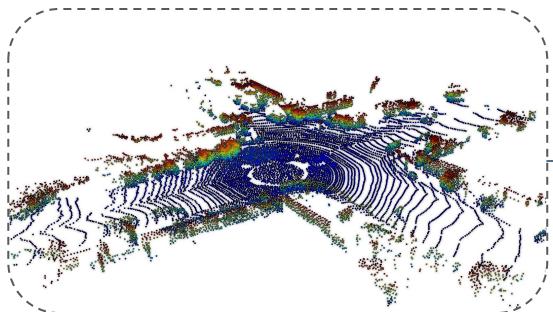
Predicted noise



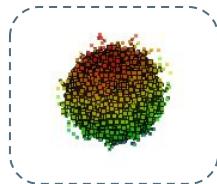
Noisy point cloud

LiDPM. Inference

Input point cloud



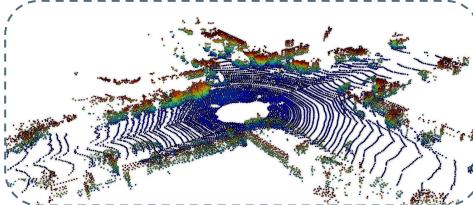
timestep t^*



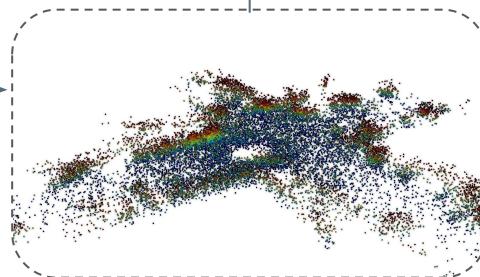
Gaussian noise

noise &
scale

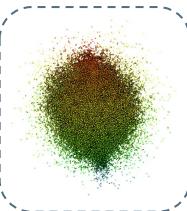
Loop $t^* \dots \rightarrow 0$



Predicted noise

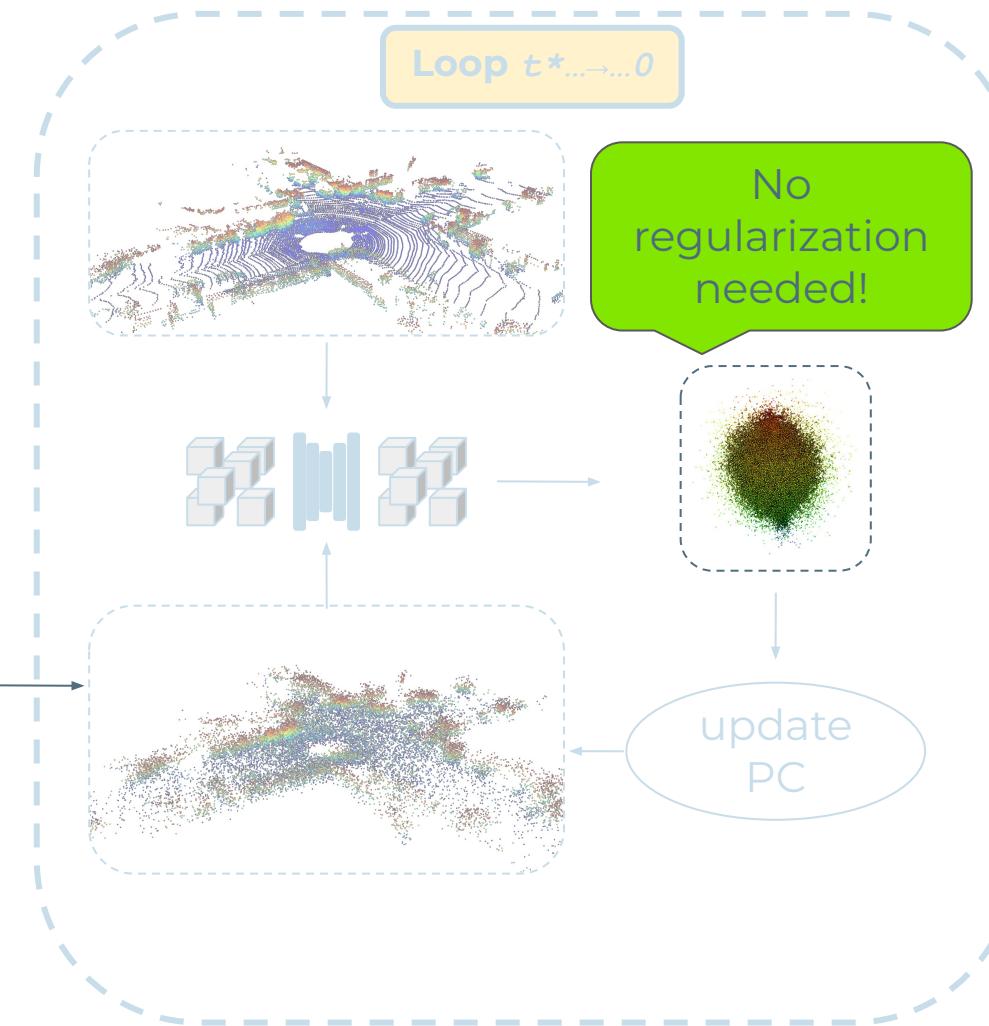
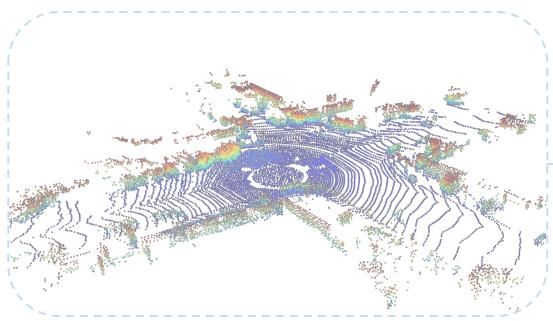


Noisy point cloud

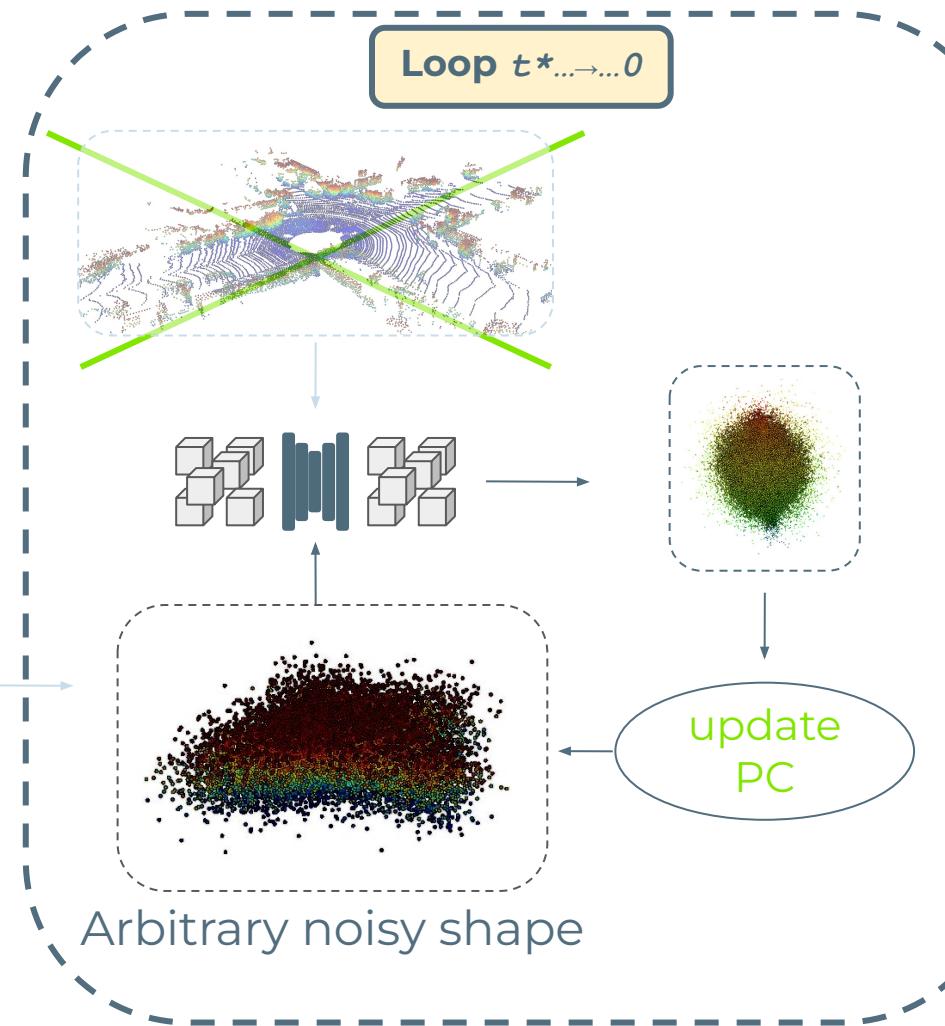
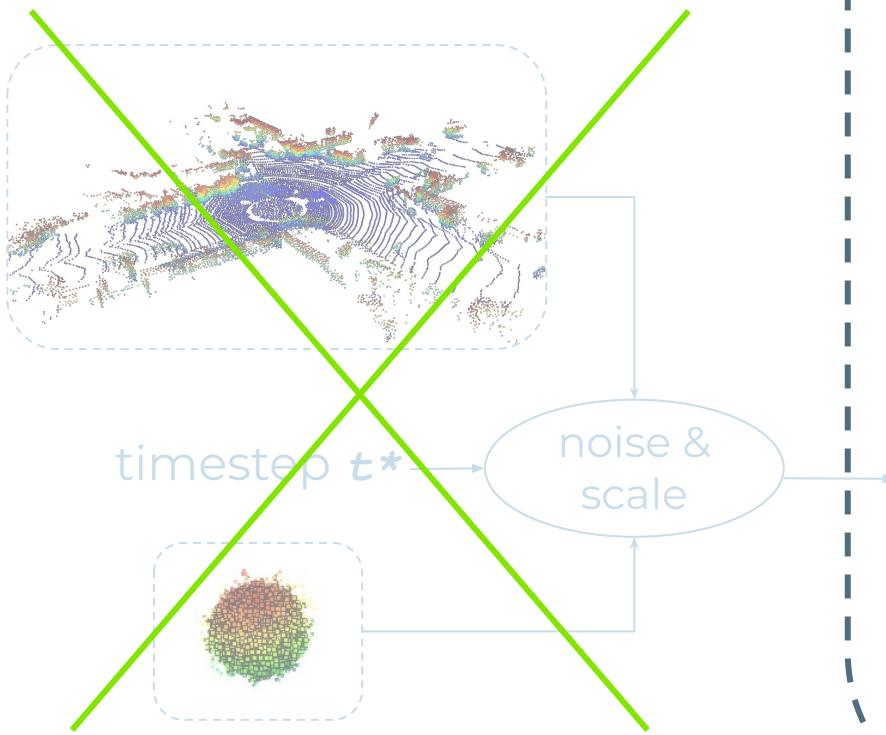


update
PC

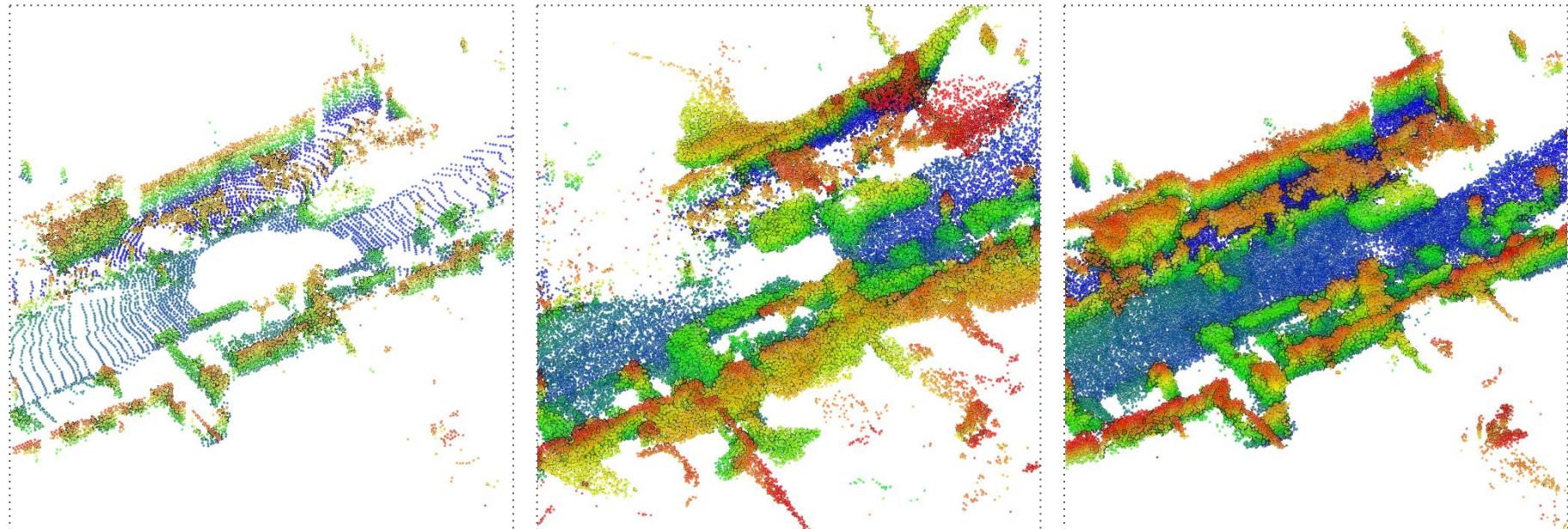
LiDPM. Inference



LiDPM. Generation



LiDPM. Results [SemKITTI]

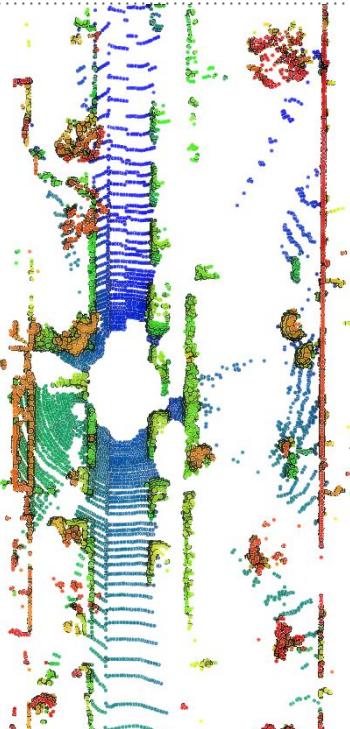


Sparse point cloud

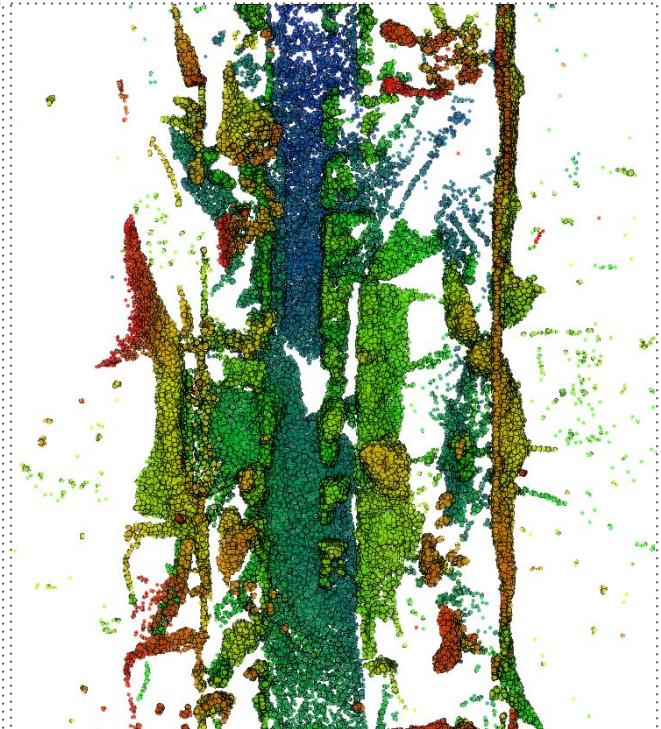
LiDiff

LiDPM (ours)

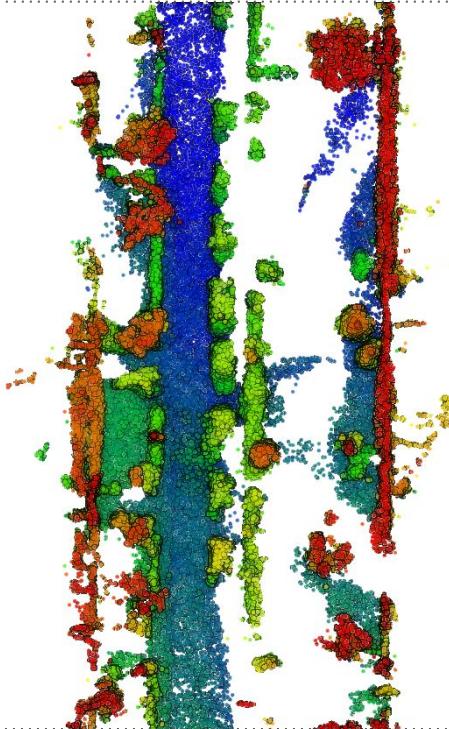
LiDPM. Results [SemKITTI]



Sparse point cloud

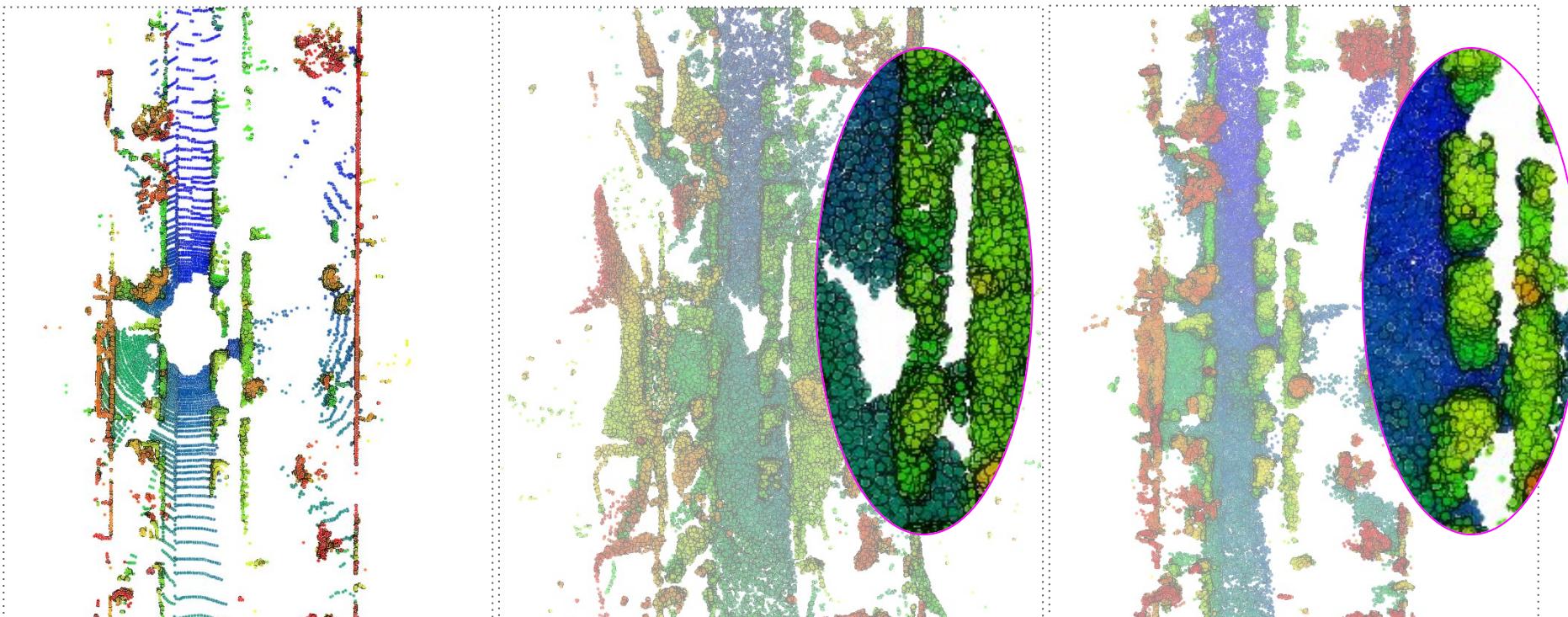


LiDiff



LiDPM (ours)

LiDPM. Results [SemKITTI]



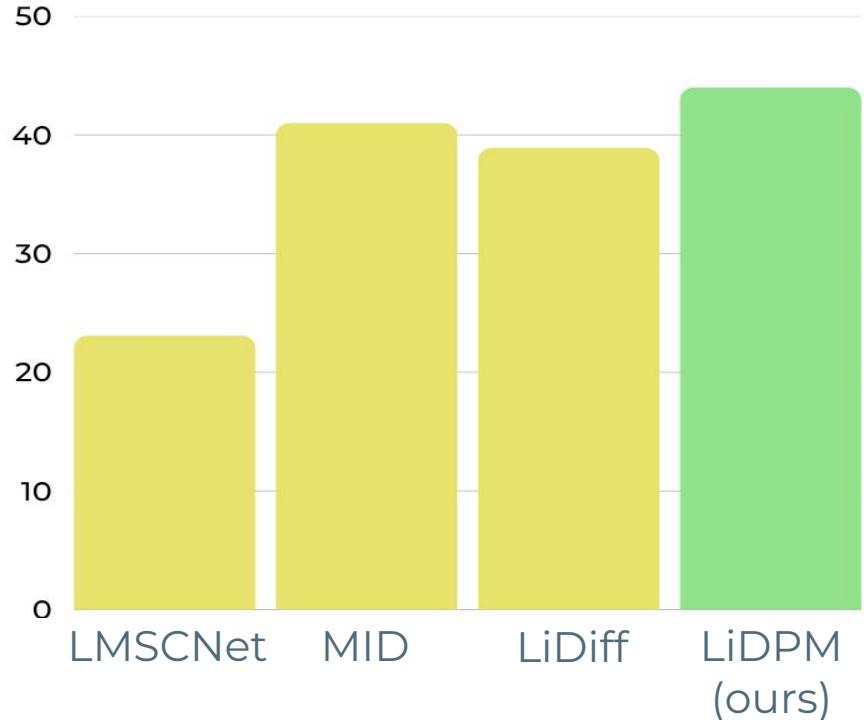
Sparse point cloud

LiDiff

LiDPM (ours)

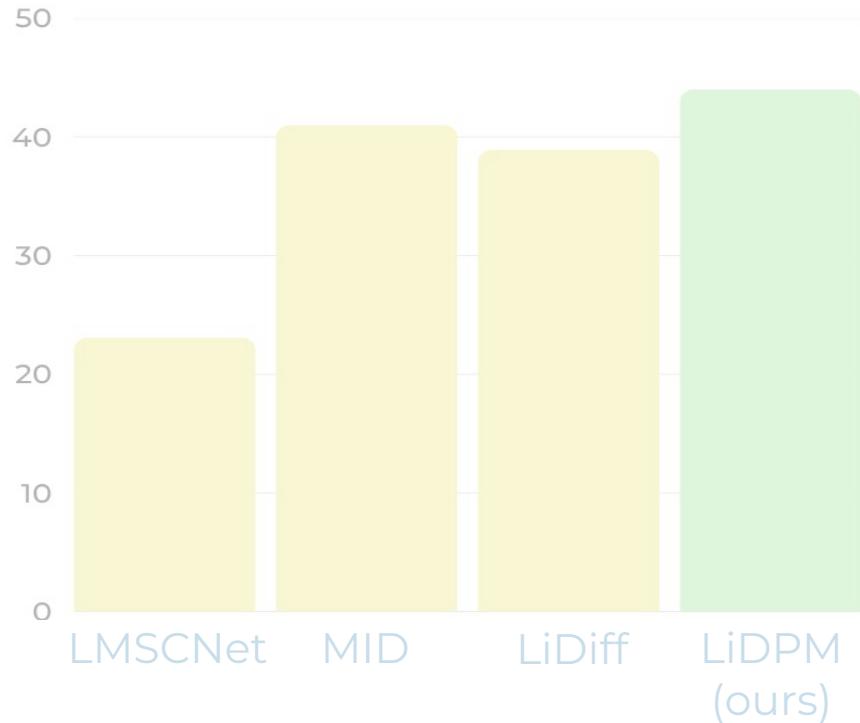
LiDPM. Results

Voxel IoU 0.2m ↑

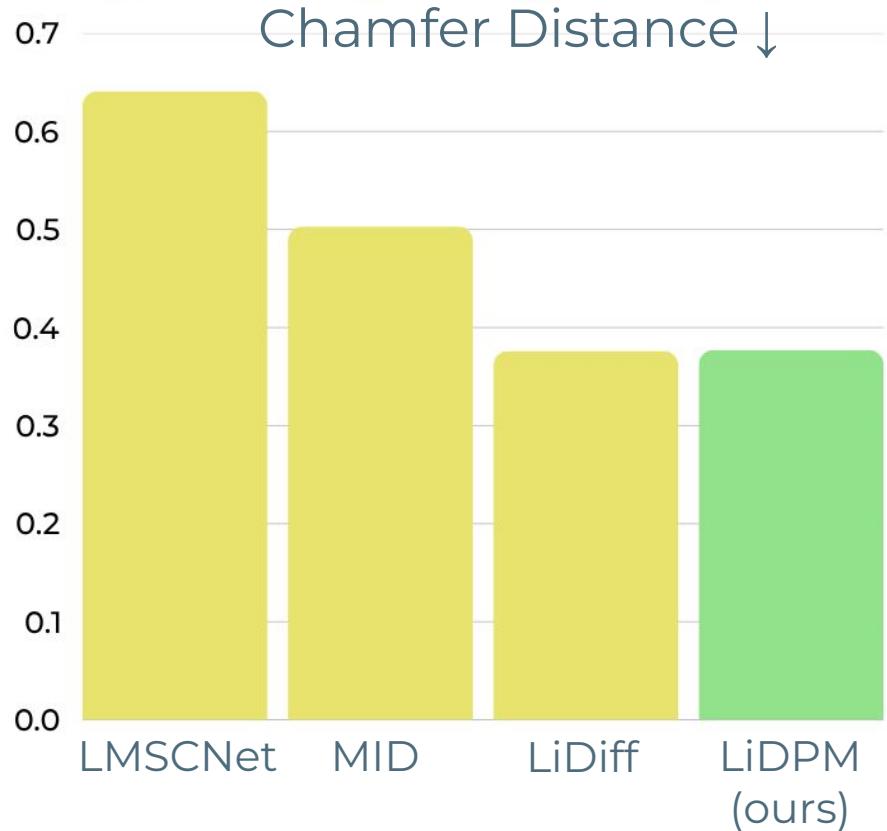


LiDPM. Results

Voxel IoU 0.2m ↑



Chamfer Distance ↓



LiDPM: Rethinking Point Diffusion for Lidar Scene Completion

TL; DR:

LiDPM (**L**idar + **D**DP*M*) is a model that enables

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 high-quality **scene-level lidar completion**

LiDPM: Rethinking Point Diffusion for Lidar Scene Completion

TL; DR:

LiDPM (**L**idar + **D**DP*M*) is a model that enables

- 💡 high-quality **scene-level lidar completion**
- 🍦 by leveraging a **vanilla diffusion (DDPM)**

LiDPM: Rethinking Point Diffusion for Lidar Scene Completion

TL; DR:

LiDPM (**L**idar + **D**DP*M*) is a model that enables

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- 🚀 with a carefully chosen initialization,

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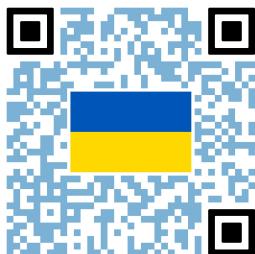
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- 🚀 with a carefully chosen initialization,
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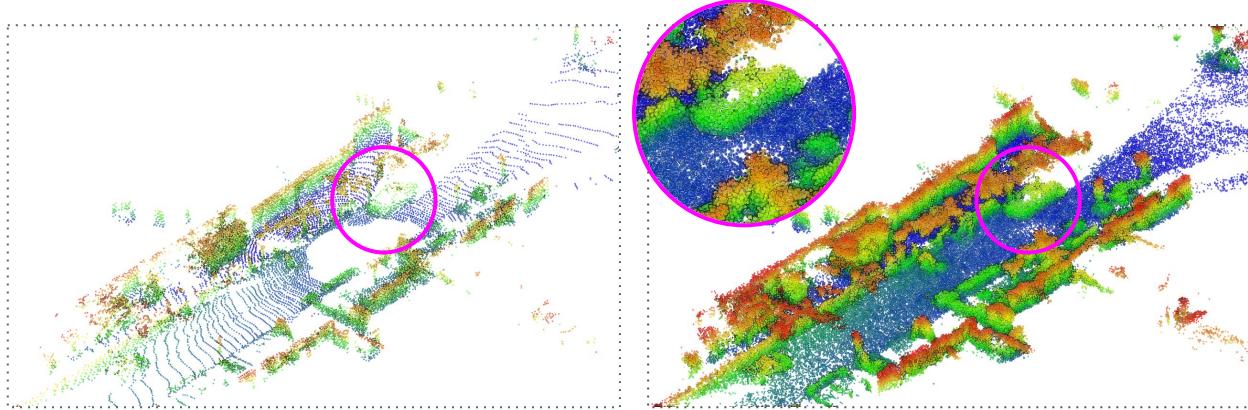


Project page



Code available!

LiDPM: Rethinking Point Diffusion for Lidar Scene Completion



Project page



Code available!