Learning 3D Shape Completion from Laser Scan Data with Weak Supervision

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Problem

Learning **3D shape completion** of sparse and noisy point clouds **without ground truth**.

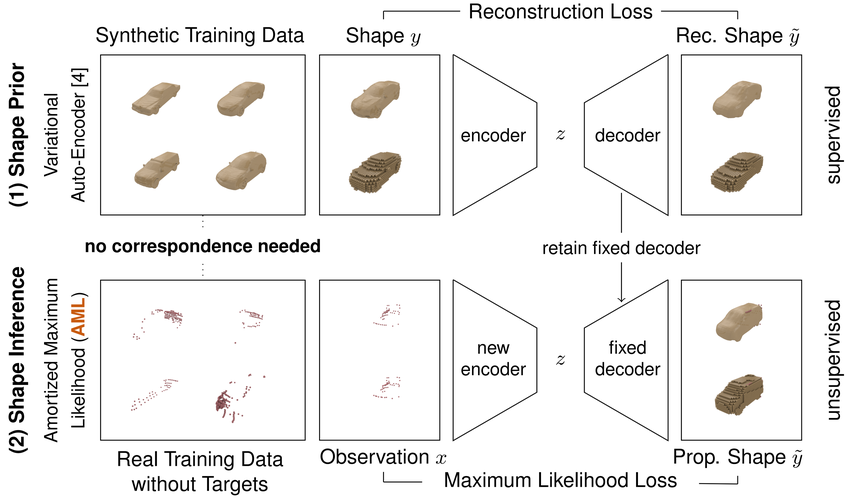
Related Work

- Data-driven [1] – slow inference;
- Learning-based [2] – supervision required.

Contributions

- Learning-based, but weakly-supervised, amortized maximum likelihood (**AML**) approach.
- Synthetic and real benchmarks.
- Improved results published in [3].

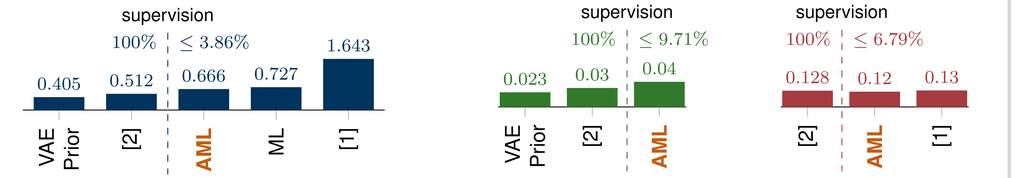
Method



References

[1] F. Engelmann et al. "Joint Object Pose Estimation and Shape Reconstruction in Urban Street Scenes Using 3D Shape Priors". In: *GCPR*. 2016.
[2] A. Dai et al. "Shape Completion using 3D-Encoder-Predictor CNNs and Shape Synthesis". In: *CVPR*. 2017.
[3] D. Stutz and A. Geiger. "Learning 3D Shape Completion under Weak Supervision". In: *arXiv.org* abs/1805.07290 (2018).
[4] D. P. Kingma and M. Welling. "Auto-Encoding Variational Bayes". In: *ICLR* (2014).
[5] A. Geiger et al. "Are we ready for Autonomous Driving? The KITTI Vision Benchmark Suite". In: *CVPR*. 2012.
[6] A. X. Chang et al. "ShapeNet: An Information-Rich 3D Model Repository". In: *arXiv.org* 1512.03012 (2015).
[7] Z. Wu et al. "3D ShapeNets: A deep representation for volumetric shapes". In: *CVPR*. 2015.
[8] B. Yang et al. "3D Object Dense Reconstruction from a Single Depth View". In: *arXiv.org* abs/1802.00411 (2018).

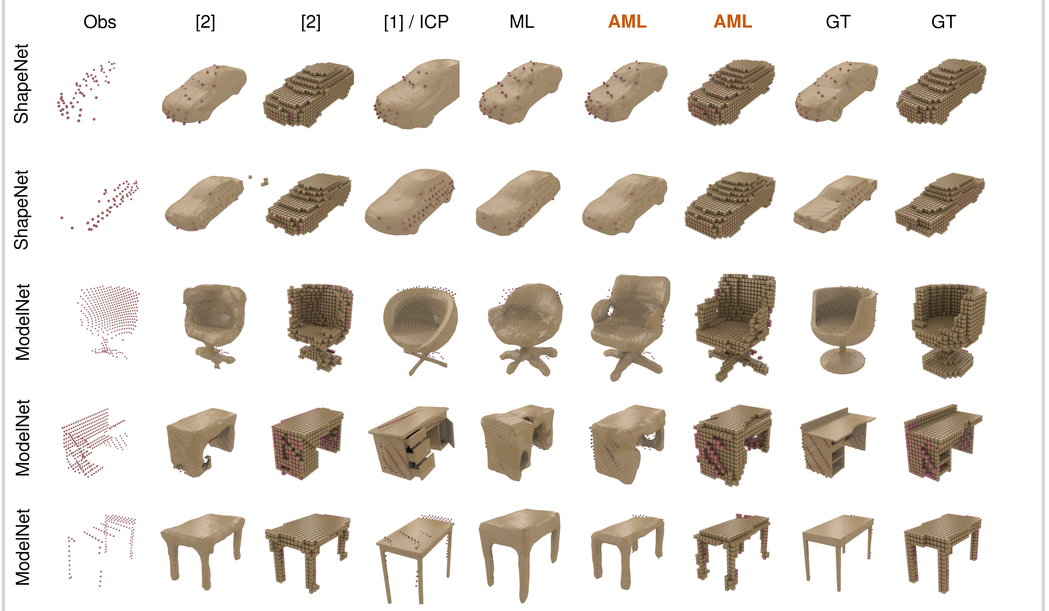
Results



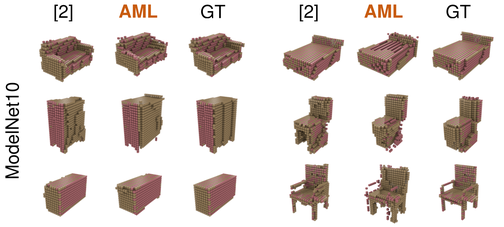
Runtime

$\sim 2ms$ (**AML** and [2], GPU) vs. $> 168ms$ ([1], CPU with Multi-Threading) and $> 30s$ (ML, GPU).

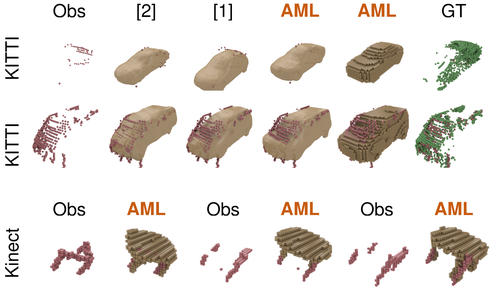
ShapeNet and ModelNet (Synthetic, Single Categories)



ModelNet10 (Synthetic, Multiple Categories)



KITTI and Kinect (Real)



Conclusion

We proposed a learning-based, but weakly-supervised, amortized maximum likelihood (**AML**) approach to 3D shape completion.

- Outperforms data-driven approach [1]; but 84 times faster.
- Competitive to learning-based approach [2]; but up to 96% less supervision.

Paper, Code and Data:
davidstutz.de/cvpr2018