Occupancy Networks

Learning 3D Reconstruction in Function Space

Lars Mescheder[1,2] Michael Oechsle[1,2,3] Michael Niemeyer[1,2]
Sebastian Nowozin[4] Andreas Geiger[1,2]

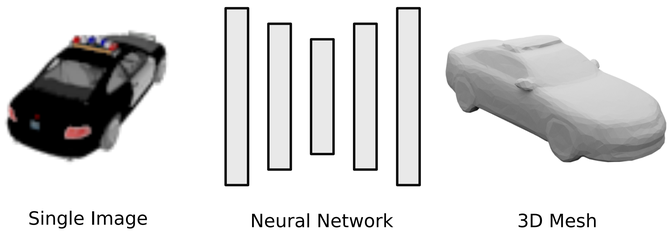
[1]MPI for Intelligent Systems [2]University of Tübingen [3]ETAS GmbH, Stuttgart [4]Google AI, Berlin

Max Planck Institute for Intelligent Systems
Autonomous Vision Group

Eberhard Karls Universität Tübingen

Motivation

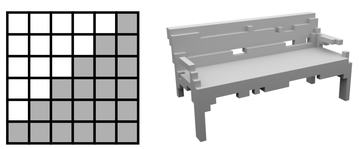
- **Deep learning** in **2D domain** has achieved **impressive results** for various tasks (e.g. object detection, semantic segmentation, optical flow estimation, ...)
- But in 3D reconstruction, we need **neural networks** that can output **3D geometry**:



- Can we find a **3D representation** that fits well to the end-to-end **deep learning** paradigm?

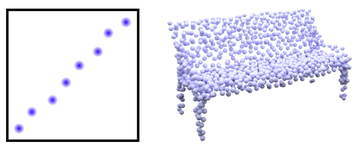
Existing 3D Representations

Voxels



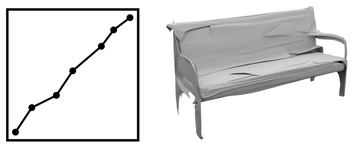
- ➕ Simple
- ➖ Cubic (!) memory
- ➖ Manhattan world

Point Cloud



- ➕ Fast and easy
- ➖ No connectivity
- ➖ Lossy postprocessing

Mesh

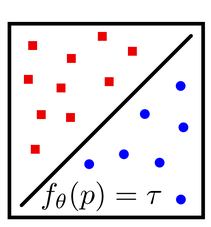


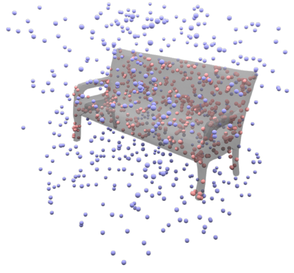
- ➕ Natural
- ➖ Requires template
- ➖ Self-intersections

Discretization artifacts

Our Representation

Idea: Represent mesh as continuous decision boundary of deep learning classifier $f_\theta : \mathbb{R}^3 \to [0, 1]$

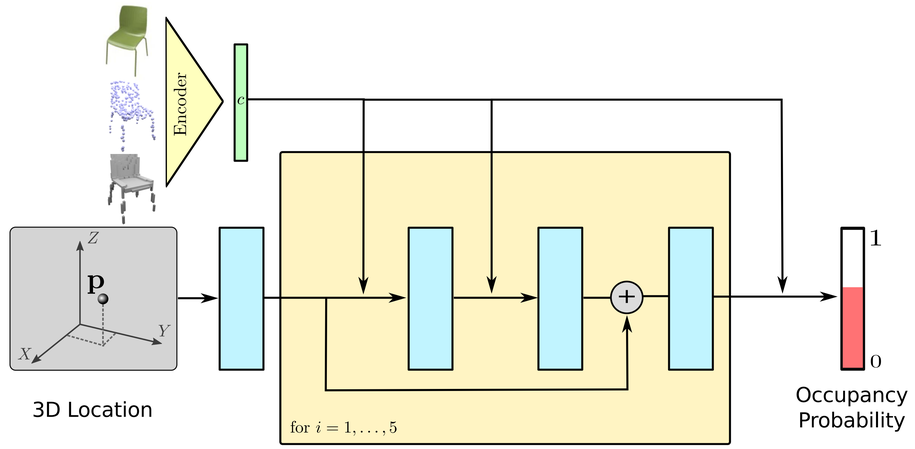




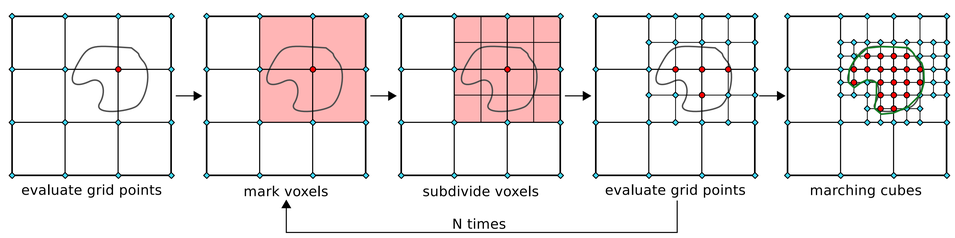
- ➕ Infinite resolution
- ➕ Arbitrary Topologies
- ➕ Watertight meshes

For supervised learning, we can condition $f_\theta(p)$ on some additional input $x \in \mathcal{X}$ (e.g. image, pointcloud, voxels, ...)

Architecture

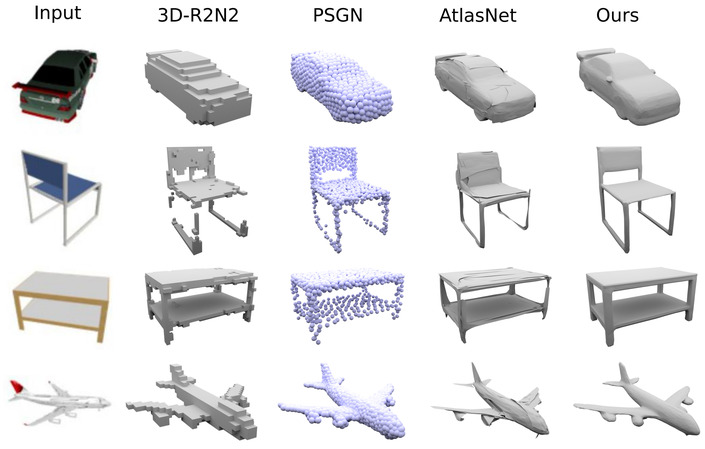


Inference

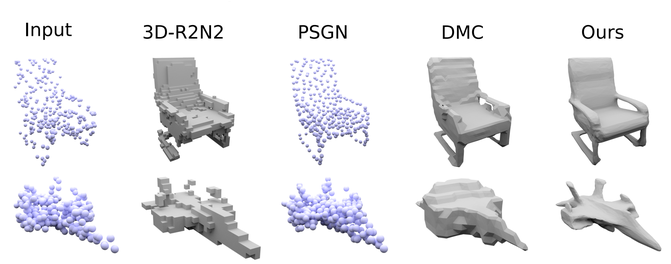


Experiments

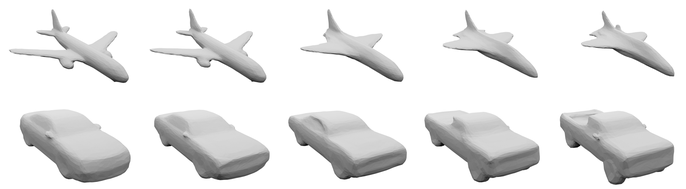
Single Image 3D Reconstruction:



Point Cloud Completion:



Unconditional Model:



Quantitative comparison:

	IoU	Chamfer-L_1	Normal Consistency
3D-R2N2	0.493	0.278	0.695
PSGN	-	0.215	-
Pix2Mesh	0.480	0.216	0.772
AtlasNet	-	**0.175**	0.811
ONet	**0.593**	0.194	**0.840**

Single Image 3D Reconstruction

	IoU	Chamfer-L_1	Normal Consistency
3D-R2N2	0.565	0.169	0.719
PSGN	-	0.144	-
DMC	0.674	0.117	0.848
ONet	**0.778**	**0.079**	**0.895**

Point Cloud Completion

lars.mescheder@tue.mpg.de