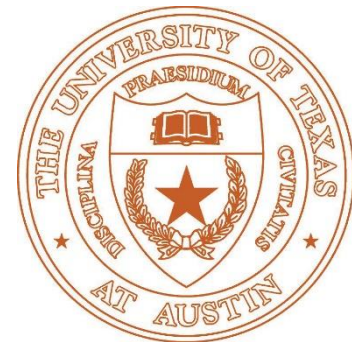
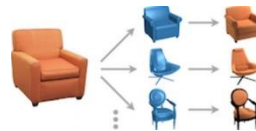
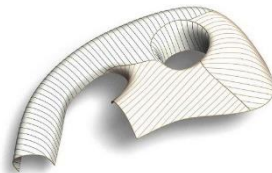
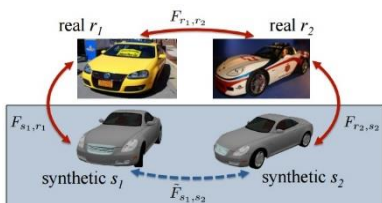
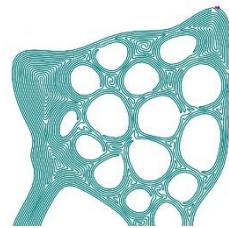
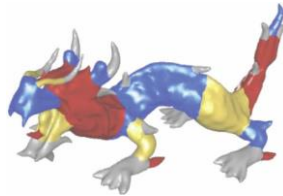
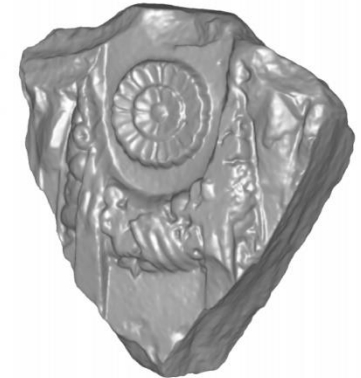
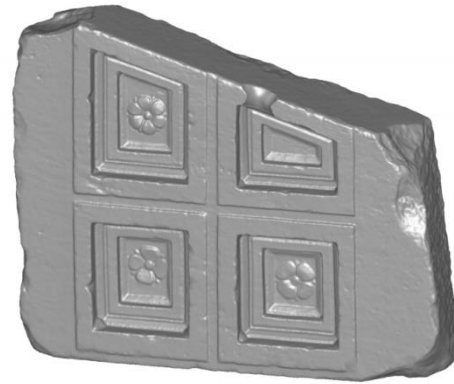
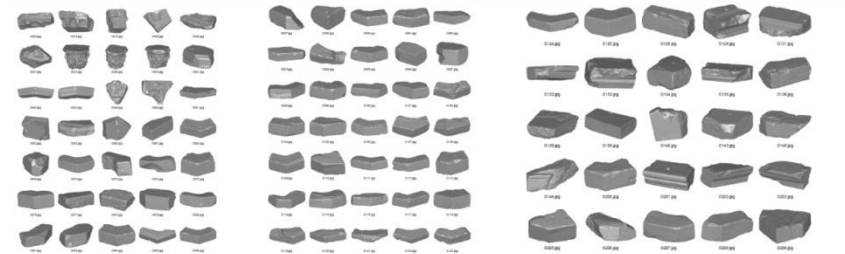


Overview of Geometry Reconstruction and Acquisition

Qixing Huang
January 19th 2017



Geometry Reconstruction and Acquisition



Method I --- Using 3D Scanners

SIGGRAPH Talks 2011

KinectFusion:

**Real-Time Dynamic 3D Surface
Reconstruction and Interaction**

**Shahram Izadi 1, Richard Newcombe 2, David Kim 1,3, Otmar Hilliges 1,
David Molyneaux 1,4, Pushmeet Kohli 1, Jamie Shotton 1,
Steve Hodges 1, Dustin Freeman 5, Andrew Davison 2, Andrew Fitzgibbon 1**

1 Microsoft Research Cambridge 2 Imperial College London

3 Newcastle University

4 Lancaster University

5 University of Toronto

Method II --- Image-Based Modeling

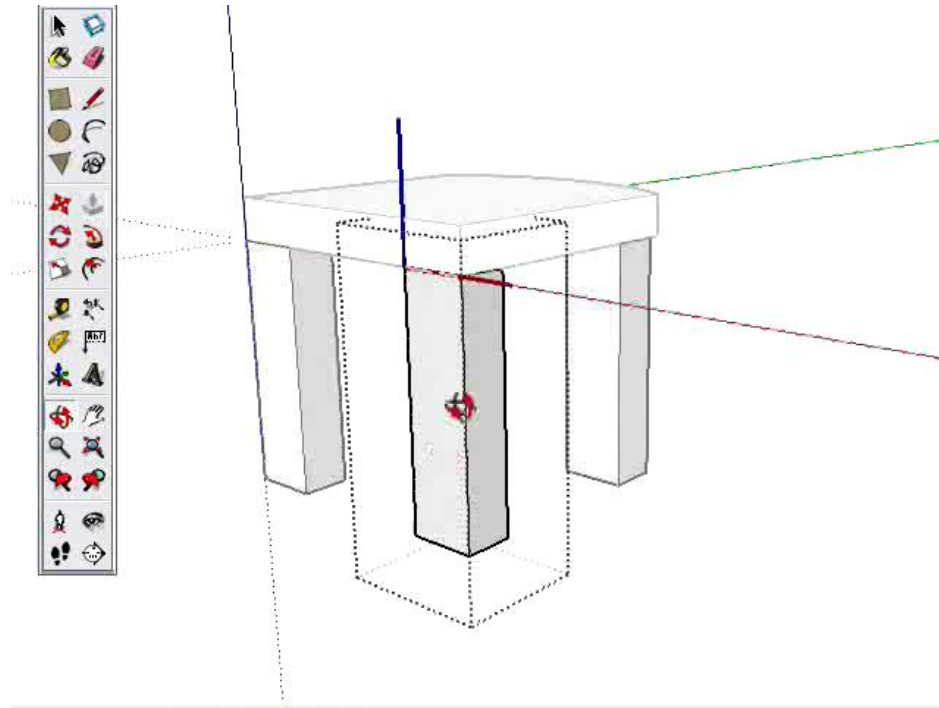


Touch Probes

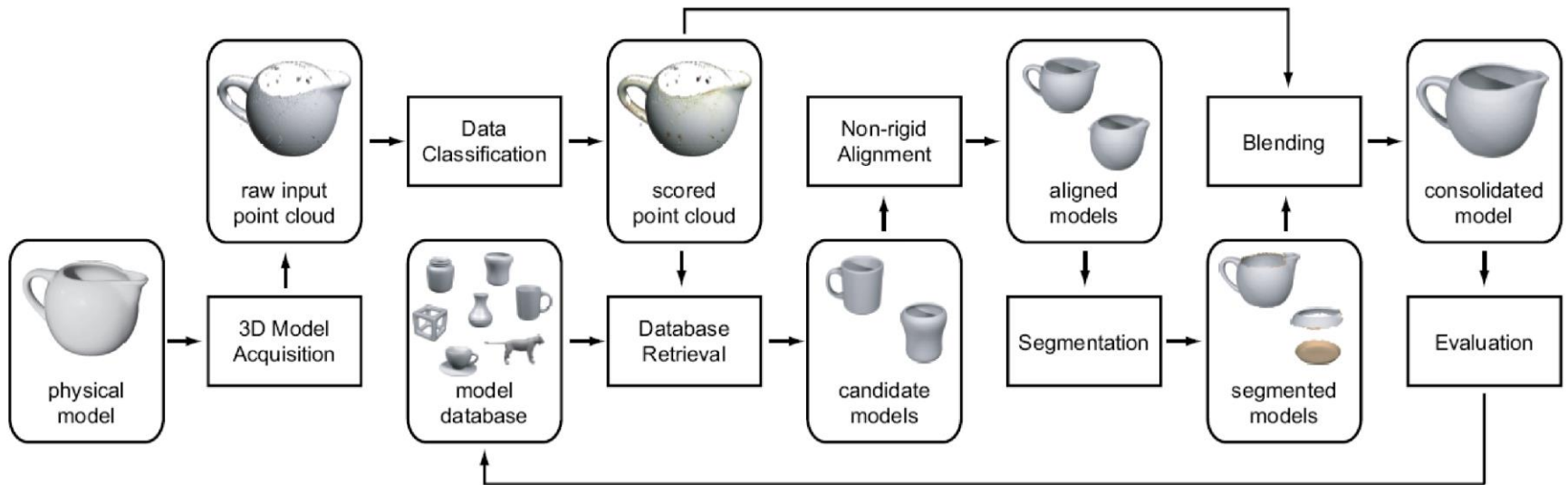


Faro Arm – Faro Technologies, Inc.

Interactive Modeling



Data-driven geometry reconstruction



Projects to Remember

Stanford Model Repository (1994-2000)

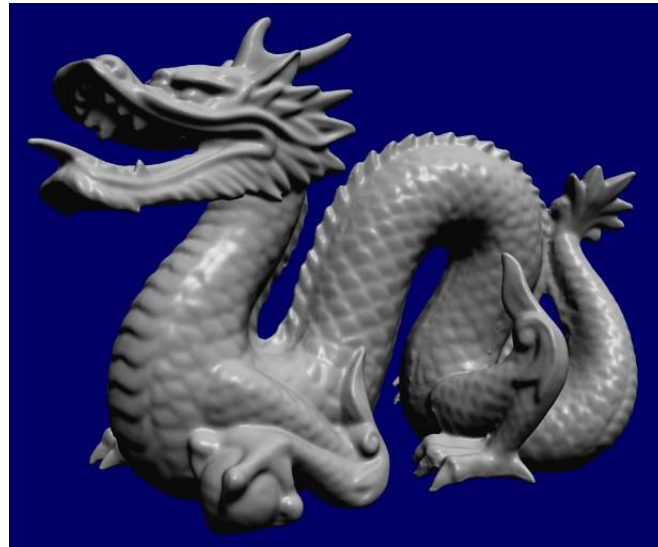


69451 triangles

Stanford Model Repository (1994-2000)



1,087,716
triangles



1,132,830
triangles



345,944
triangles

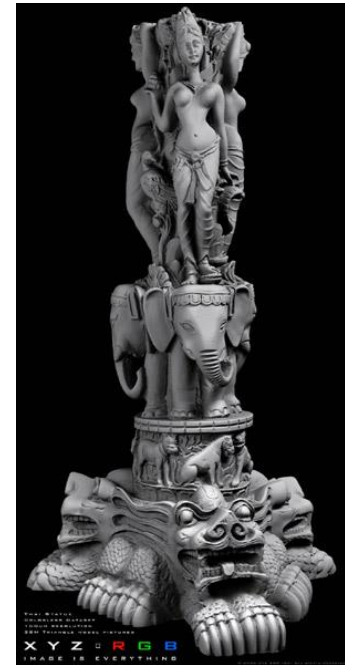
Stanford Model Repository (1994-2000)



28,055,742
triangles

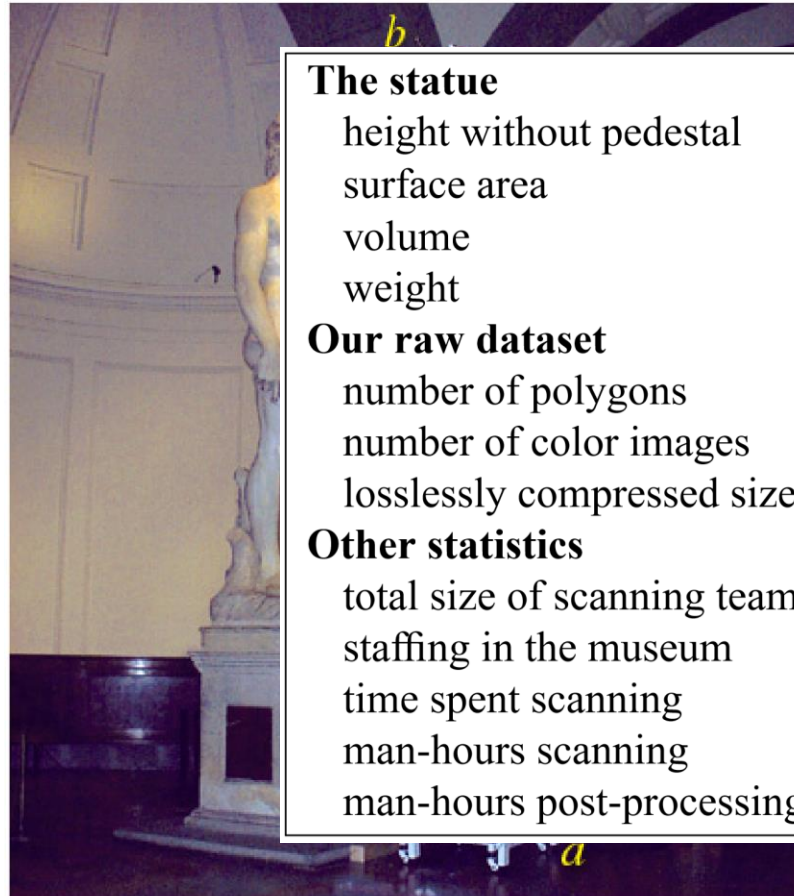


7,218,906
triangles



10,000,000
triangles

The Digital Michelangelo Project (2000)



The statue

height without pedestal
surface area
volume
weight

517 cm
19 m²
2.2 m³
5,800 kg

Our raw dataset

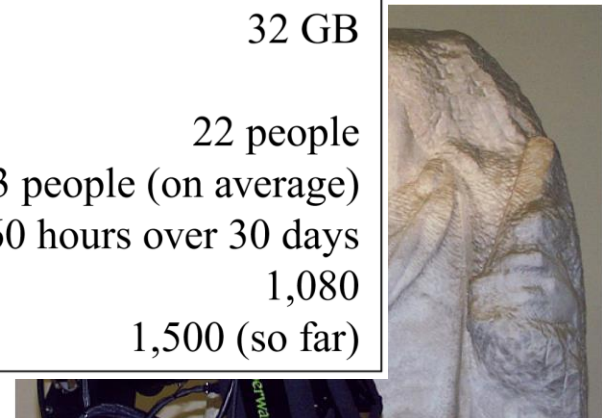
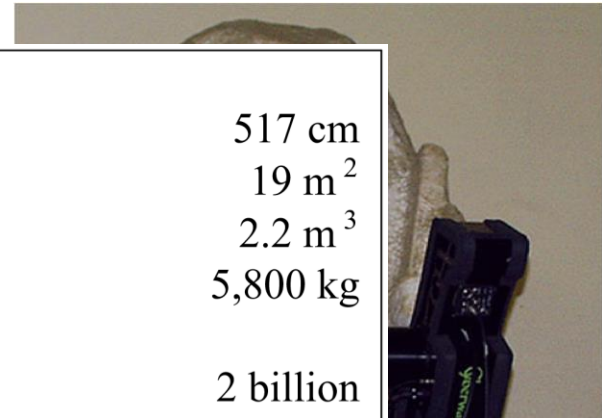
number of polygons
number of color images
losslessly compressed size

2 billion
7,000
32 GB

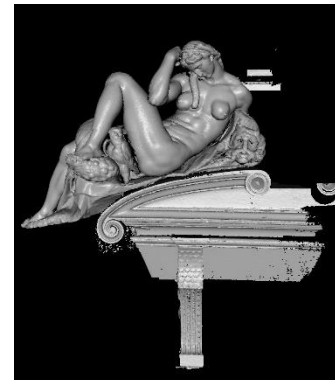
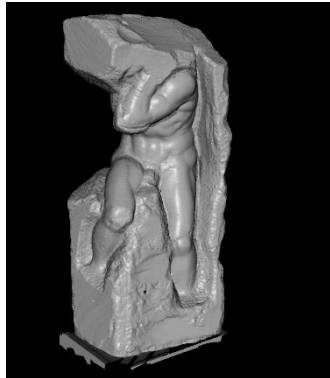
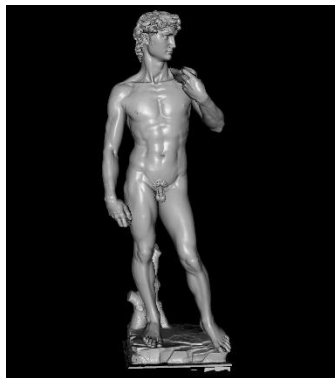
Other statistics

total size of scanning team
staffing in the museum
time spent scanning
man-hours scanning
man-hours post-processing

22 people
3 people (on average)
360 hours over 30 days
1,080
1,500 (so far)



The Digital Michelangelo Project (2000)



A Large Dataset of Object Scans

[Choi et al. 16]



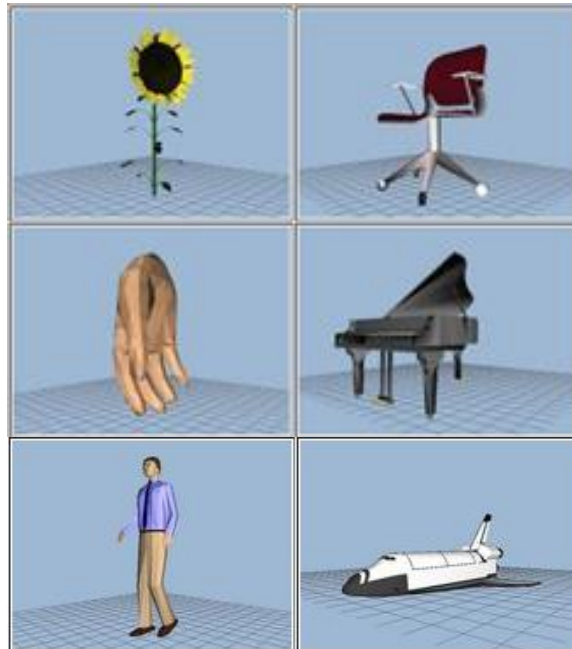
10K 3D models

Other Projects



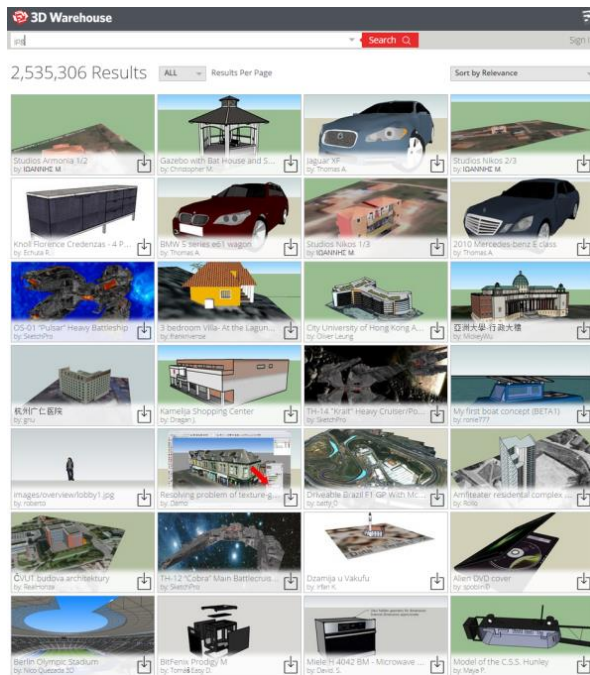
Princeton Shape Benchmark

1800 models in **90** categories

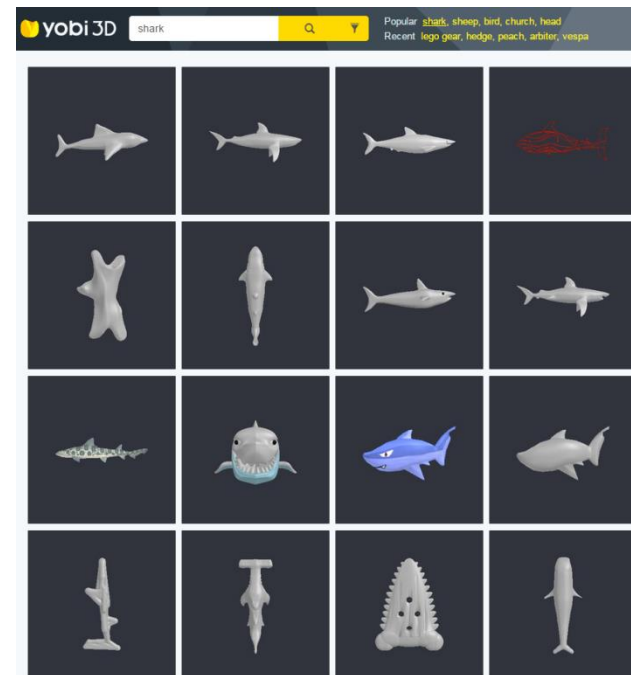


Princeton shape benchmark
[Shilane et al. 04]

Large-scale online repositories



3D Warehouse



Yobi3D

3M models in more than 4K categories

Discussion:

What is the next landmark project?

Applications of Geometry Reconstruction

Model Checking



Stability Analysis



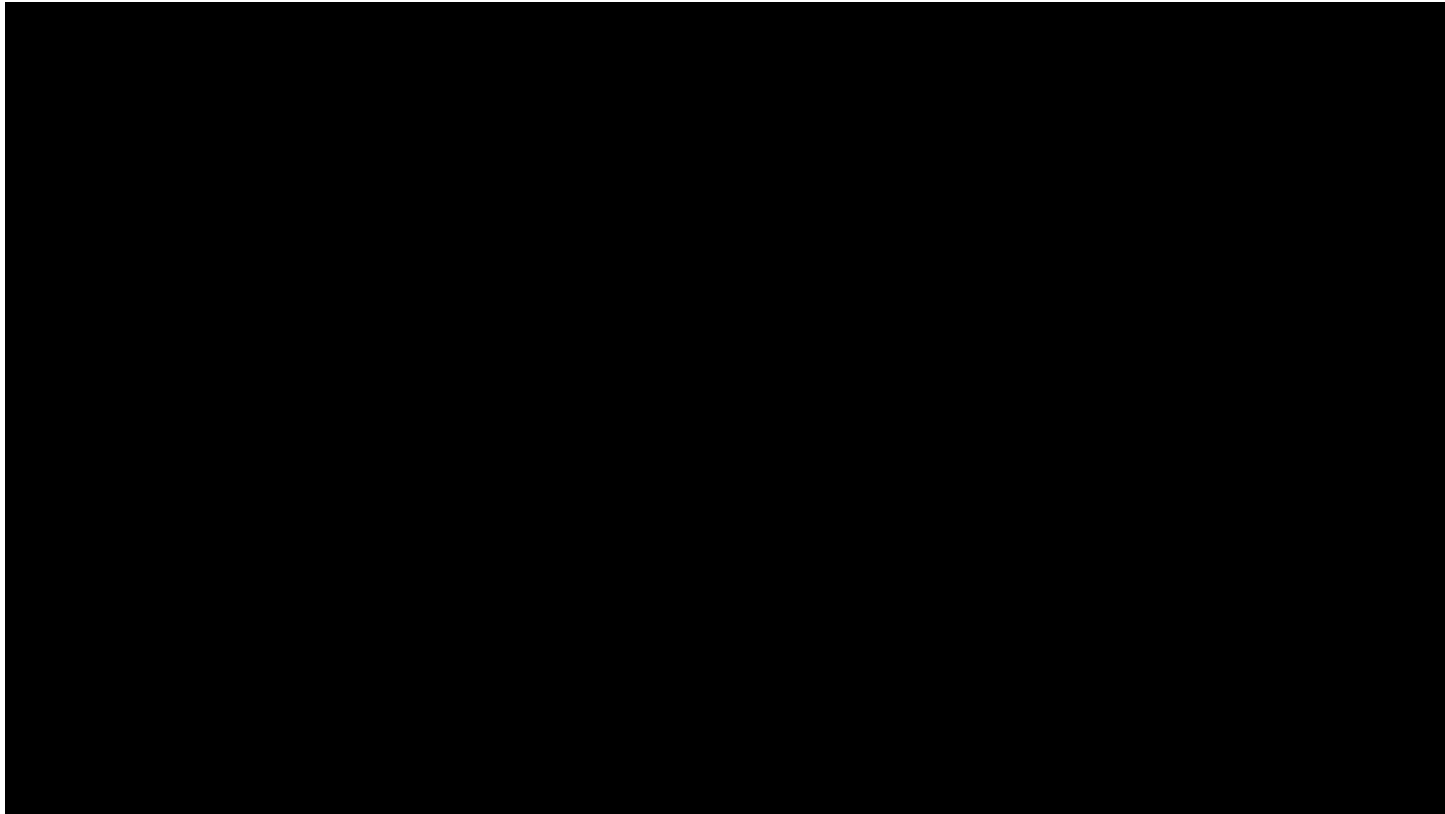
Virtual Reality



3D Scanning for Games



Medical Applications



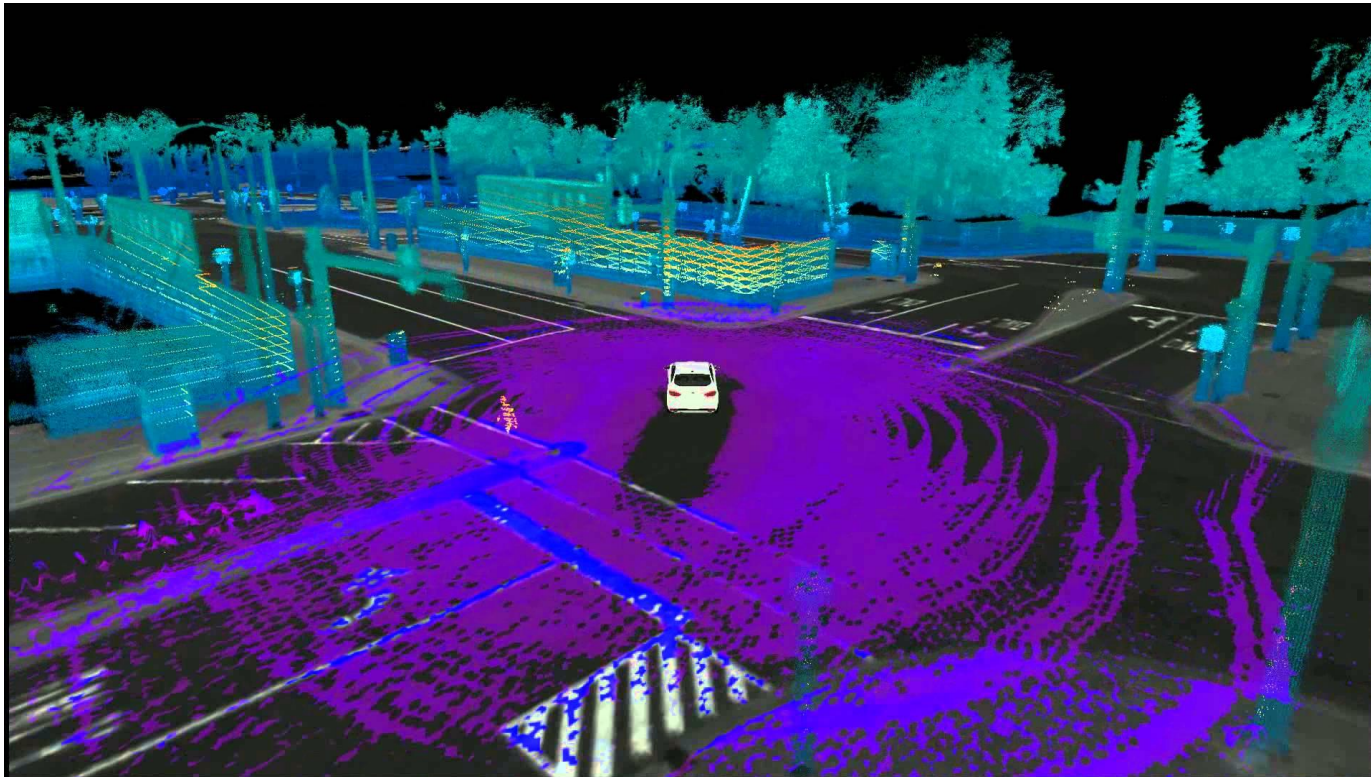
Medical Applications



Autonomous Driving



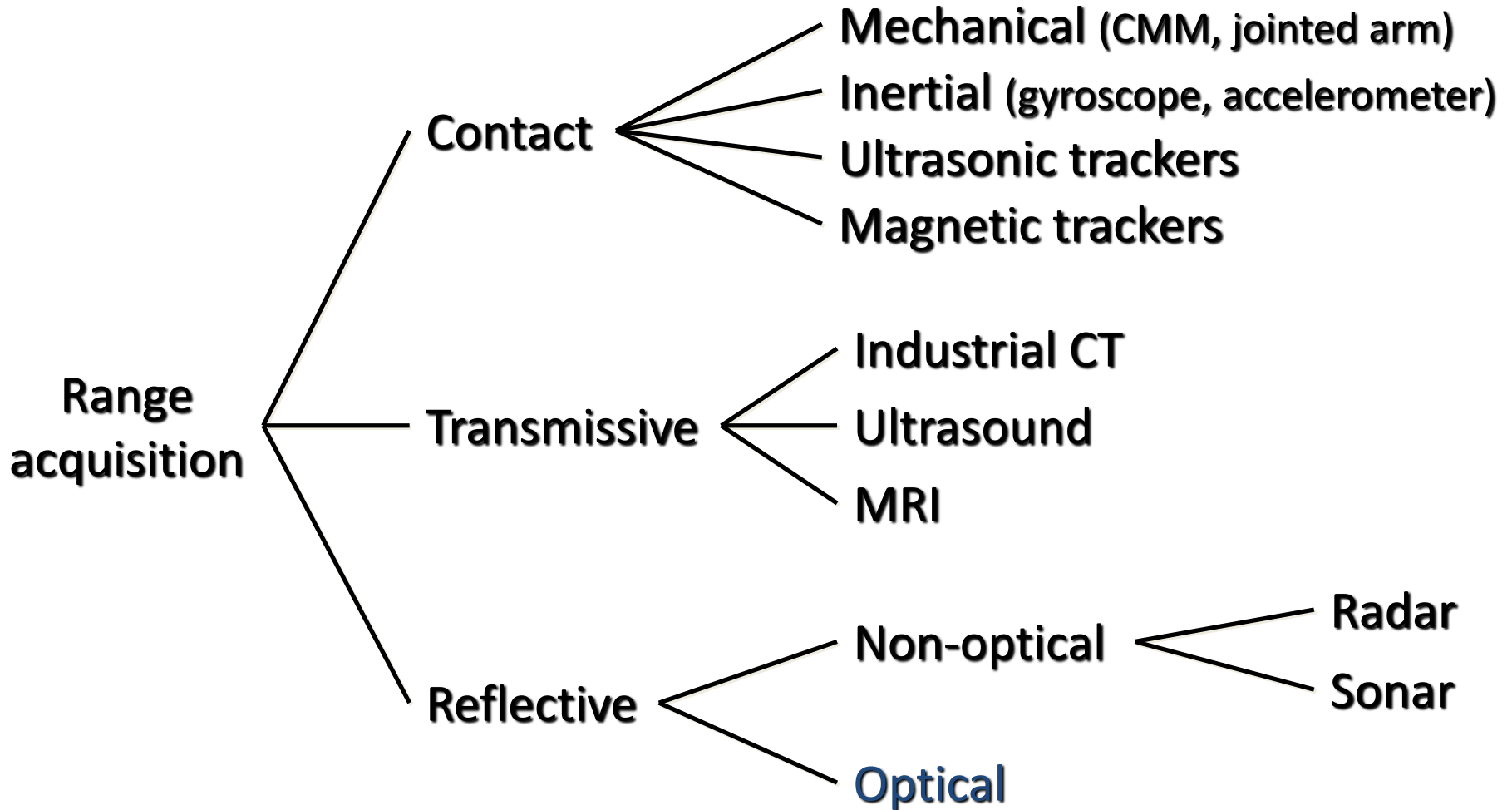
Autonomous Driving



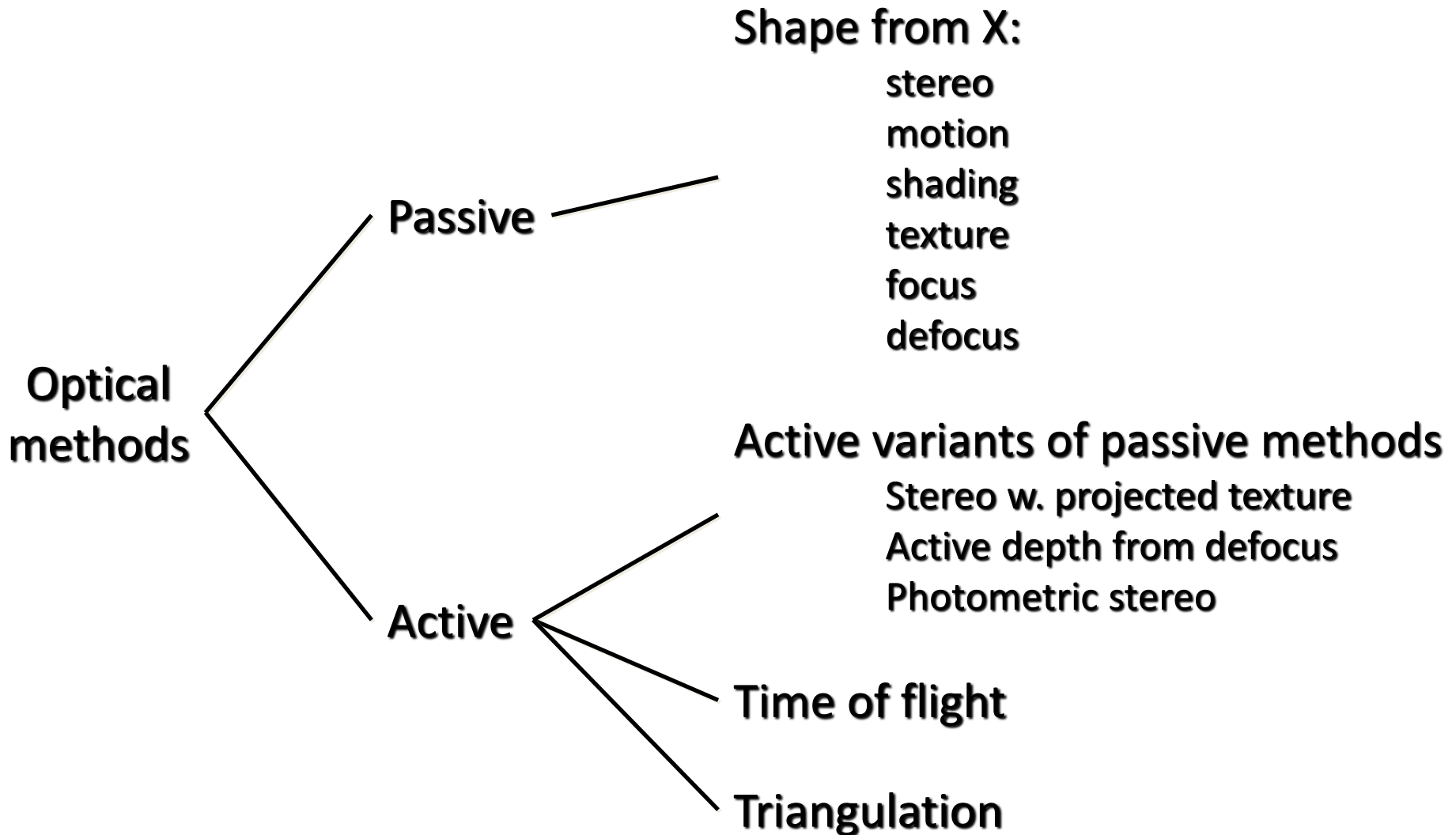
Geometry Reconstruction from 3D Scanners

Acquisition

Range Acquisition Taxonomy

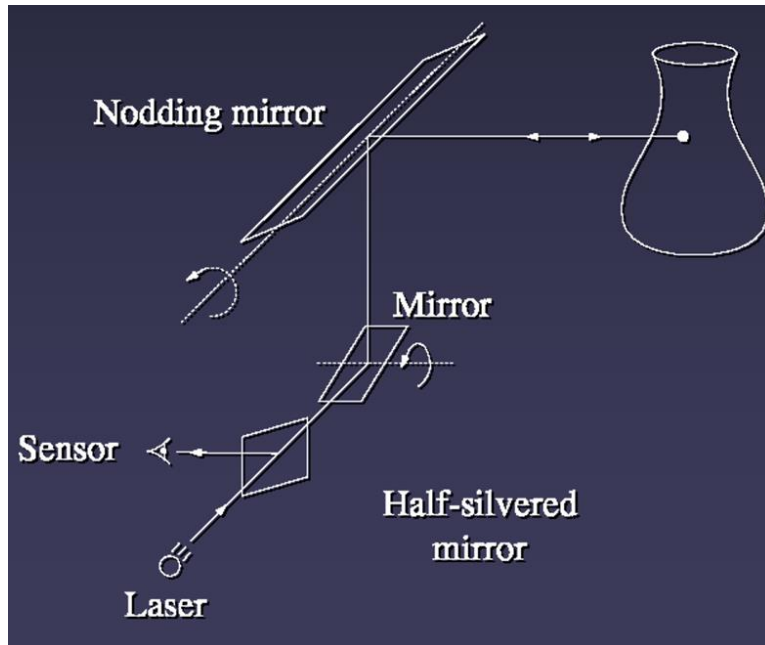


Range Acquisition Taxonomy



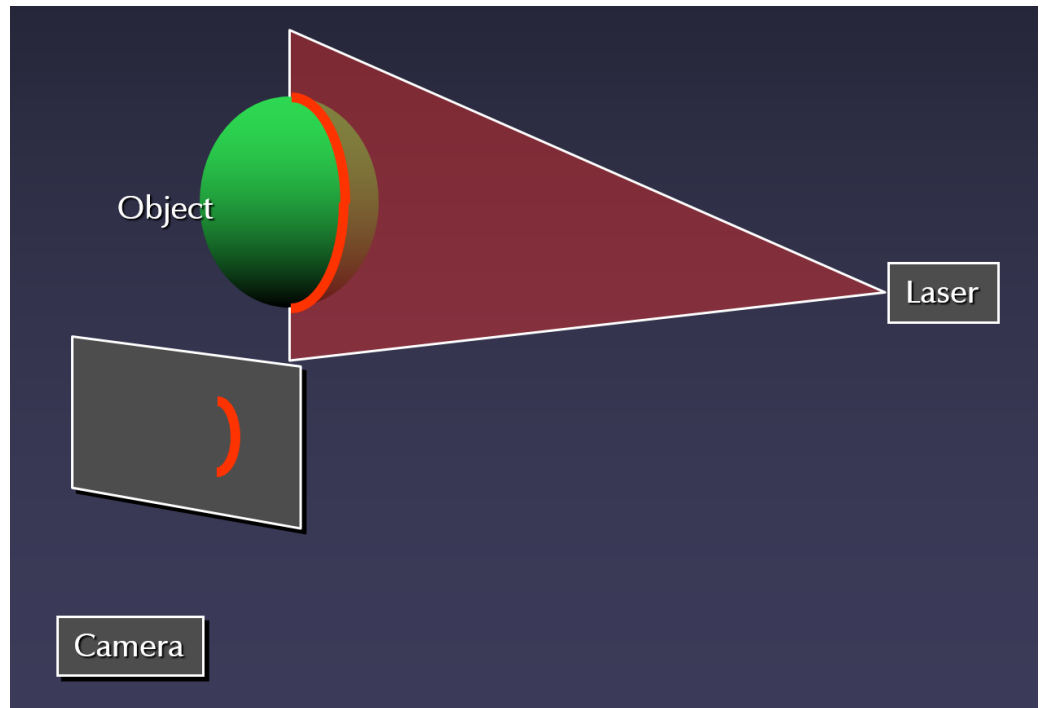
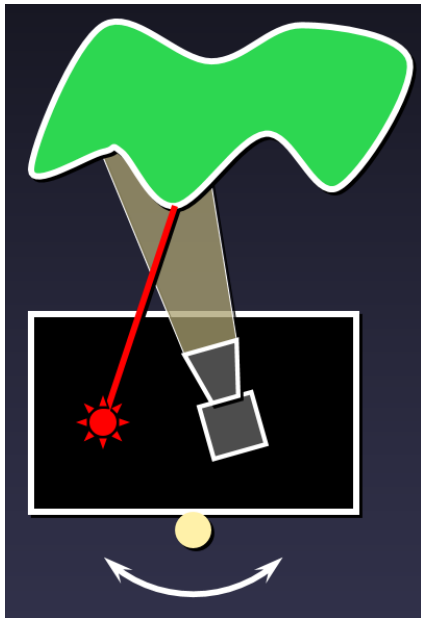
Time of Flight

- Send out pulse of light (usually laser), time how long it takes to return



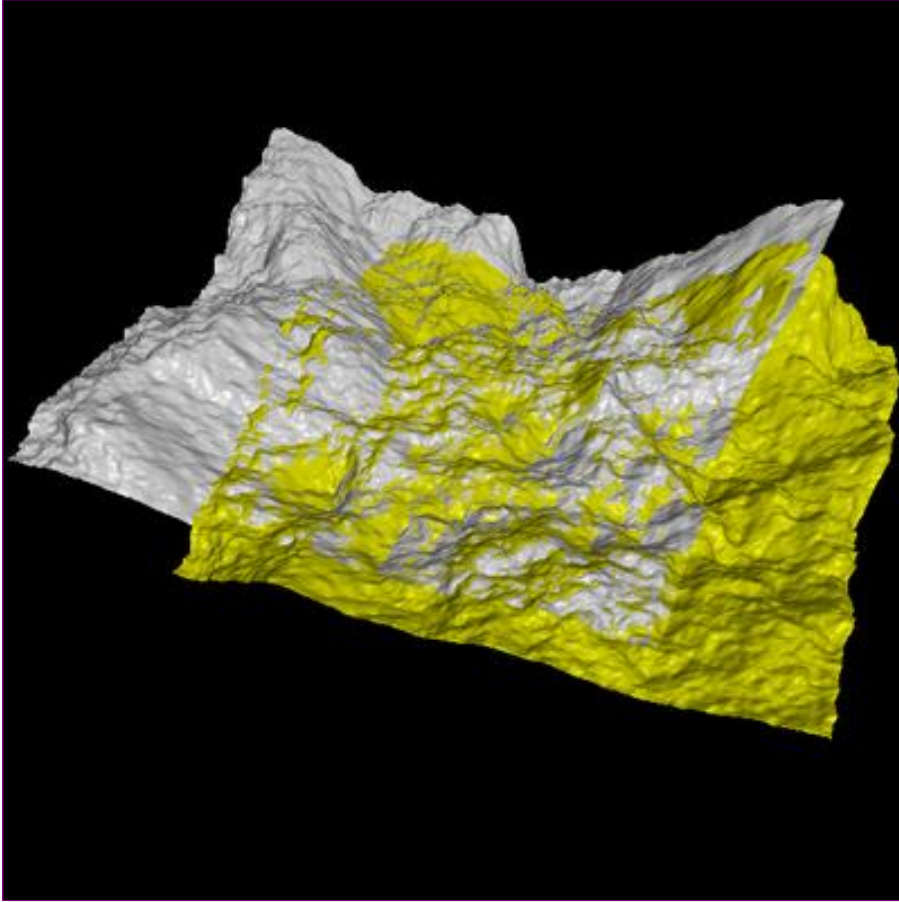
Buildings + Large Volumes

Triangulation



Registration

Geometry Registration

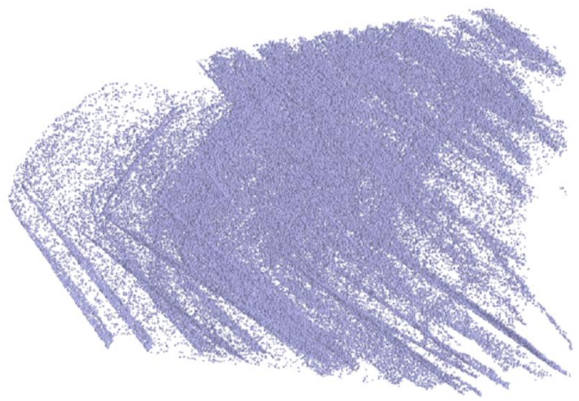


ICP:

Point-2-point

Point-2-plane

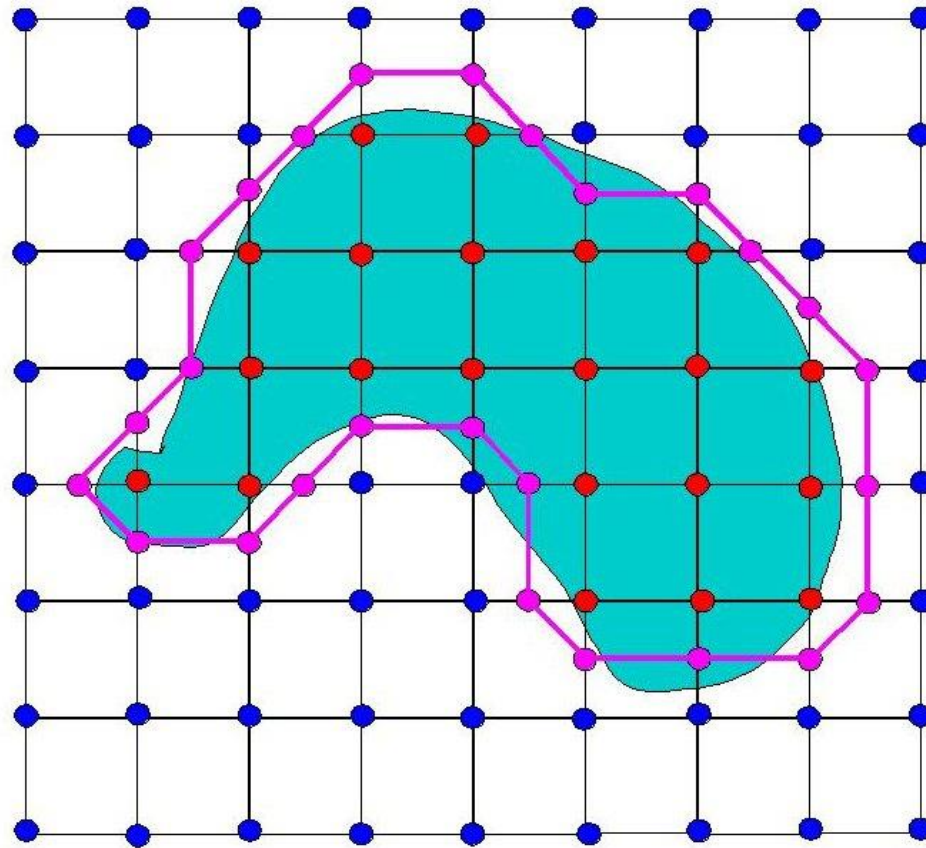
Multi-View Registration



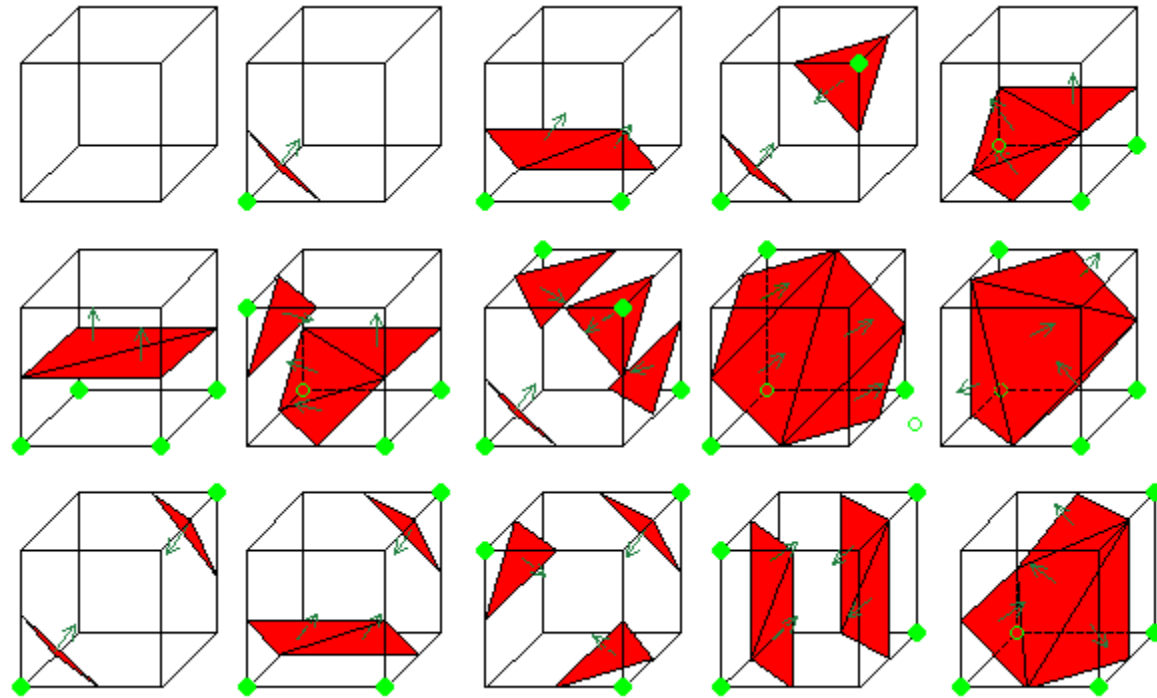
Discussion

Reconstruction

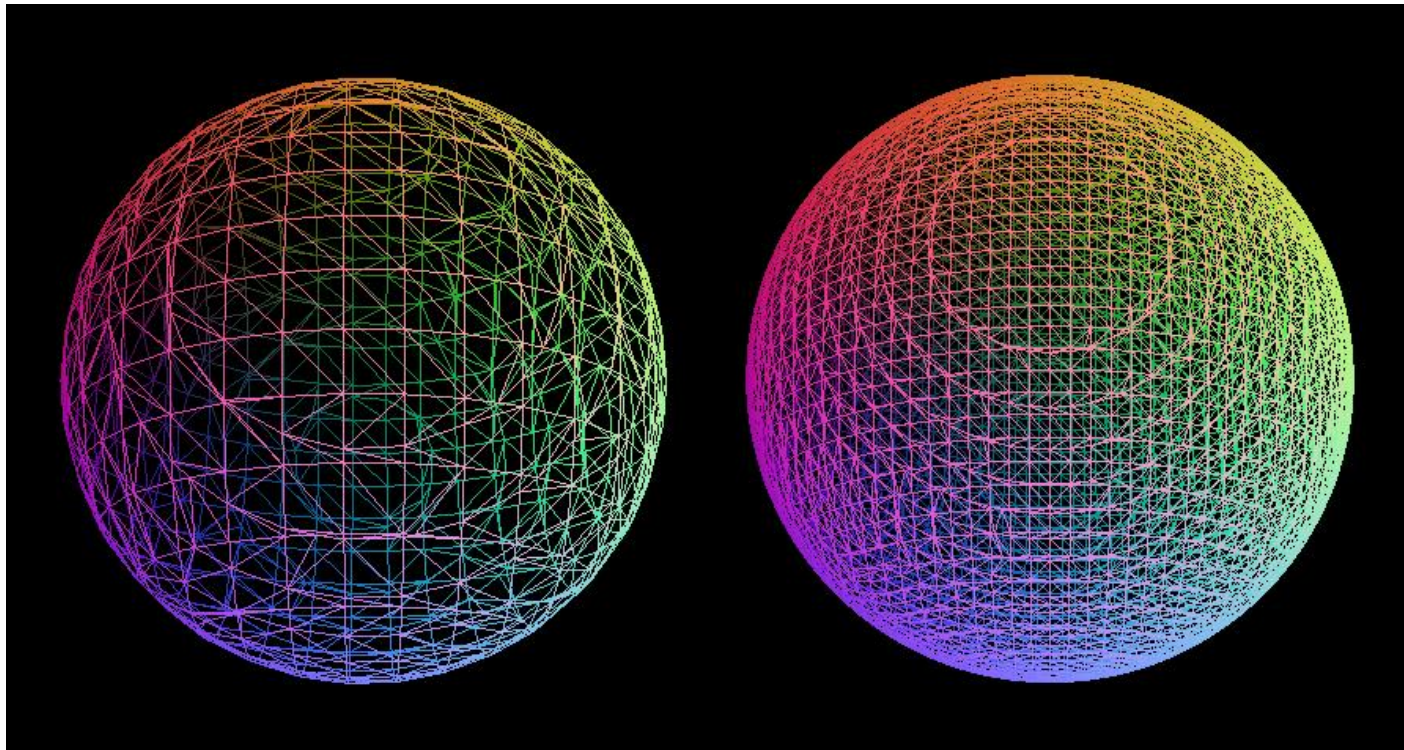
Marching Cube (1987)



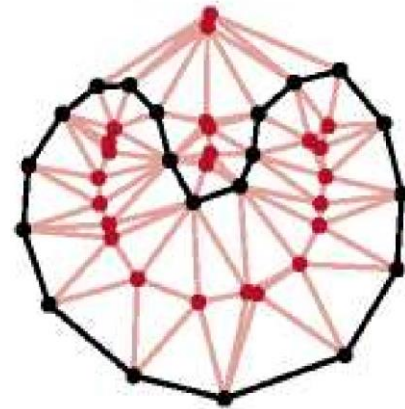
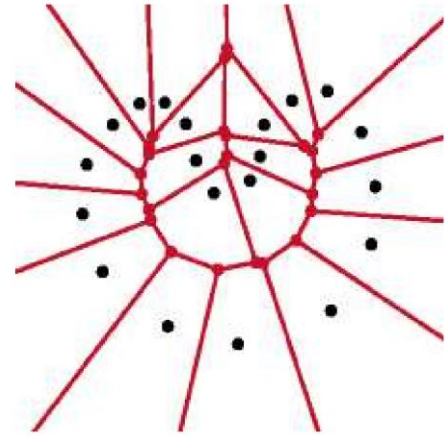
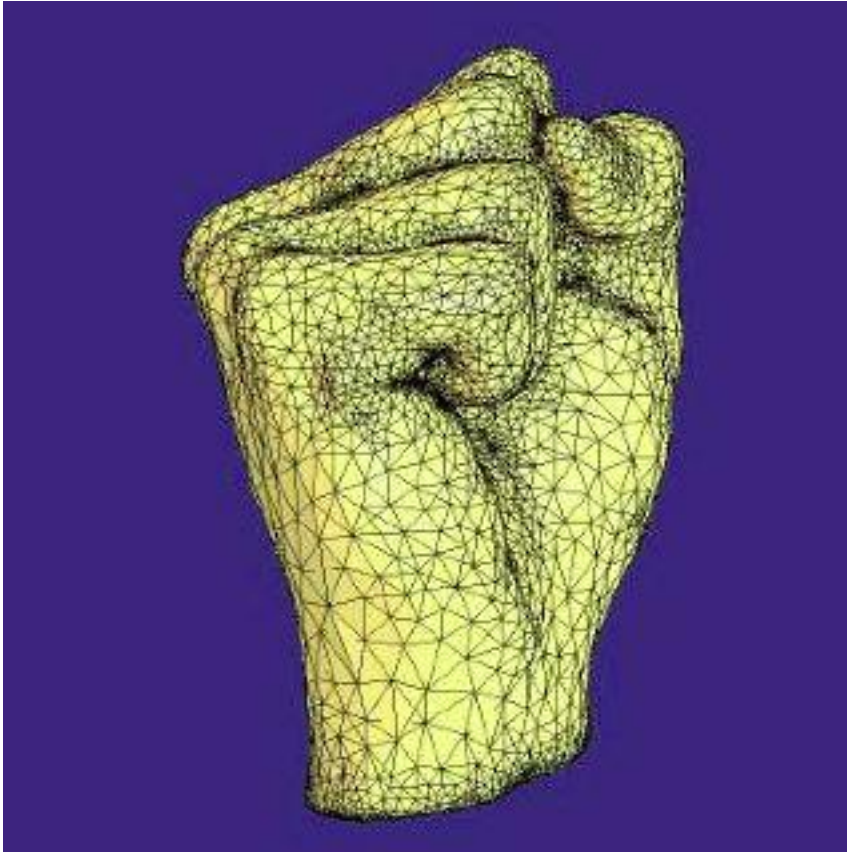
Marching Cube (1987)



Marching Cube (1987)



Computational Geometry Based (1998)

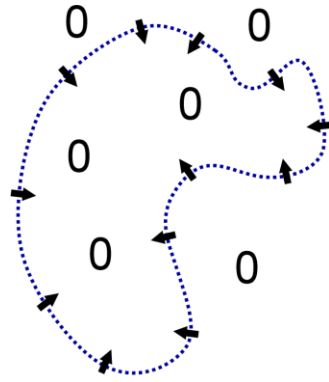


Poisson Geometry Reconstruction (2006)



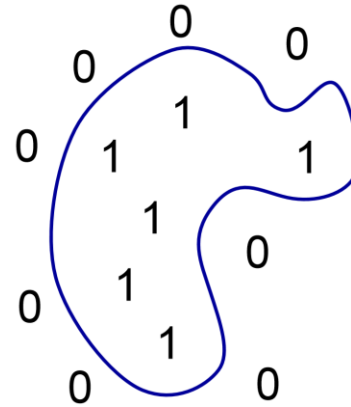
Oriented points

$$\vec{V}$$



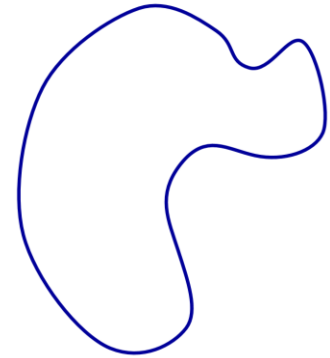
Indicator gradient

$$\nabla\chi_M$$



Indicator function

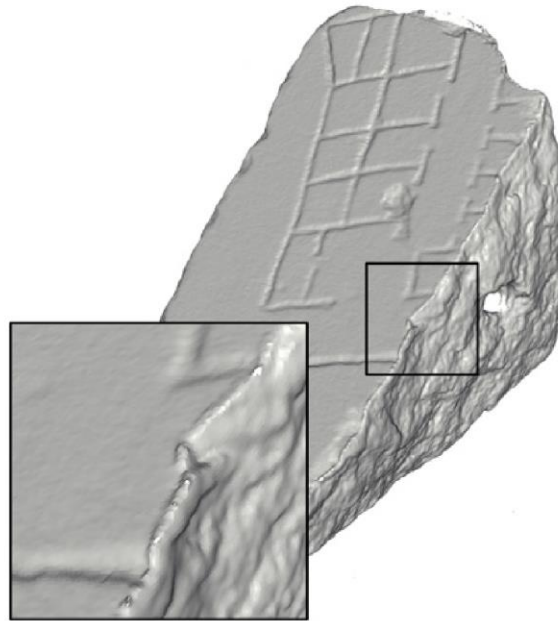
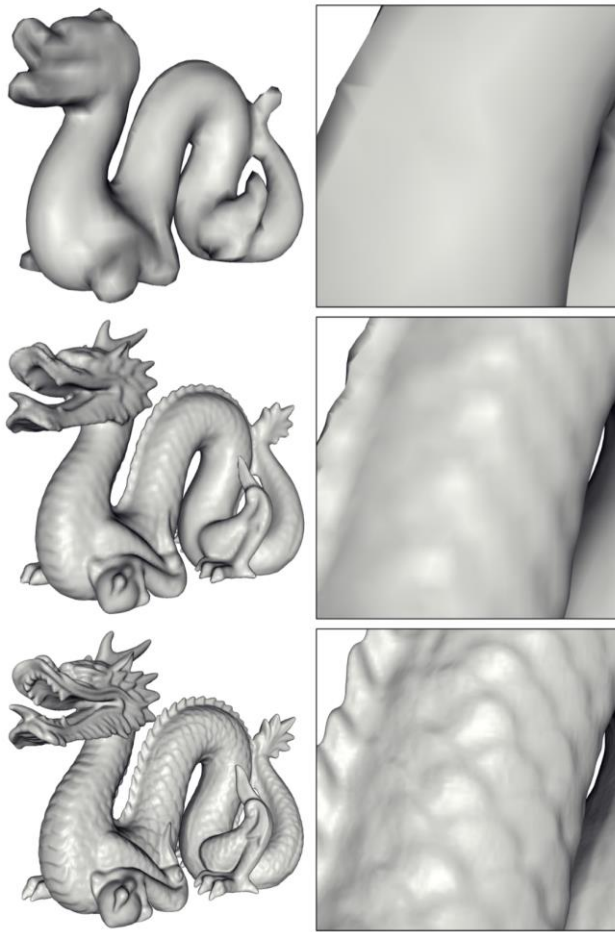
$$\chi_M$$



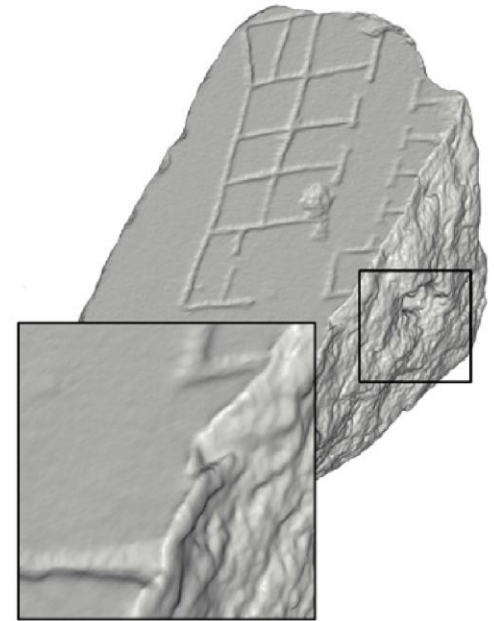
Surface

$$\partial M$$

Poisson Geometry Reconstruction (2006)



VRIP

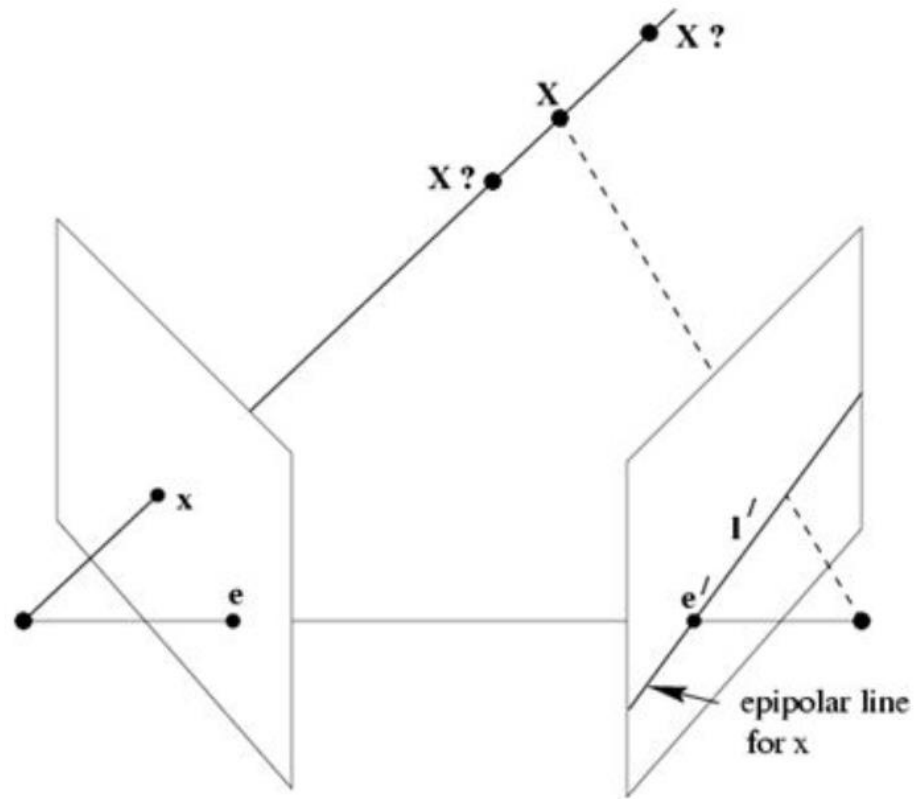


Poisson
solution

Discussion

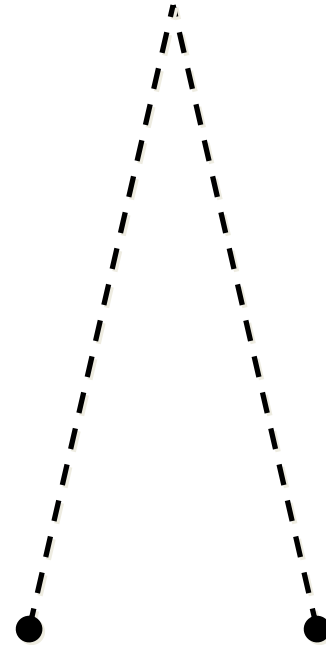
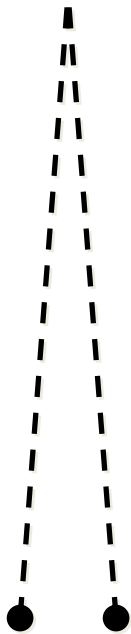
Stereo-Based Reconstruction

Stereo --- Two-View Geometry

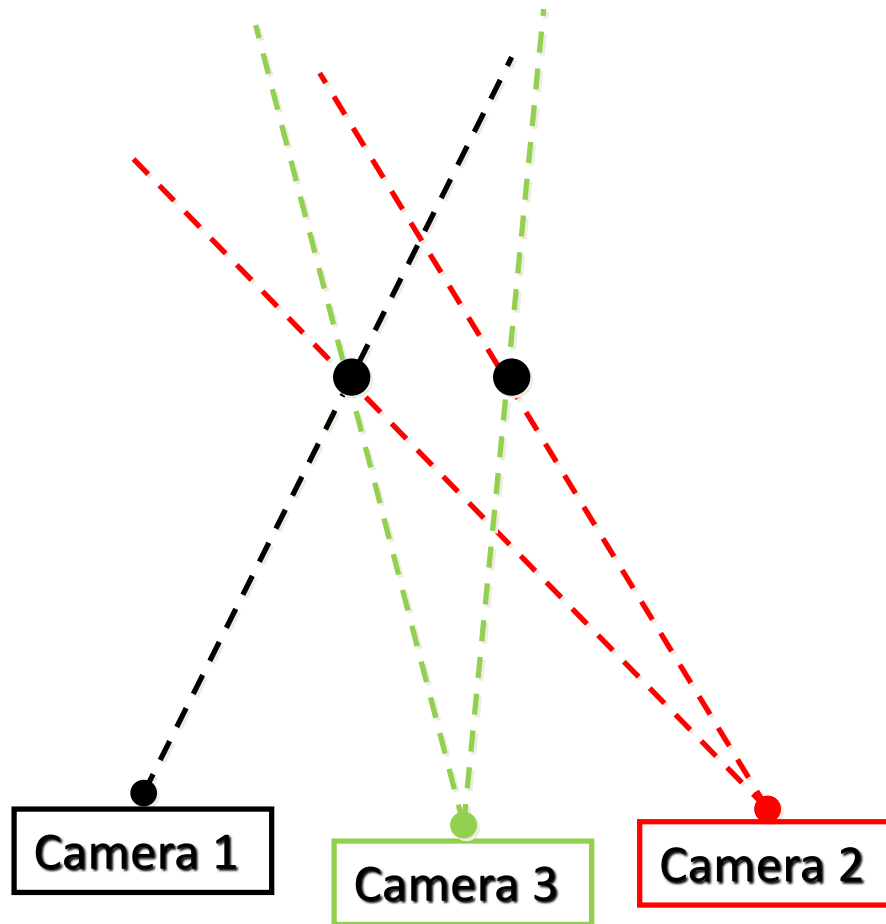


Why More Than 2 Views?

- Baseline
 - Too short --- low accuracy
 - Too long --- matching becomes hard



Multi-View Stereo



Where should the Cameras Come from?

Landmark Projects

Photo Tourism (2006)

[Snavely et al. 06]

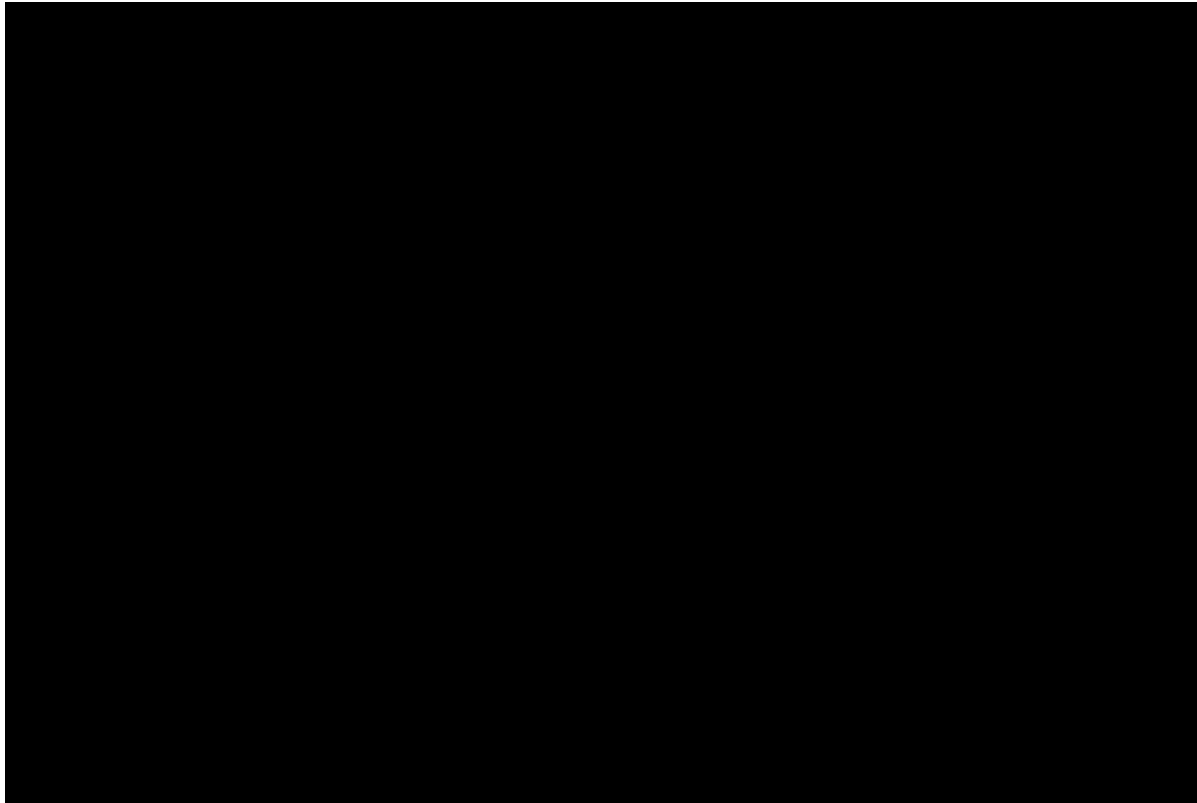
Photo Tourism

Exploring photo collections in 3D

Noah Snavely Steven M. Seitz Richard Szeliski
University of Washington *Microsoft Research*

SIGGRAPH 2006

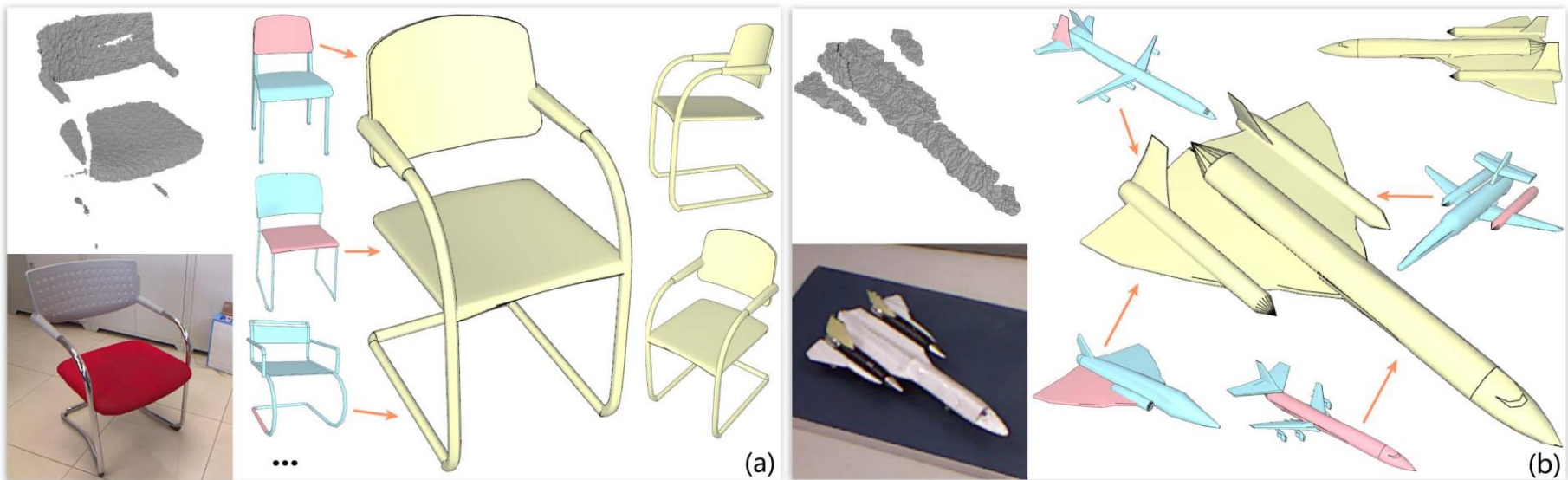
Building Rome on a Cloudless Day (2010)



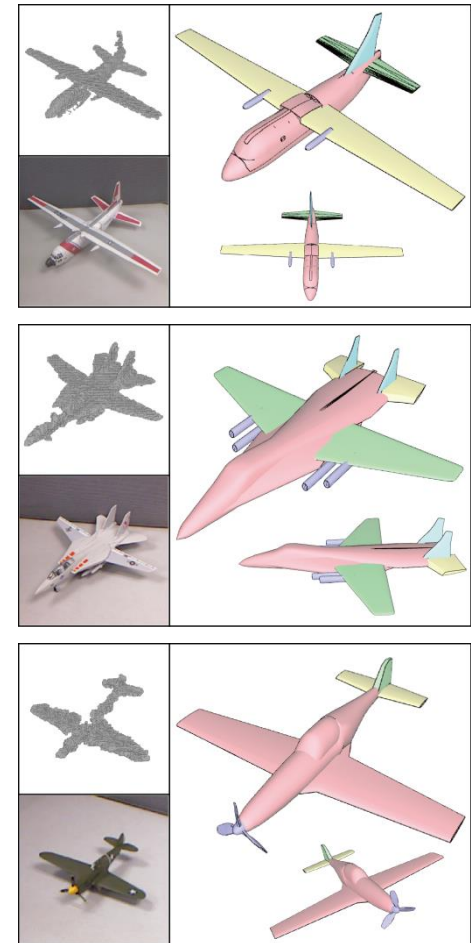
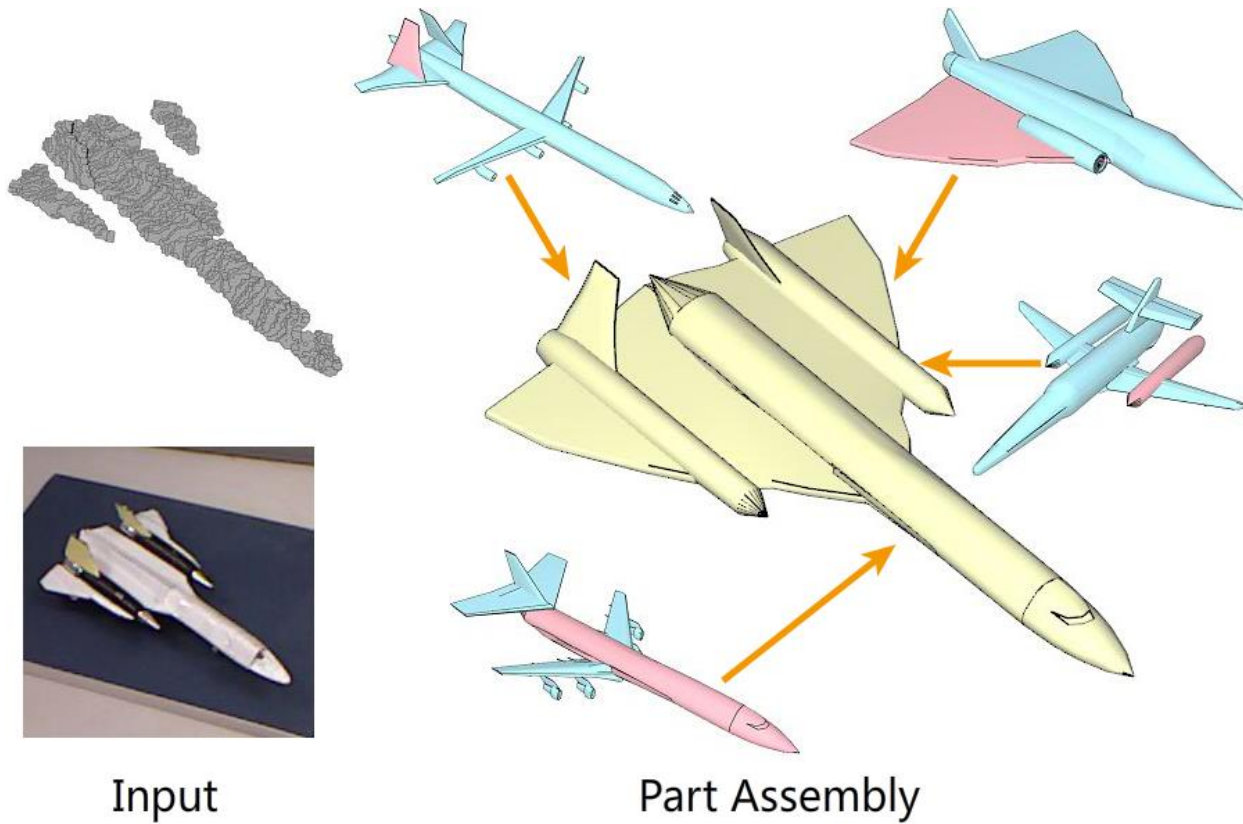
The impact of Big-Data on Geometry Reconstruction

Data-Driven Geometry Reconstruction



[Shen et al. 12]




Data-Driven Geometry Processing




Data-Driven Image-Based Modeling

[American Windsor Chairs](#) [Antique Windsor Chairs](#) [Modern Windsor Chairs](#) [Wing Chair](#) [Windsor Rocking Chair](#) [Victorian Chairs](#) [Windsor Arm Chairs](#) [Handi Winds](#)

Size ▾ Color ▾ Type ▾ Layout ▾ People ▾ Date ▾ License ▾ See all favorites  SafeSearch: **Moderate** ▾

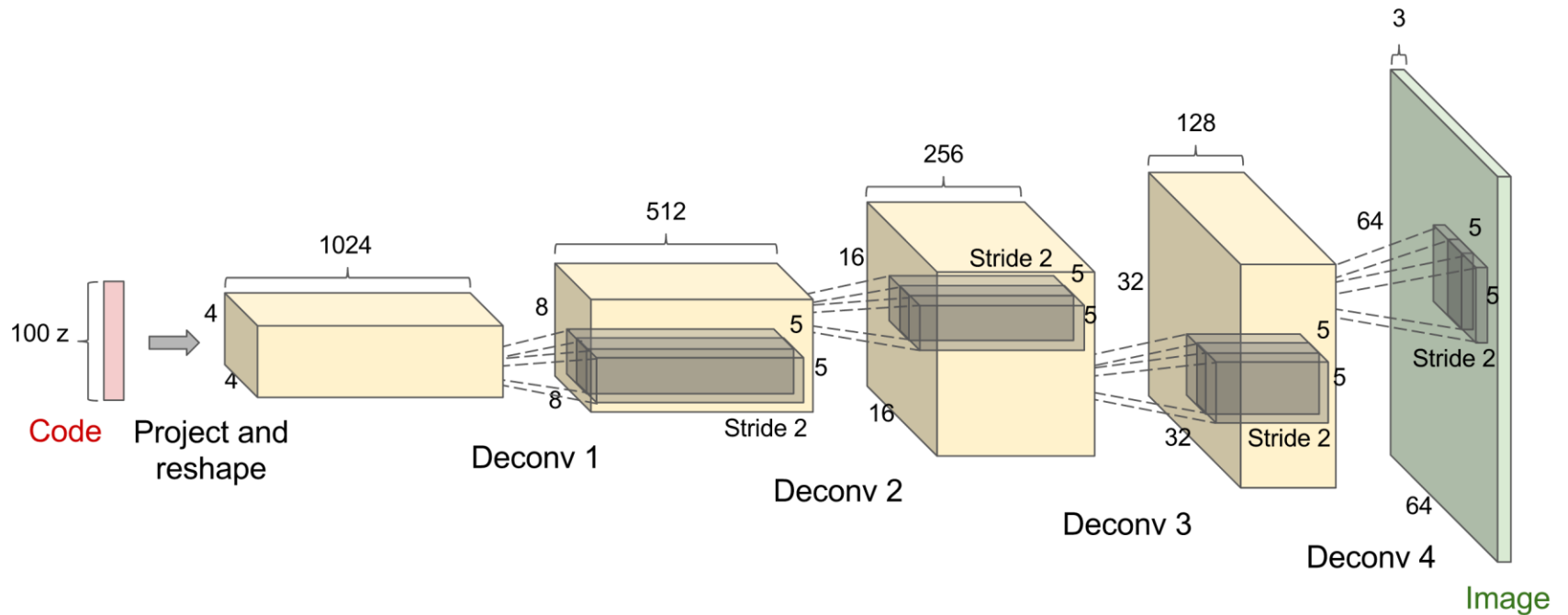


The image displays a grid of 21 different Windsor chair models. The chairs vary in style, including American, Antique, Modern, Wing, and Victorian designs. Some are armchairs, some are rocking chairs, and some are simple Windsor chairs. The colors range from dark wood to light wood and even some painted finishes. The chairs are arranged in three rows: the first row has five chairs, the second row has five chairs, and the third row has six chairs. The chairs are shown from various angles, including front, side, and back views.

The impact of Deep Learning on Geometry Reconstruction

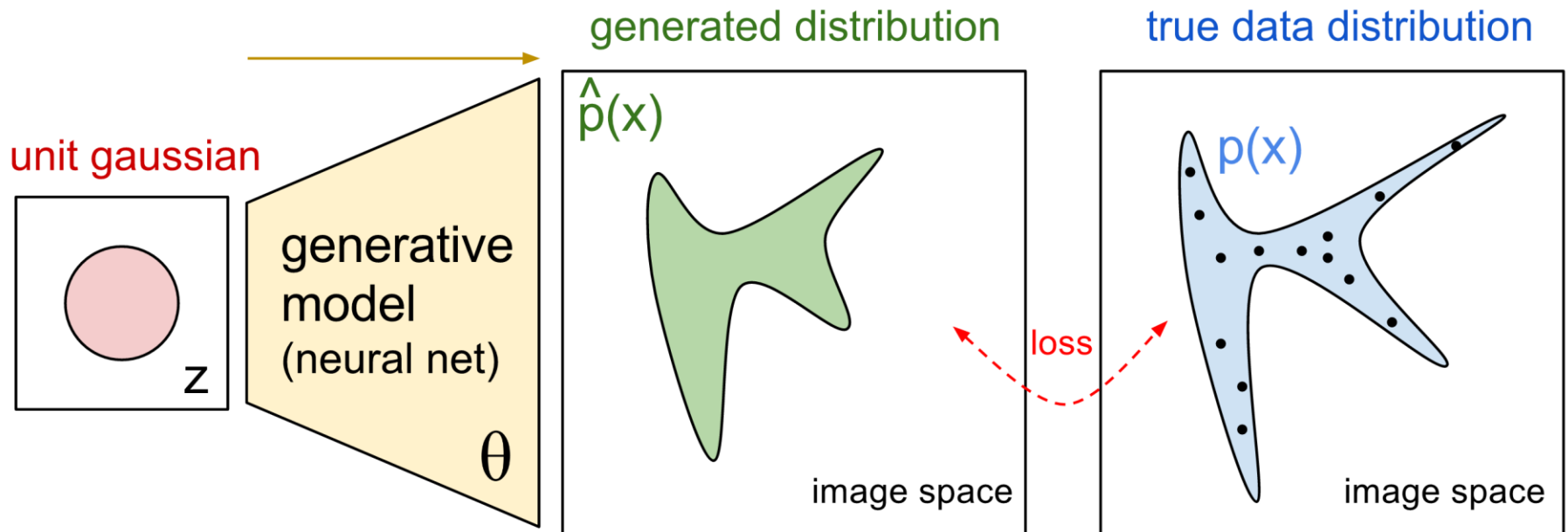
Generative Adversarial Network for Image Generation

[Goldfellow et al. 14]



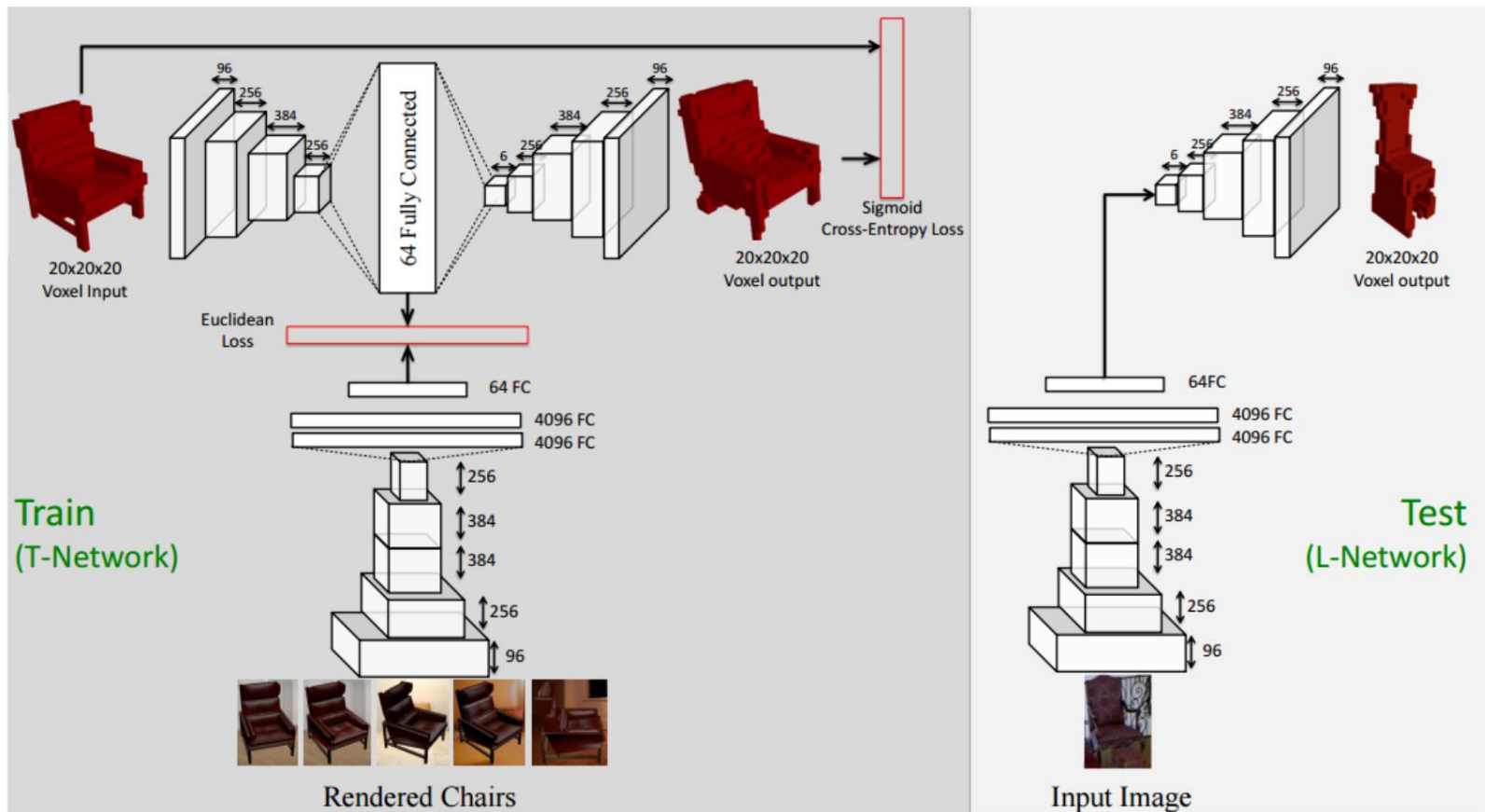
Generative Adversarial Network for Image Generation

[Goldfellow et al. 14]



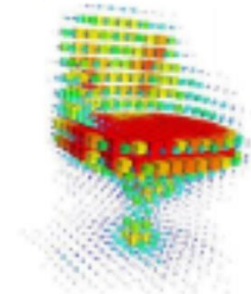
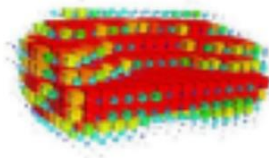
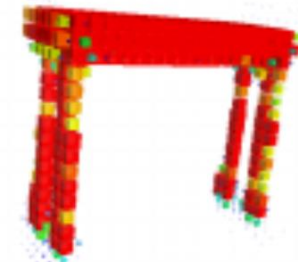
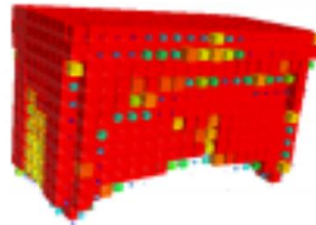
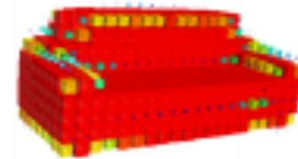
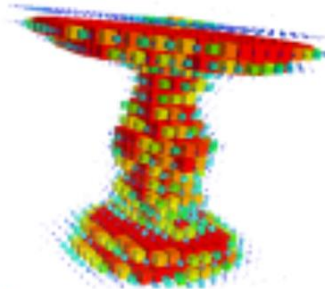
Auto-Encoder on 3D Model Generation

[Girdhar et al. 16]



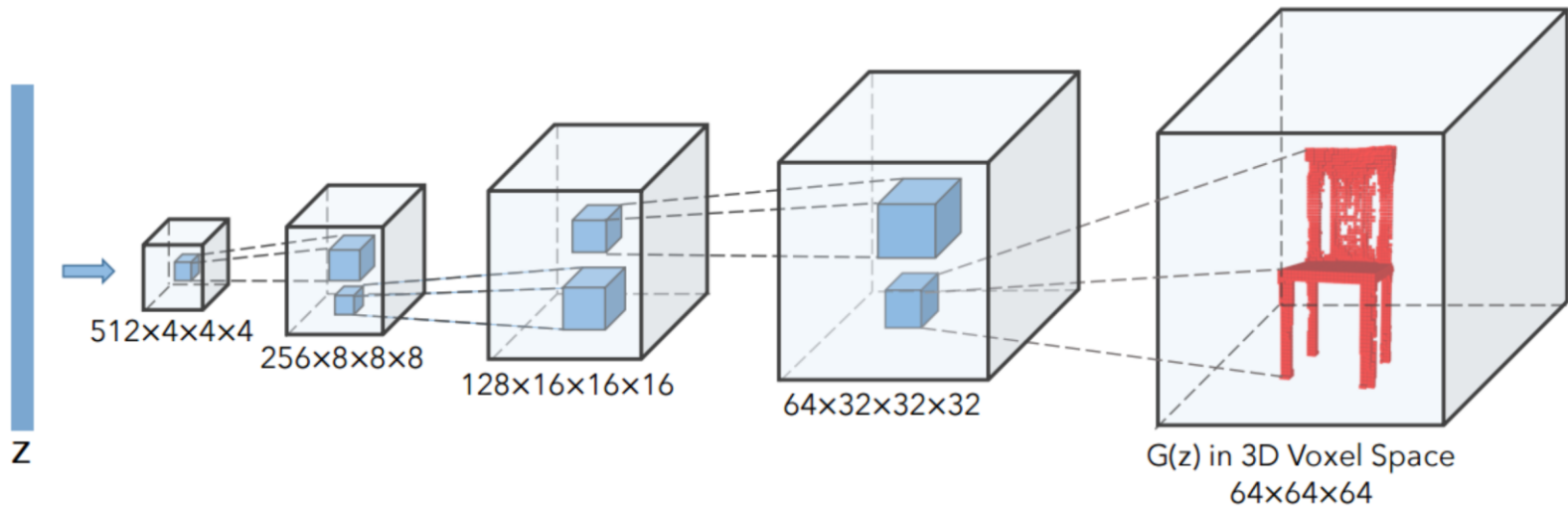
Auto-Encoder on 3D Model Generation

[Girdhar et al. 16]



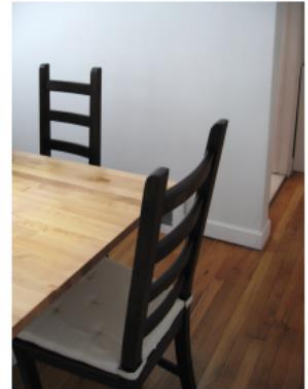
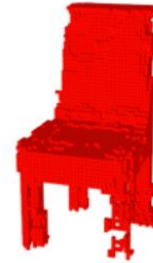
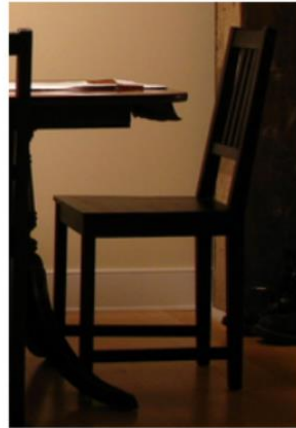
GAN on 3D Model Reconstruction

[Wu et al. 16]



GAN on 3D Model Reconstruction

[Wu et al. 16]



Questions?