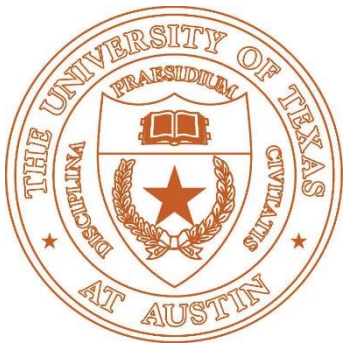
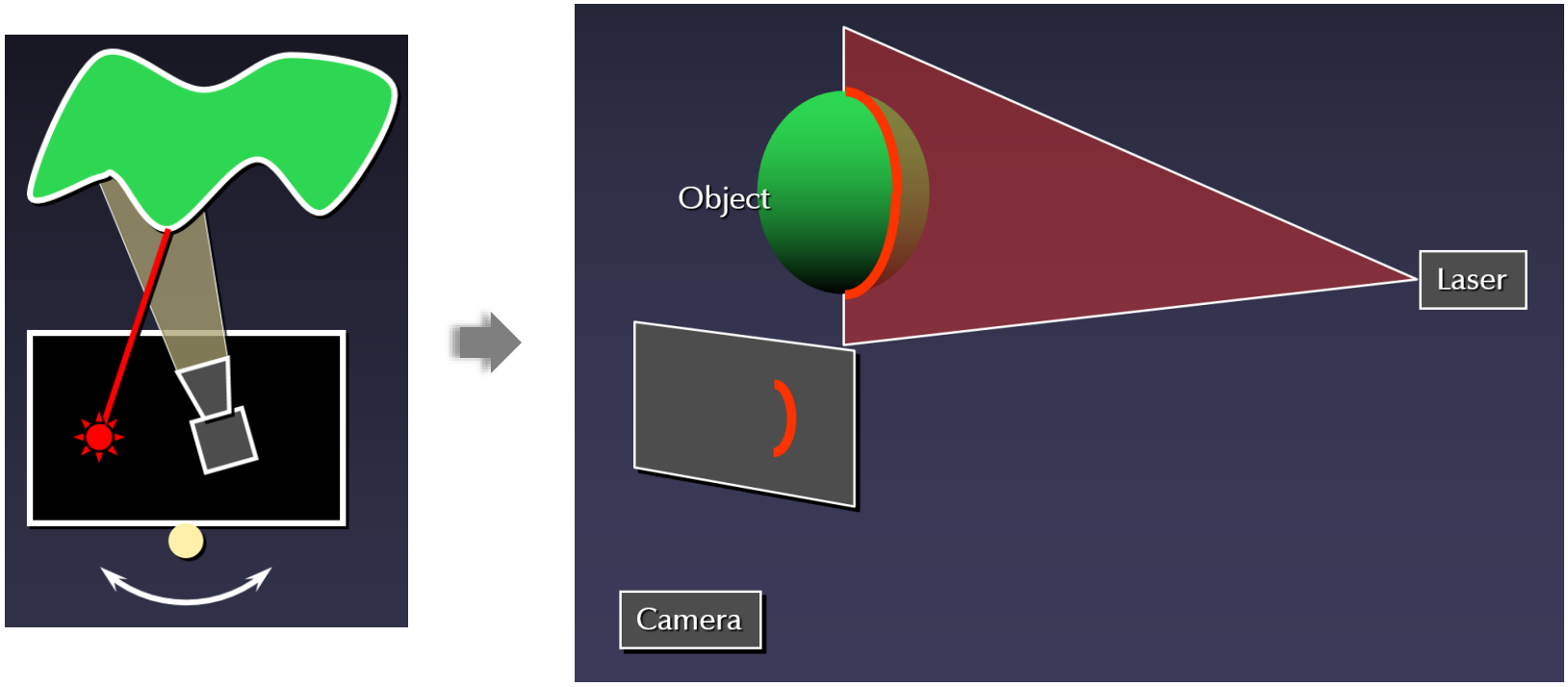
Overview of Geometric Data Analysis

Qixing Huang

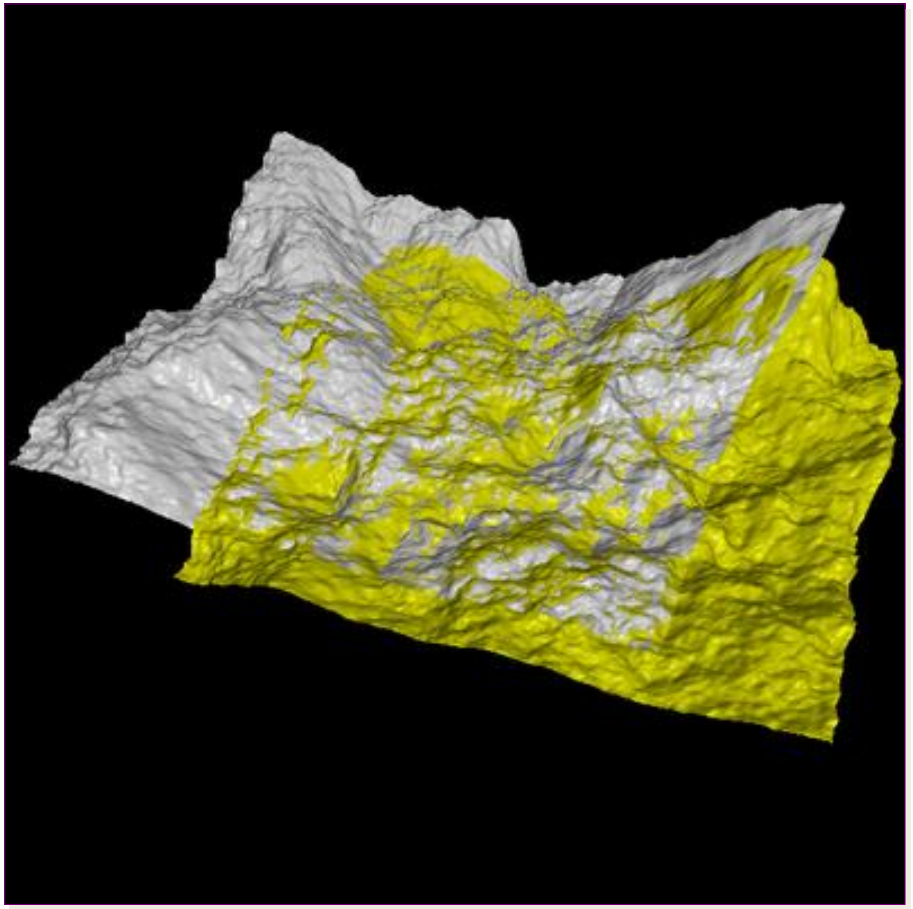
Janurary 23th 2017



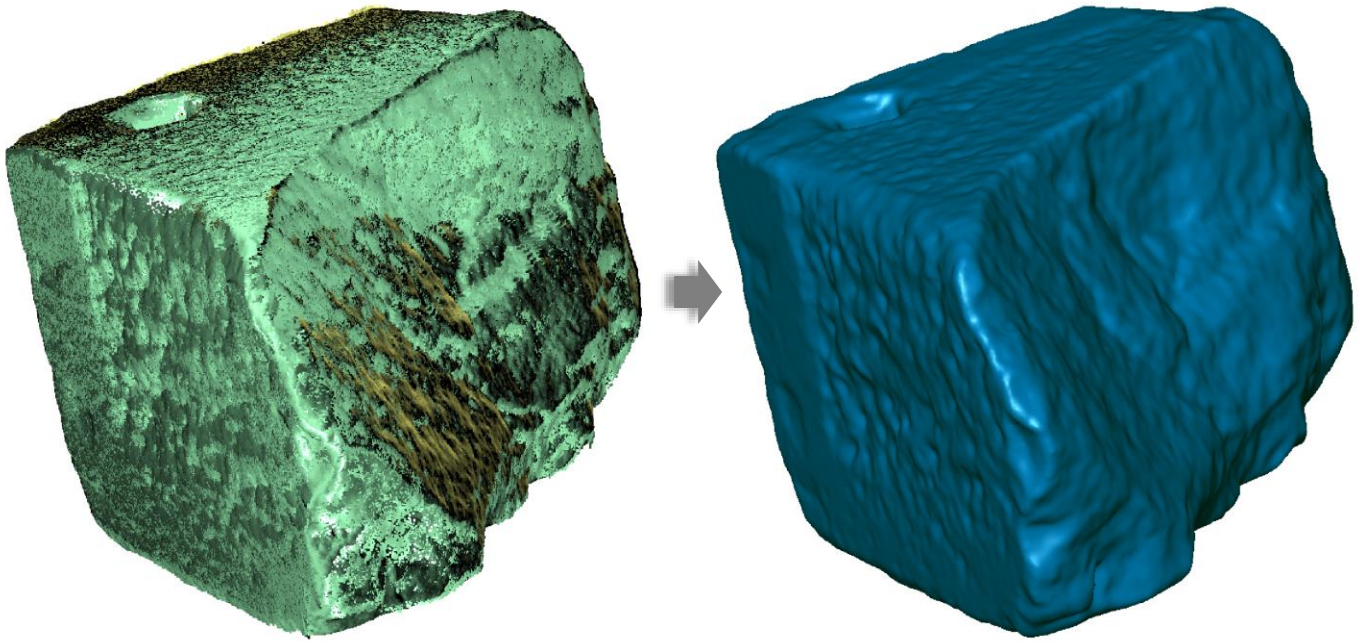
Last Lecture --- Scanning



Last Lecture --- Registration



Last Lecture --- Reconstruction

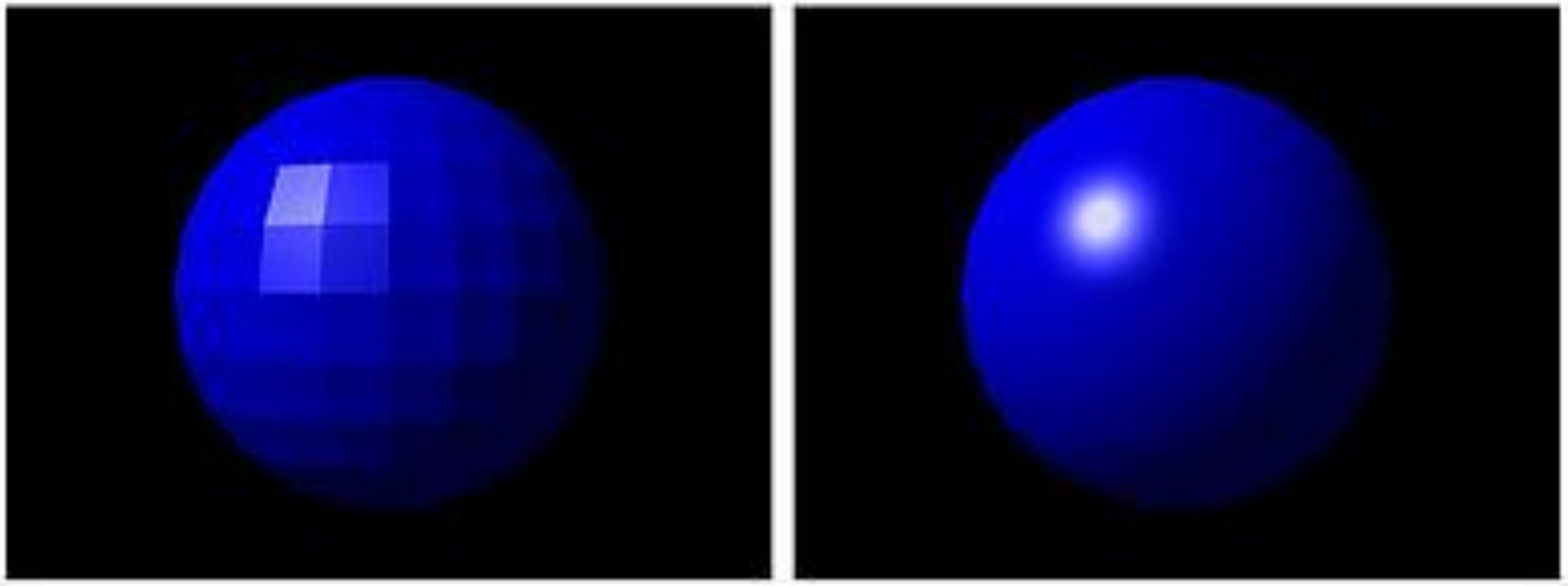


This Lecture --- Overview of Geometric Data Analysis

- Local analysis
- Global analysis
- Semantic analysis

Local Analysis

Normal – Triangular Mesh

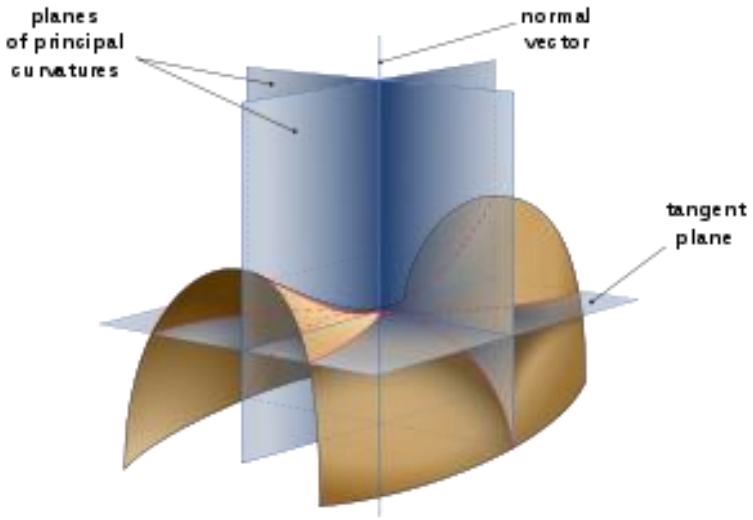


FLAT SHADING

PHONG SHADING

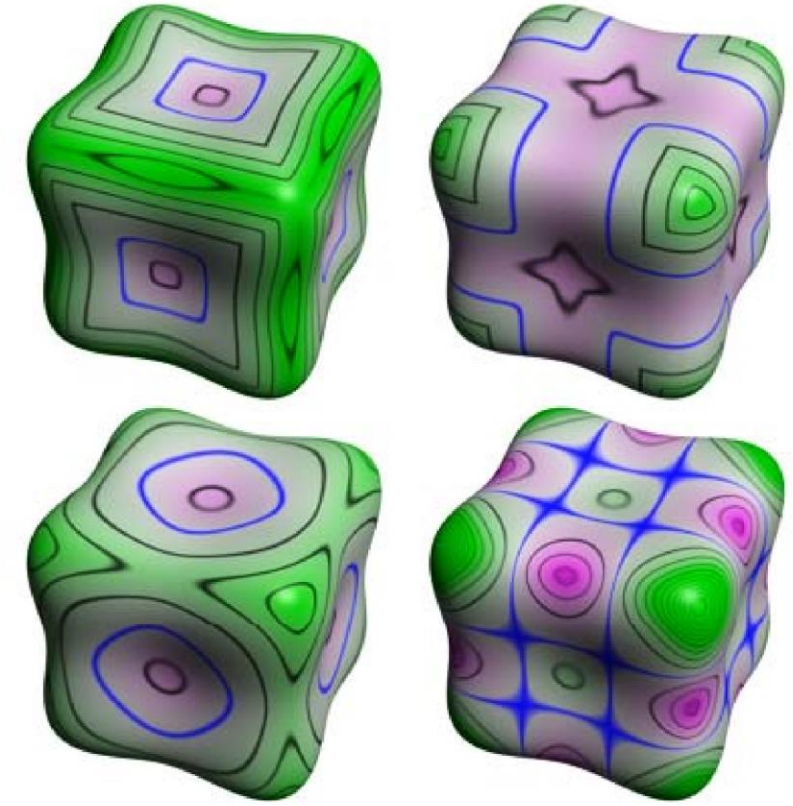
Normal – Pointcloud

Curvature



Maximum
principal curvature

Minimum
principal curvature



Mean curvature

Gaussian curvature

Application in View Selection

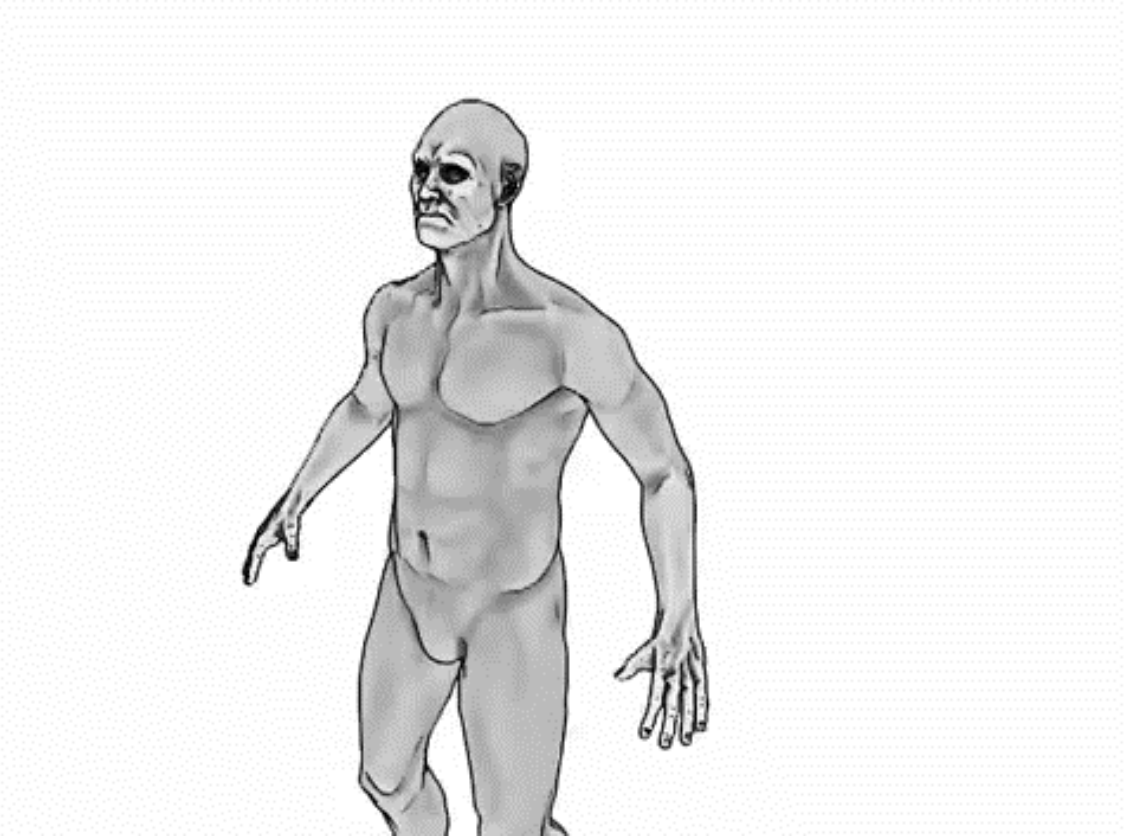
[Lee et al. 05]

Feature Lines

[Ohtake et al. 04]

Suggestive Contours

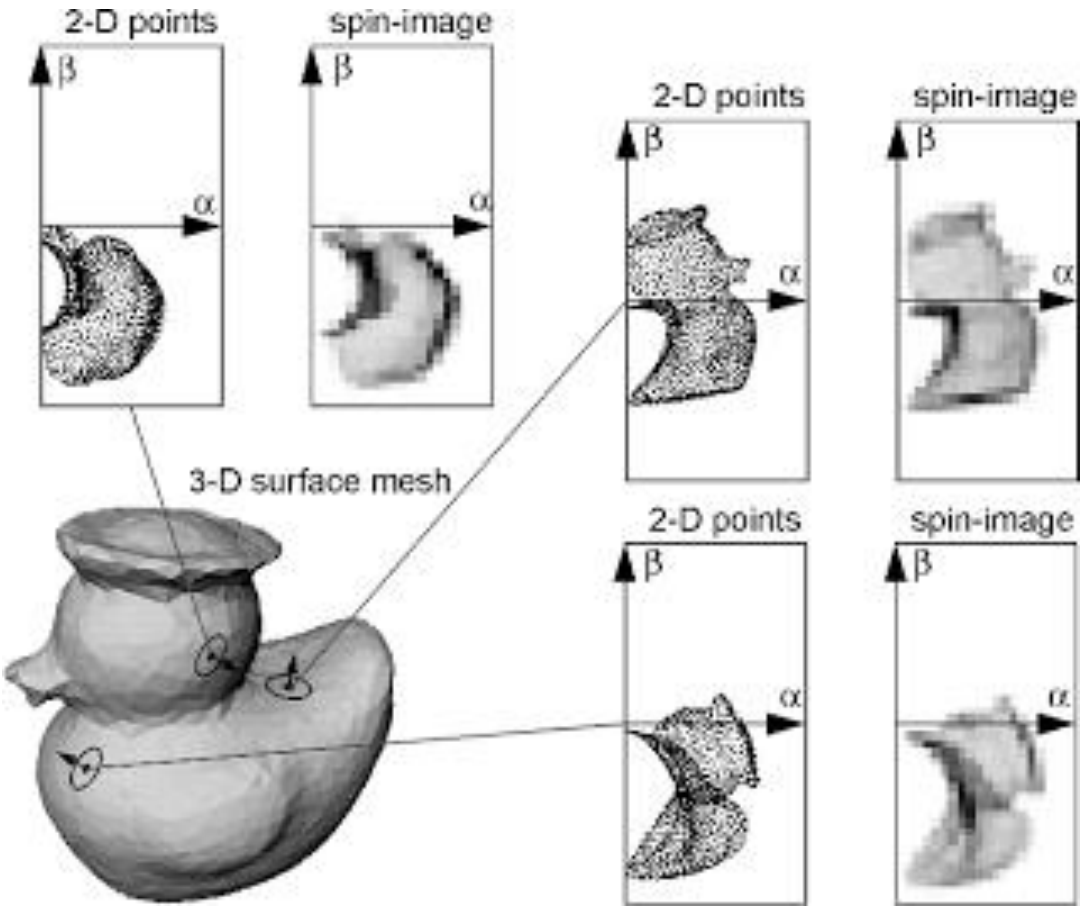
[DeCarlo et al. 03]



Local Analysis --- Feature Point Extraction

Local Analysis --- Point Descriptors

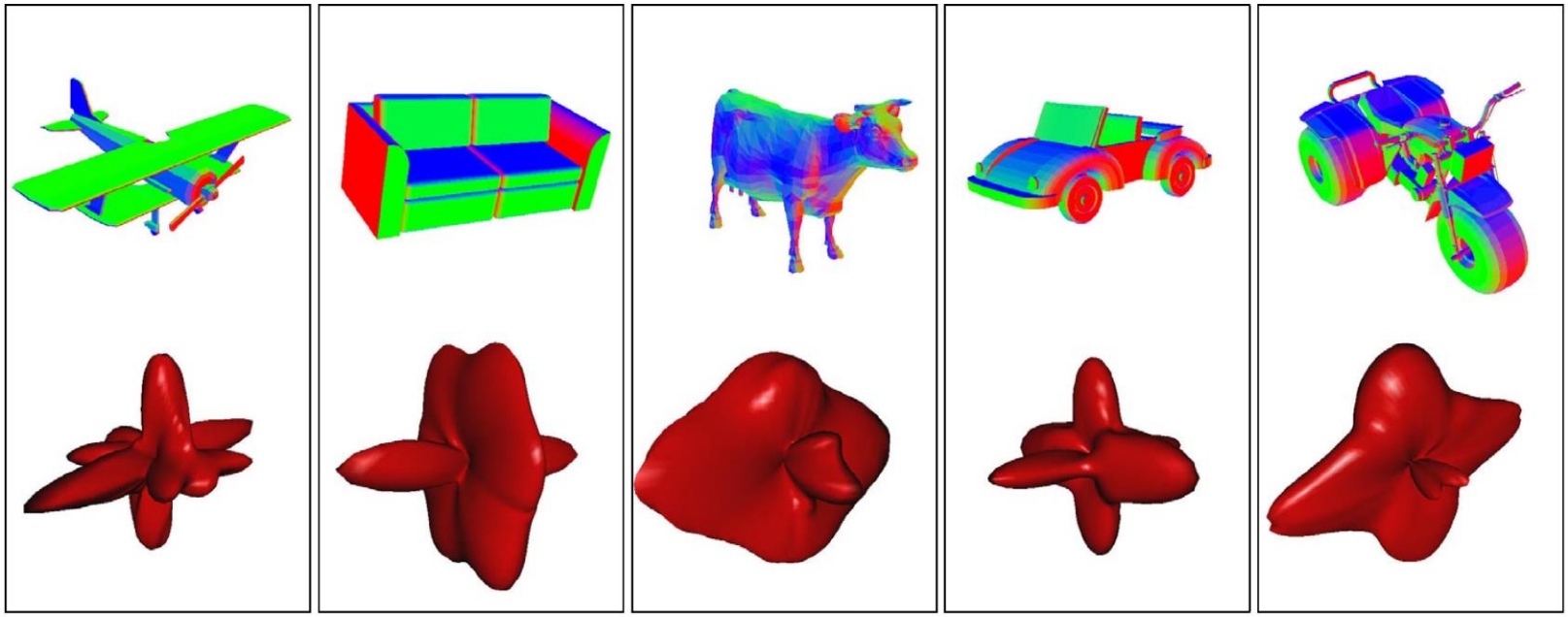
[Johnson and Hebert' 99]



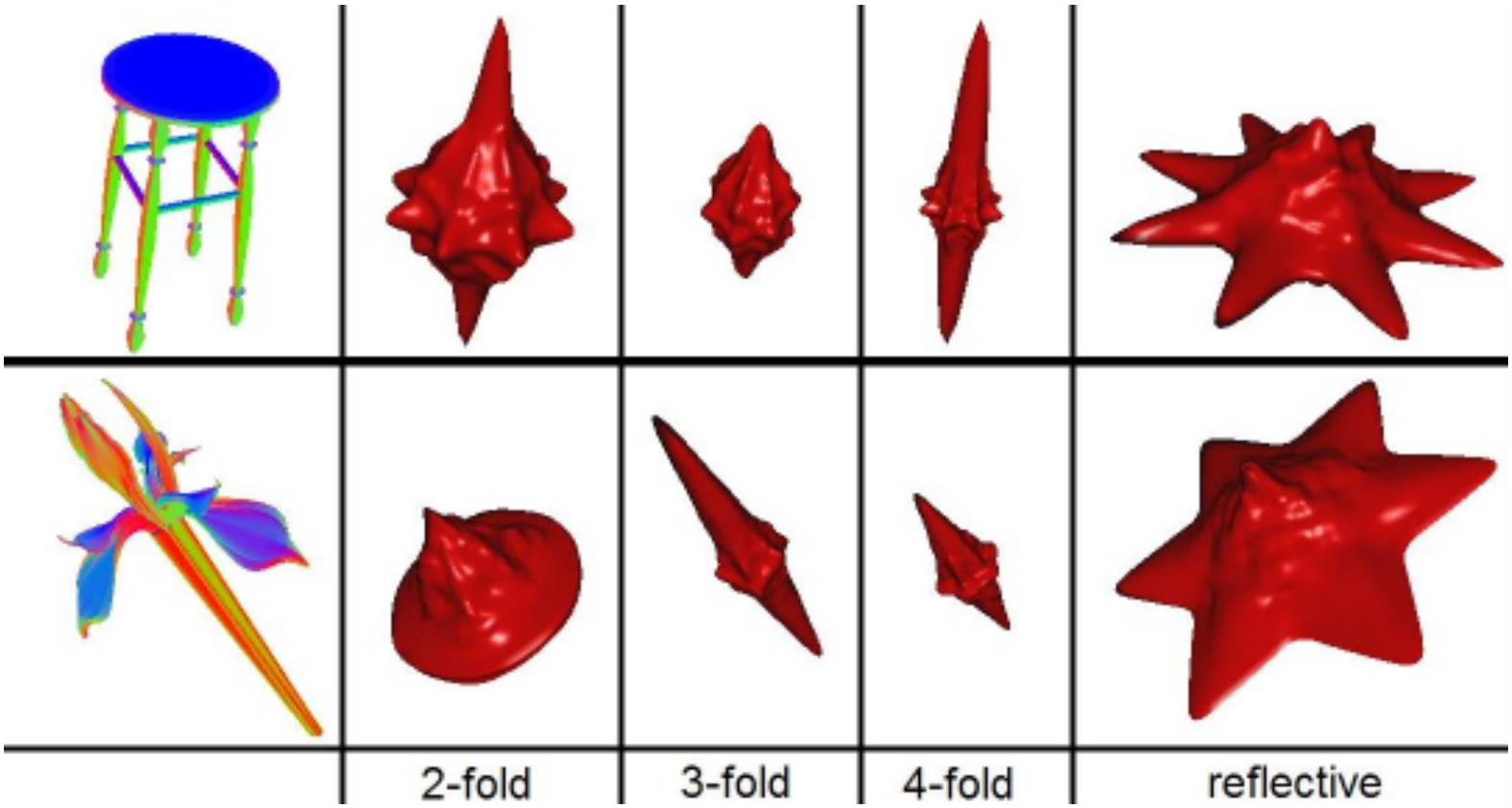
Structure Analysis

Reflection Symmetry

[Kazhdan 02]

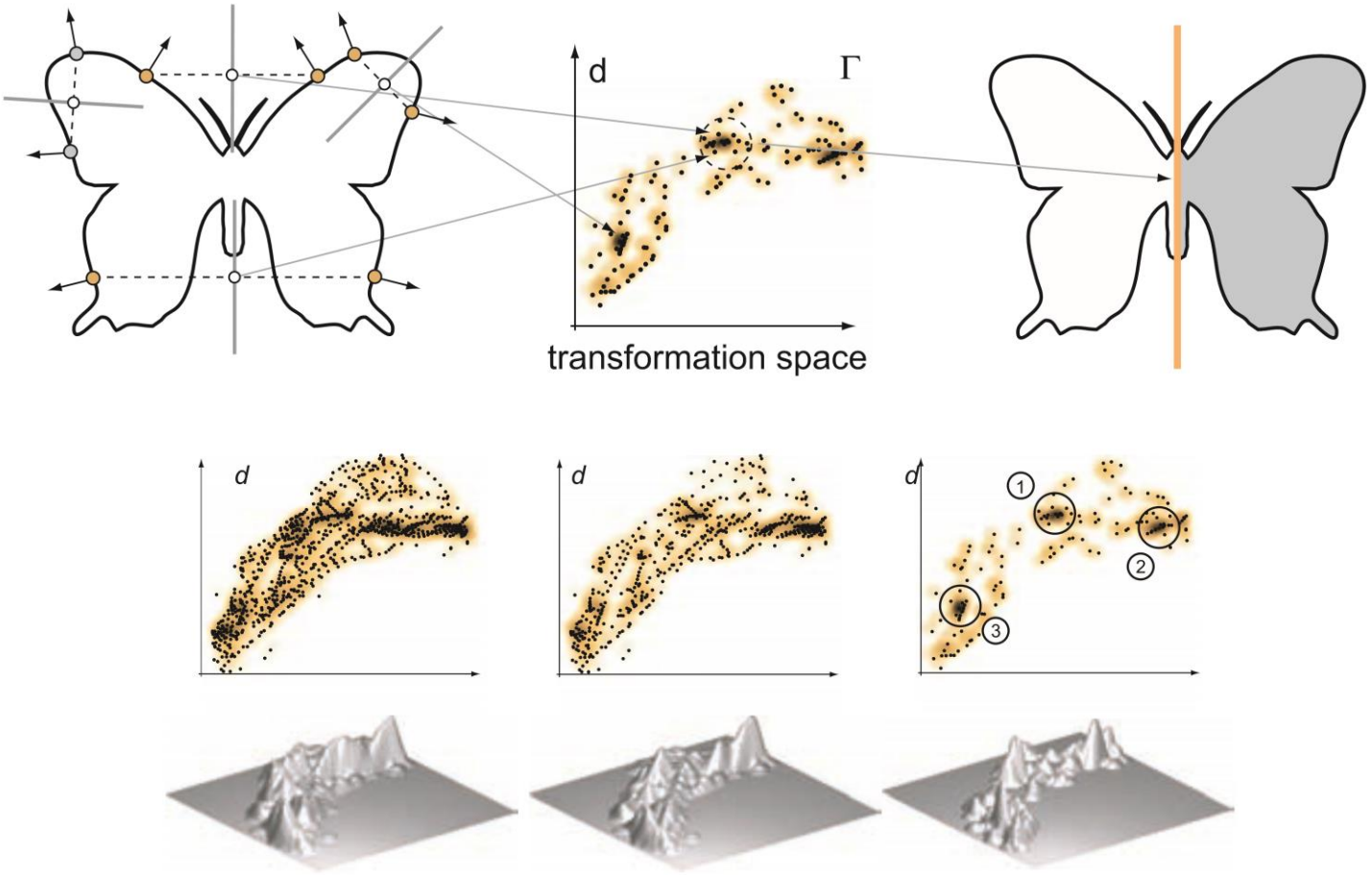


Rotational Symmetry



Voting-Based Detection

[Mitra et al. 06]

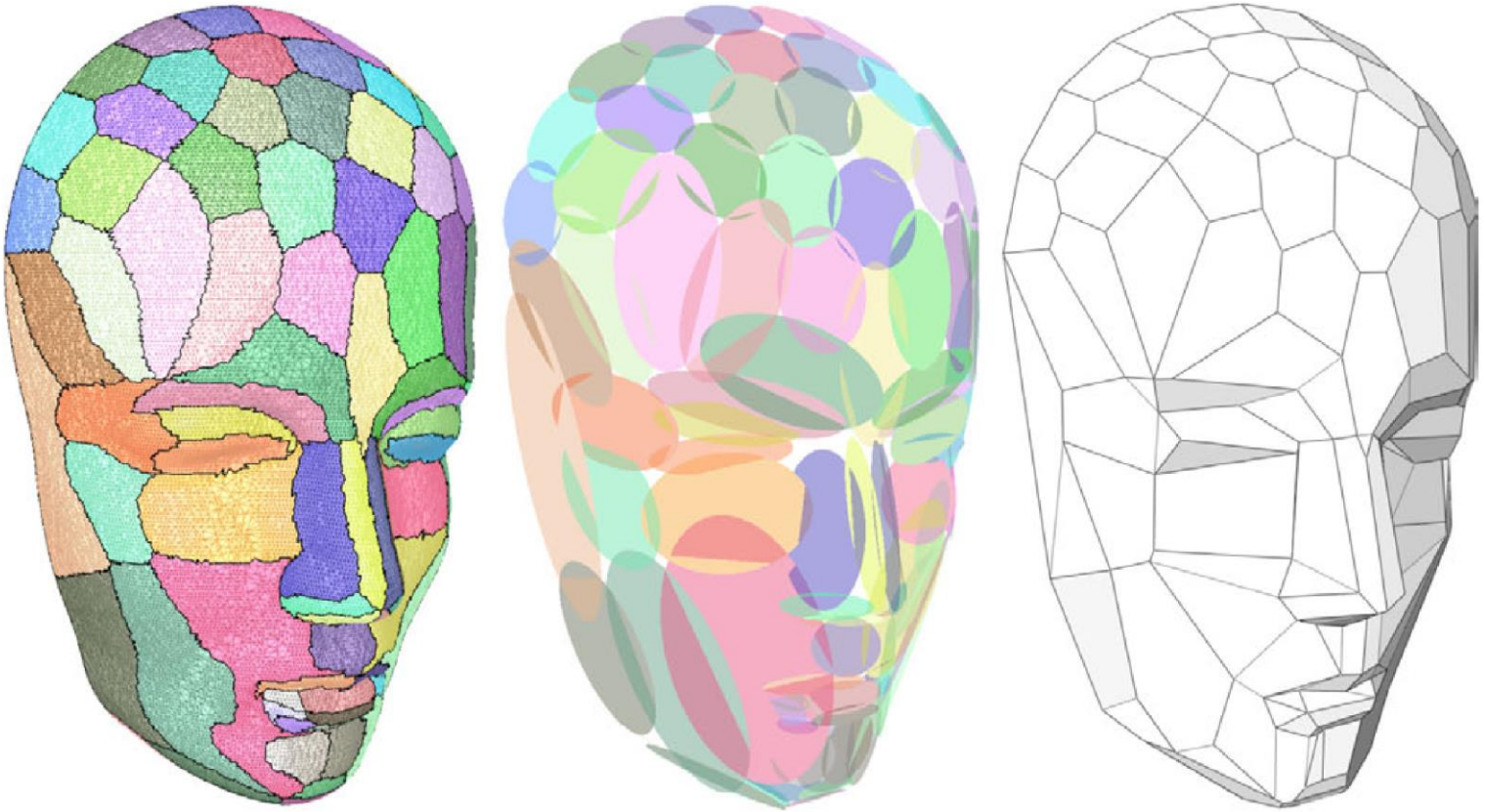


Symmetrization

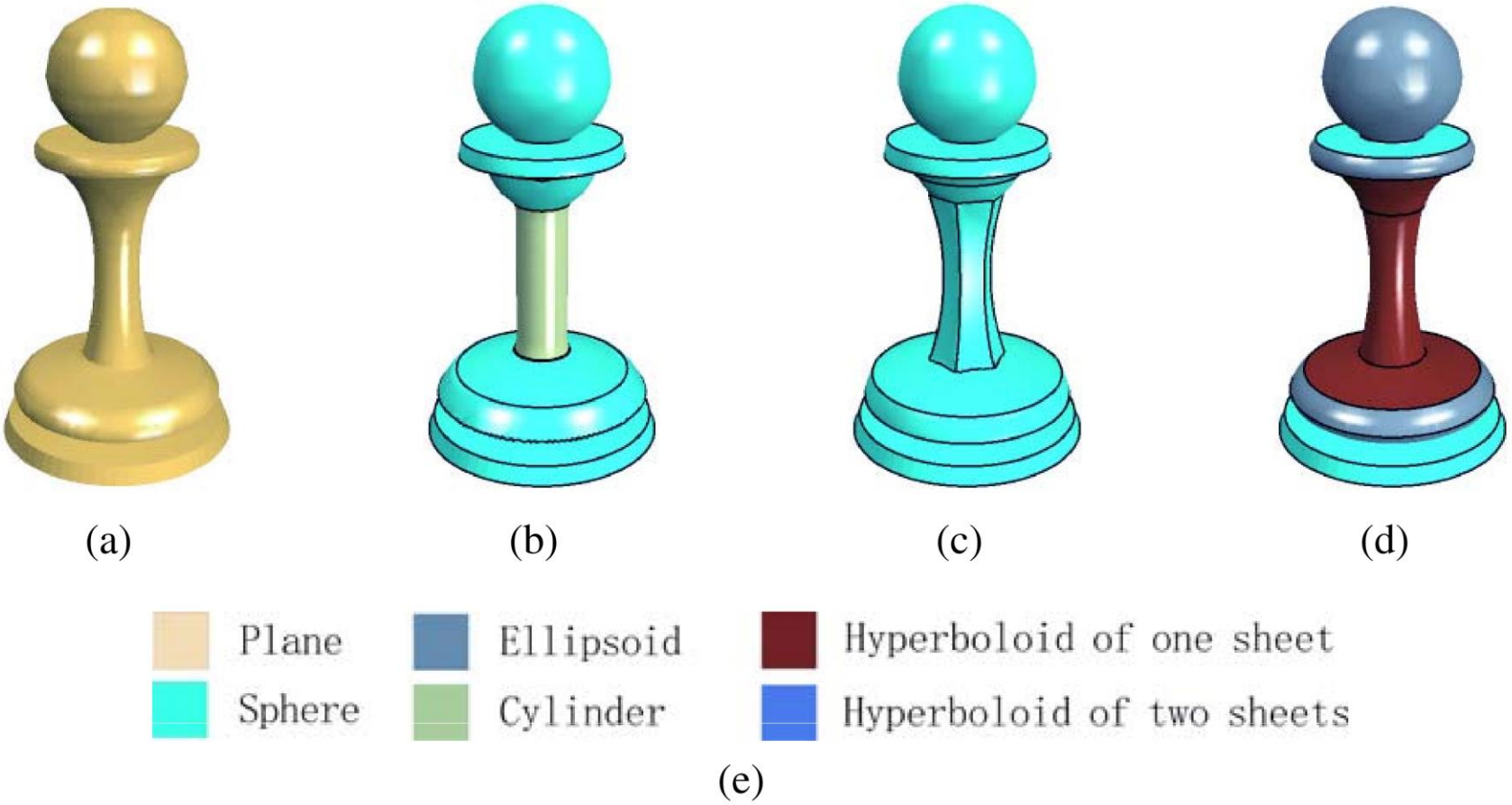
[Mitra et al. 07]

Primitive Segmentation

[Cohen-Steiner et al. 04]

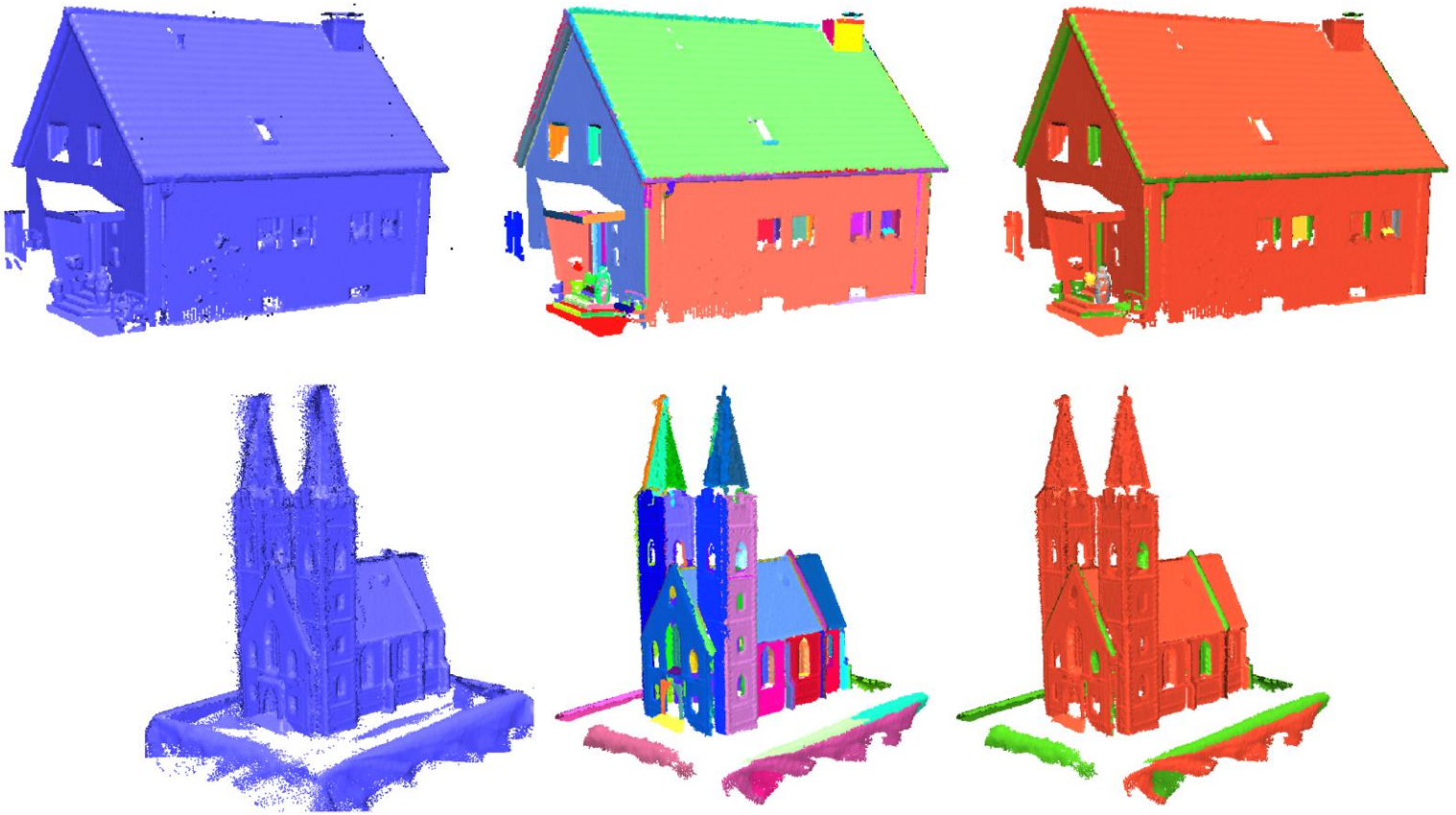


Primitive Segmentation

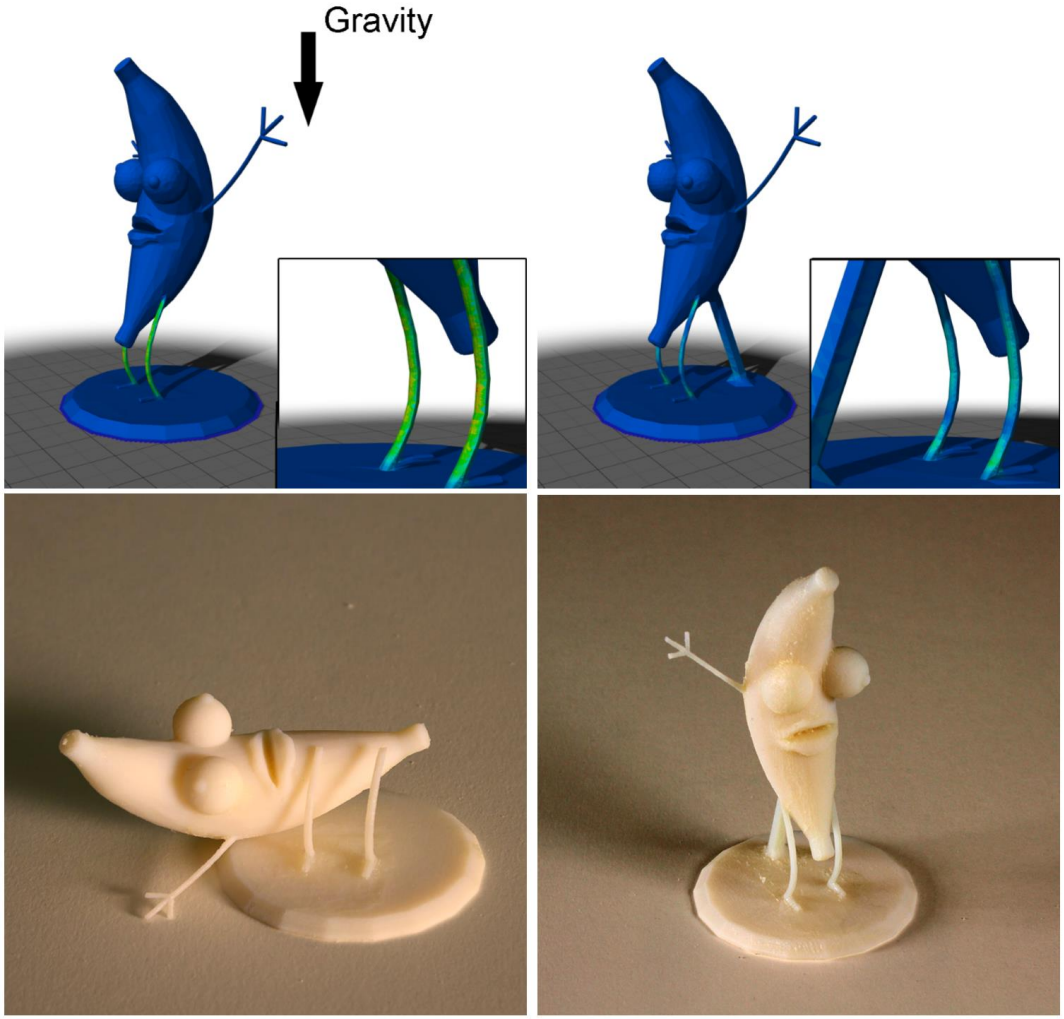


Primitive Segmentation --- Reserve Engineering

[Schnabel et al. 07]



Stability Analysis --- 3D Printing



Stability Analysis --- Self Supporting Struct.

[Prevost et al. 13]

Make It Stand: Balancing Shapes for 3D Fabrication

Romain Prévost[1] Emily Whiting[1] Sylvain Lefebvre[2] Olga Sorkine-Hornung[1]

[1]ETH Zurich [2]INRIA

(contains audio)

Stability Analysis --- Self Supporting Struct.

[Deuss et al. 14]

Assembling Self-Supporting Structures

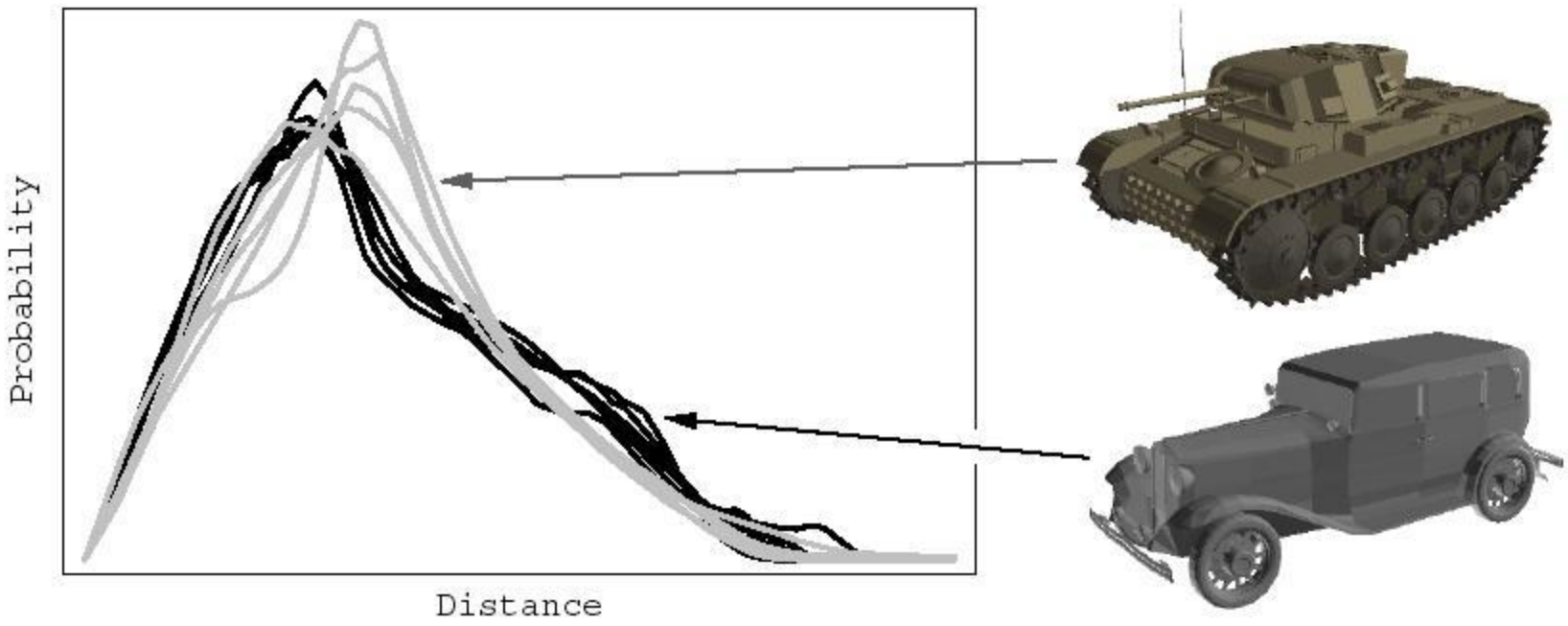
Mario Deuss, Daniele Panozzo, Emily Whiting, Yang Liu
Philippe Block, Olga Sorkine-Hornung, Mark Pauly

(contains audio)

Vision-Related Analysis

Shape Distributions

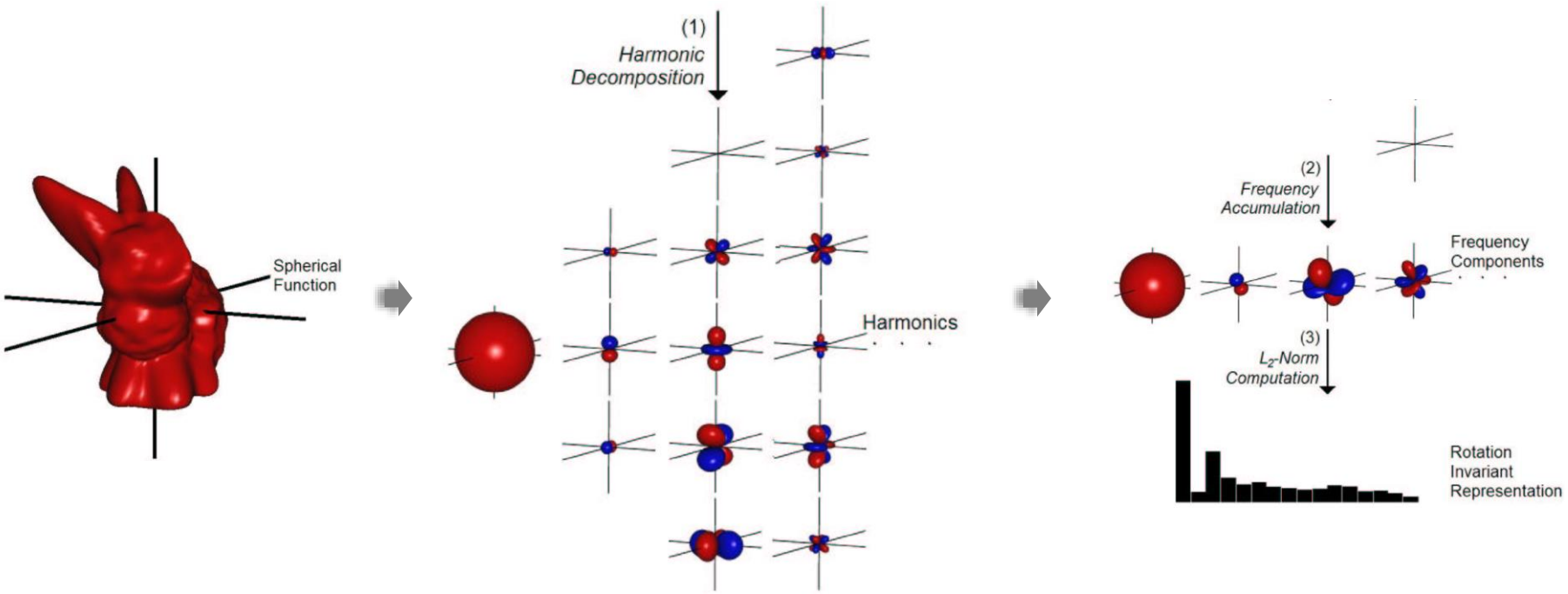
[Osoda et al. 02]



Distributions of pair-wise distances

Invertible

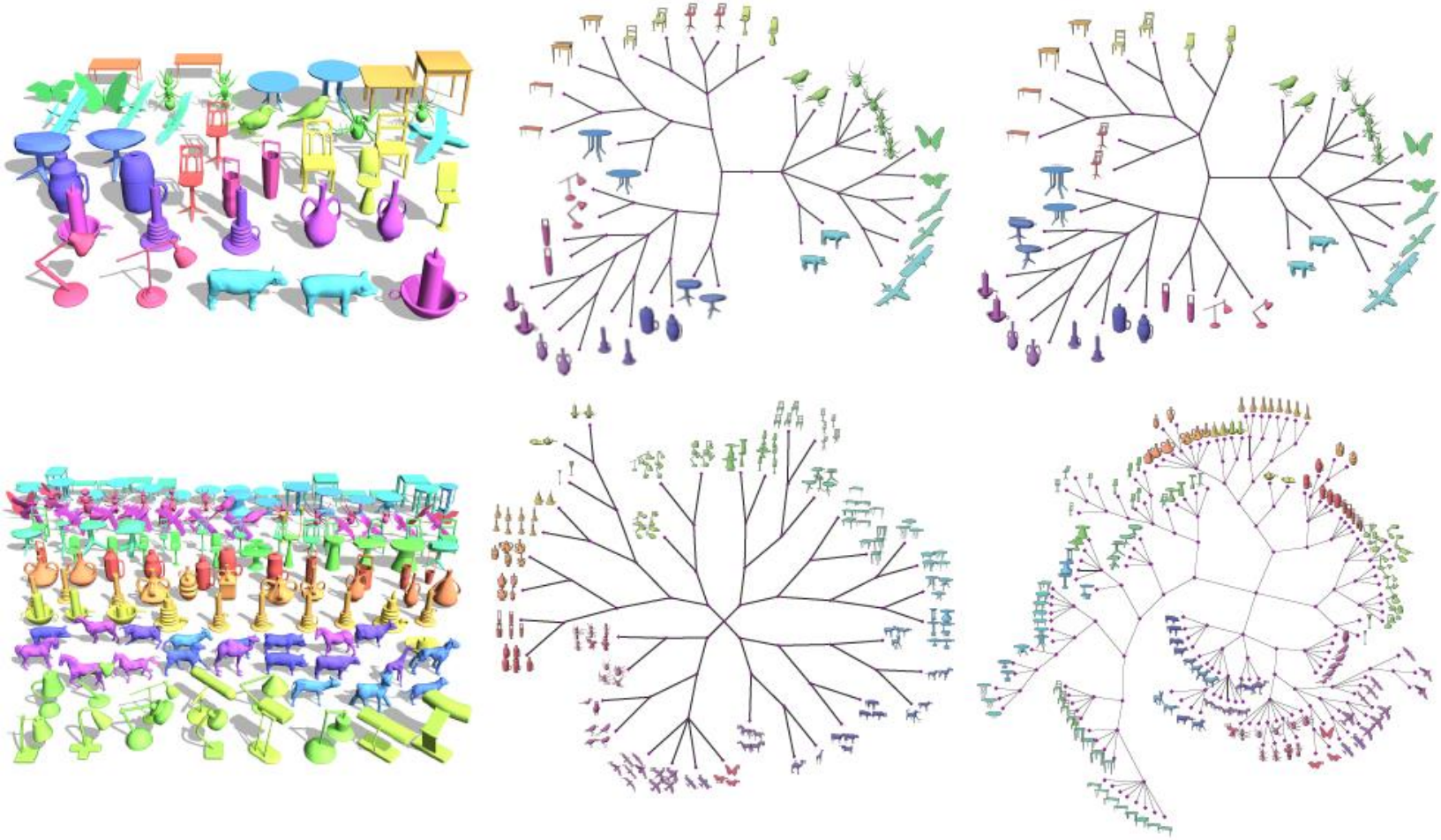
Spherical Harmonics



Light-Field Descriptors

Shape Organization

[Huang et al. 13]

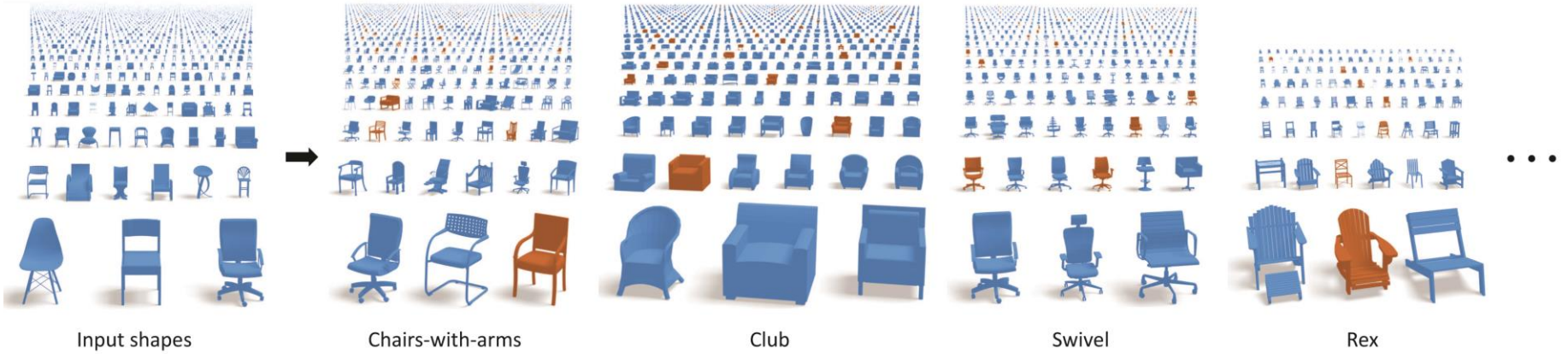


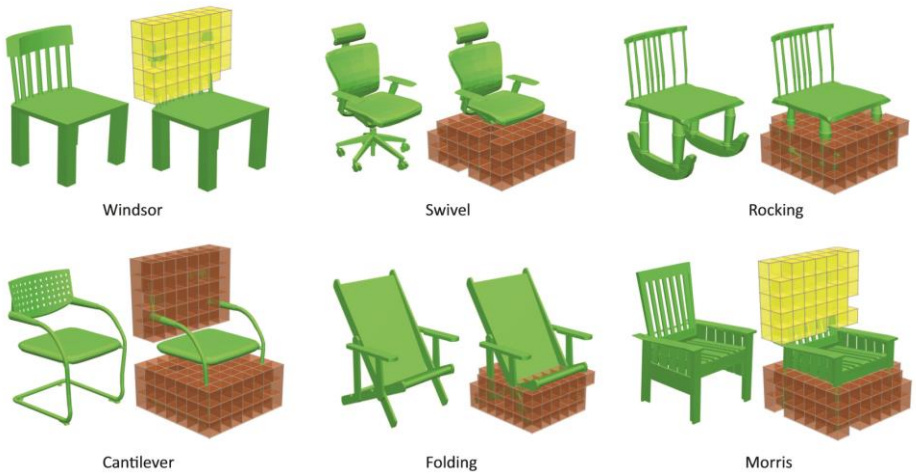
Shape Exploration

[Huang et al. 13]

Fine-grained Shape Classification

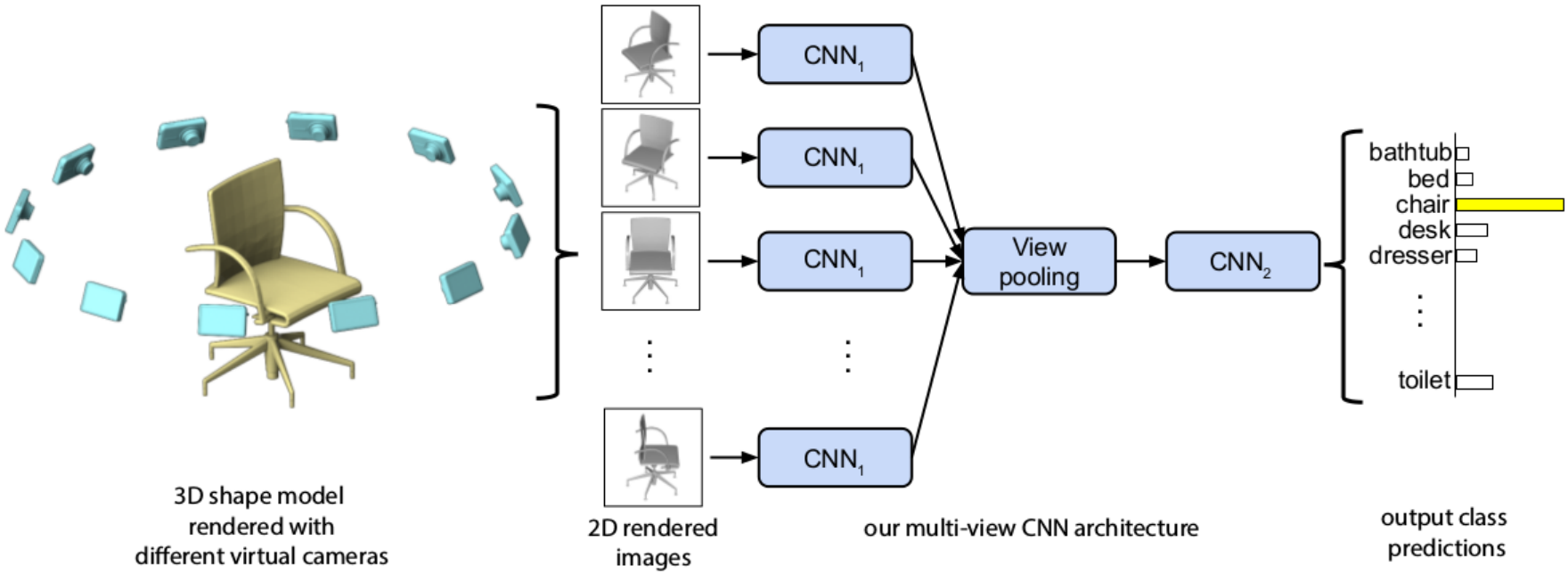
[Huang et al. 13]



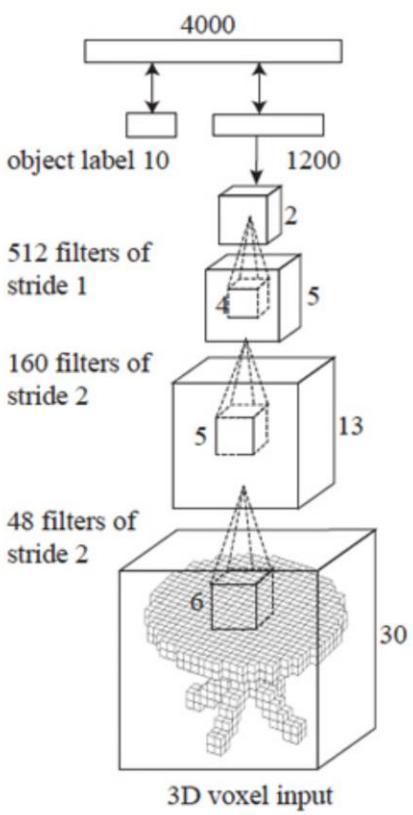


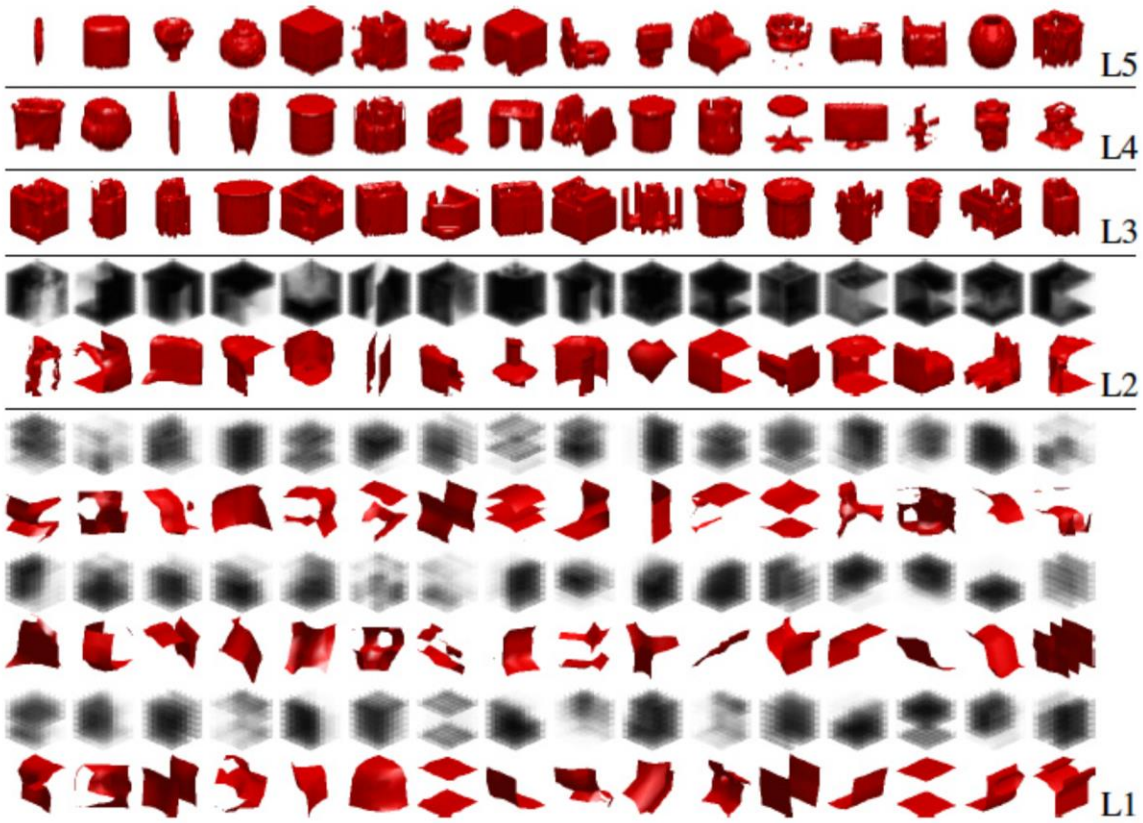
Shape Classification

[Hang et al. 15]



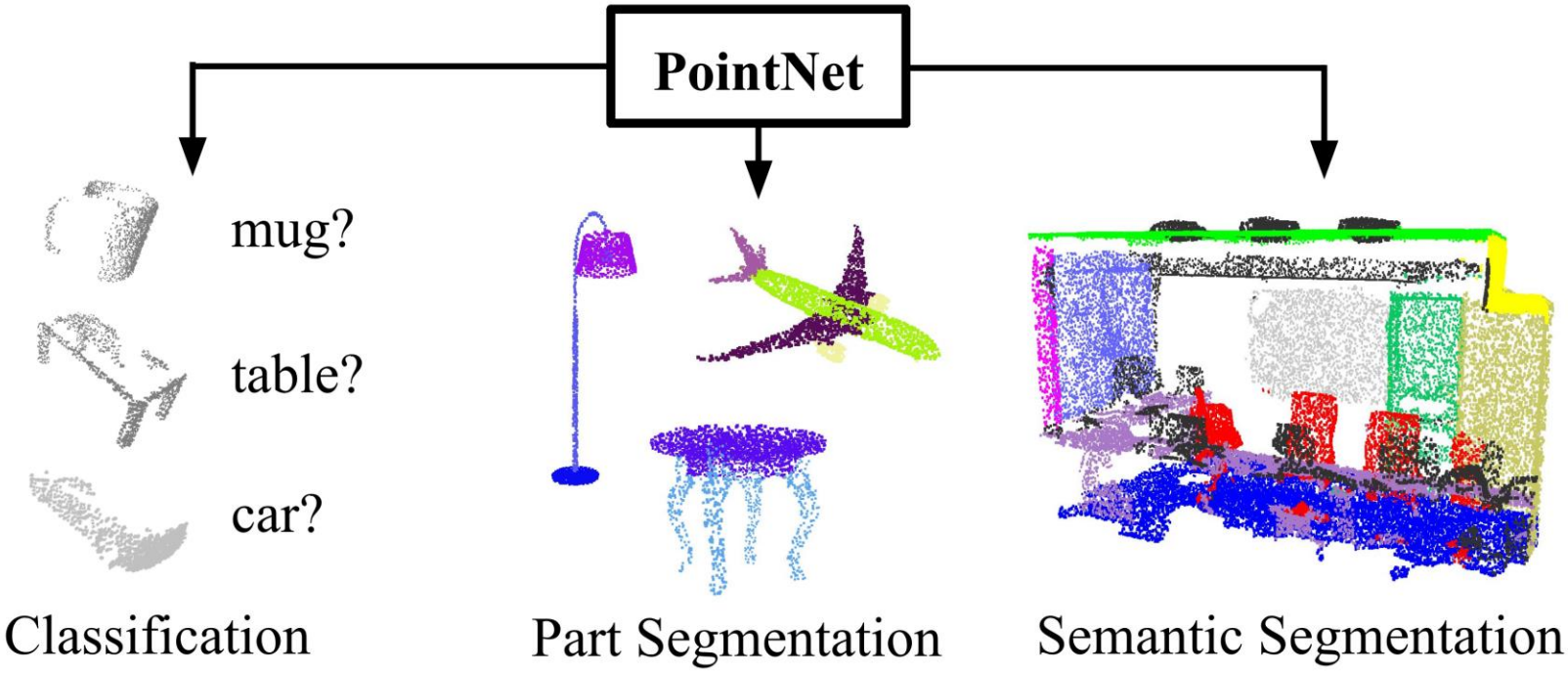
3D Convolutions





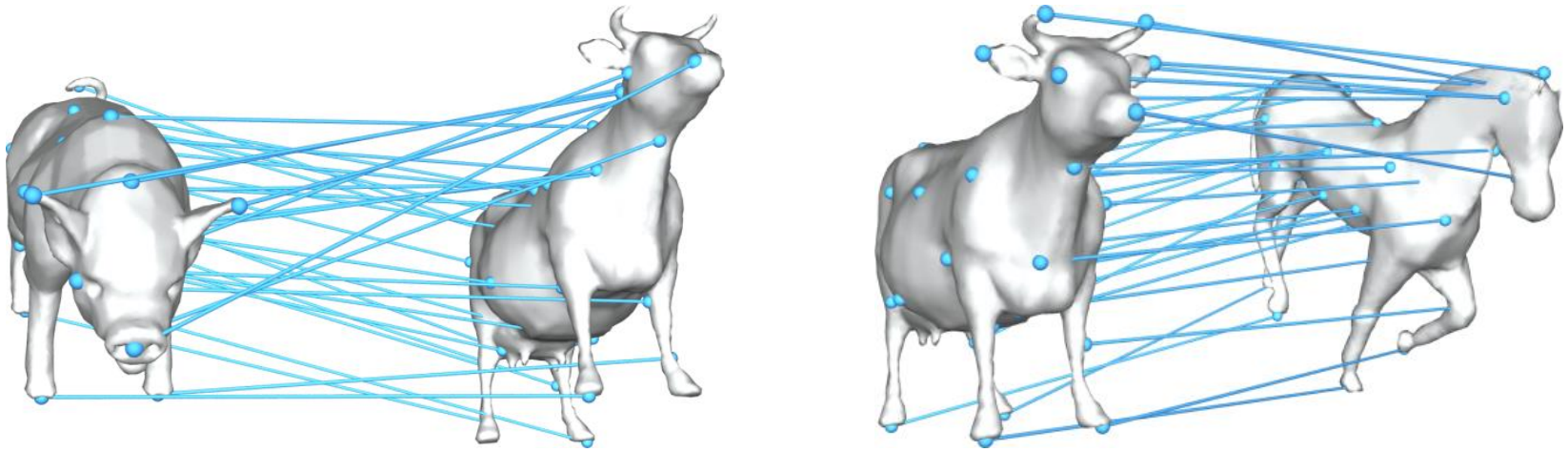
Scene Classification

[Su et al. 16]



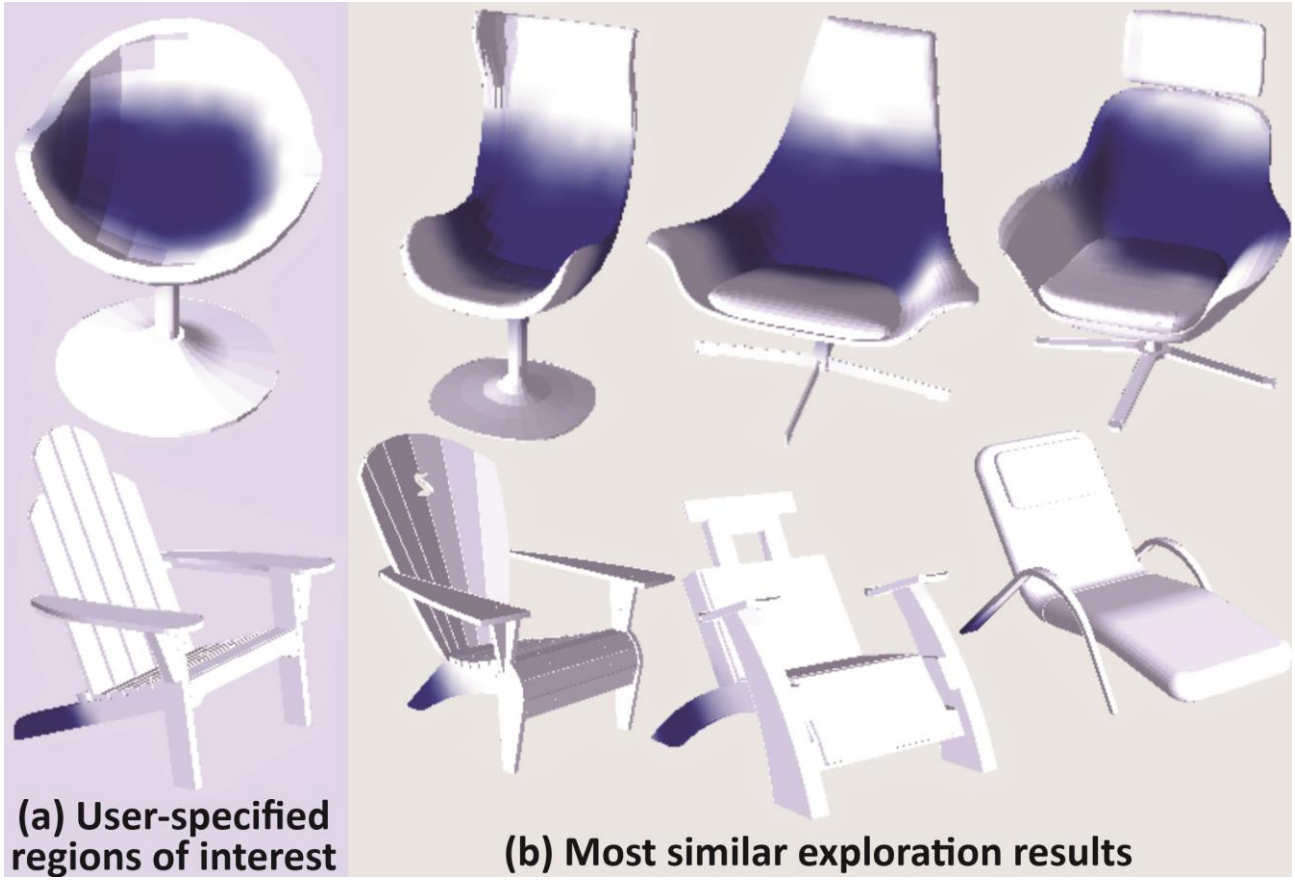
Shape Matching

[Kim et al. 11]



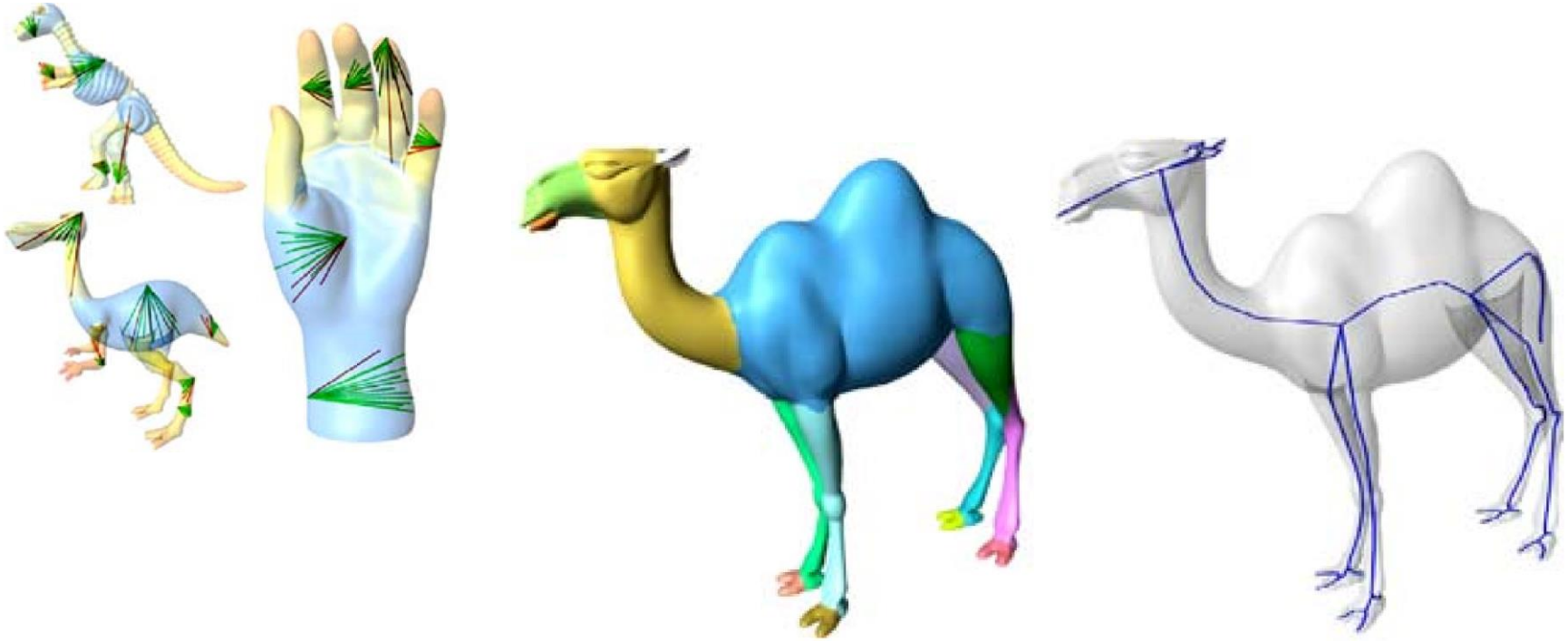
Fuzzy Correspondences

[Kim et al. 12]

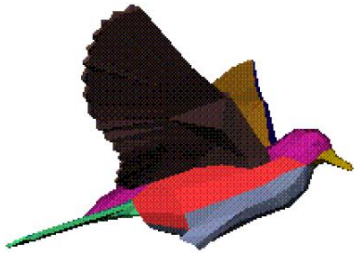


Shape Distance Function

[Shapira et al. 08]



Shape Segmentation

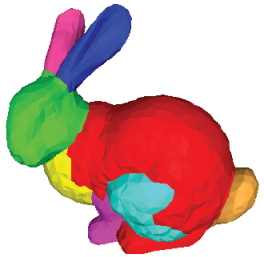


[Shalfman et al. 2002]

K-Means

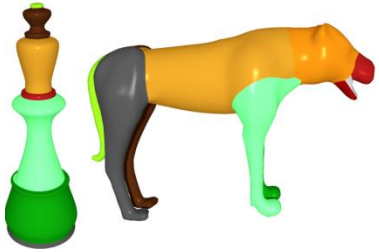
[Katz et al. 05]

Core Extraction



[Golovinskiy and Funkhouser 08]

Normalized Cuts

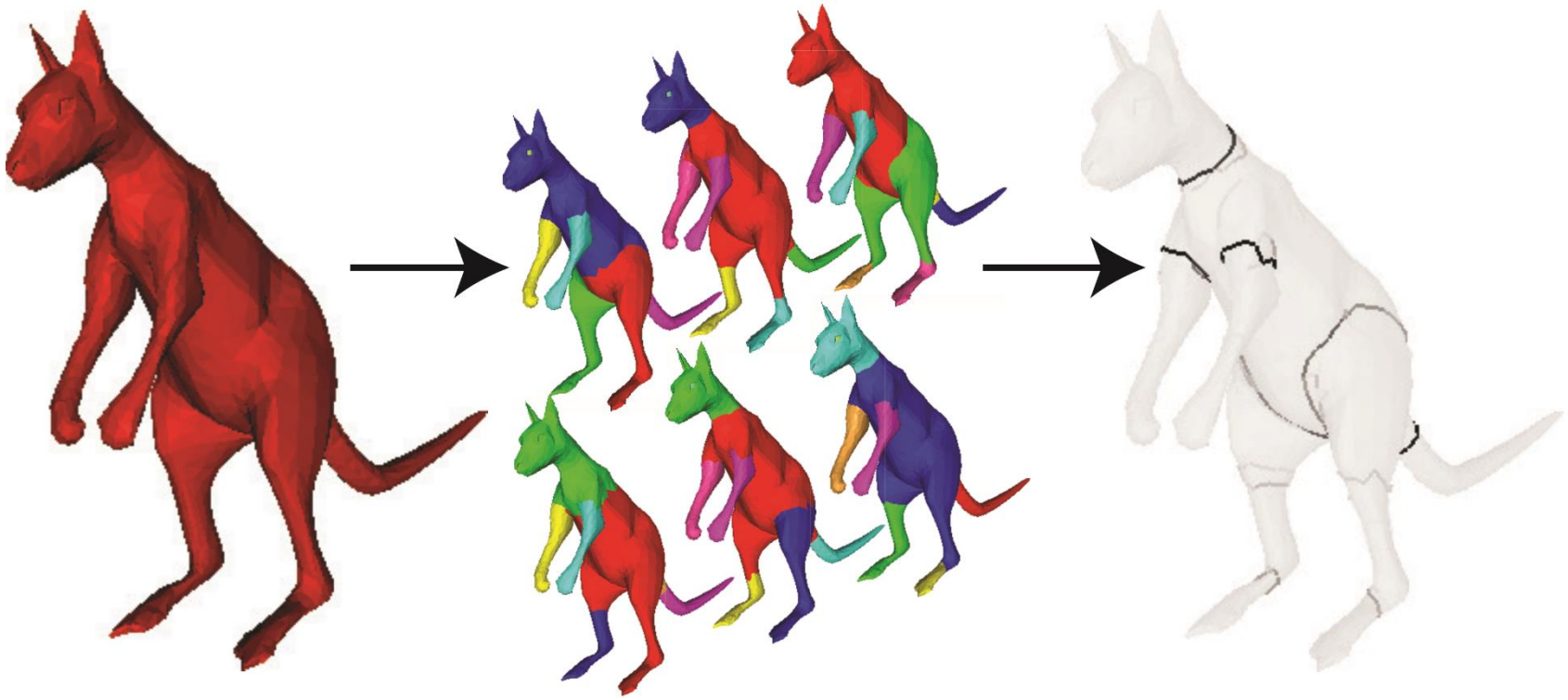


[Lai et al. 08]

Random Walks

Randomized Cuts

[Golovinskiy and Funkhouser' 08]



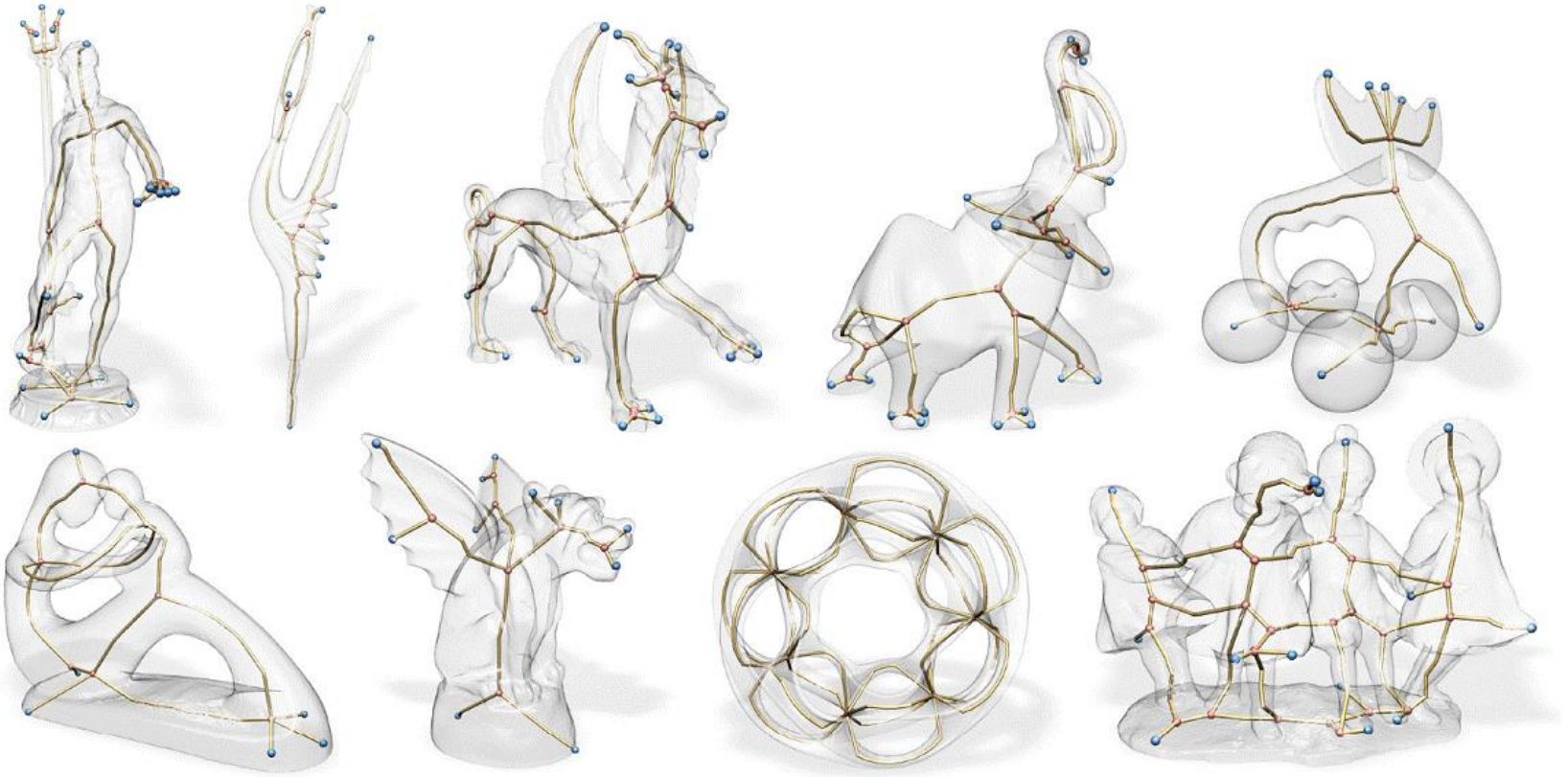
Input mesh

Randomized Cuts

Partition Function

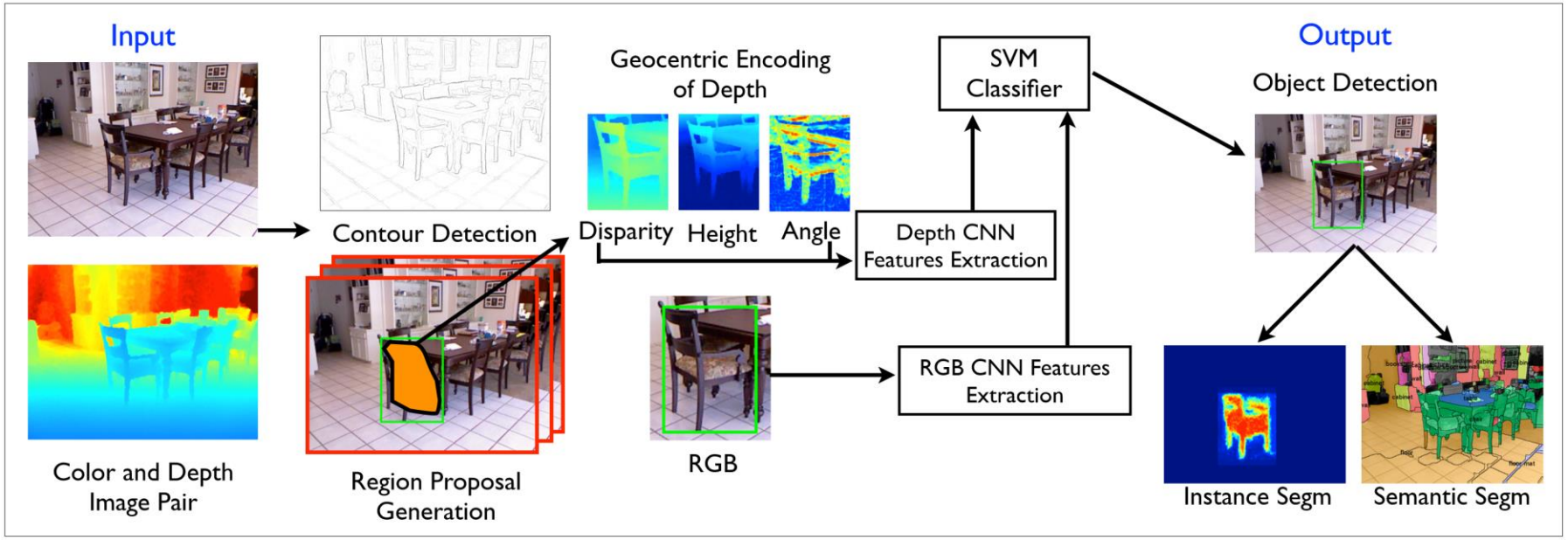
Skeleton Extraction

[Au et al. 08]



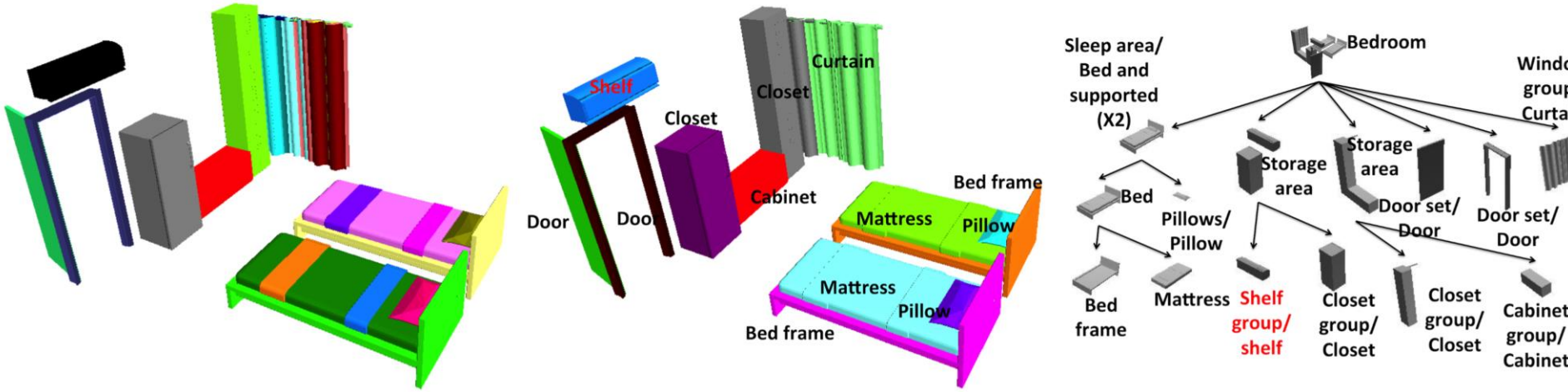
Scene Understanding

[Gupta et al. 14]



Hierarchical Scene Understanding

[Liu et al. 14]



(a) *Input* **(b)** *Output leaf nodes* **(c)** *Output hierarchy*

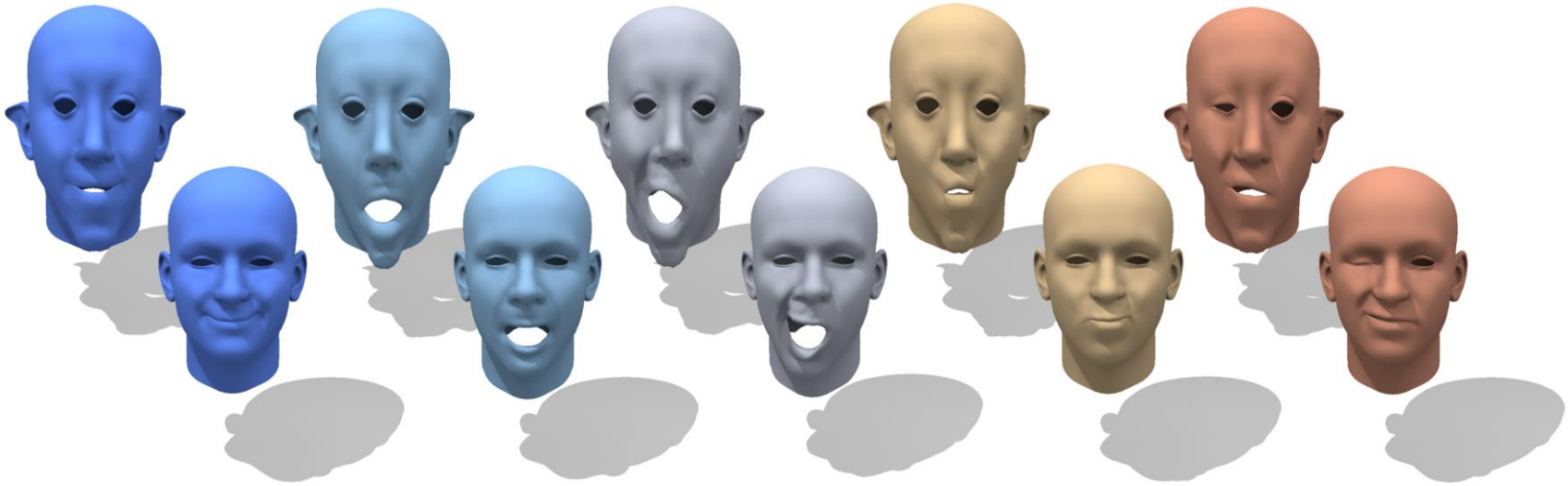
Semantics Analysis --- Functional Labeling

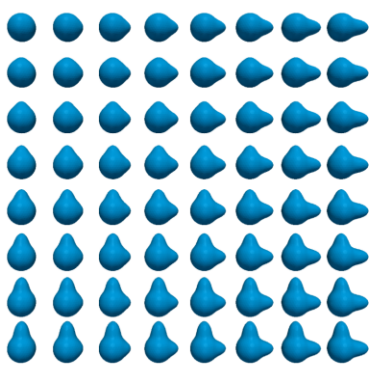
[Hu et al. 15]

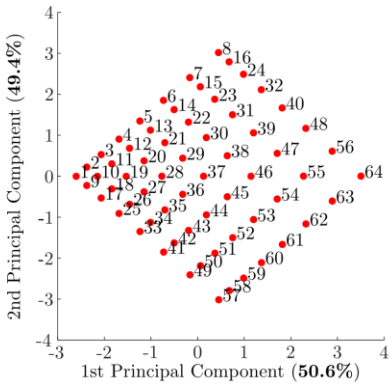
Figure 1: *Similarity between shapes (top) vs. similarity between functionalities (bottom). A shape descriptor (LFD) considers the middle cart more similar to the desk, as shown on the left using a 2D MDS projection of the distances between objects. Our contextual descriptor, interaction context or ICON, takes into account object-to-object interactions and identifies the two carts as more similar.*

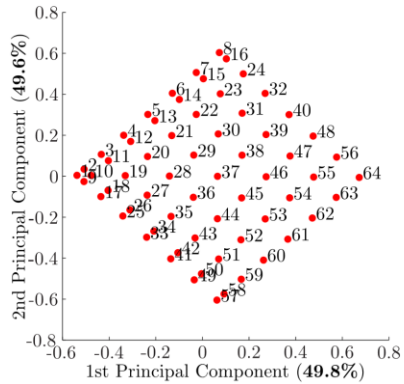
More Shape Analysis --- Shape Difference

[Rustamov et al. 13]









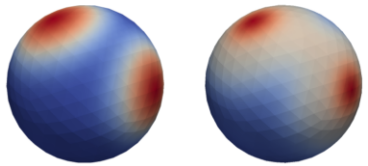
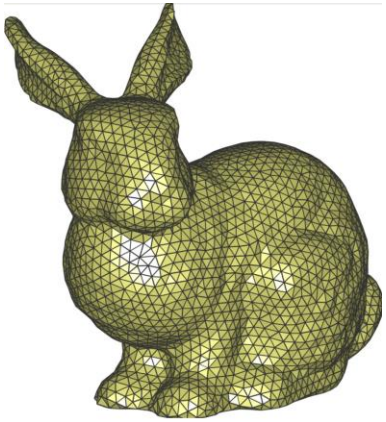


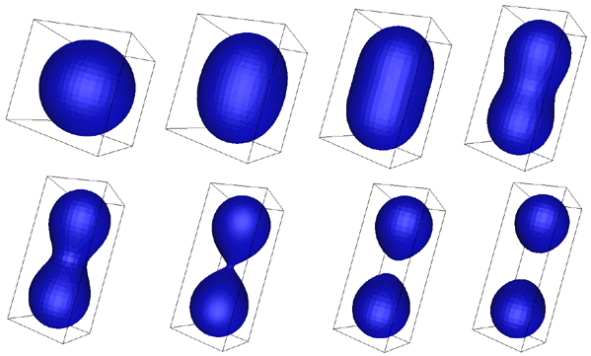
Image Analysis vs Shape Analysis

Data Representation

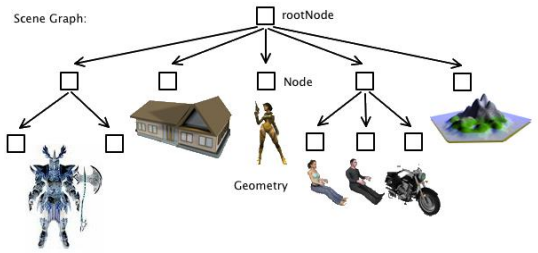


Triangular mesh

Point cloud

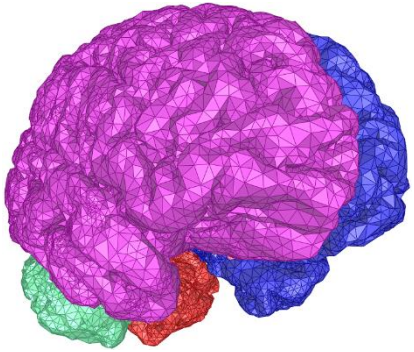


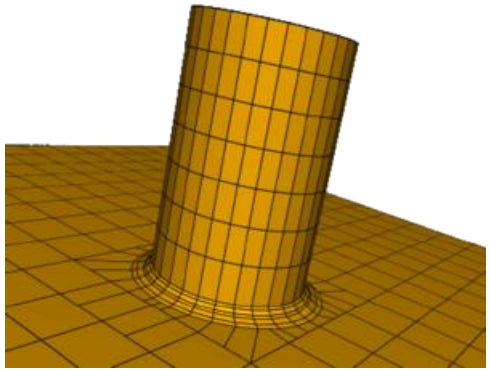
Implicit surface

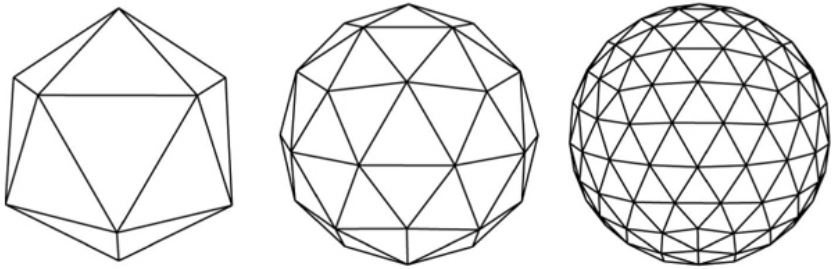


Part-based models

Triangular Meshes



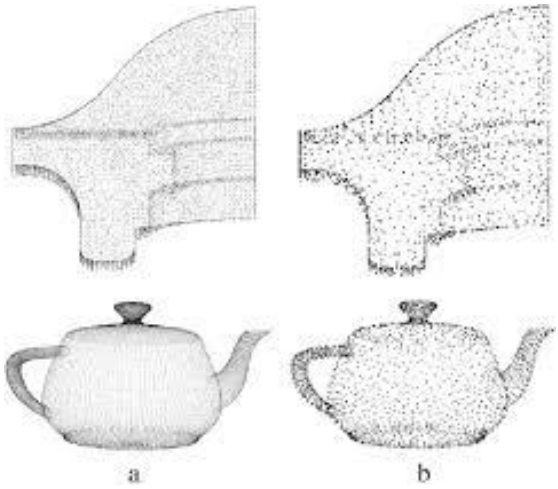


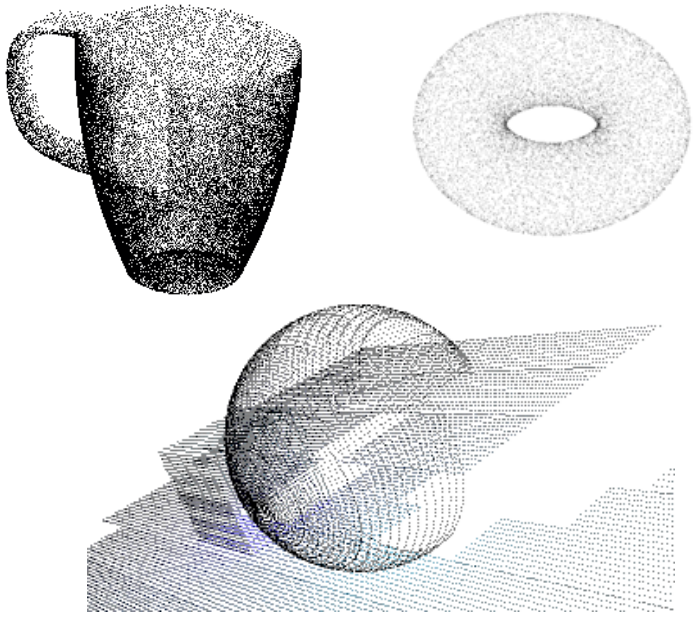


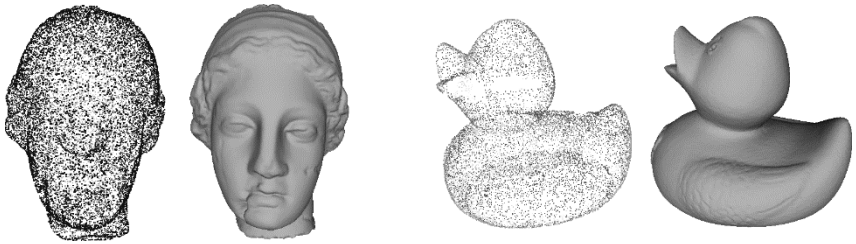
Discrete Exterior Calculus

Subdivision Surfaces

Point Cloud Representation

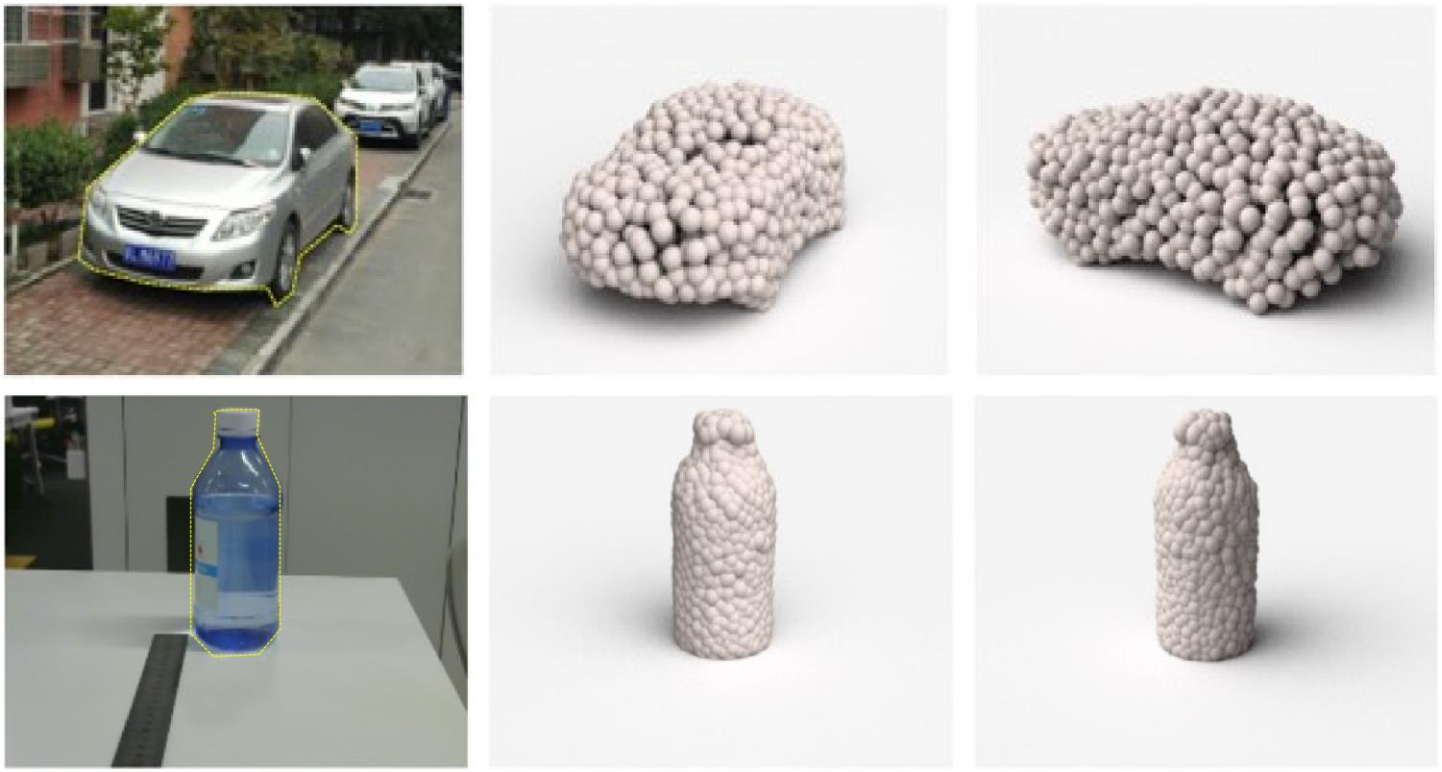




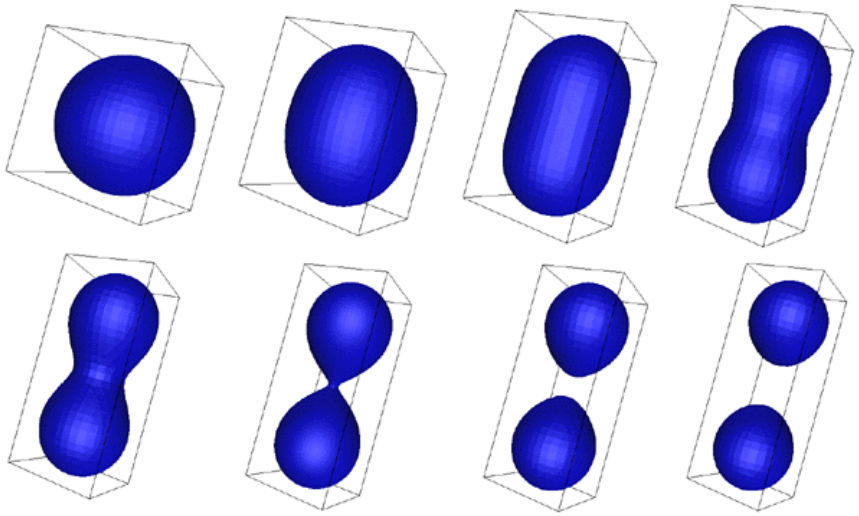


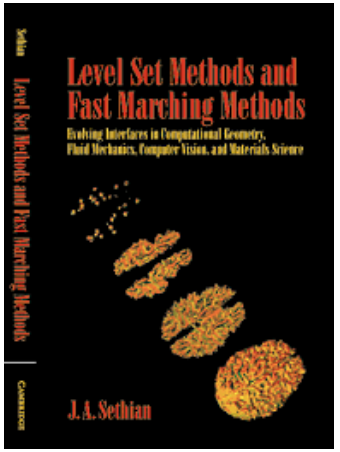
Point Cloud Representation

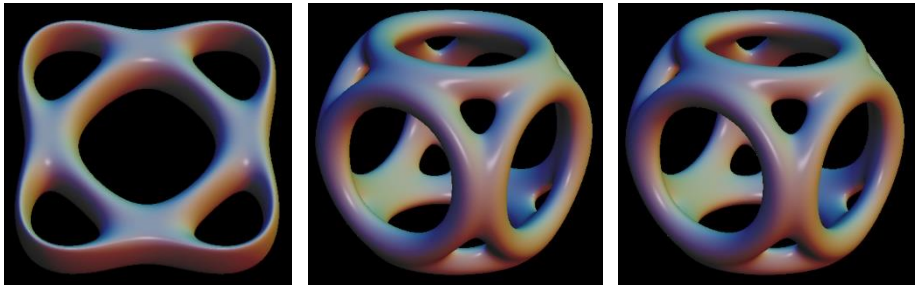
[Su et al. 16]

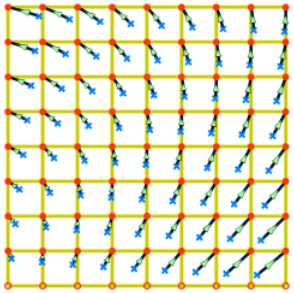


Implicit Surface Representation

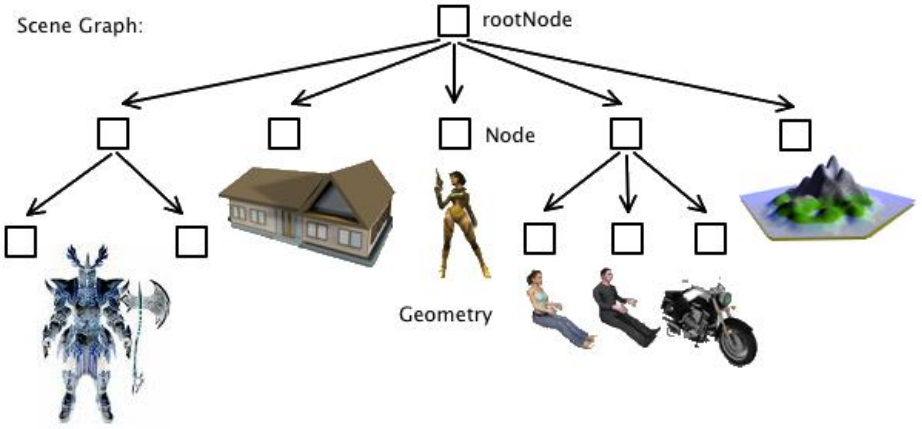


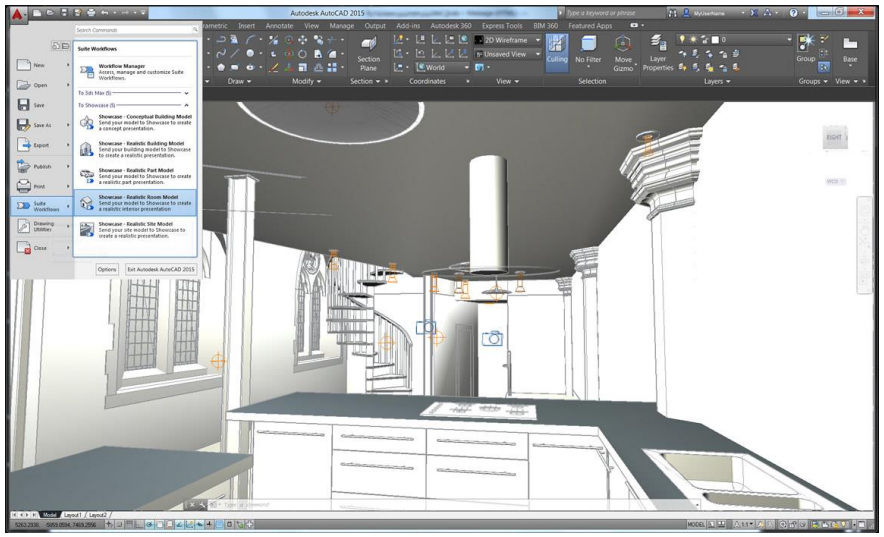




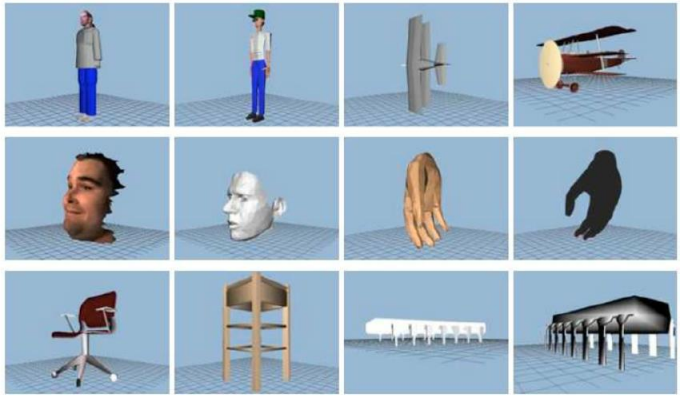


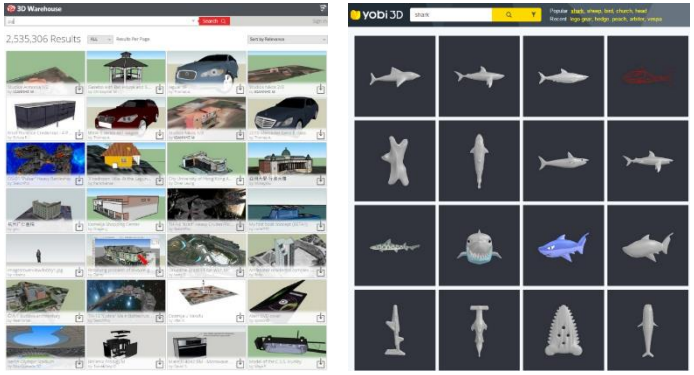
Scene Graph Representation



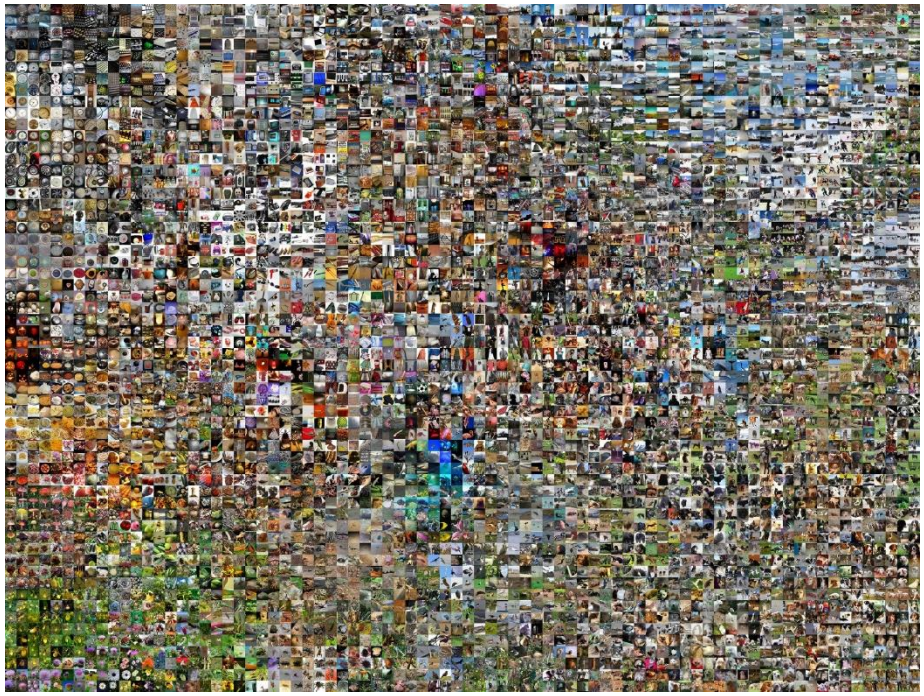


Scalability of Training Data





3M models in more than
4K categories



3.5 Trillion Images

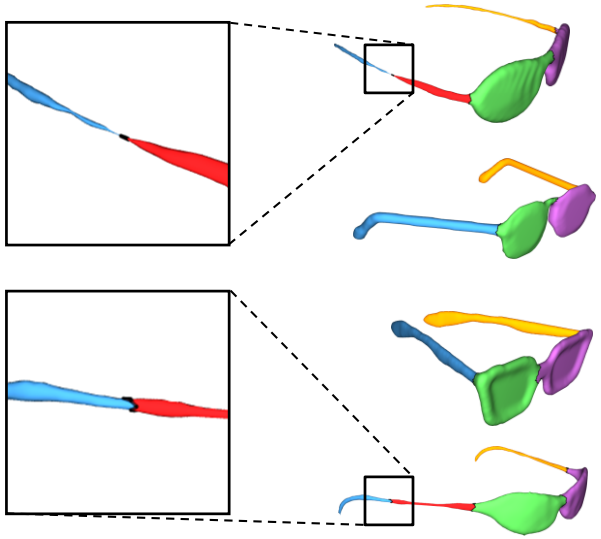
The impact of BigData

Single Analysis vs Joint Analysis

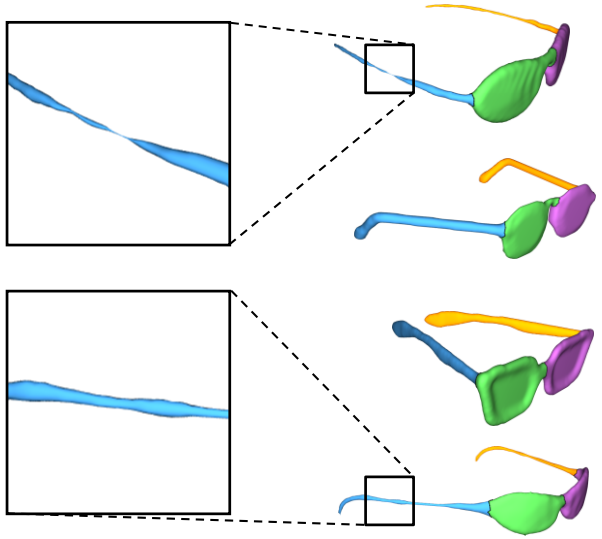
Structural similarity of segmentations

- Extraneous geometric clues

Single shape segmentation
[Chen et al. 09]



Joint shape segmentation
[Huang et al. 11]

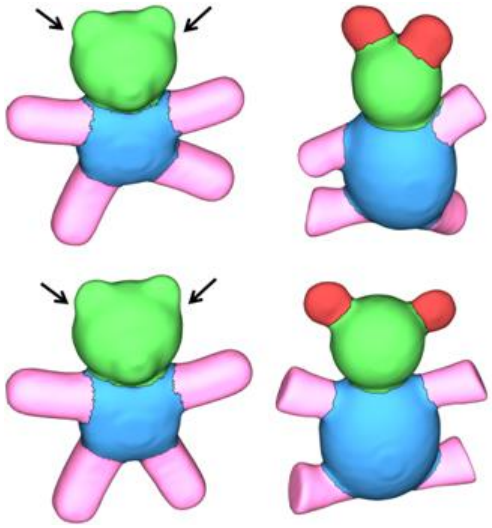


Single Analysis vs Joint Analysis

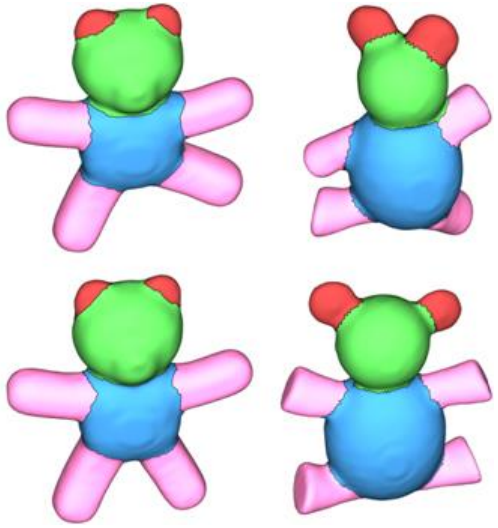
Structural similarity of segmentations

- Low saliency

Single shape segmentation
[Chen et al. 09]



Joint shape segmentation
[Huang et al. 11]

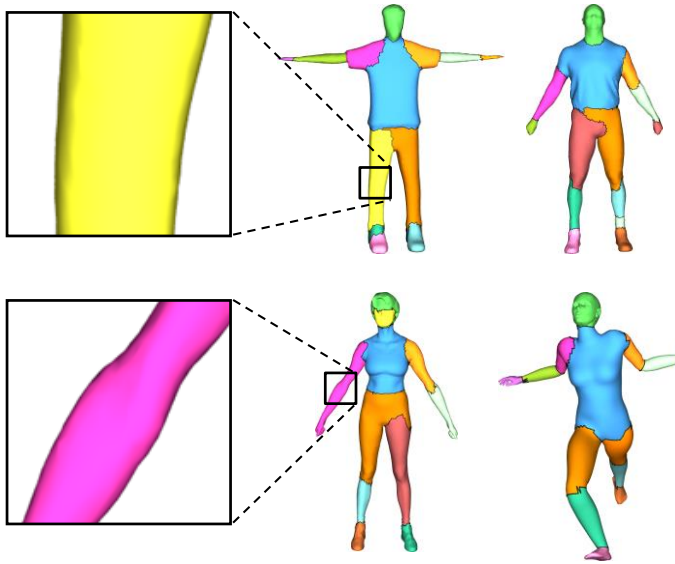


Single Analysis vs Joint Analysis

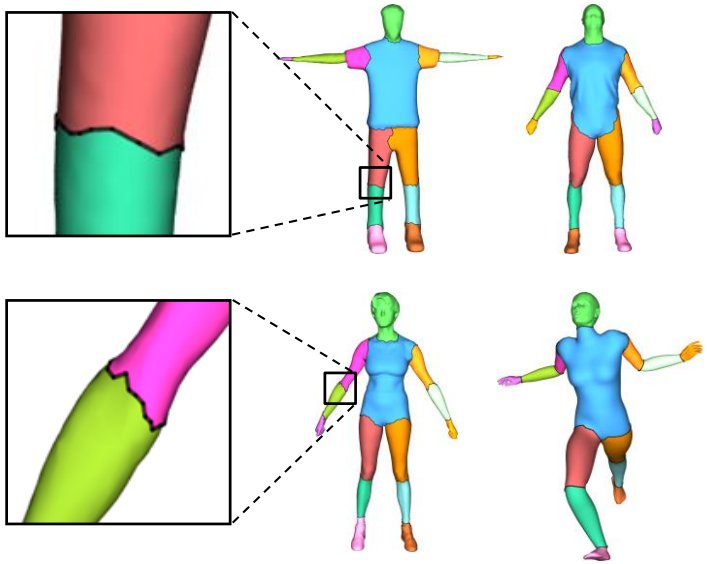
(Rigid) invariance of segments

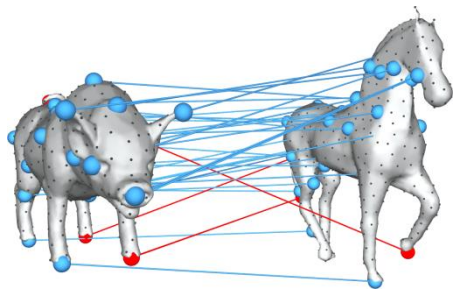
- Articulated structures

Single shape segmentation
[Chen et al. 09]



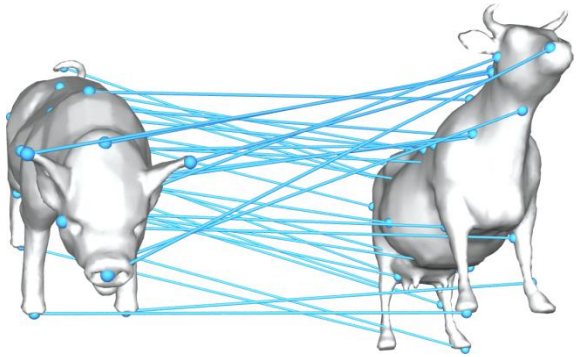
Joint shape segmentation
[Huang et al. 11]

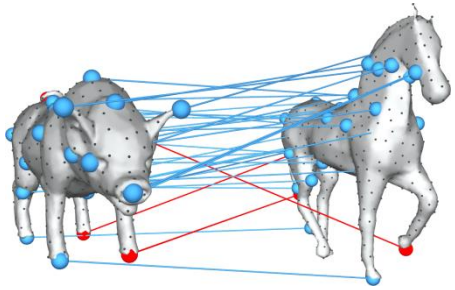




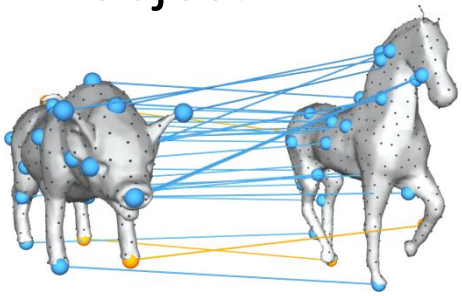
Blended intrinsic maps
[Kim et al. 11]

Matching through intermediate objects --- map propagation



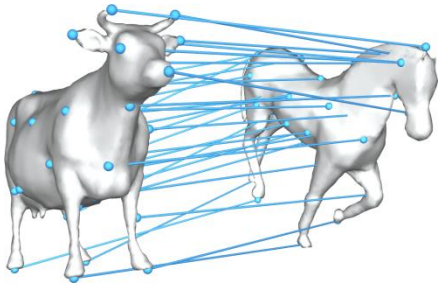


Intermediate object

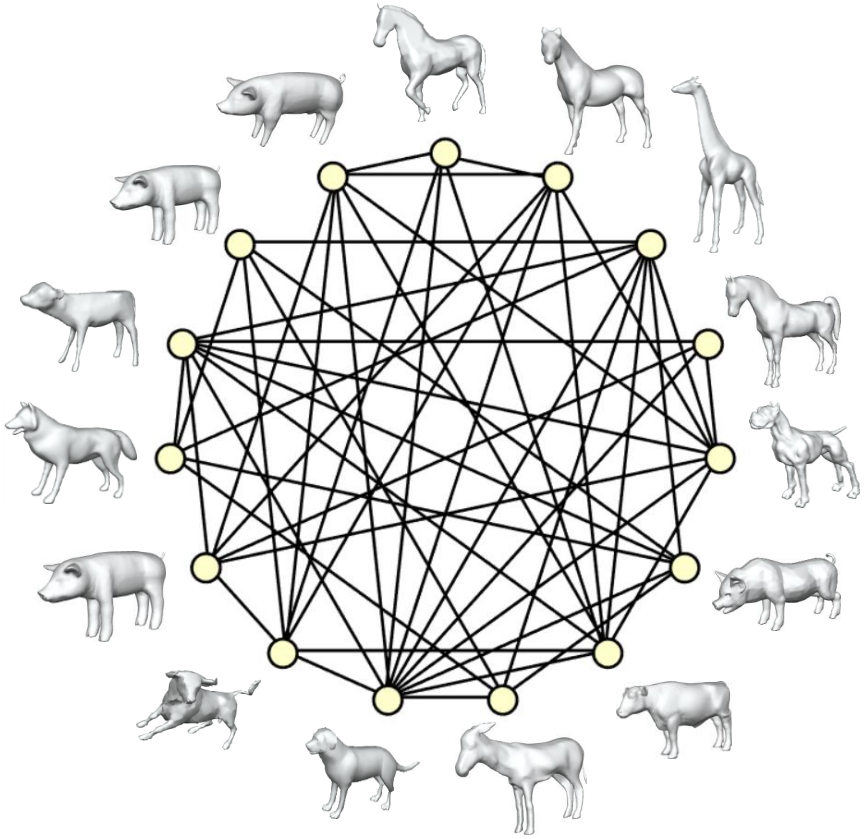


Composite map

Blended intrinsic maps [Kim et al. 11]

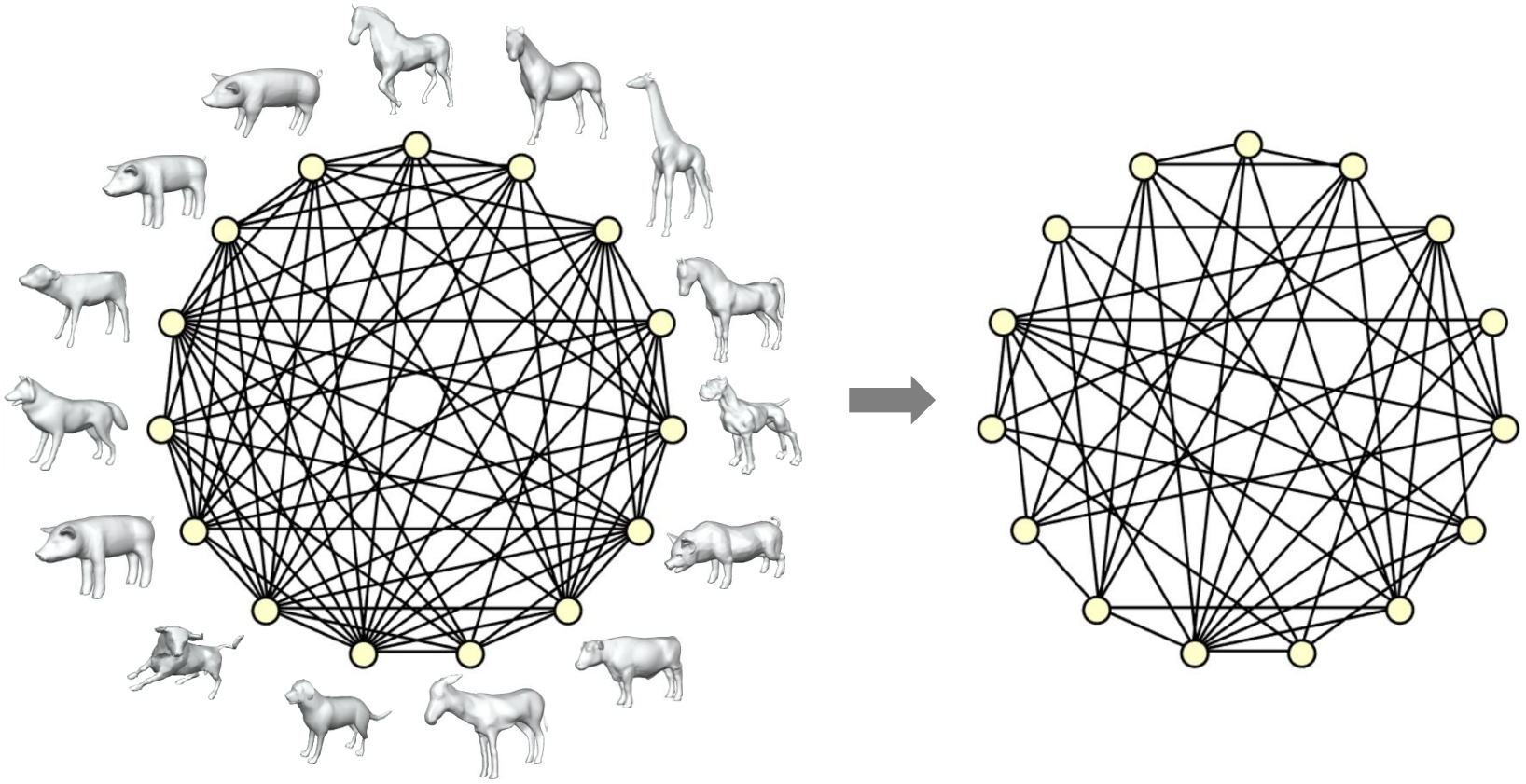


In the data collection, correct maps usually form a connected sub-graph



Network of approximately correct blended intrinsic maps

The map synchronization problem



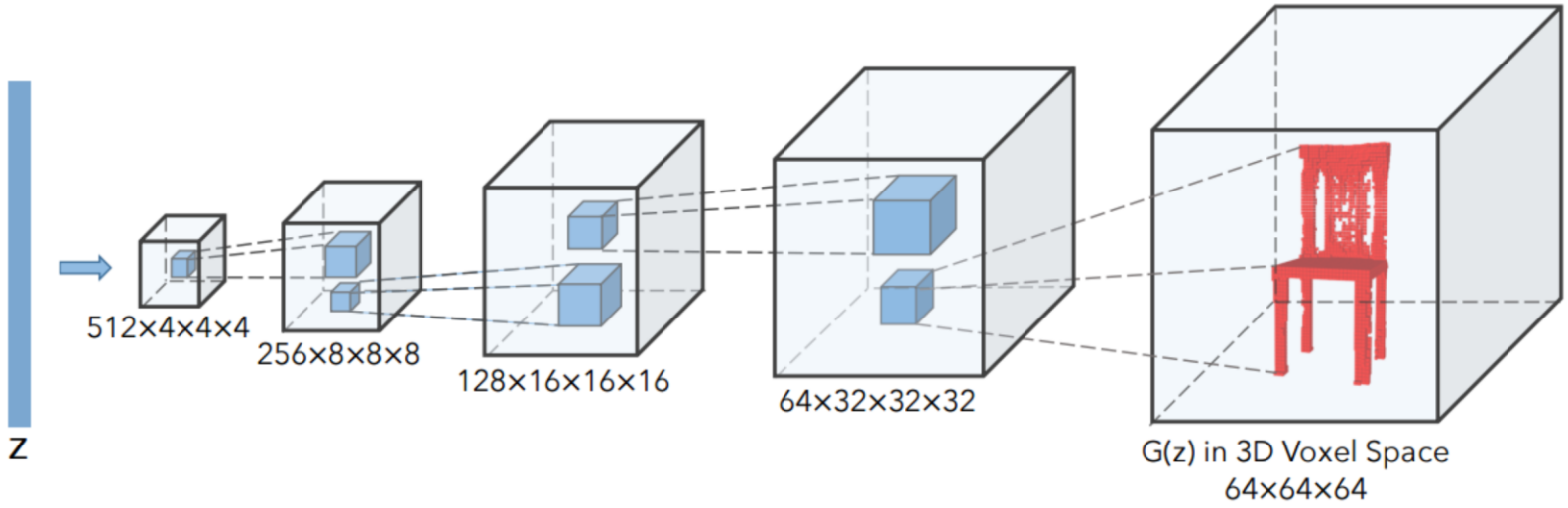
Identify correct maps among a (sparse) network of maps

The Influence of Deep Learning

ShapeNet3D

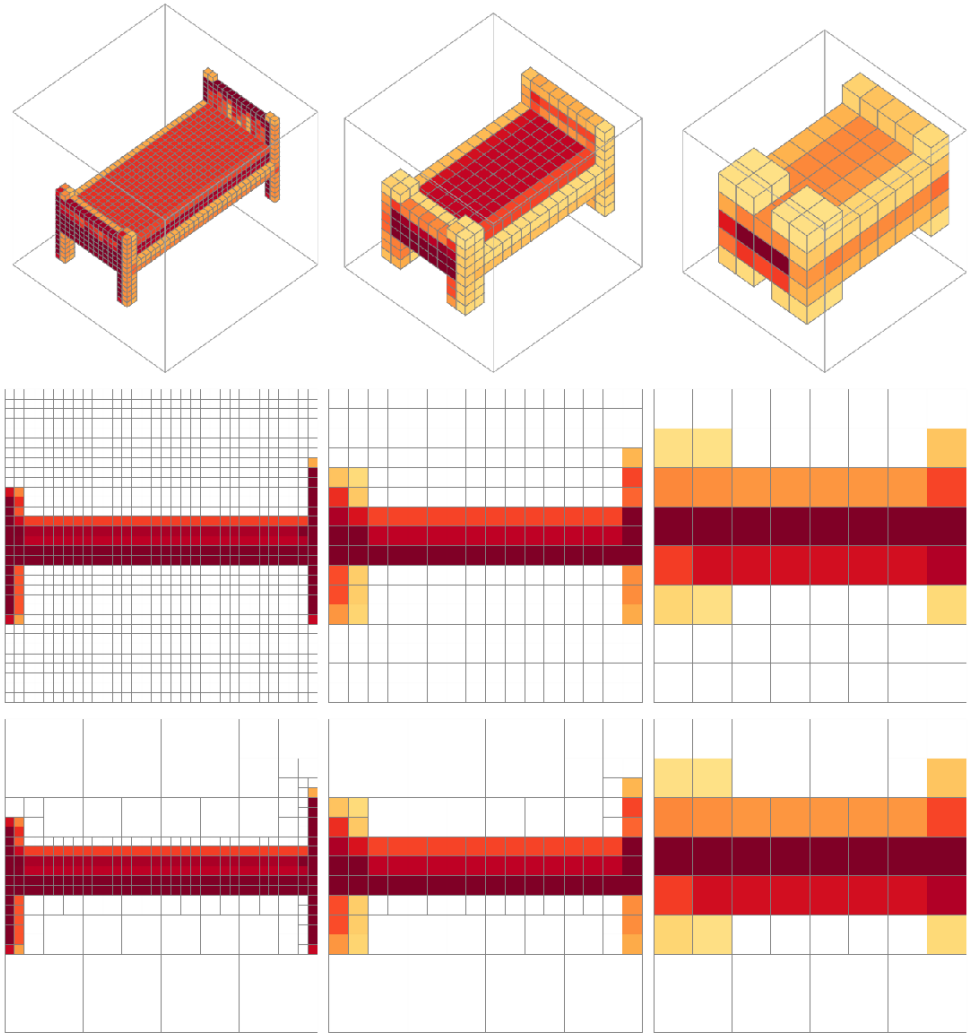
Generative Adversarial Network for 3D Voxel Grid

[Wu et al. 16]



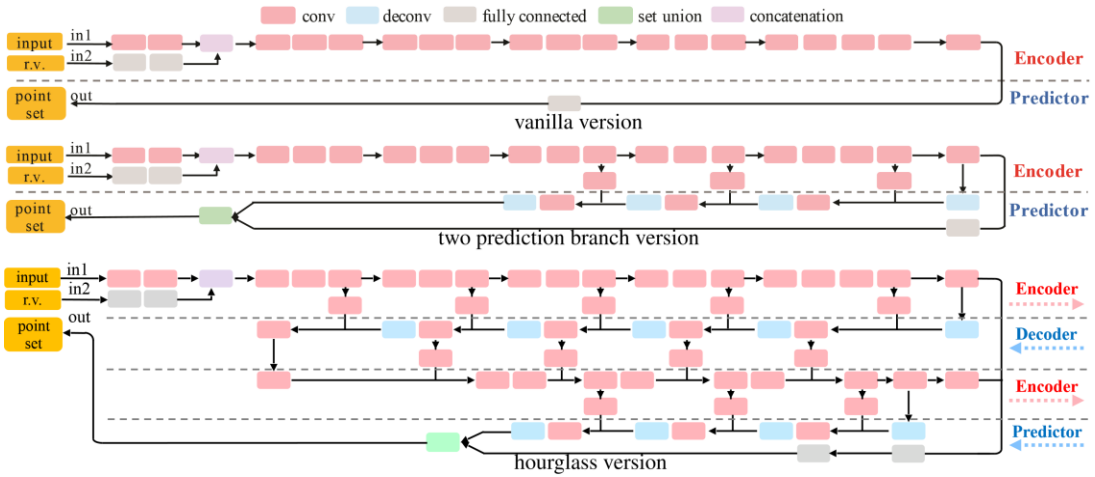
Sparse Convolutions

[Riegler et al. 16]

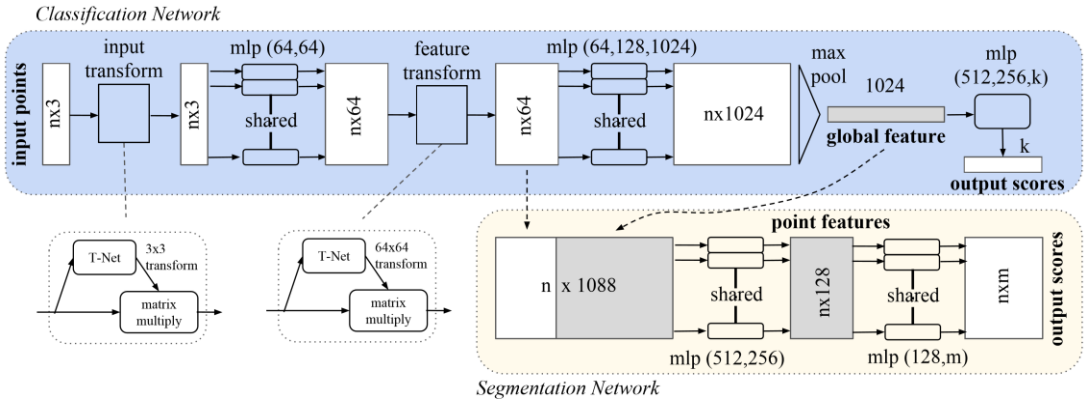


Deep Architecture for 3D Point Clouds

[Su et al. 16a, 16b]



Generative Model



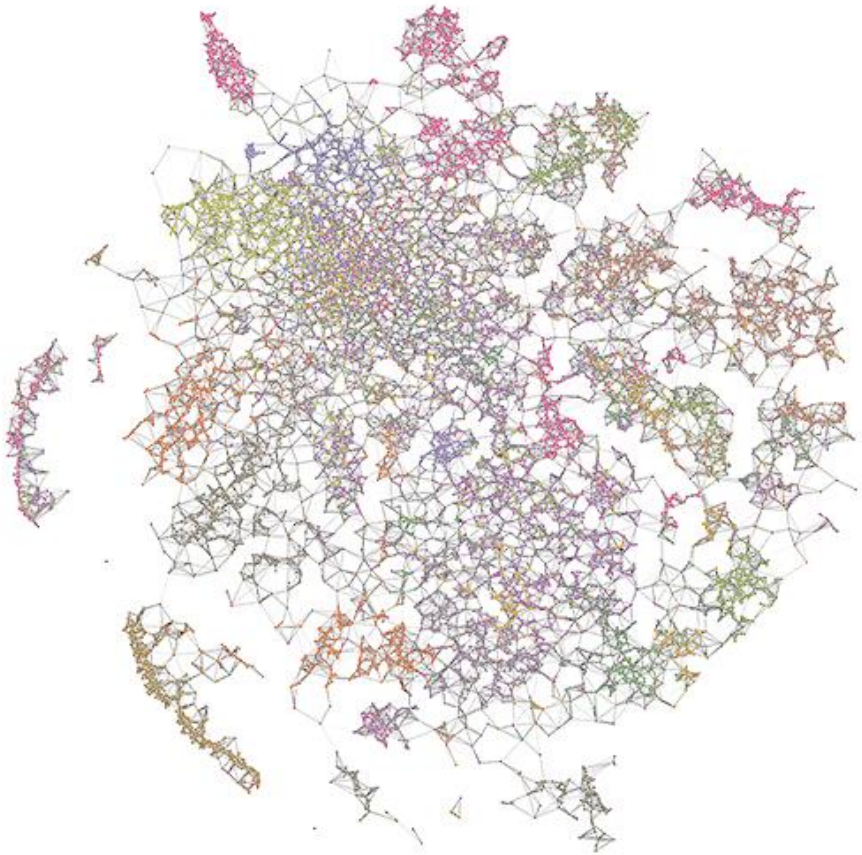
Classification

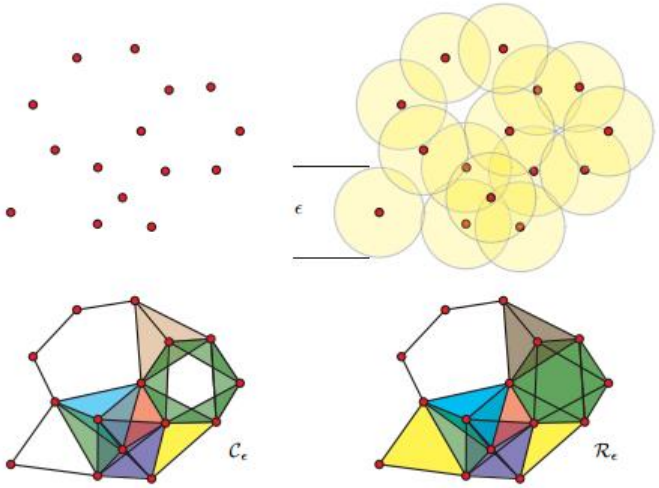
Triangular Meshes?

Scene Graphs?

Other Topics

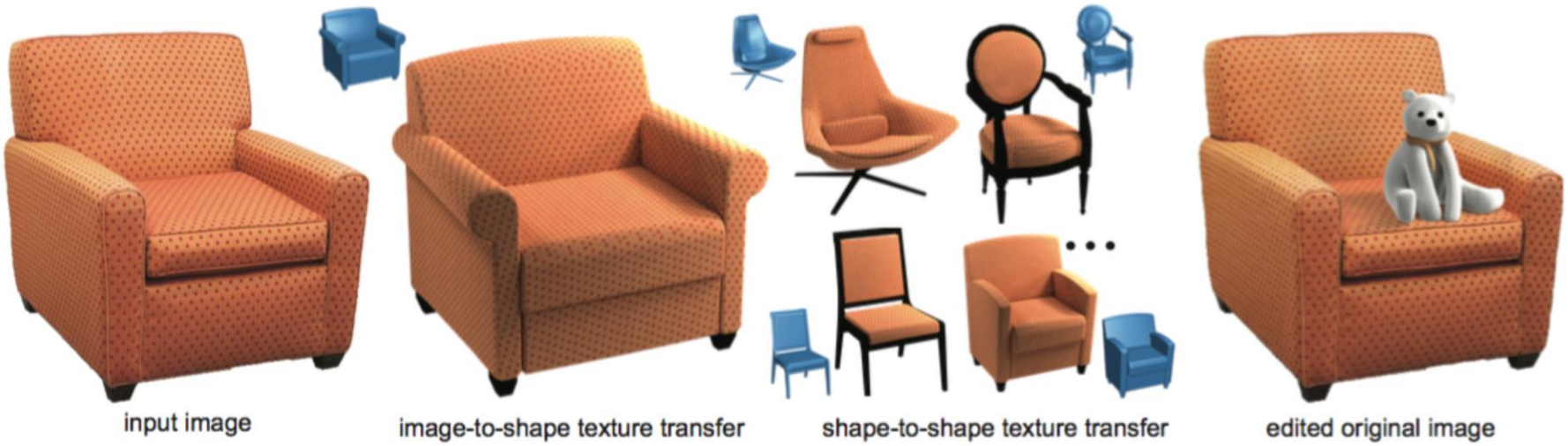
Topological Data Analysis





Joint Image and Shape Analysis

[Y. Wang et al. 16]



Discussion