Deluge of geometric data

KINECT for XBOX 360 SoftKinetic The Interface is You

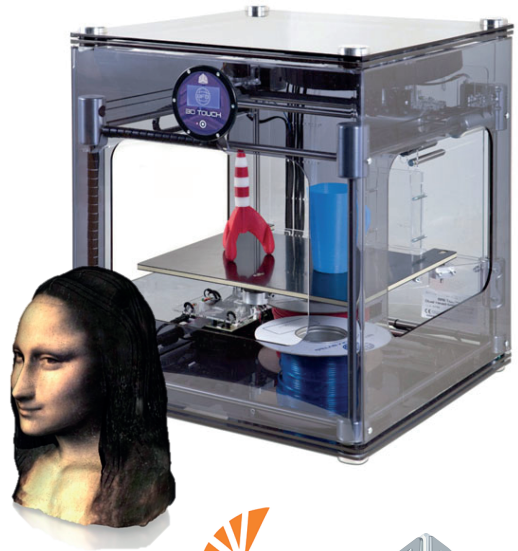
intel REALSENSE

3D sensors

Google 3D warehouse

shapeways

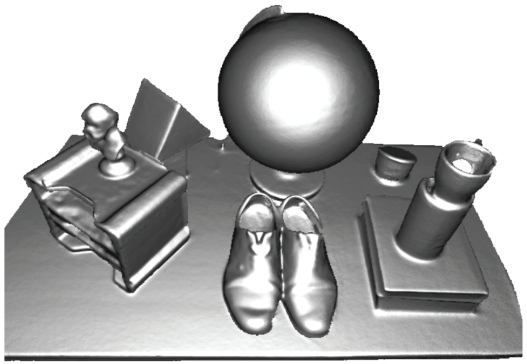
Repositories



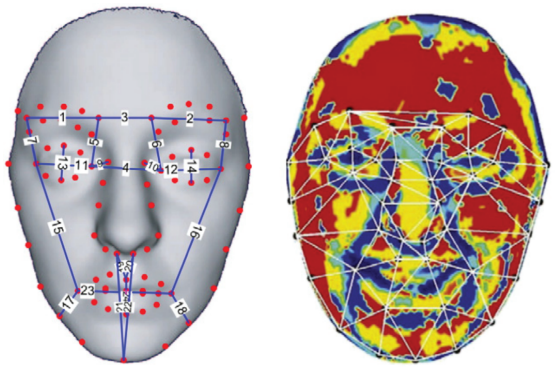
Stratasys 3DSYSTEMS

3D printers

Applications



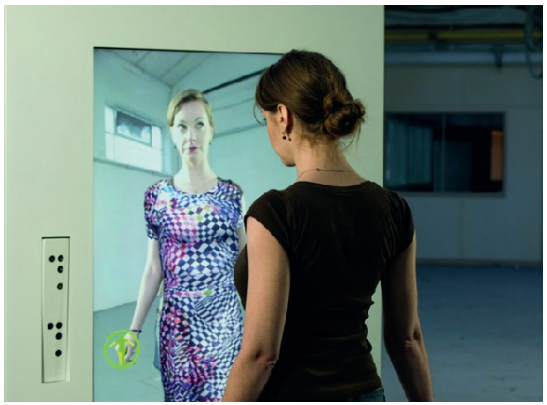
Reconstruction



Recognition

Retrieval

Avatars

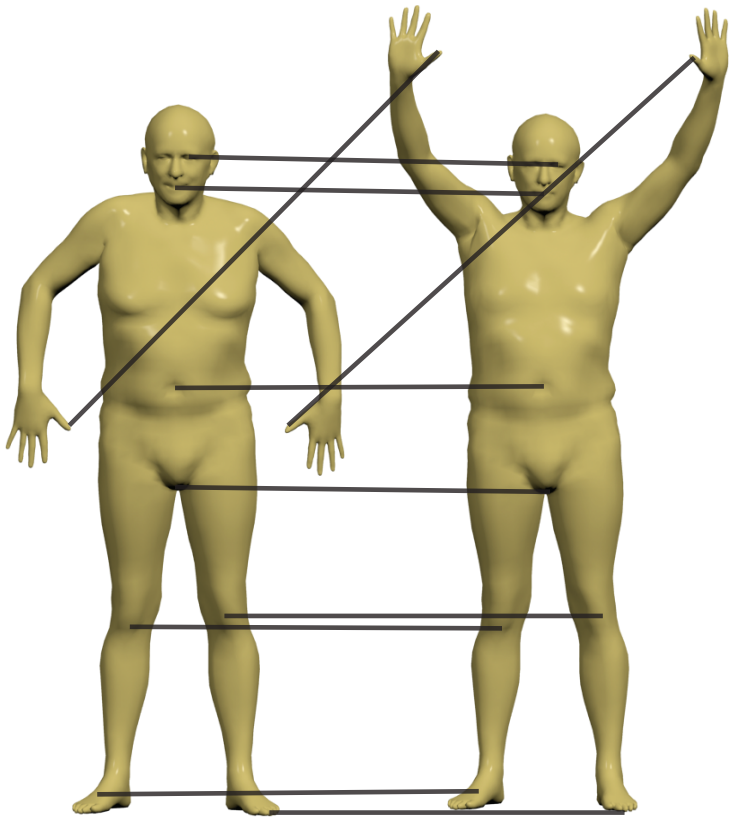


Virtual dressing

Gesture control

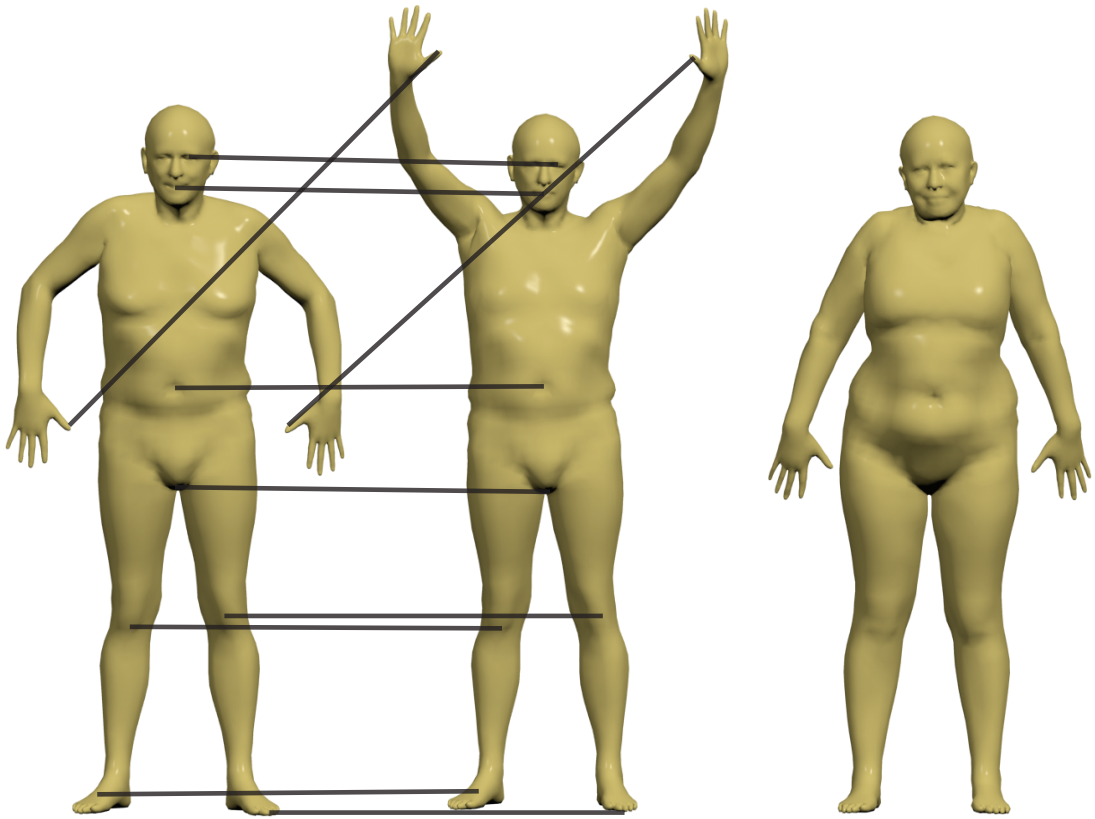
Images: Davison et al. 2011; Zaiferiou et al. 2012; Kim et al. 2013; Faceshift; Fashion3D; Minority report

Basic problems: shape similarity and correspondence



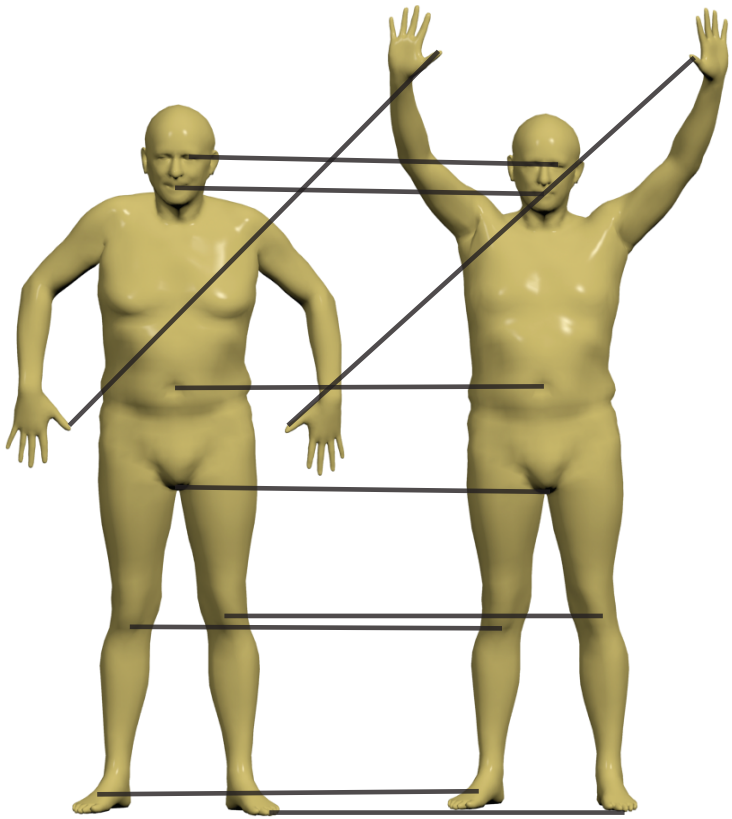
Isometric

Basic problems: shape similarity and correspondence



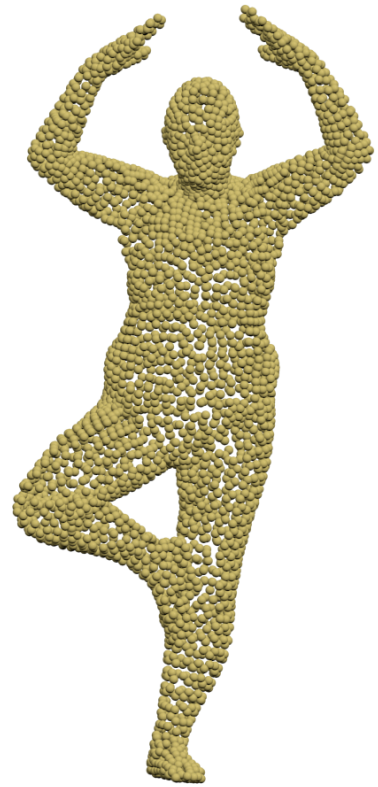
Isometric Non-isometric

Basic problems: shape similarity and correspondence



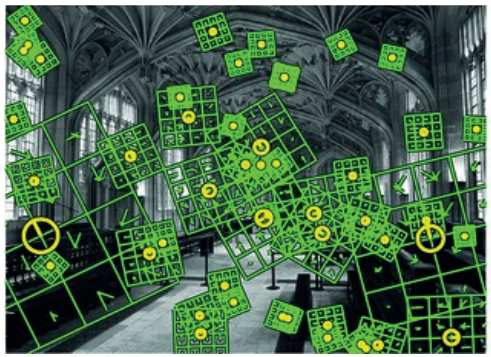
Isometric

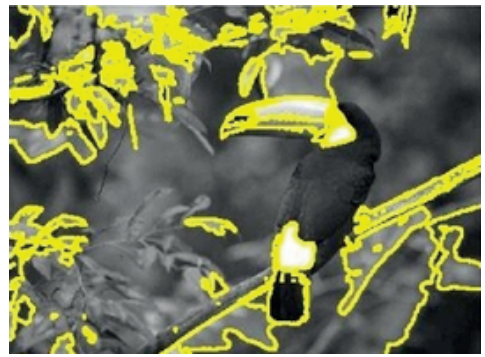
Non-isometric

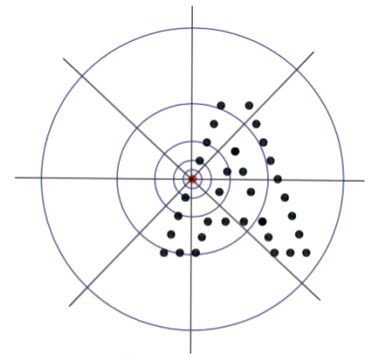


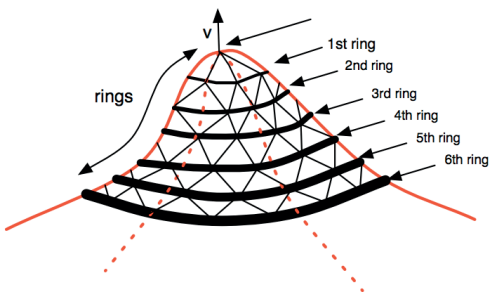
Different representation

3D feature descriptors



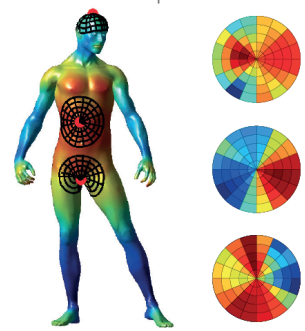




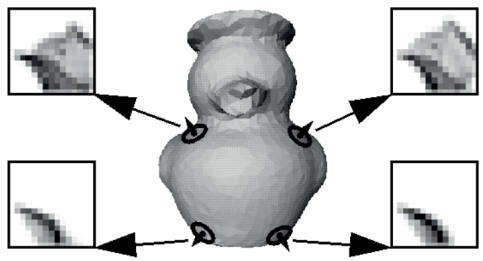


SIFT[1] / MeshHOG[2]

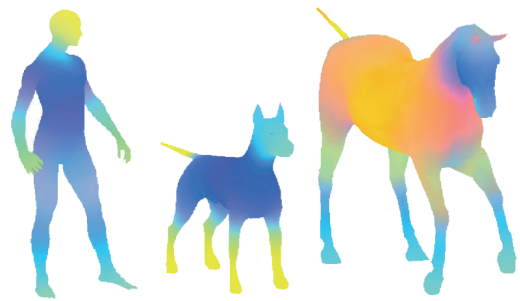
MSER[3] / ShapeMSER[4]



(Intrinsic[6]) Shape context[5]



Spin image[7]

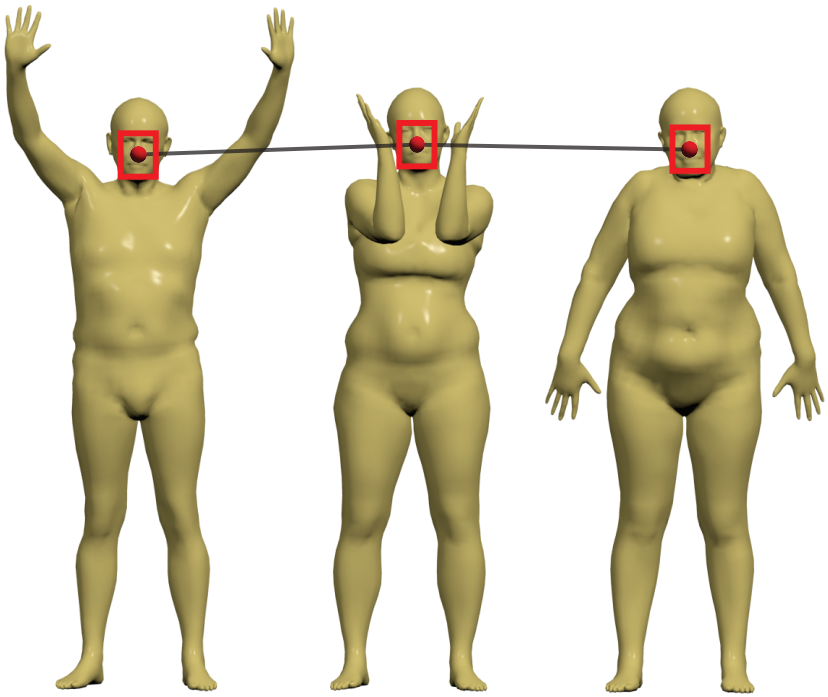


Heat kernel signature[8]

[1]Lowe 2004; [2]Zaharescu et al. 2009; [3]Matas et al. 2002; [4]Litman et al. 2010;
[5]Belongie et al. 2000; [6]Kokkinos et al. 2012; [7]Johnson et al. 1999; [8]Sun et al. 2009

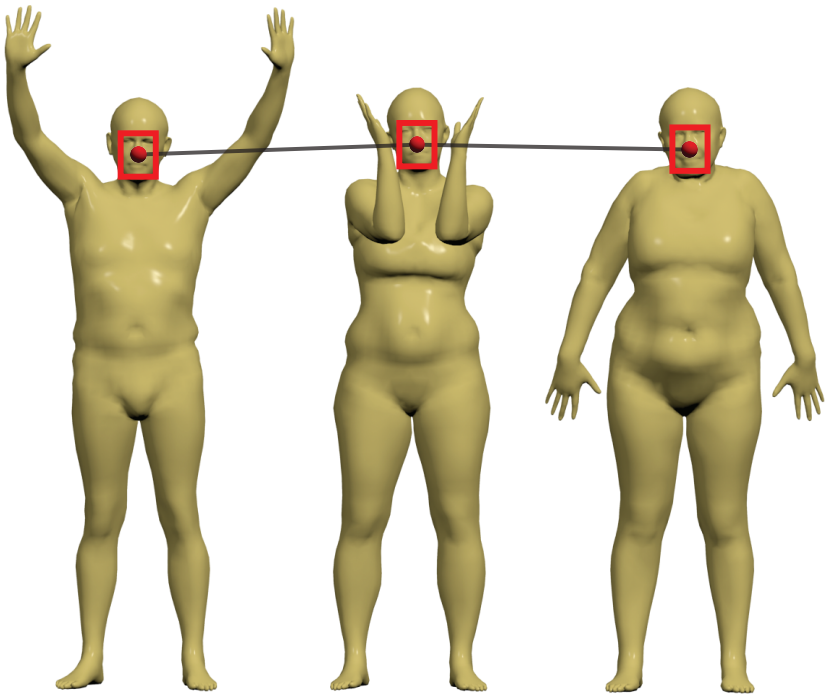
Task-specific features

Correspondence

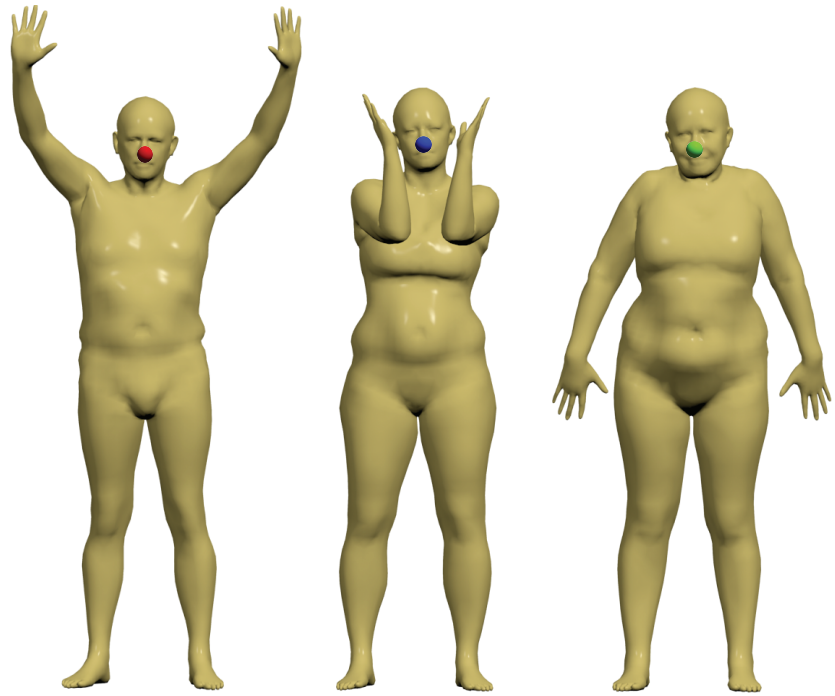


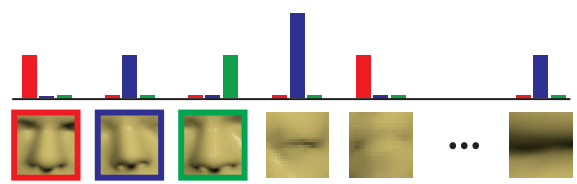
Task-specific features

Correspondence



Similarity





Deep learning (r)evolution

2012

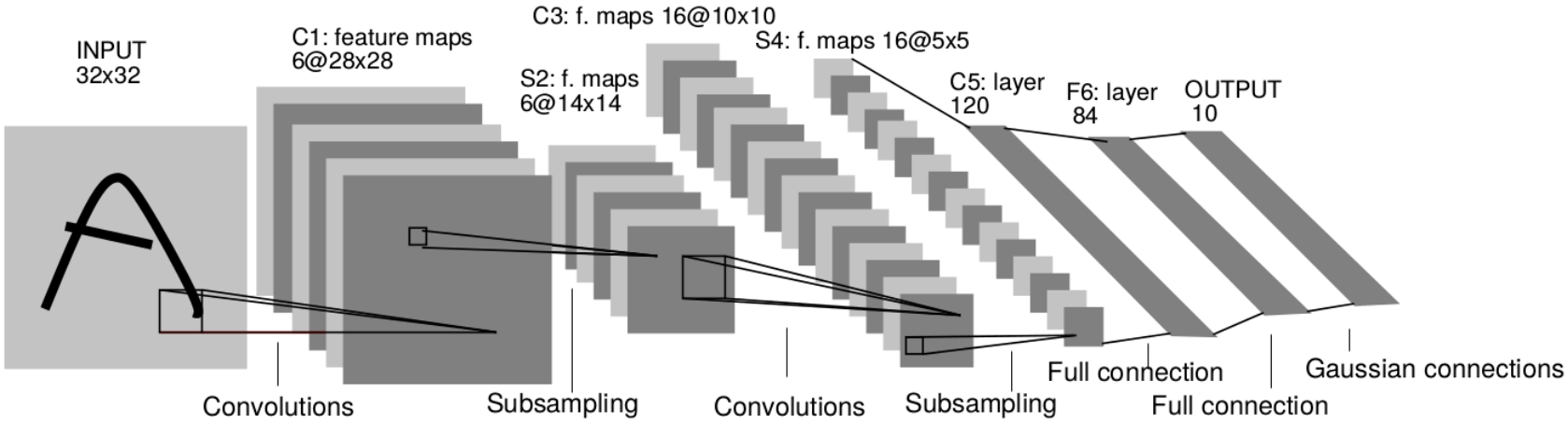
ImageNet Classification with Deep Convolutional Neural Networks

Alex Krizhevsky
University of Toronto
kriz@cs.utoronto.ca

Ilya Sutskever
University of Toronto
ilya@cs.utoronto.ca

Geoffrey E. Hinton
University of Toronto
hinton@cs.utoronto.ca

Convolutional neural networks

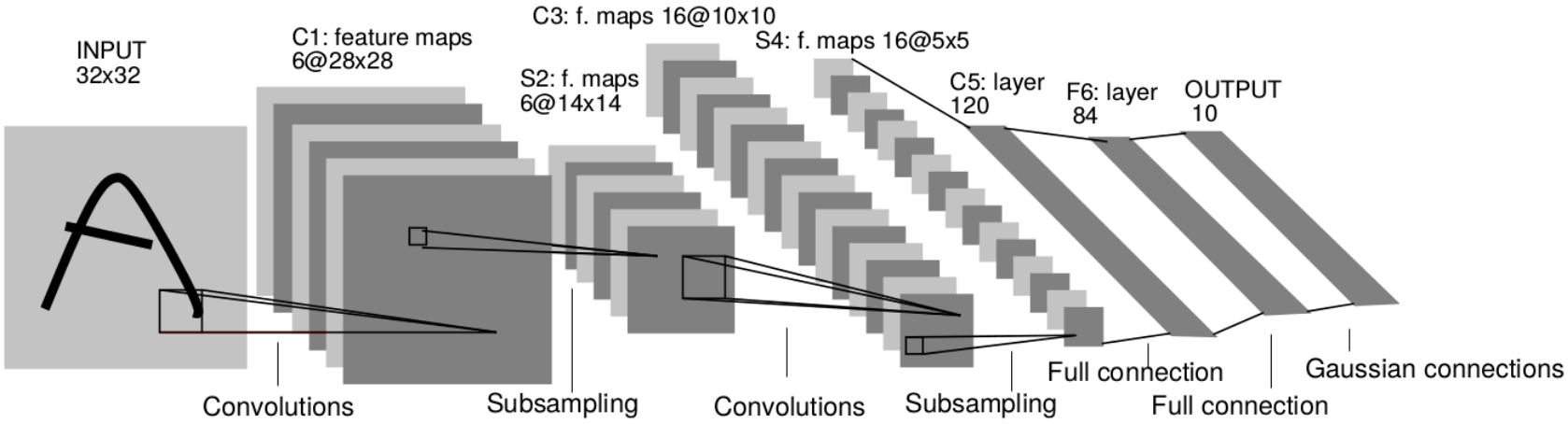


Typical CNN architecture

- Combination of convolution and pooling layers

Fukushima 1980; LeCun et al. 1989; Image: H. Wang

Convolutional neural networks

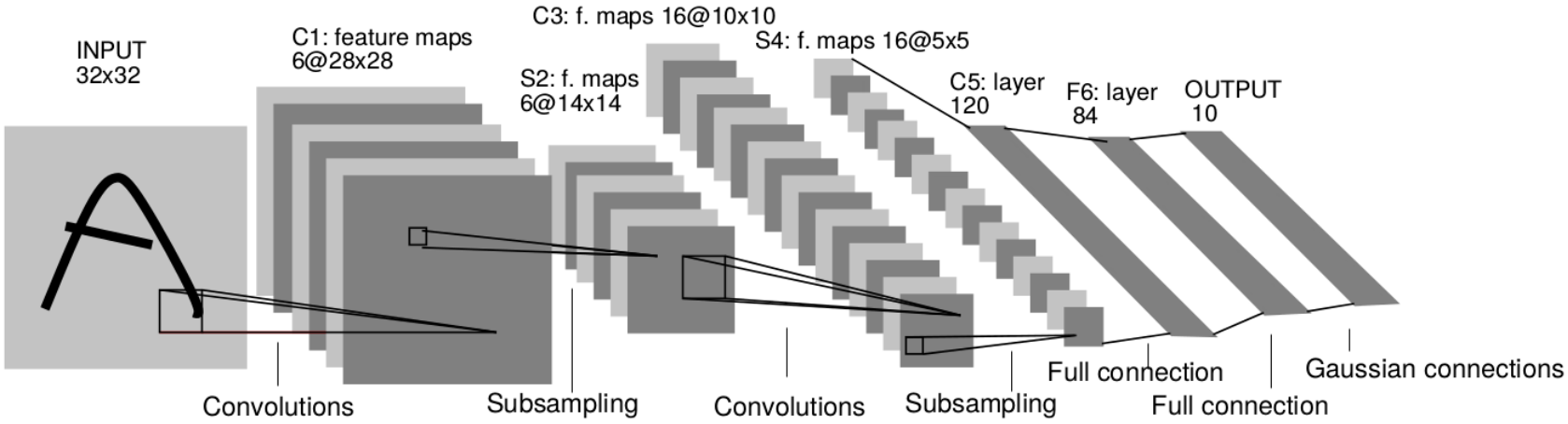


Typical CNN architecture

- Combination of convolution and pooling layers
- Learn hierarchical abstractions from data with little prior knowledge

Fukushima 1980; LeCun et al. 1989; Image: H. Wang

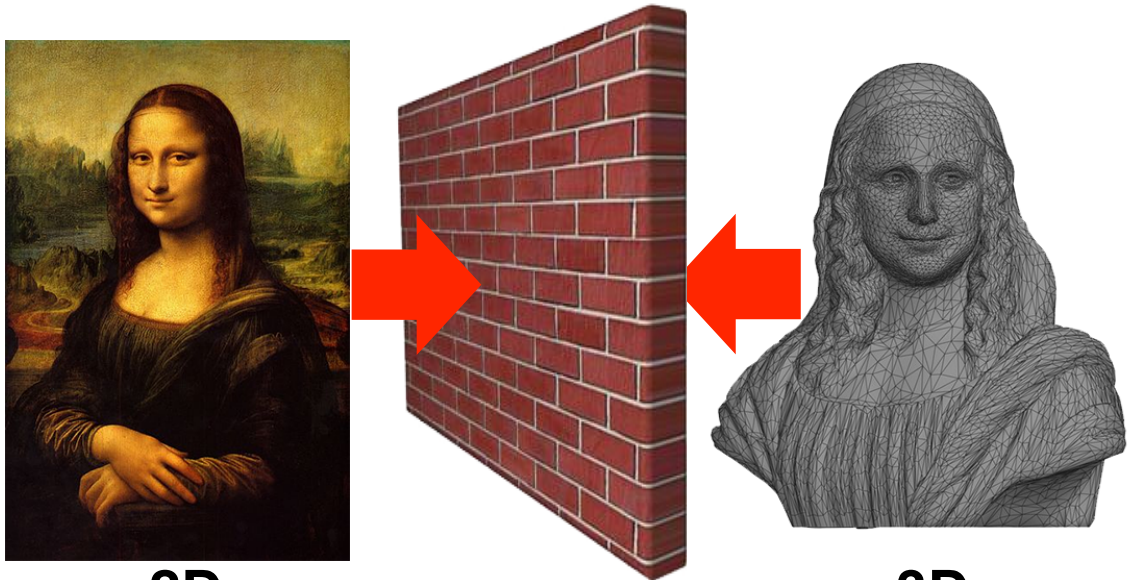
Convolutional neural networks



Typical CNN architecture

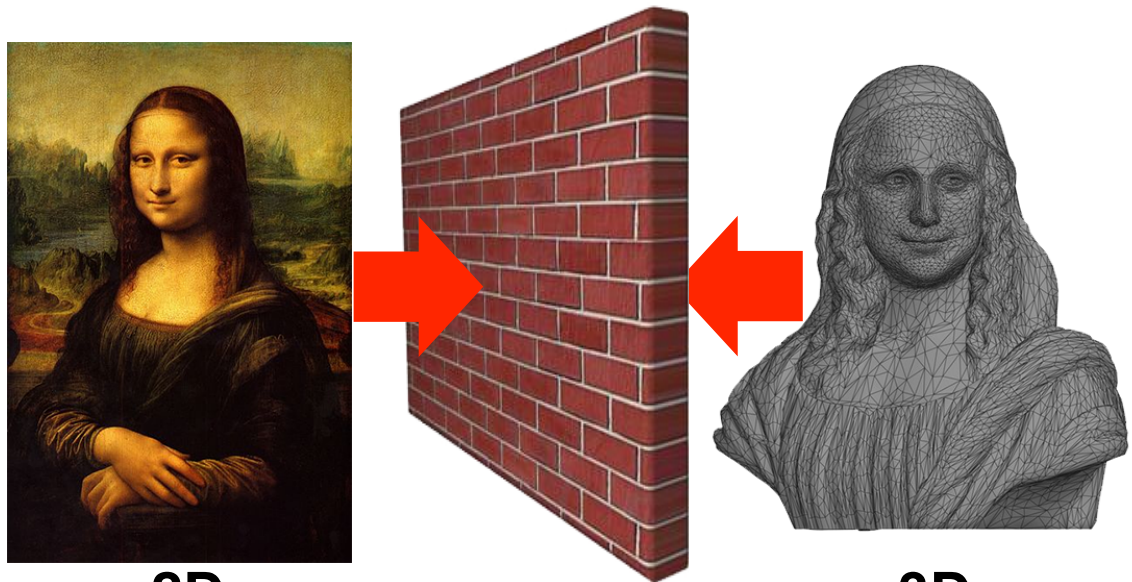
- Combination of convolution and pooling layers
- Learn hierarchical abstractions from data with little prior knowledge
- State-of-the-art performance in a wide range of applications

Fukushima 1980; LeCun et al. 1989; Image: H. Wang



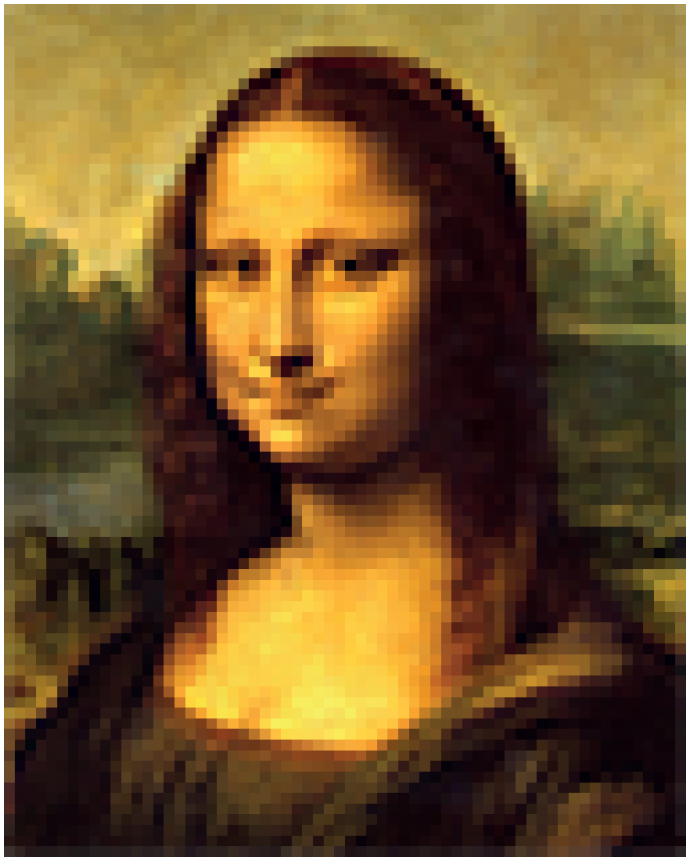
2D

3D

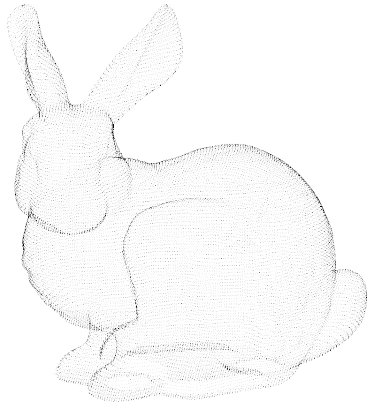


Generalize deep learning to non-Euclidean data
in a geometrically meaningful way

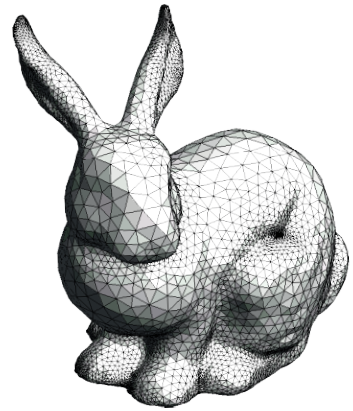
3D shapes vs images



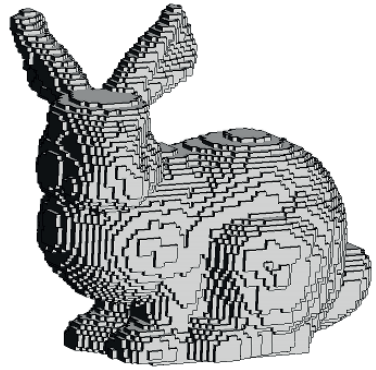
Array of pixels



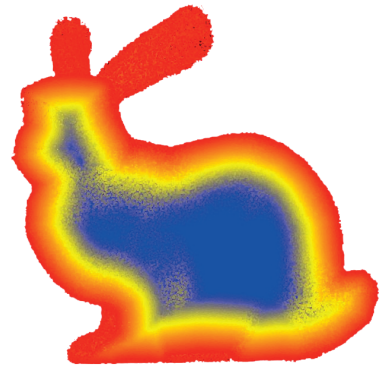
Point cloud



Mesh

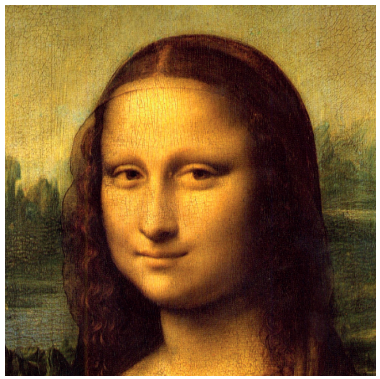
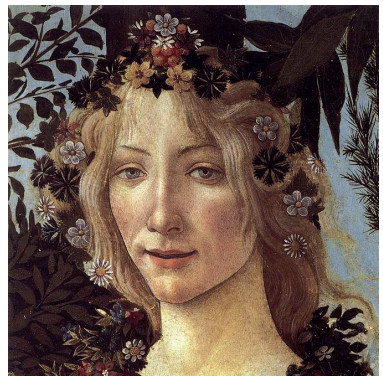
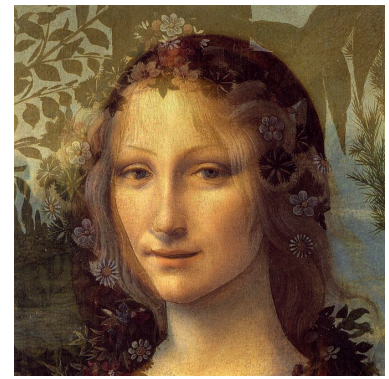


Voxels

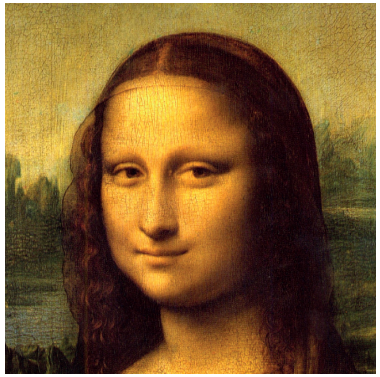
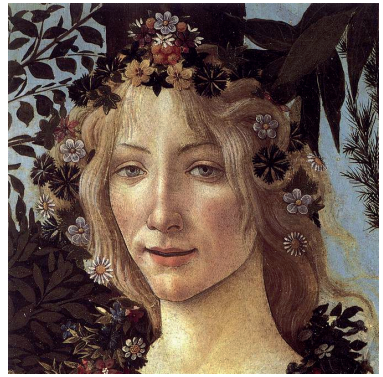
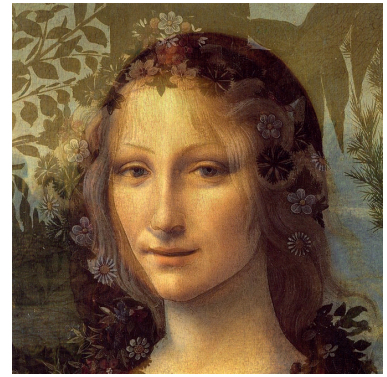


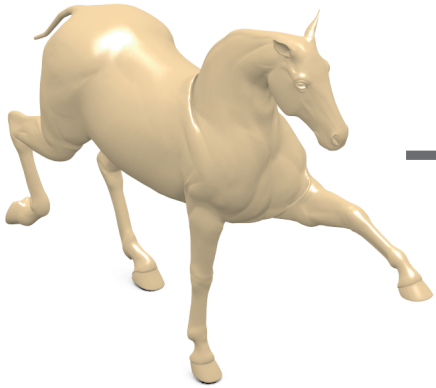
Level set

3D shapes vs images

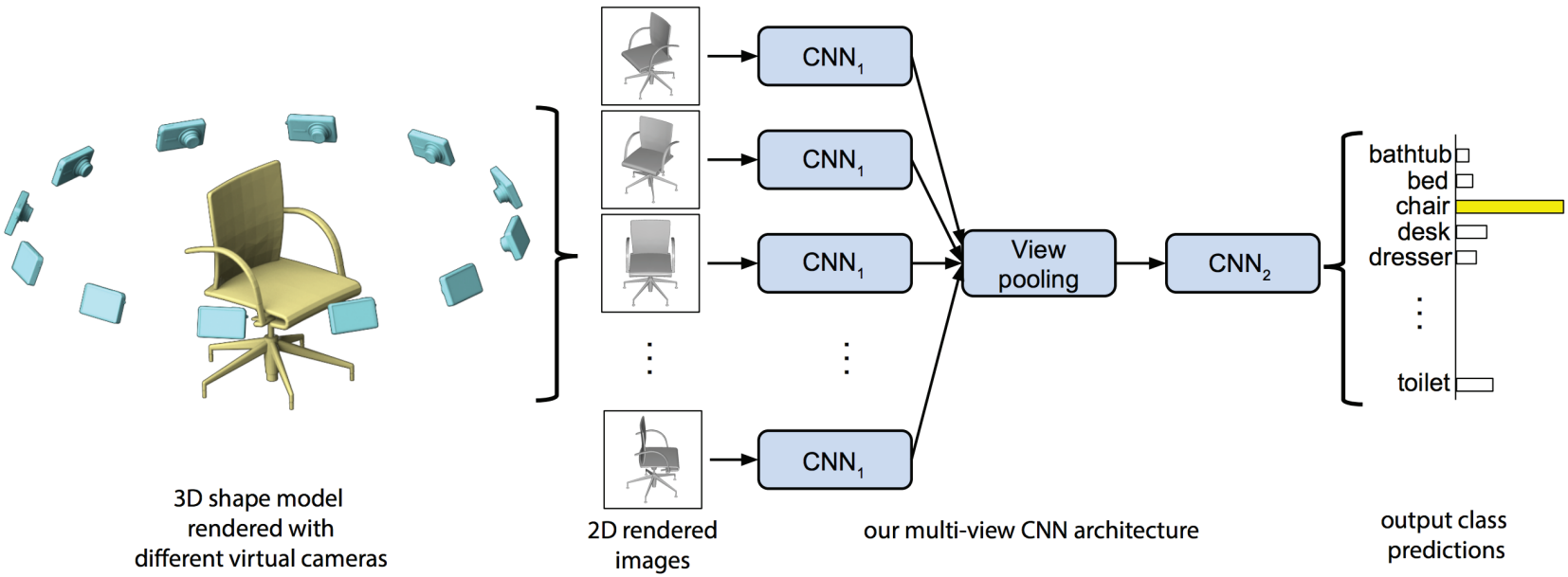
½  + ½  = 

3D shapes vs images

½  + ½  = 

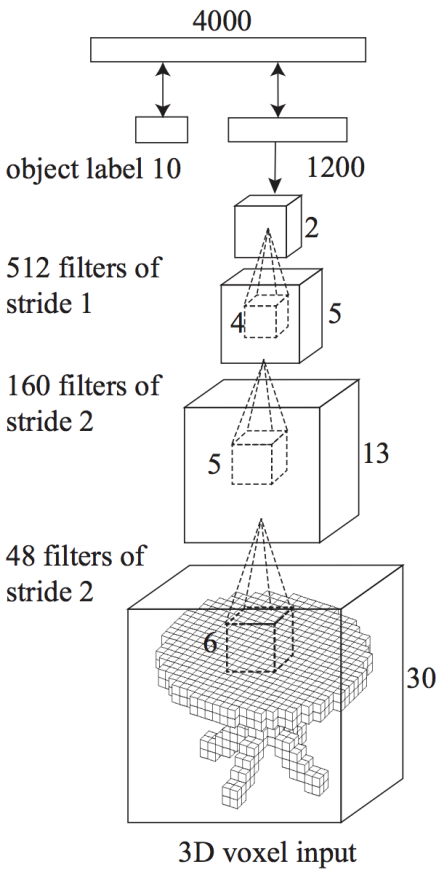
½  + ½  = ?

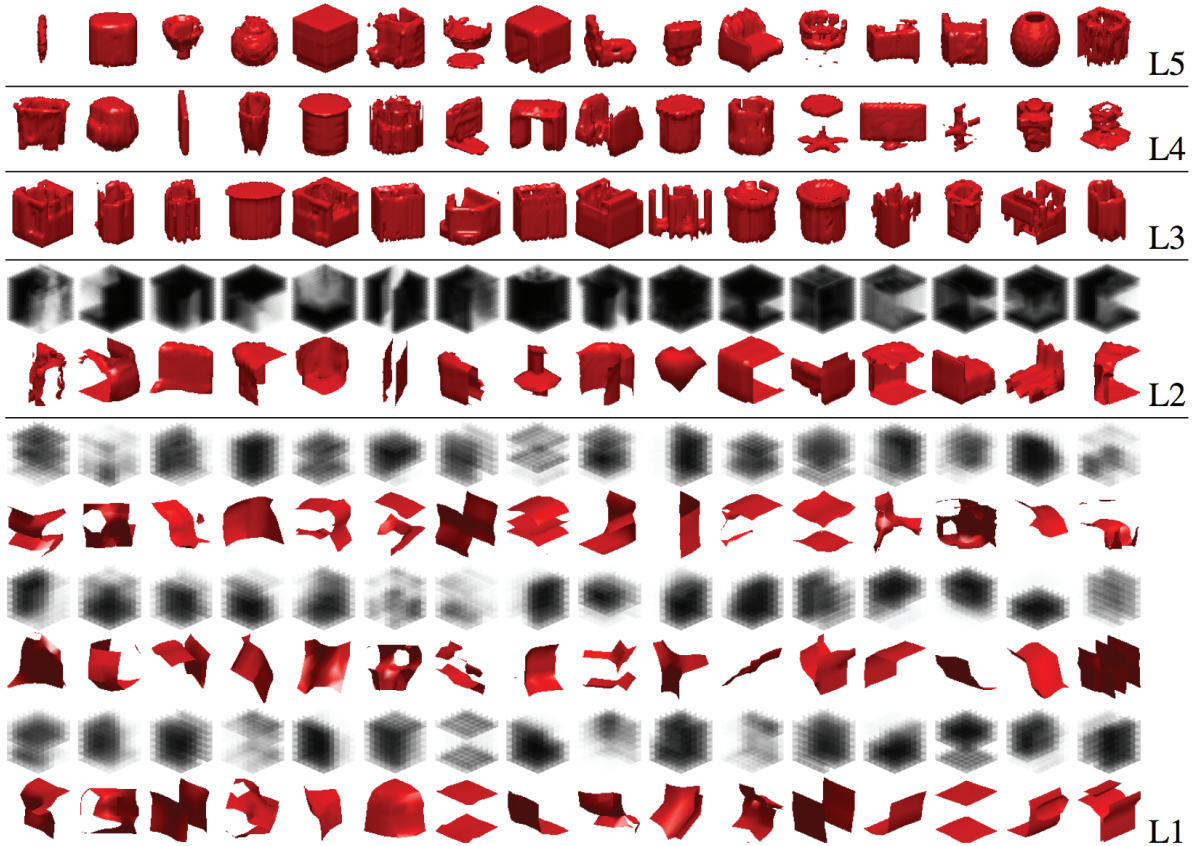
Deep learning on 3D data



Su, Maji, Kalogerakis, Learned-Miller 2015

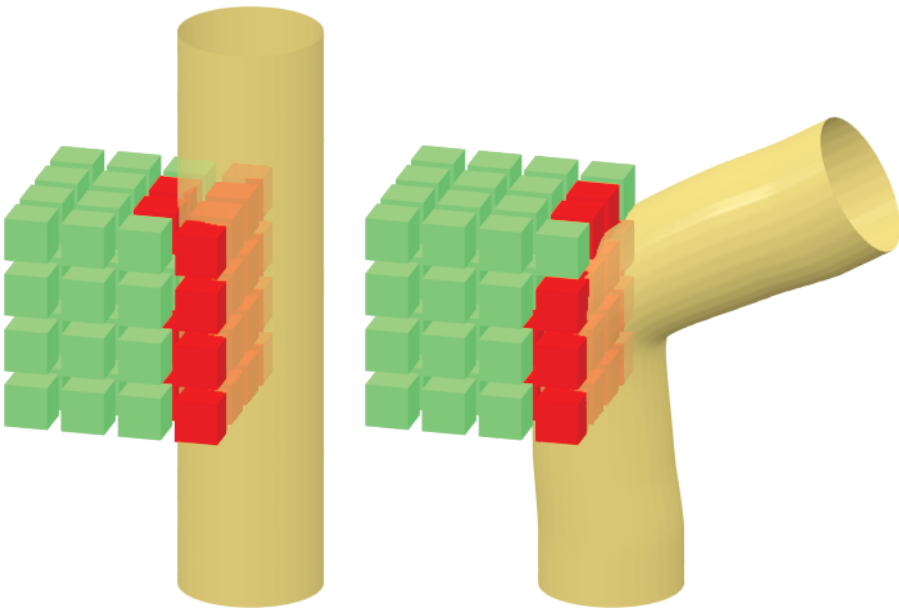
Deep learning on 3D data



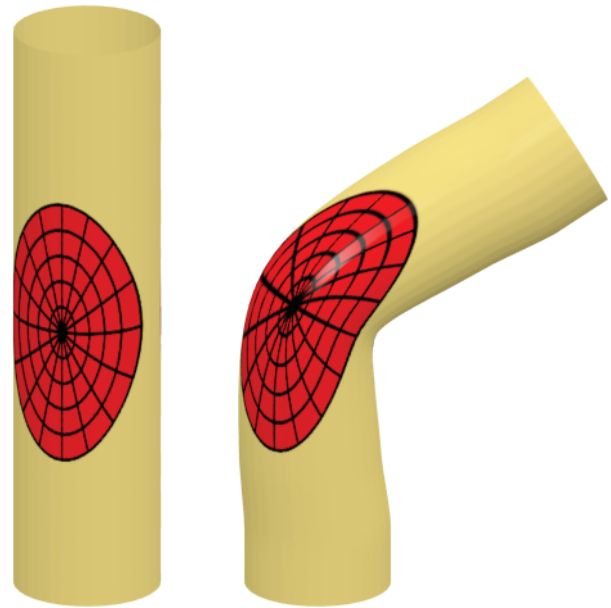


Wu et al. 2015

Extrinsic vs Intrinsic



Extrinsic



Intrinsic

Outline

- Extrinsic methods: volumetric and view-based CNNs
- Intrinsic methods: spectral descriptors
- Optimal spectral descriptors
- Random forests
- Intrinsic CNN
- Applications: correspondence, similarity, retrieval