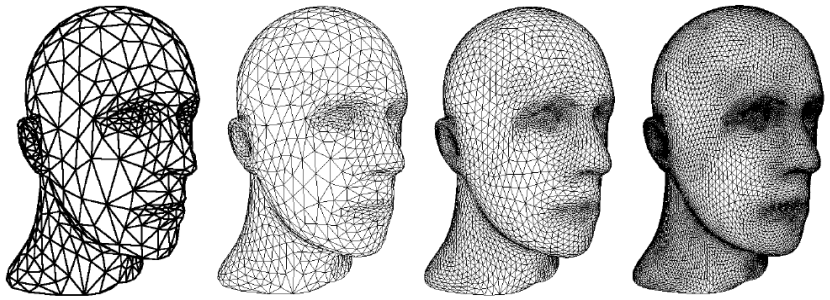
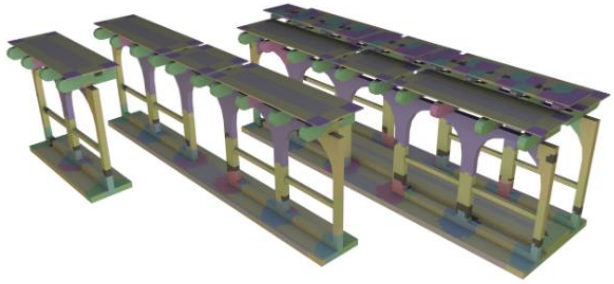
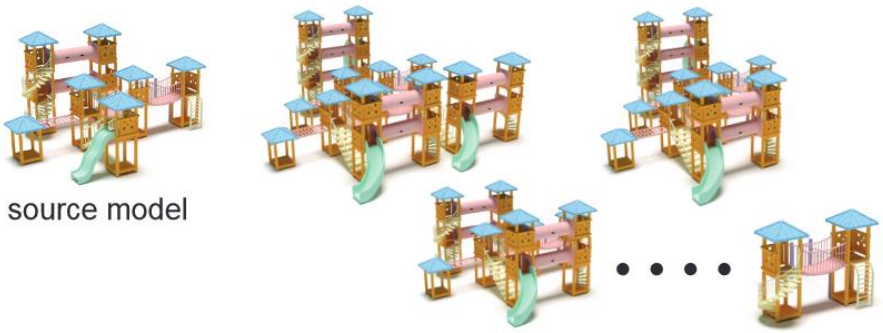


Advanced Geometry



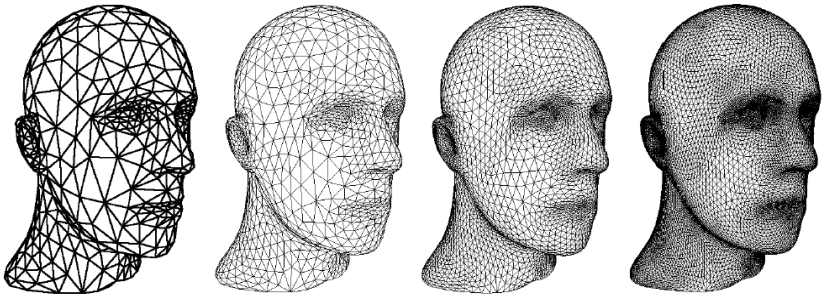
Topics

1. Automatic content creation



[Liu et al. Eurographics 2015]

2. Level-of-detail representations



Content creation

Traditional manual approach

- Use of 3D modeling software
- Manually define geometry and materials
- Compose model of multiple primitives
- Requires expertise and time, expensive

Example image of modeled fish from Wikipedia.

Automatic content creation

Main idea

- Generate 3D models without manual modeling

- Two options

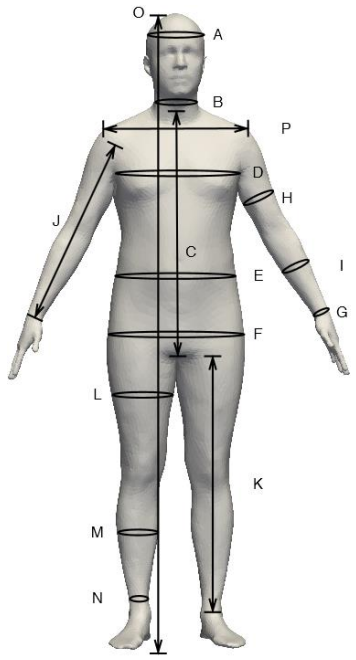
    1. Measuring real-world objects

    2. Modifying existing 3D models

Measuring real-world objects

Traditional Acquisition Techniques

- Small set of discrete measurements
- Used in different applications
  - Anthropometric measurements
  - Surveying
- Main advantage
  - Easy to acquire and process measurements
- Main disadvantage
  - Impossible to get a detailed shape description



	Measurement
A	Head circumference
B	Neck circumference
C	Shoulder-blade/crotch length
D	Chest circumference
E	Waist circumference
F	Pelvis circumference
G	Wrist circumference
H	Bicep circumference
I	Forearm circumference
J	Arm length
K	Inside leg length
L	Thigh circumference
M	Calf circumference
N	Ankle circumference
O	Overall height
P	Shoulder breadth

3D Scanners

- New technology
  - 3D (animation) scanners
  - Record 3D video
  - Active research area
- Powerful tool
  - Preserve artwork / historic artifacts
  - Acquire populations of 3D shapes for analysis

[P. Jenke, WSI/GRIS Tübingen]

Types of 3D Scanners

Scanning Techniques:

- Time-of-flight
  - Time-of-flight laser scanner
  - Time-of-flight depth cameras (dynamic)
- Triangulation
  - Laser line sweep
  - Structured light
- Stereo / computer vision
  - Passive stereo
  - Active stereo / space time stereo
  - Other techniques

Example Scan (time of flight laser scanner)

Example scan (structured light scanner)

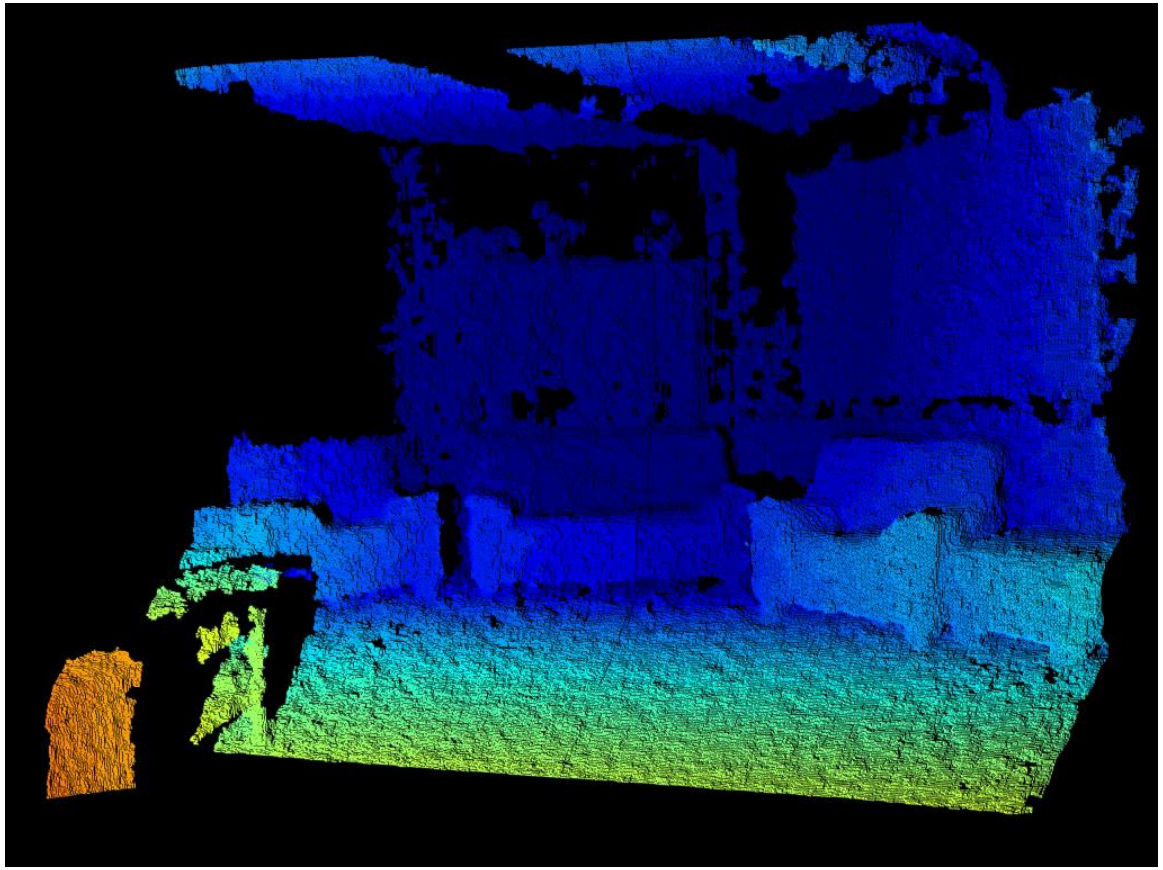
color-coded structured light

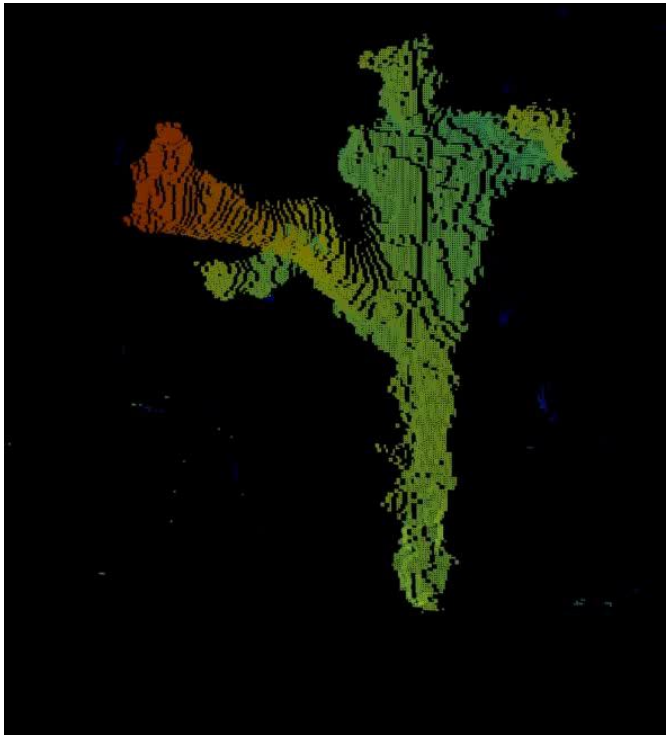
courtesy of Phil Fong, Stanford University

motion compensated structured light

courtesy of Sören König, TU Dresden

Example scan (active stereo scanner)





Example scan (stereo reconstruction)

multi view matching (8 cameras)
(piecewise smooth variational surface
on presegmented images
solved with Bayesian belief propagation)

[Data set: Zitnick et al.,
Microsoft Research, Siggraph 2004]

multi view matching (6 cameras)
(photo-consistent space carving)

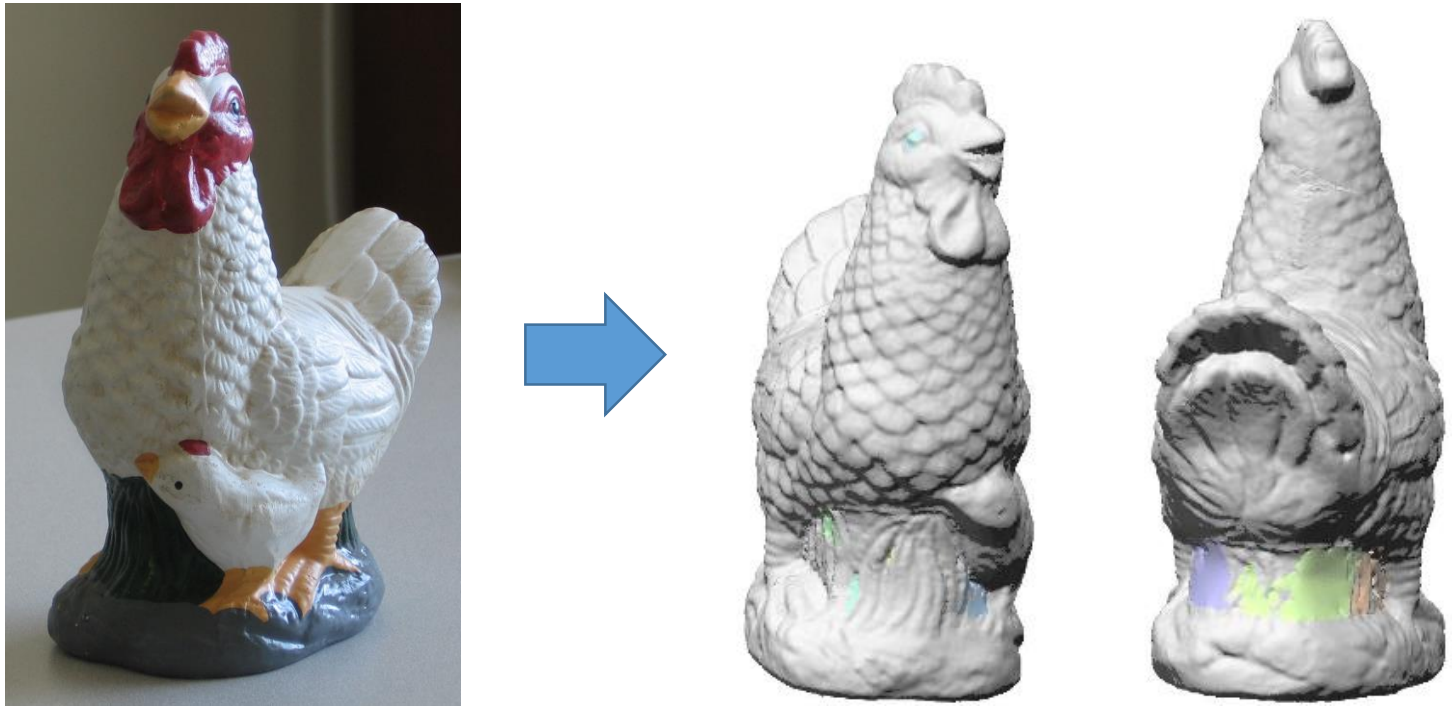
[Data set: Christan Theobald, MPII, 2006]

Processing the scans

To be useful, the scans need to be processed

- Hole filling
- Outlier removal
- …
- Many methods and software libraries available

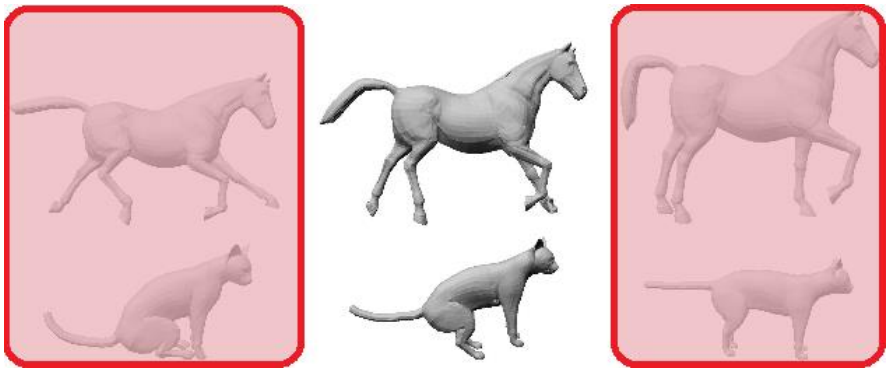
Allows for direct content creation



Modifying existing 3D models

Possibilities

- Common possibilities
  - Extrapolation
  - Interpolation
  - Structure-aware modification

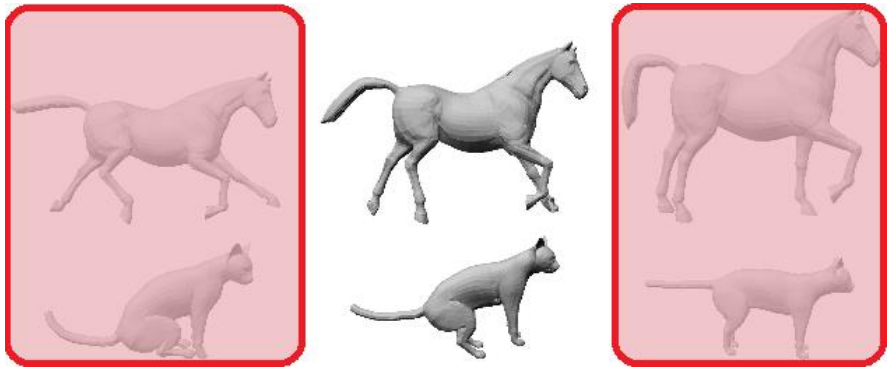


- Many possibilities, active area of research

Exercise

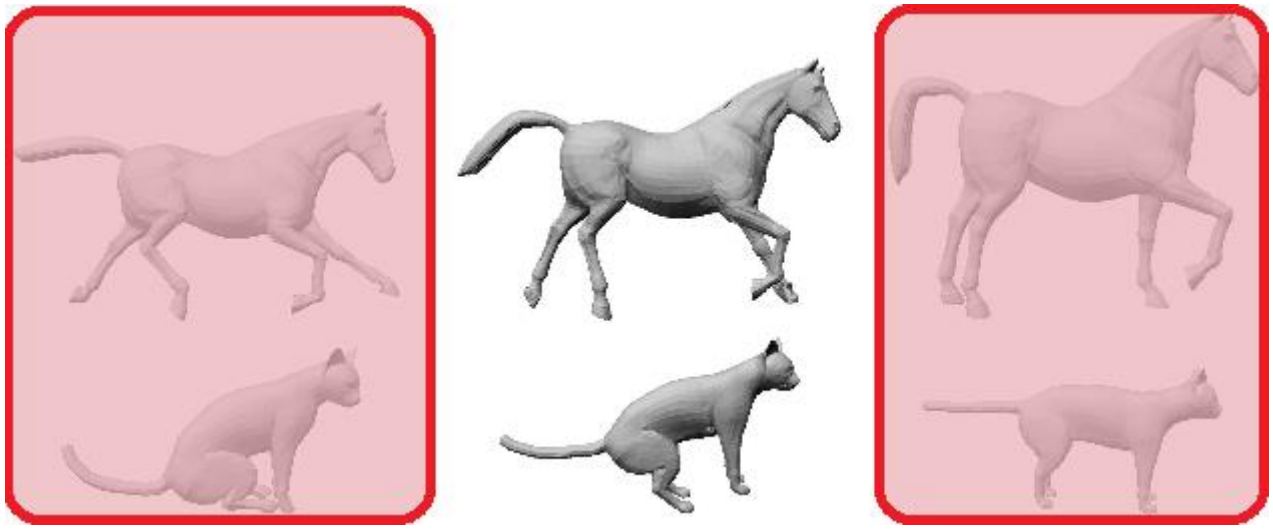
Propose a way to interpolate and extrapolate between two 3D shapes

- How do you represent the shapes?
- What interpolation / extrapolation equation to use?
- What are the advantages and disadvantages of the method?



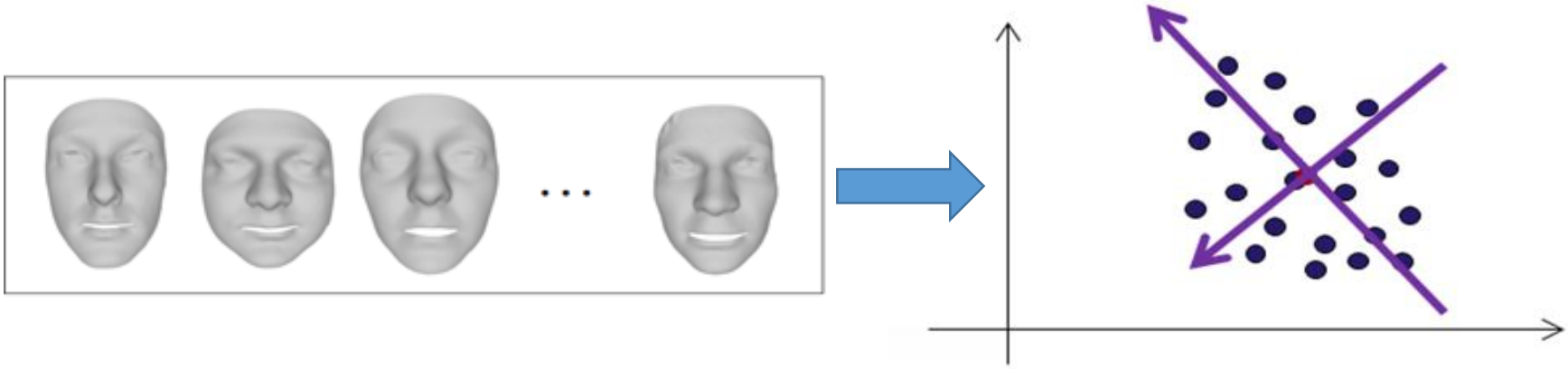
Shape interpolation and extrapolation

- Possible in shape space using correspondence information



Statistical shape spaces possible

- Learn statistical distribution of geometry of shape



- Use this information for synthesis

Structure-aware modification

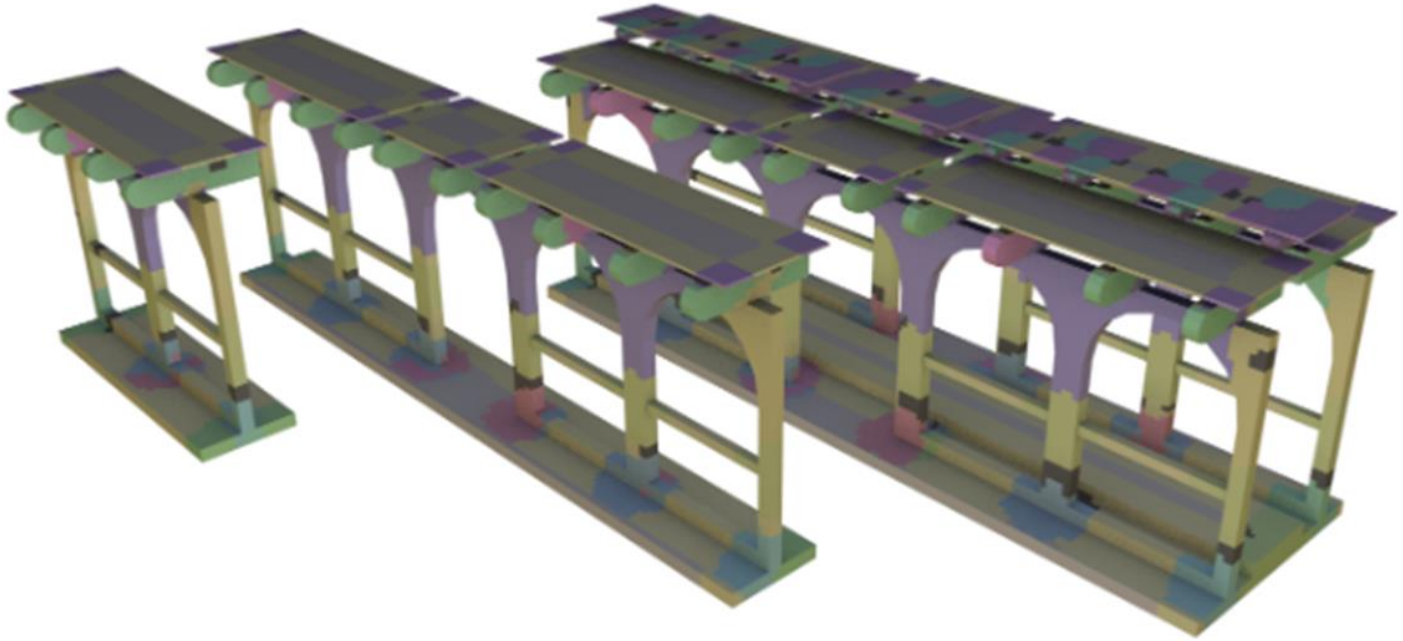
Challenge

- Direct point-to-point correspondence cannot be established
- Point-wise or triangle-wise modification not meaningful

Liu et al. Eurographics 2015

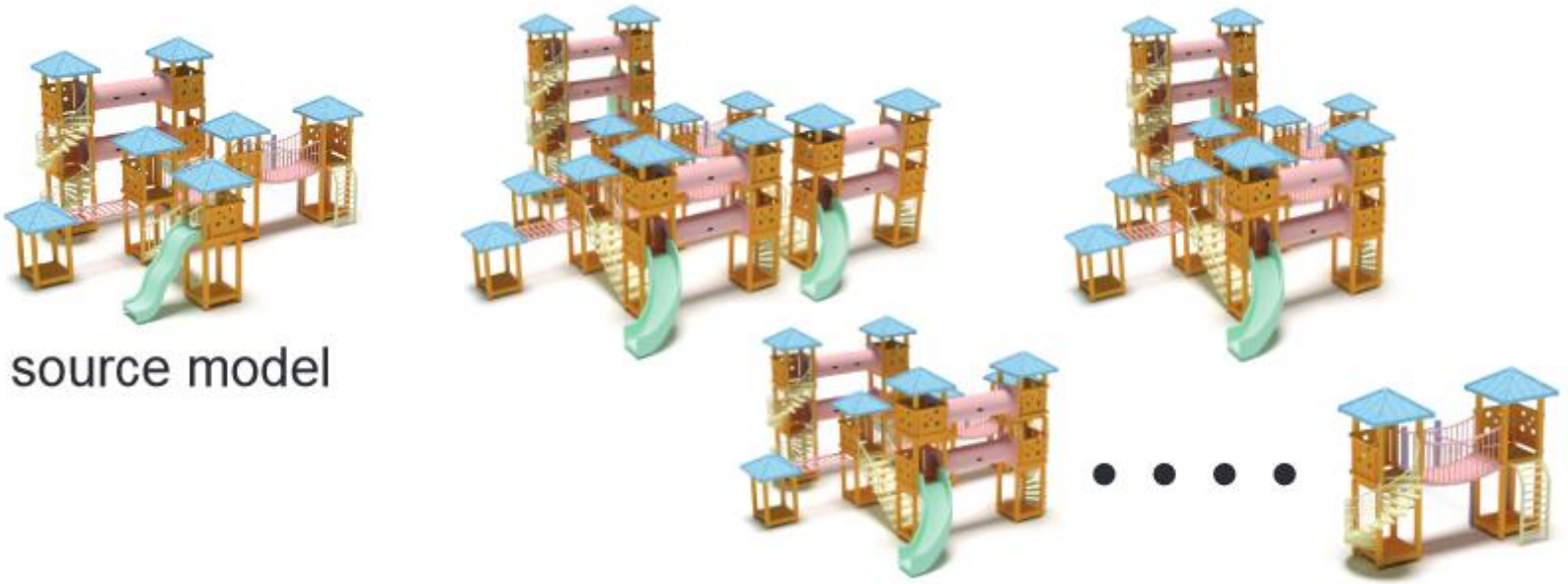
- Active area of research

Take advantage of symmetry information



Kalojanov et al. SGP 2012

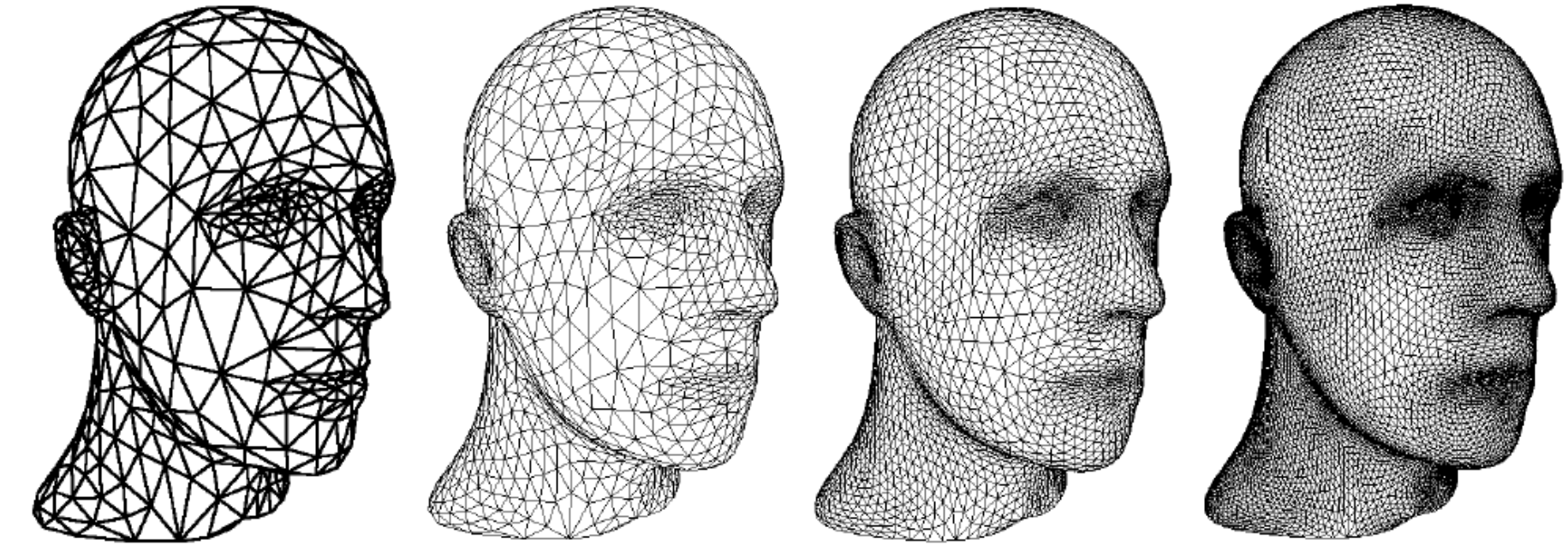
Decompose into basic building blocks



Liu et al. Eurographics 2015

Level-of-detail representations

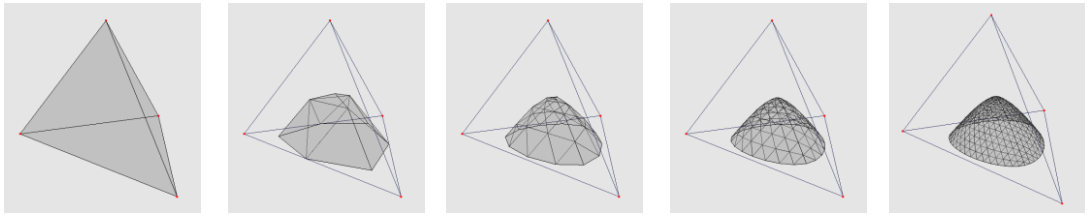
Key idea



Distance from camera = less geometric detail required

Subdivision surfaces

- We saw them already

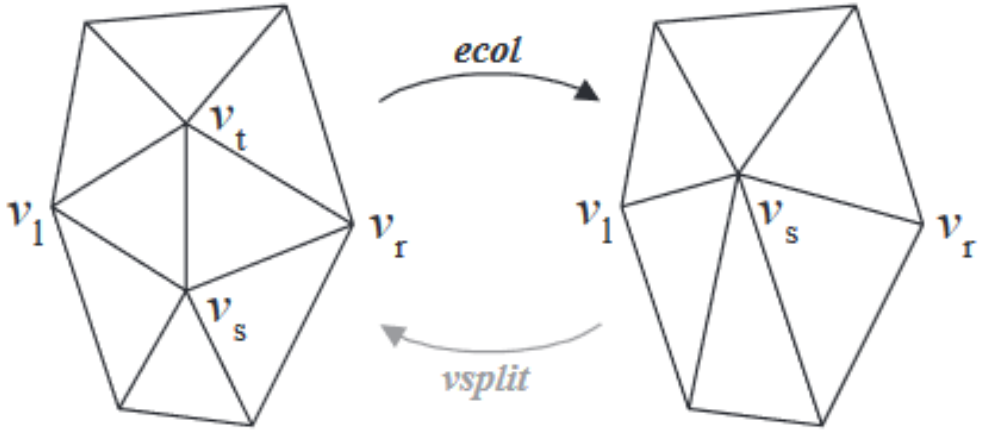


- Advantages
  - Very strong geometric compression (4 triangles become 1)
  - Theoretical convergence properties

- Disadvantages
  - Not applicable to downsample shapes that do not have this structure

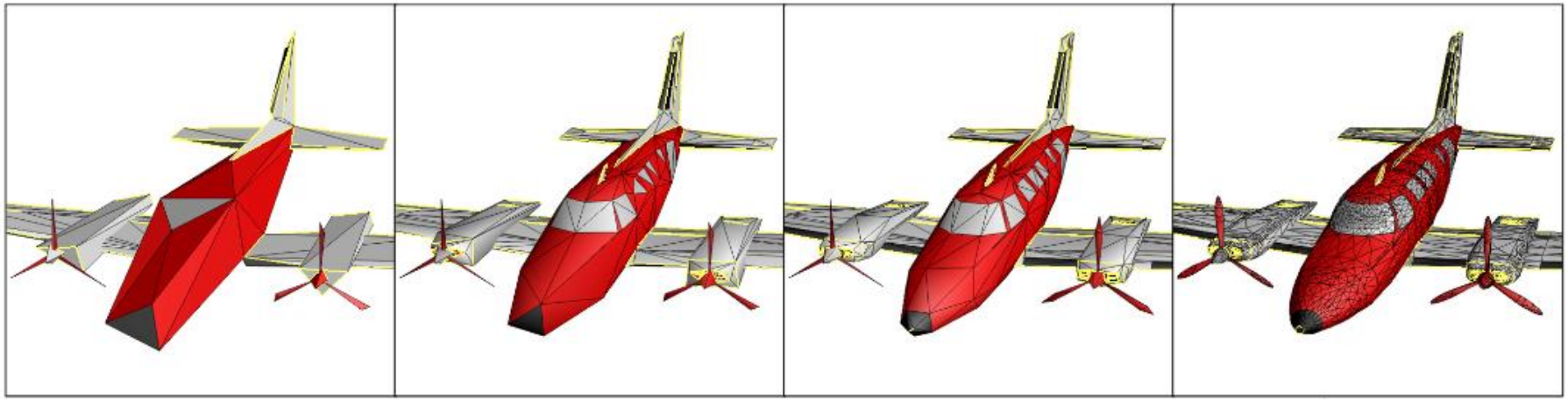
Edge collapse

- Models can be downsampled by sequence of edge collapses



[Hoppe, Progressive Meshes, SIGGRAPH 1996]

Example result



[Hoppe, Progressive Meshes, SIGGRAPH 1996]