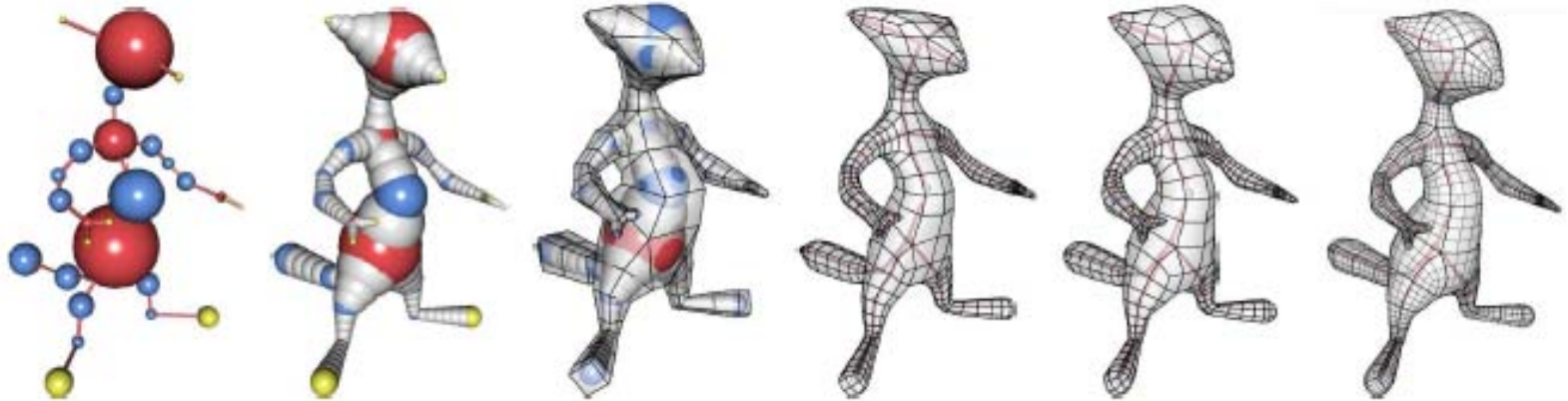


# Digital Geometry Processing



Instructor: Ligang Liu

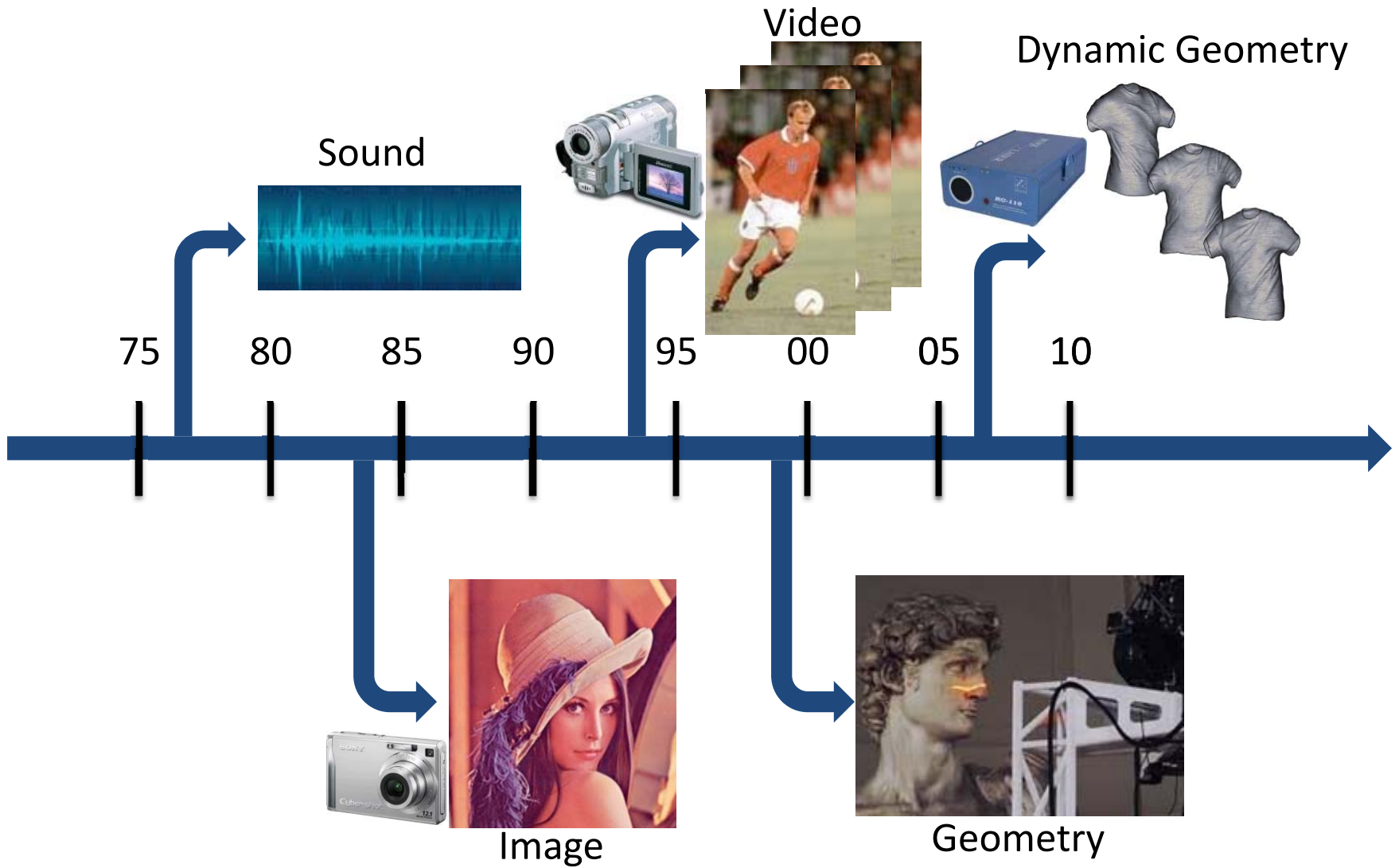
[lgliu@ustc.edu.cn](mailto:lgliu@ustc.edu.cn)

<http://staff.ustc.edu.cn/~lgliu>

# About This Course

- Prerequisite
  - Computer Graphics
  - CAGD
  - C/C++, Matlab
- State-of-the-art of geometry modeling and processing
  - Hot topics
  - Future trend

# Digital Media



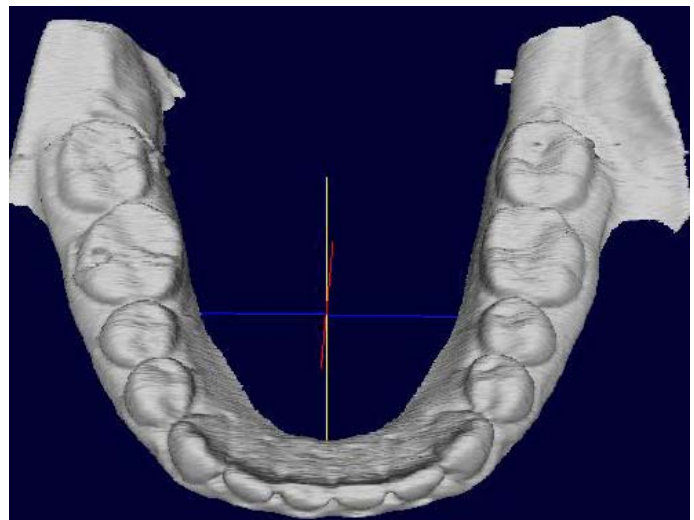
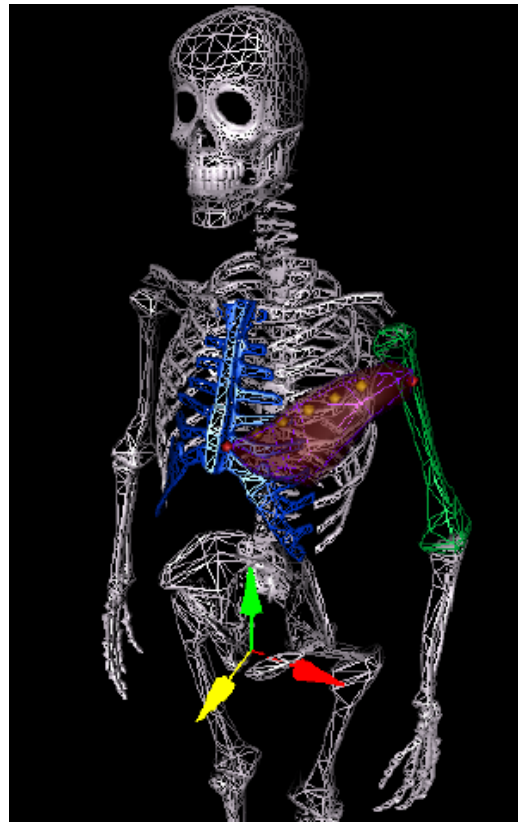
# Digital Media

- Sound
- Image
- Video
- Geometry
  - Computer animation
  - Visualization
  - Computer game
  - Entertainment



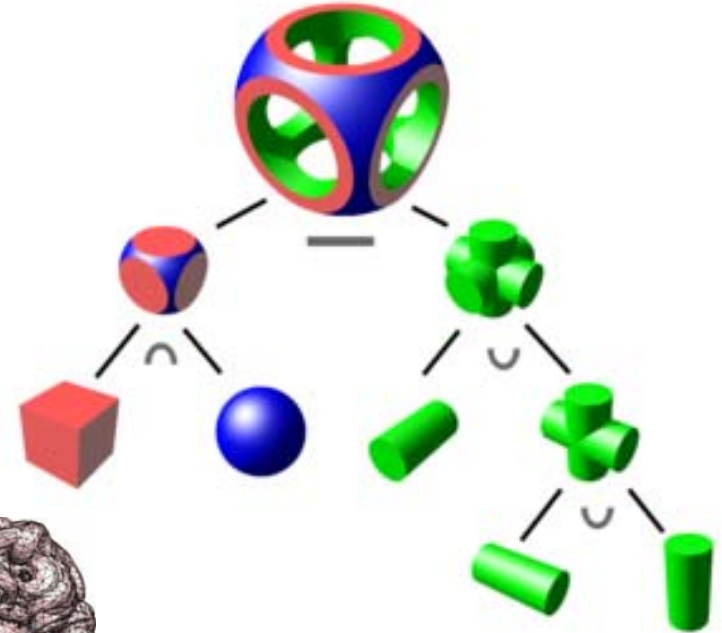
*Celestial Exploring*  
art by KAGAYA

© 2003 KAGAYA / © 2003 Synforest / CD-ROM SW-008



# Geometry Representations

- Constructive Solid Geometry (CSG)
  - Cube, cylinder, cone...
  - Boolean operations
- Boundary Representation
  - B-spline, NURBS
  - **Triangular mesh**
    - Rendering engine



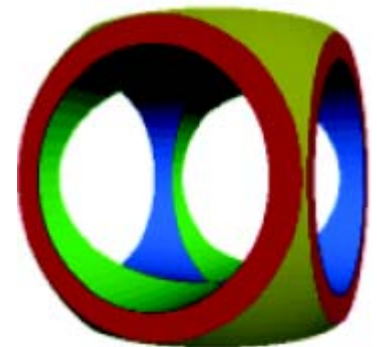
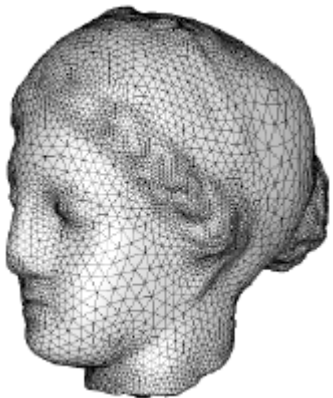
# Mesh Surfaces

- Demo: Examples of mesh surfaces



# Geometry Examples

- Meshes
- Point clouds
- Implicit surfaces
- Volumetric data
- CSG

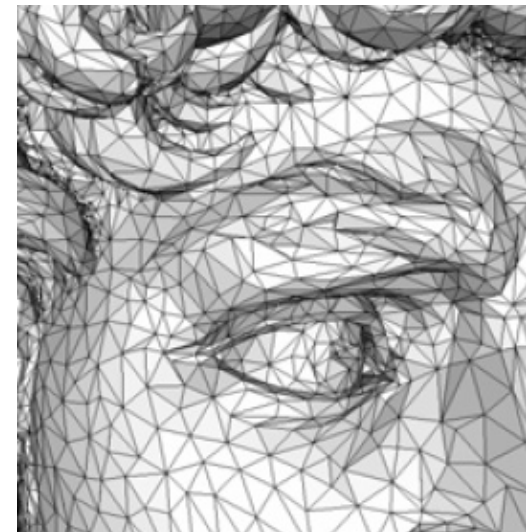


# Geometry Processing

- 3D Geometry is based data for
  - CAD/CAM, Engineering
  - Visualization and simulation - medical, physics, etc...
  - Graphics, multimedia
- Geometry processing
  - Computerized modeling of 3D geometry
- Digital Geometry  $\approx$  Mesh Processing

# Digital Geometry Processing (DGP)

- Processing of discrete models
  - Polygonal mesh (Typically triangular)
- Why discrete?
  - Simplicity - ease of description
  - Based data for rendering software/hardware
  - Input to most simulation/analysis tools
  - Output of most acquisition tools
    - laser scanner, CT, MRI, etc...



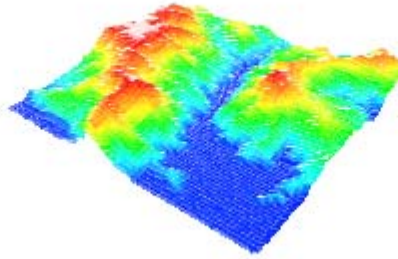
# Applications



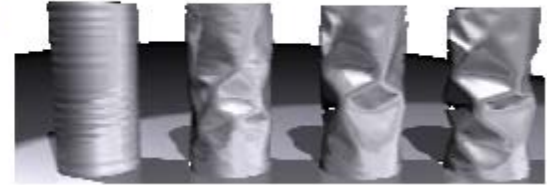
Medical



Engineering



Topography



Simulation



Game



Movies



E-commerce



Art history

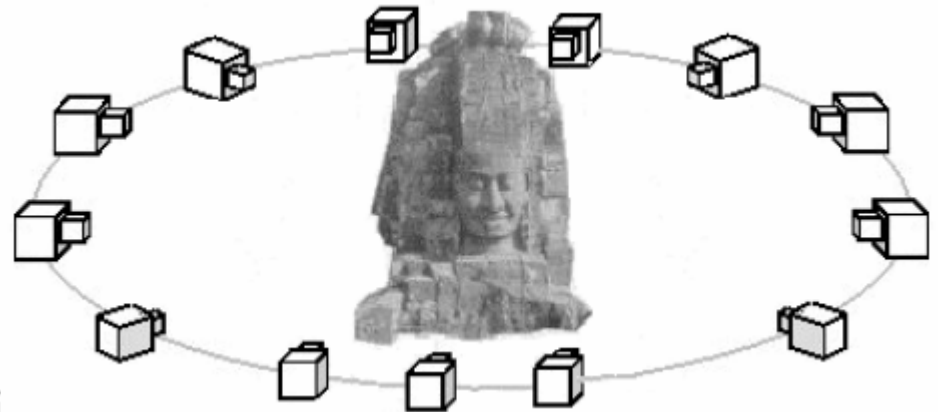
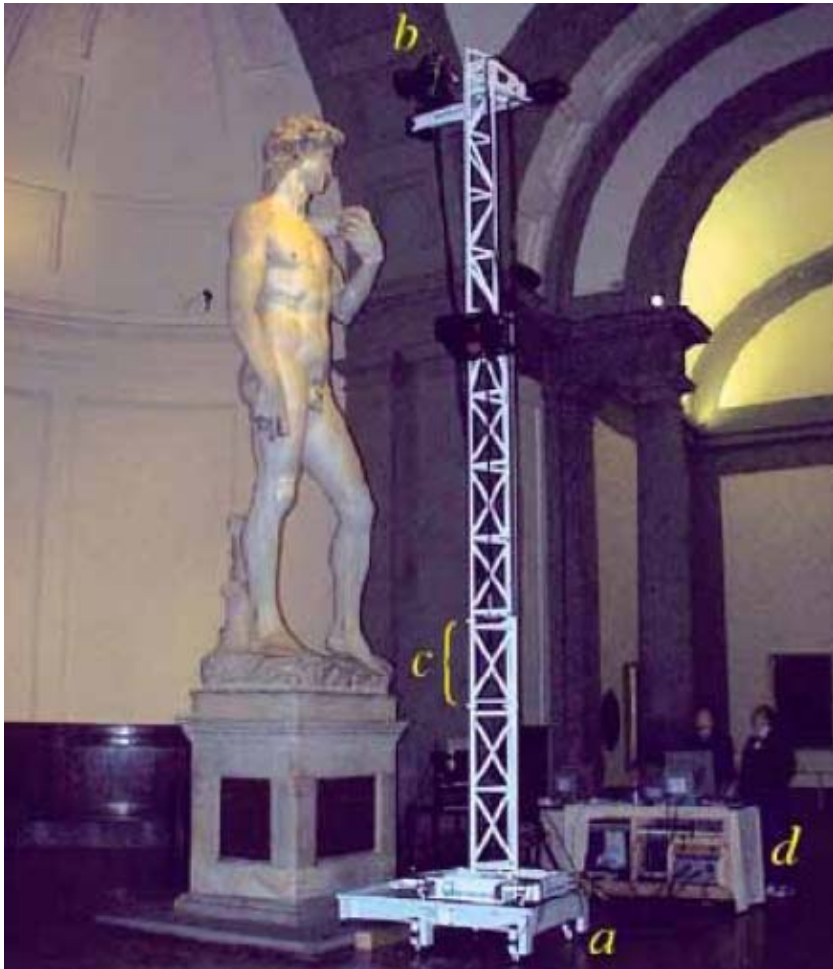
# Geometry Data Processing

- Data acquisition and reconstruction
- Data storage and compression
- Data representation
- Data editing
- Data rendering
- Data retrieval

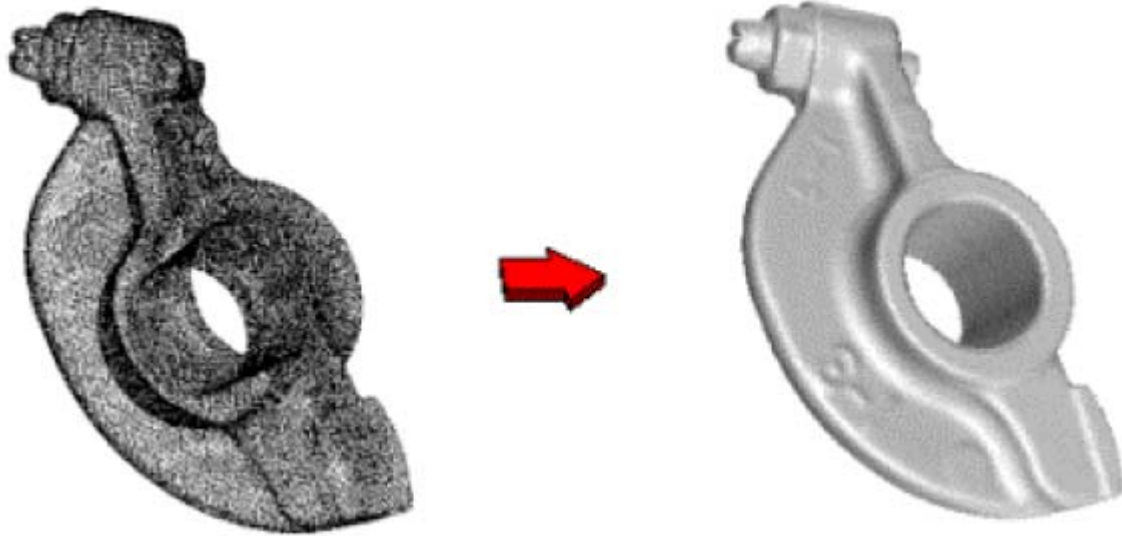
# Course Syllabus

- Model acquisition
- Surface reconstruction
- Mesh simplification and Remeshing
- Geometry compression
- Mesh parameterization
- Mesh editing, deformation and morphing
- Subdivision surfaces
- Discrete differential geometry

# Data Acquisition



# Surface Reconstruction

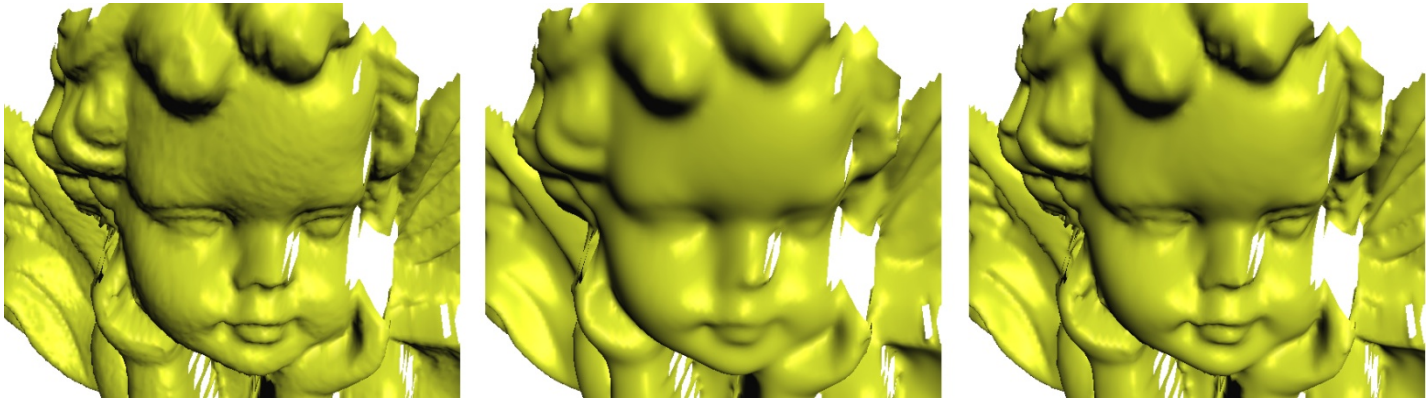




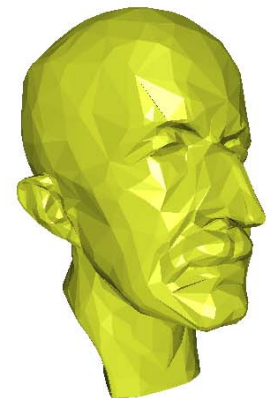
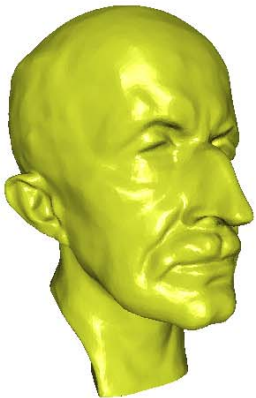
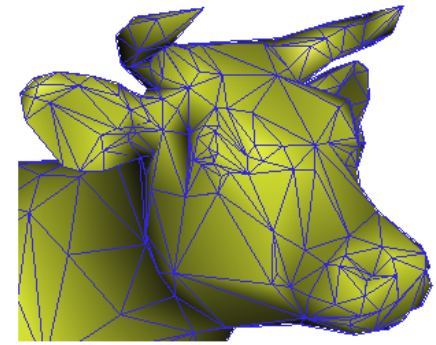
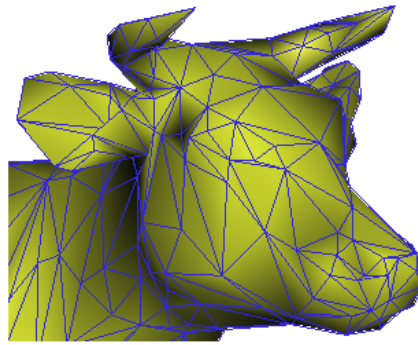
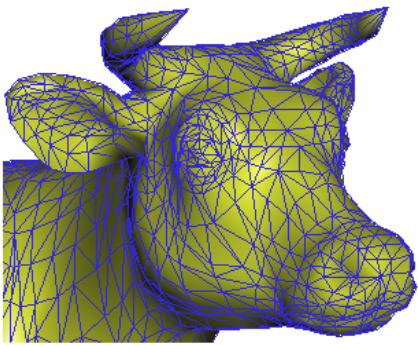
# Differential Geometry



# Smoothing/Fairing



# Mesh Simplification

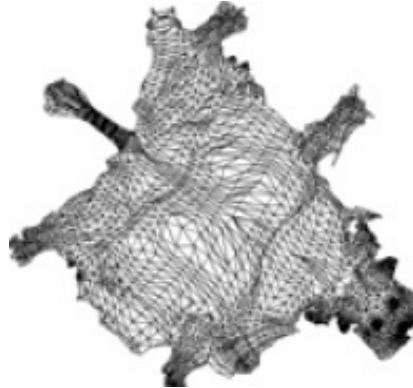
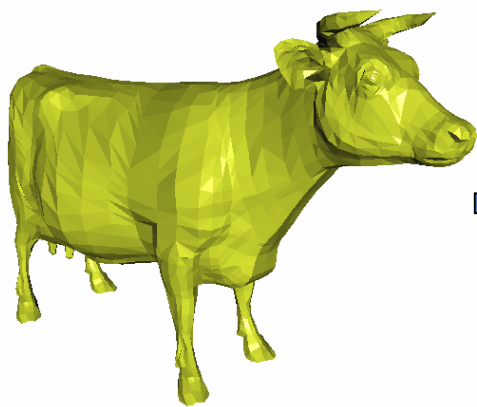
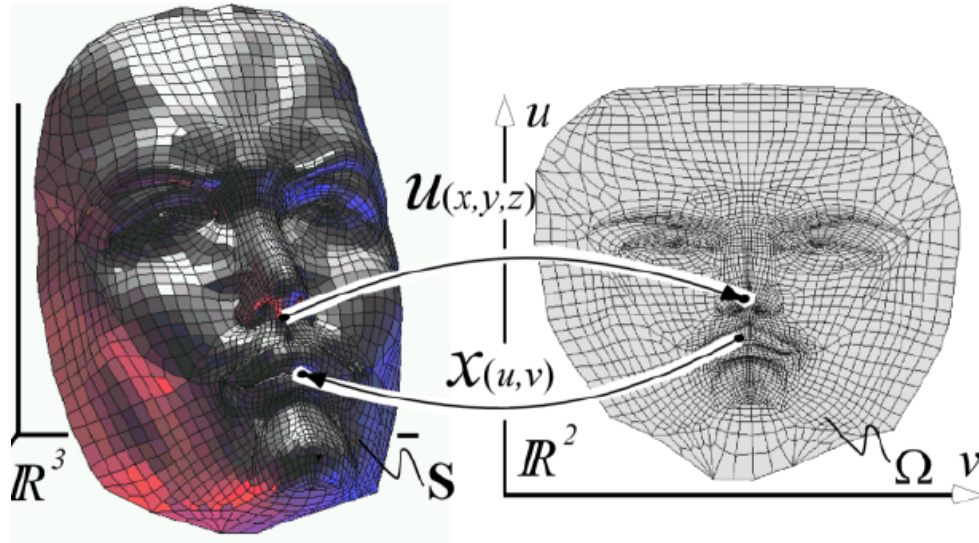


# Geometry Coding

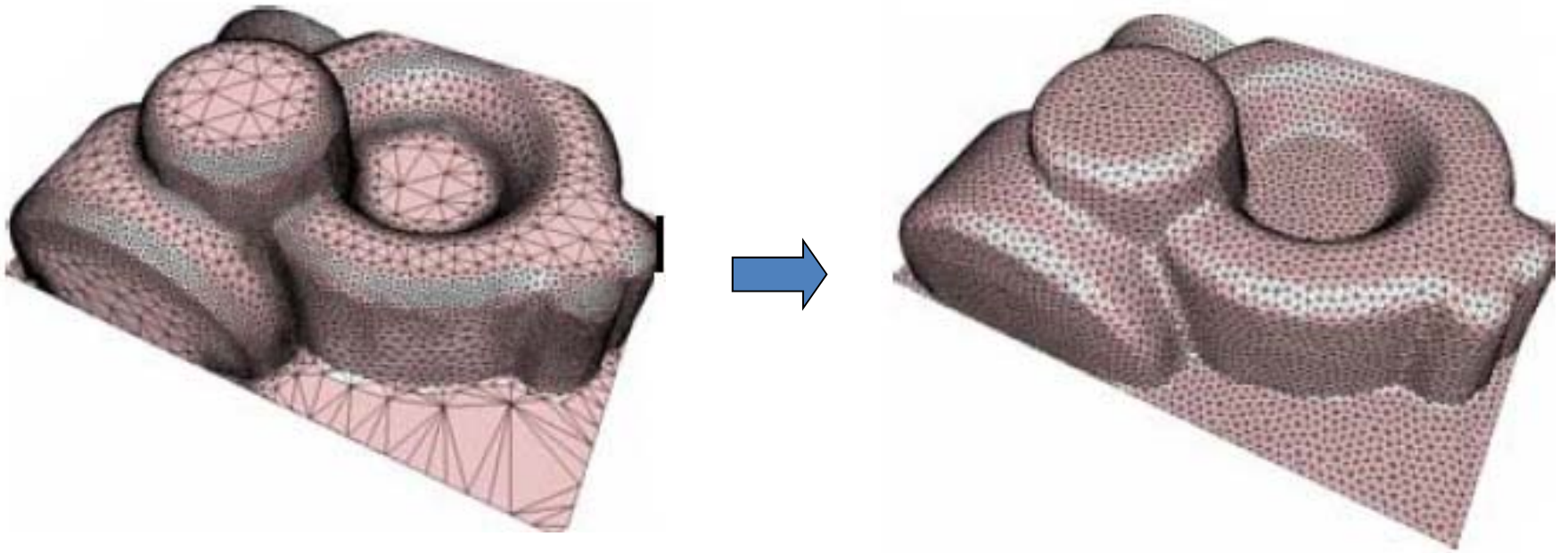


010011110010101100010101 ...

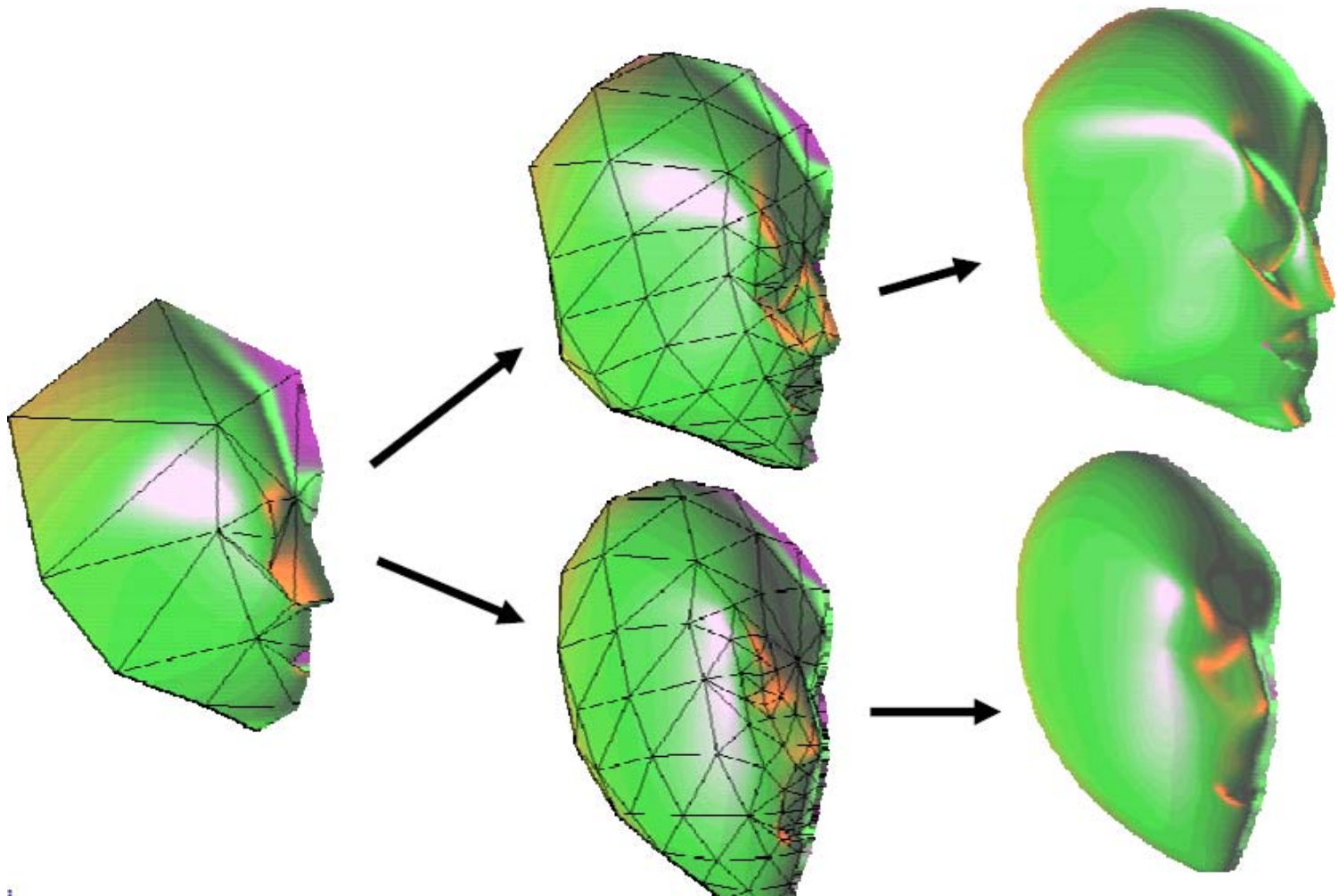
# Parameterization



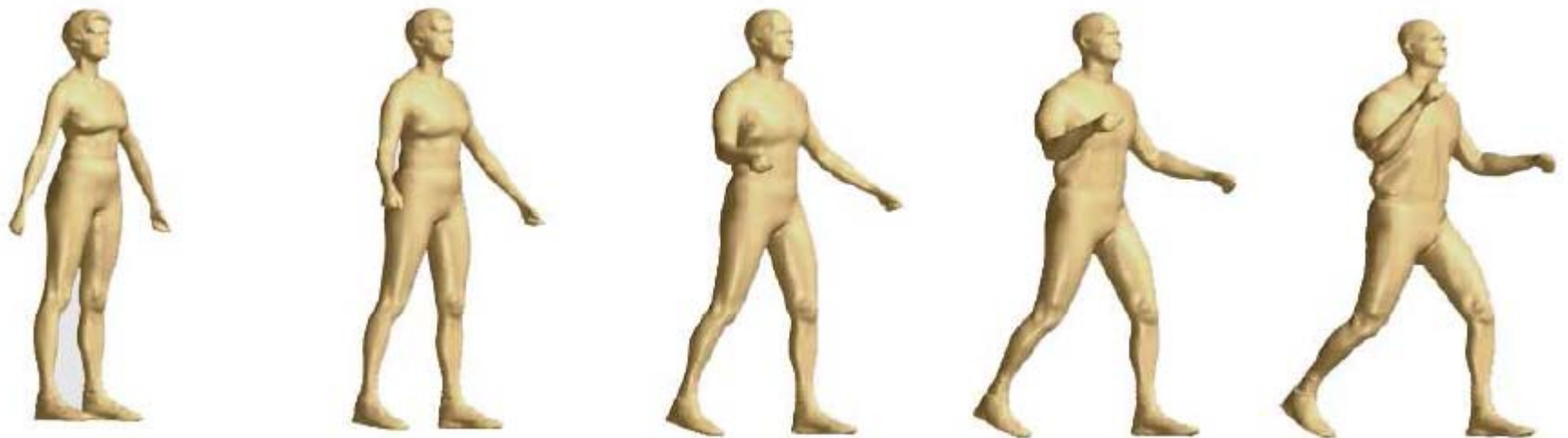
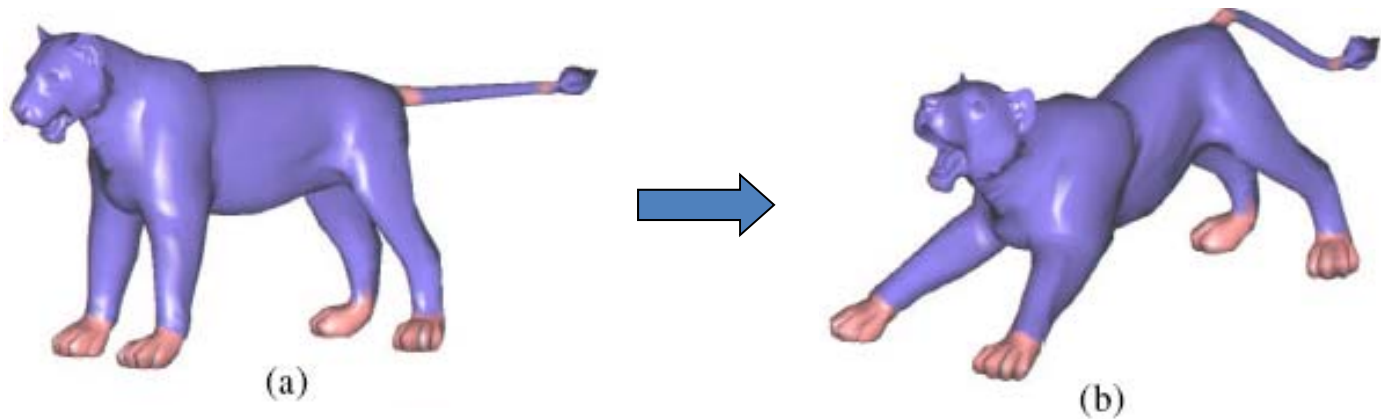
# Remeshing



# Subdivision Surfaces

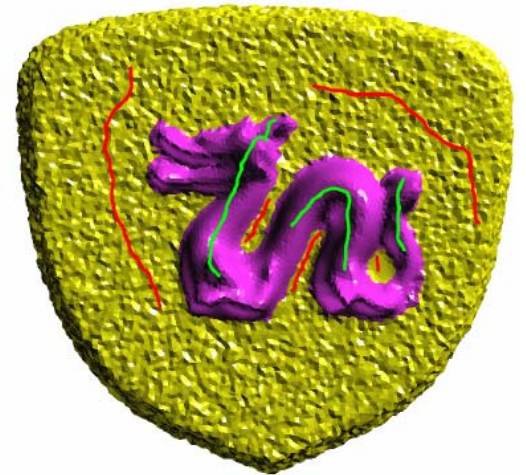
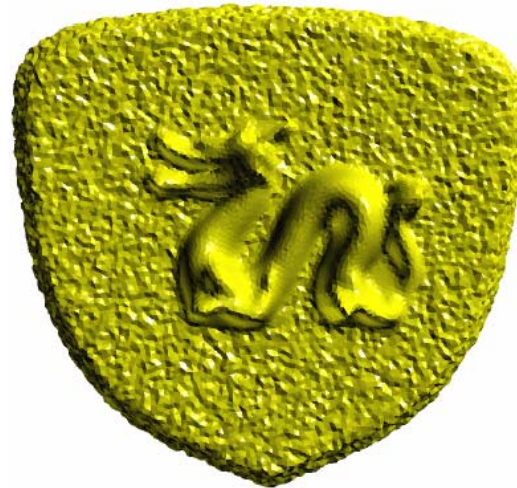
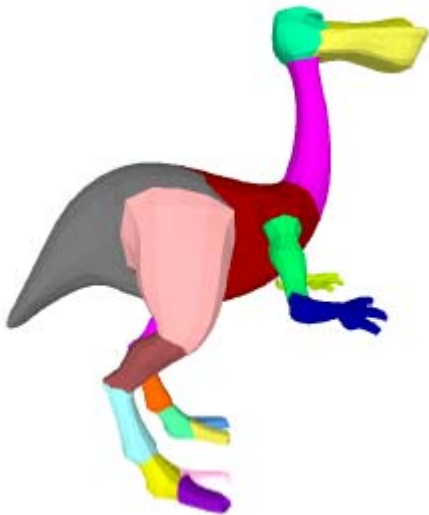


# Mesh Editing and Morphing





# Segmentation



# Point Based Surfaces



# Others

- Matching
- Deformation transfer
- Connectivity shape
- Statistical learning
- ...

# Course Requirements

- Programming exercises (30%)
  - Mesh library
  - Parameterization
  - Deformation
- Final projects (40%)
  - Develop an algorithm for interesting problem
  - Or implement existing paper
- Survey report (30%)
  - Literature survey on an interesting topic

# Expectations

- DGP
  - Many interesting topics
  - Wide applications
- Do something interesting
- Learn something
  - Coding, writing, [demo](#), presentation
- Hard work!

Have fun! 😊

# Resources

- Course website:
  - <http://staff.ustc.edu.cn/~lgliu> → “Teaching” → “Digital geometry processing”
- [http://www.math.zju.edu.cn/ligangliu/Resources/Graphics/resource\\_graphics.htm](http://www.math.zju.edu.cn/ligangliu/Resources/Graphics/resource_graphics.htm)

# Q&A