Digital Geometry -Introduction

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http://jjcao.github.io/DigitalGeometry/

Pleasure may come from illusion, but happiness can come only of reality.

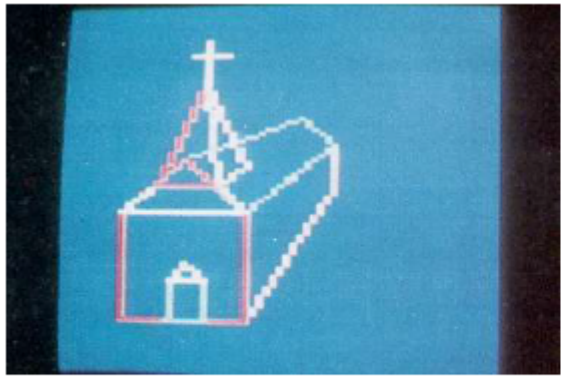
Contents

- Motivations
- What is DGP
- Pipeline
- About the course

What is Computer Graphics?

- CG studies **visual/geometric** information using **computer & *mathematics***.

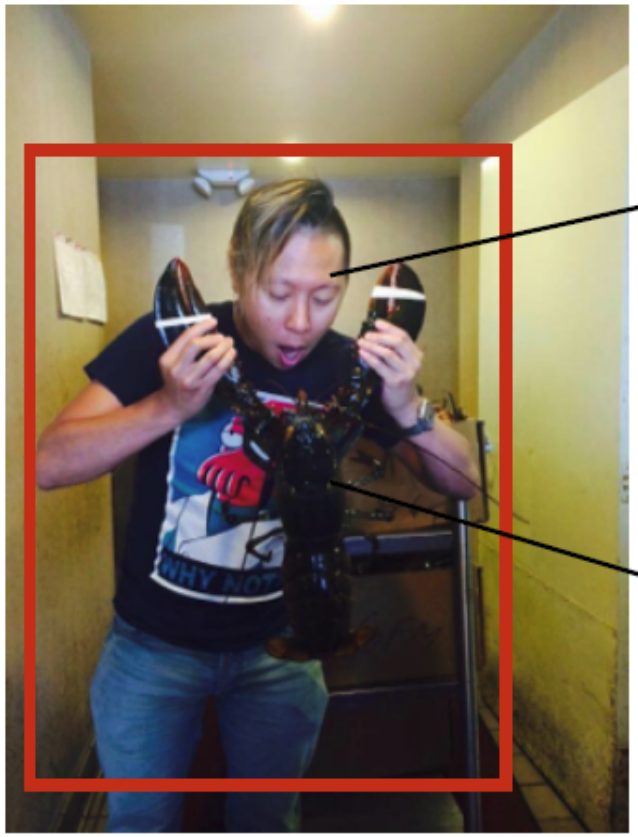
- 3D graphics programming in 1979



approx. 25 triangles

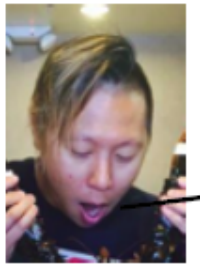
approx. 50 x 100 pixels

Computer Vision



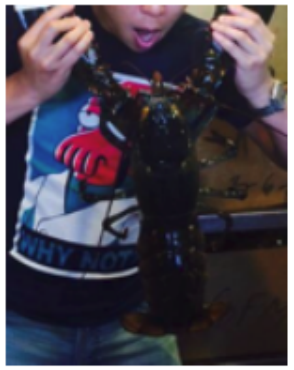
ROI

input
an image



face

mouth open 70%



shrimp 20%
lobster 60%
crap 40%

output
Hao is eating a lobster

Image → Computer Vision → Story

Computer Graphics

Action!

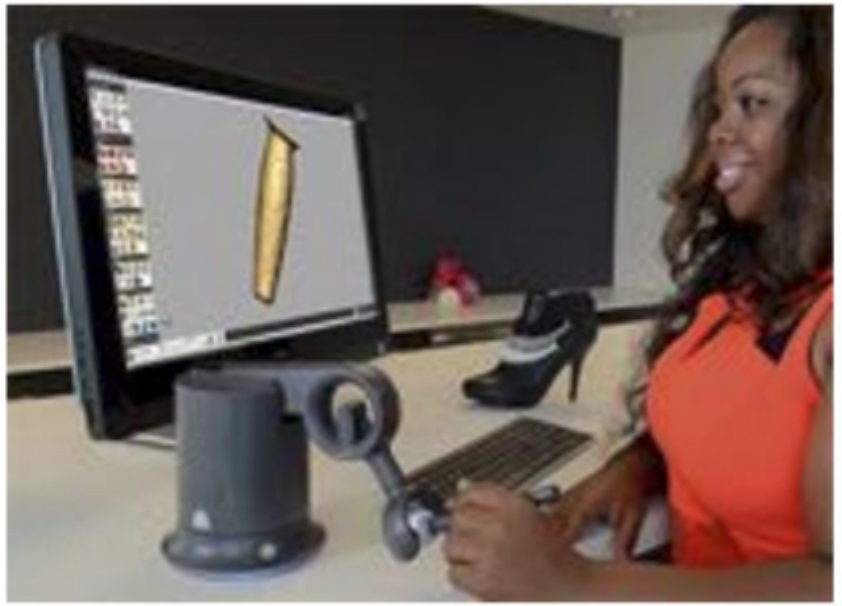
Story → Computer Graphics → Image

What is computer graphics?

- The use of computers to synthesize and manipulate **visual information**.

- The use of computers to synthesize and manipulate **sensory information**.

(sound)



(touch)

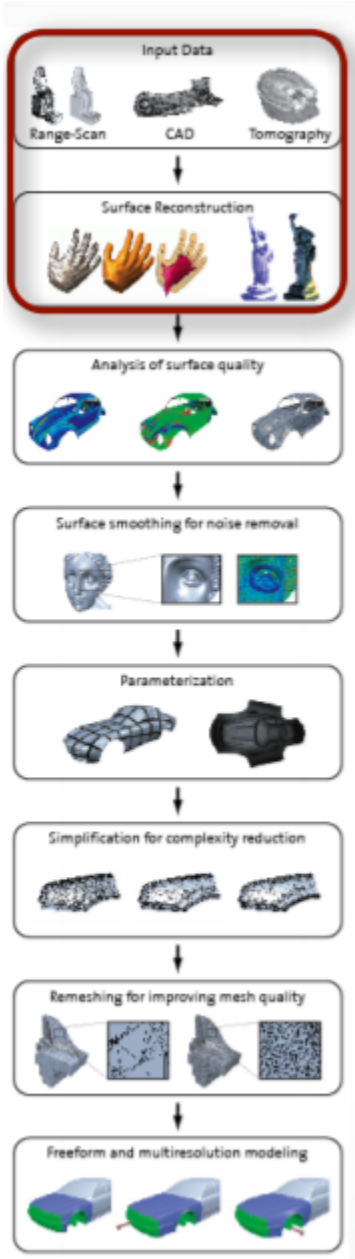
SIGGRAPH & SIGGRAPH Asia

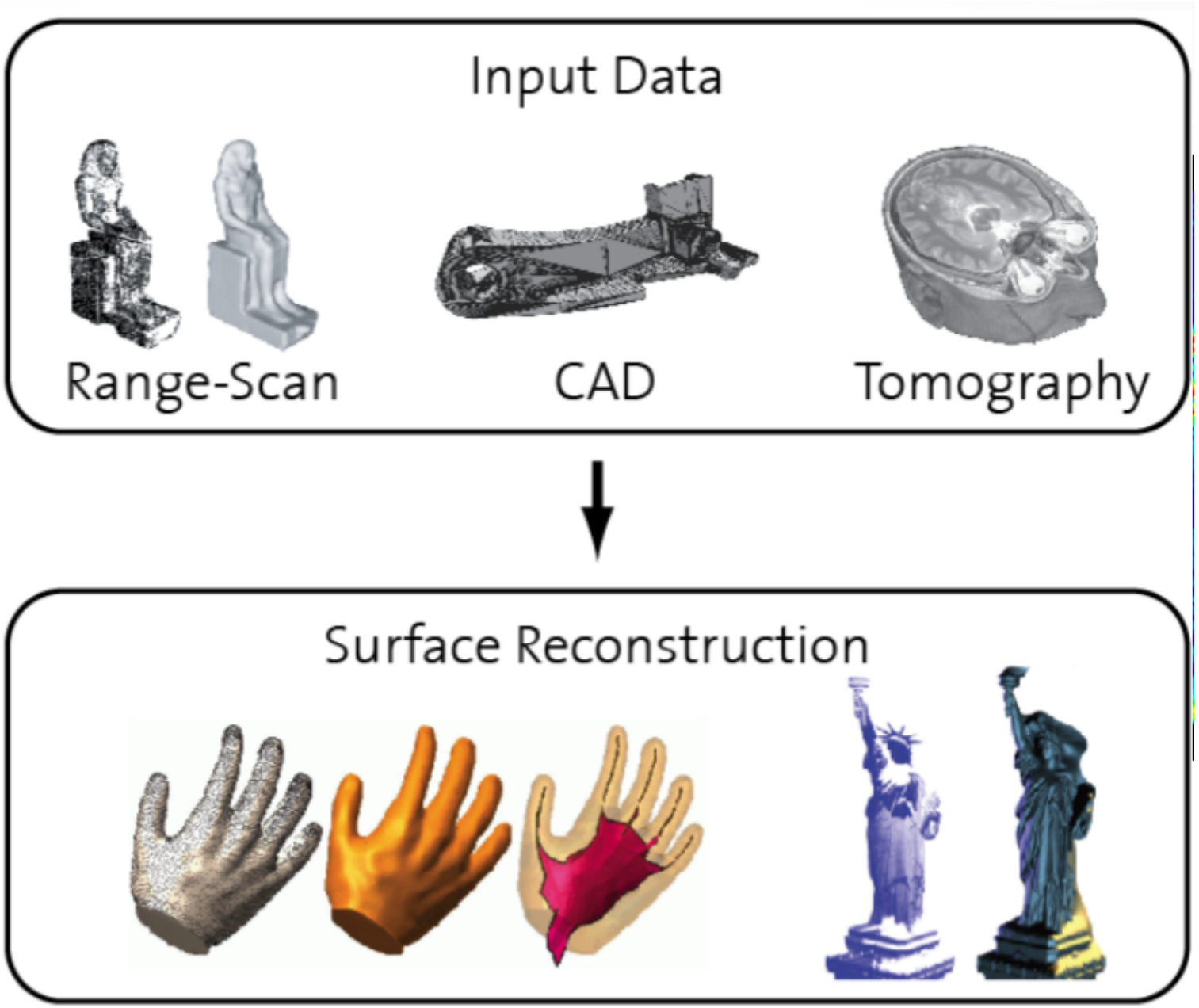
- Main computer graphics event
- Twice a year
- up to 30K attendees
- Academia, industry, artists

CG & Digital Geometry Processing

- DGP is advanced CG without some traditional parts, like rendering, etc

Geometry Processing Pipeline





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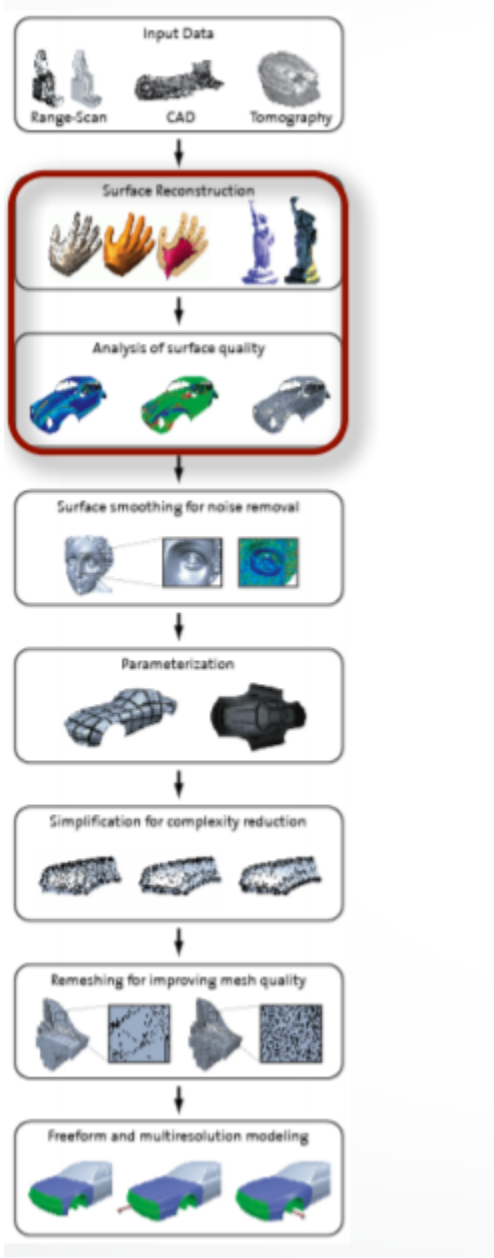
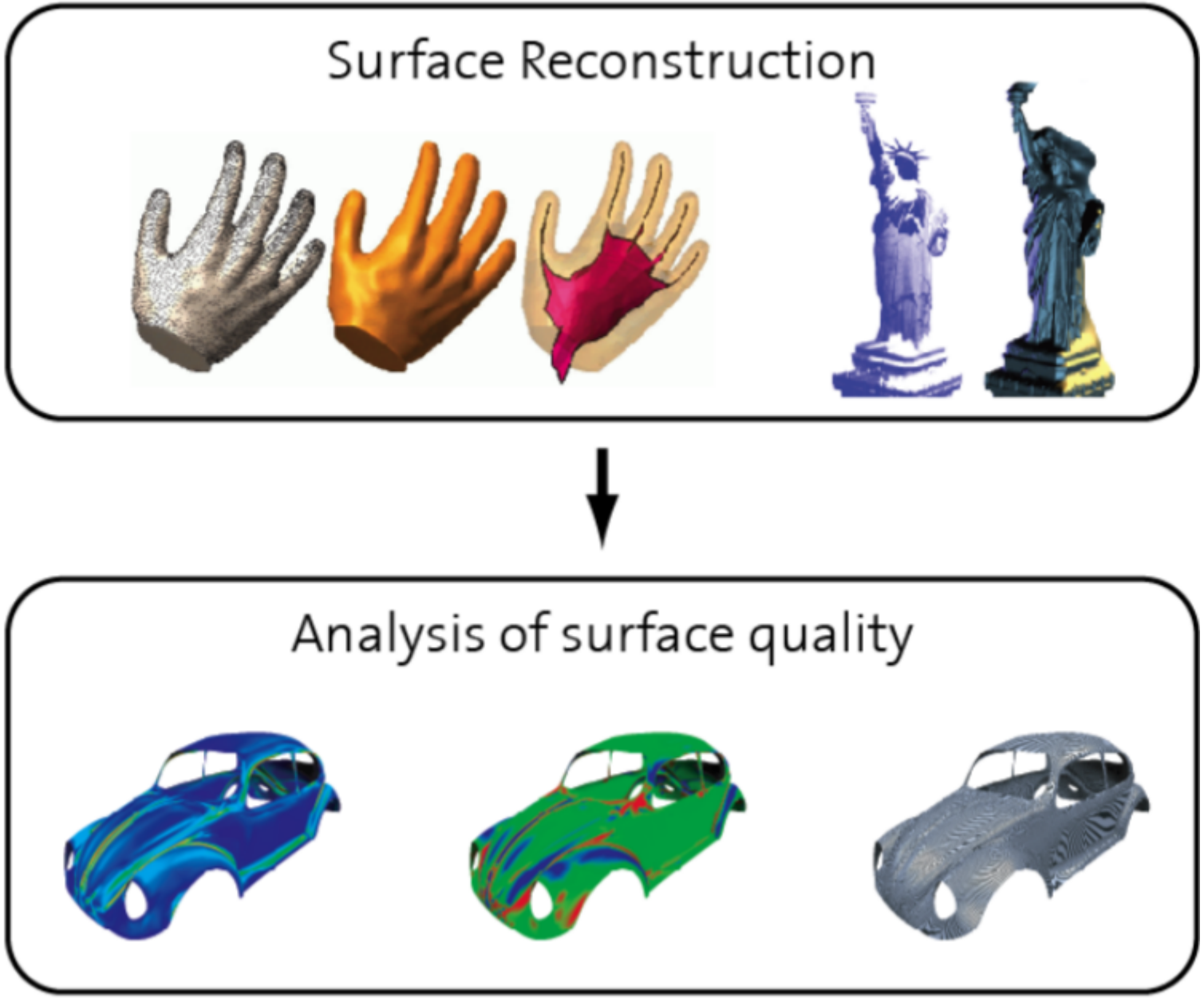
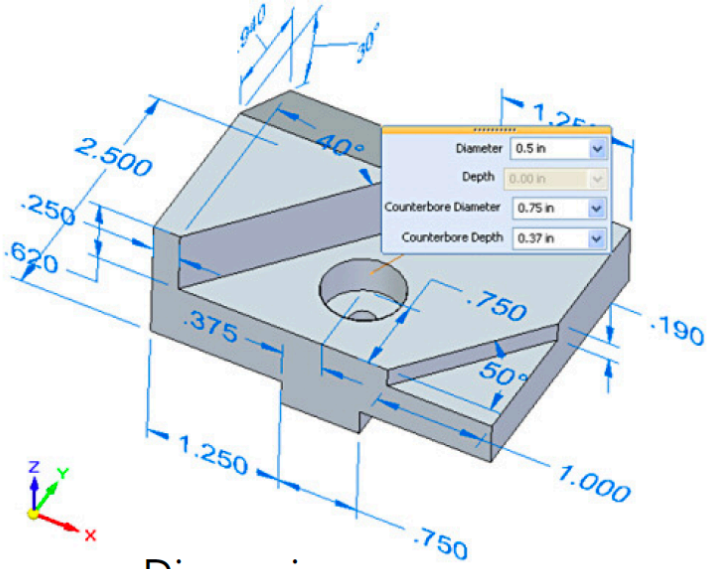
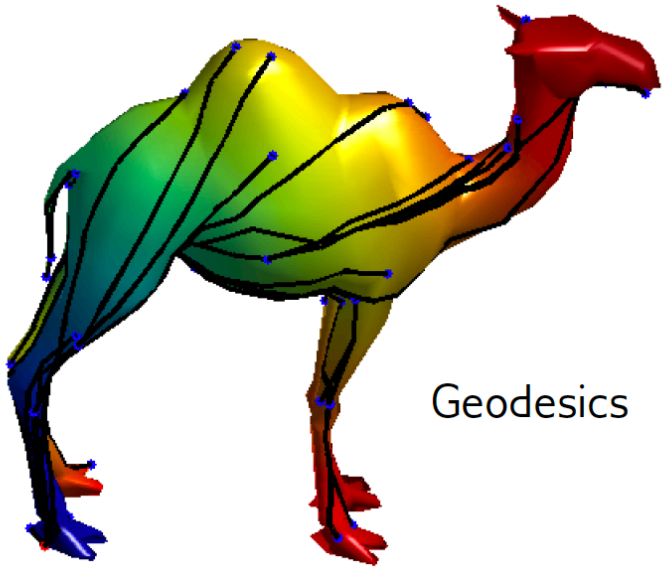




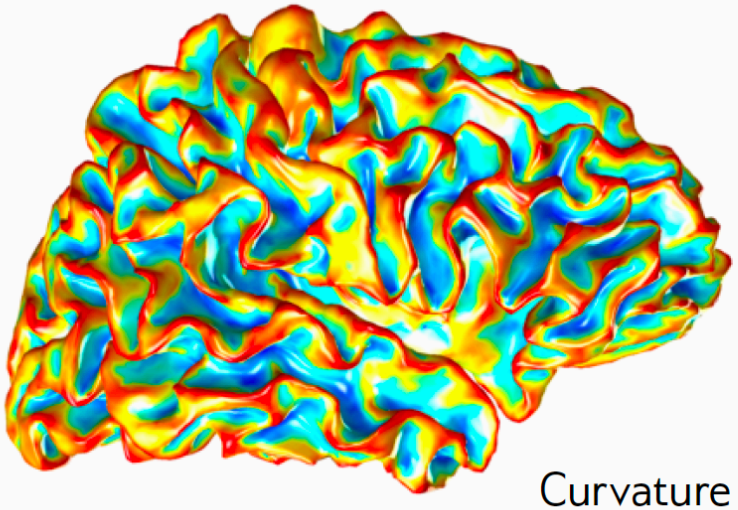
Basic Geometric Analysis



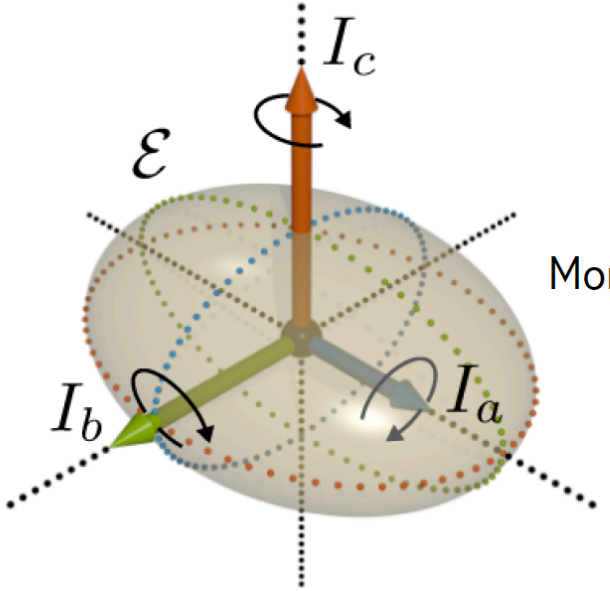
Dimensions



Geodesics

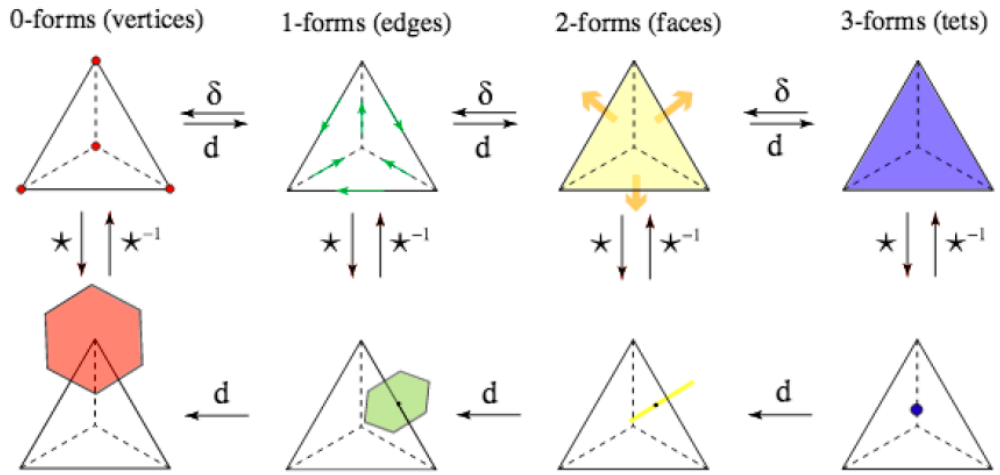


Curvature

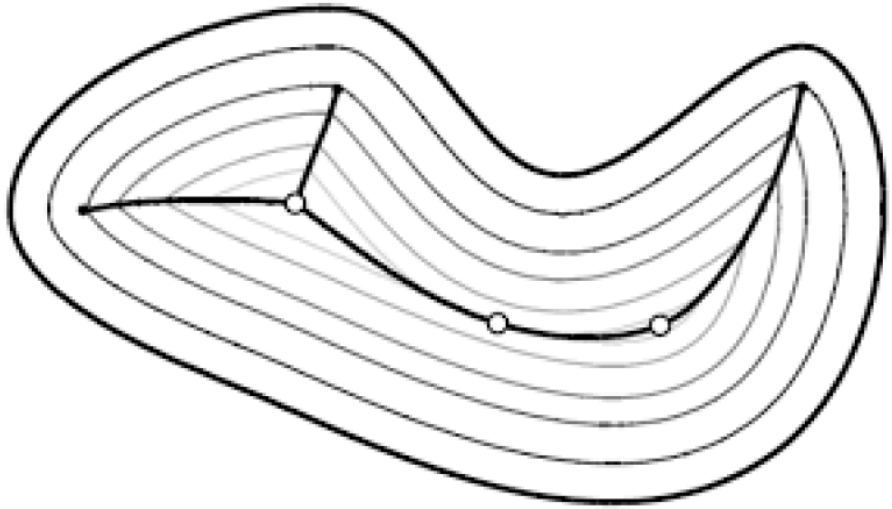


Moments

Advanced Geometric Analysis



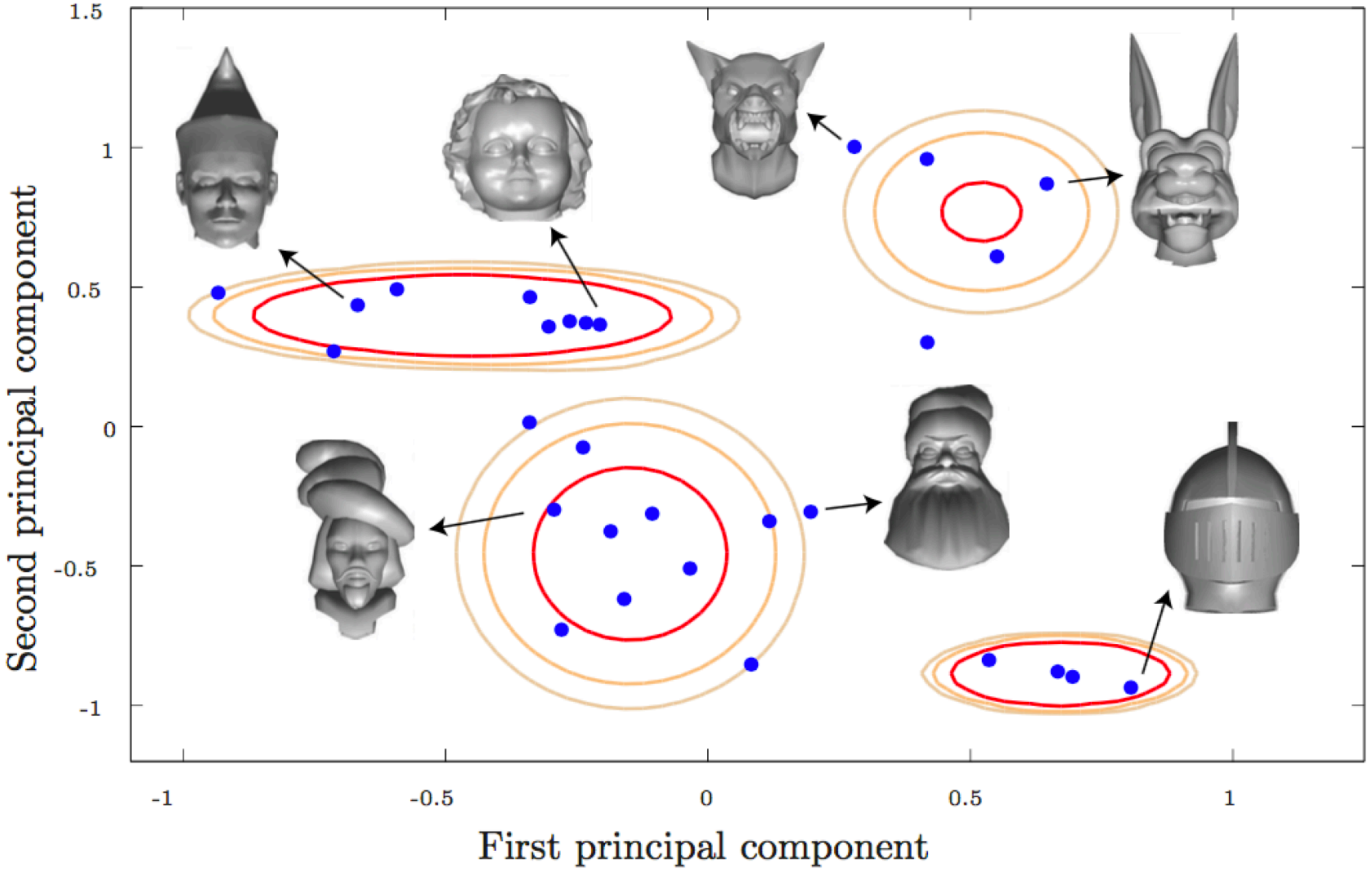
Discrete Differential Geometry



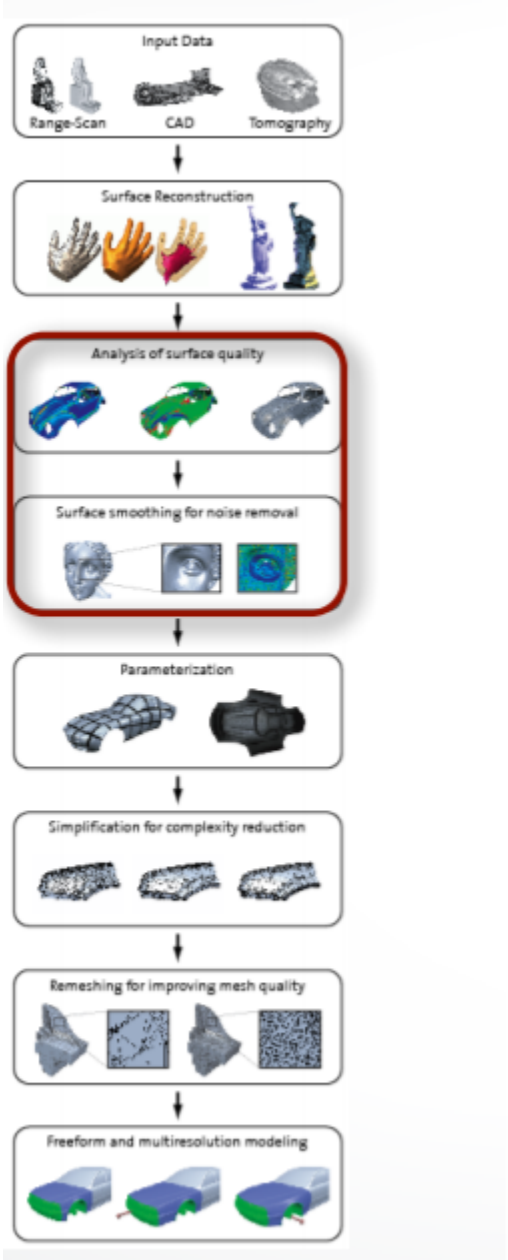
Medial Axis Transform

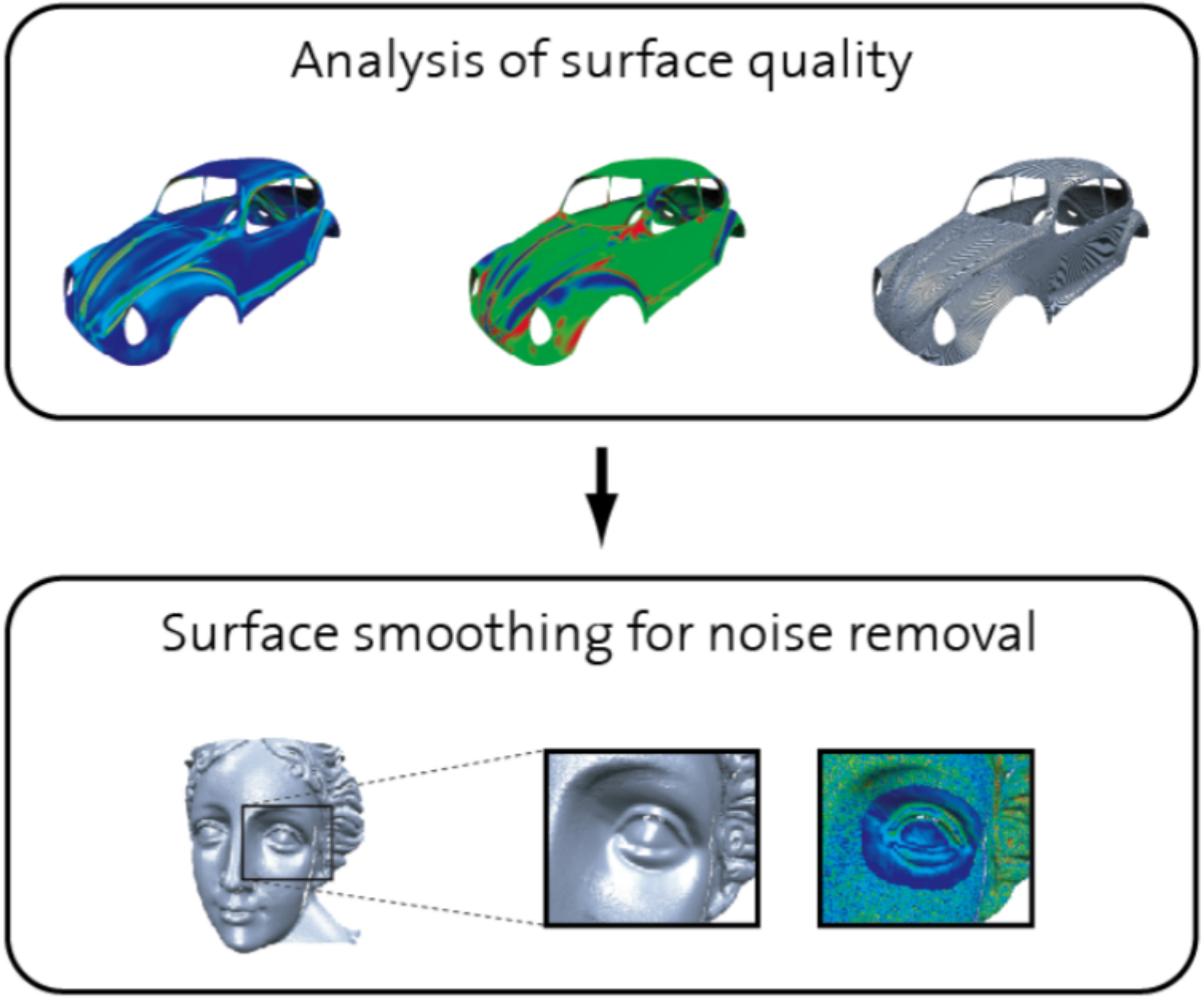
Spectral Decomposition

Global Shape Features



Geometry Processing Pipeline





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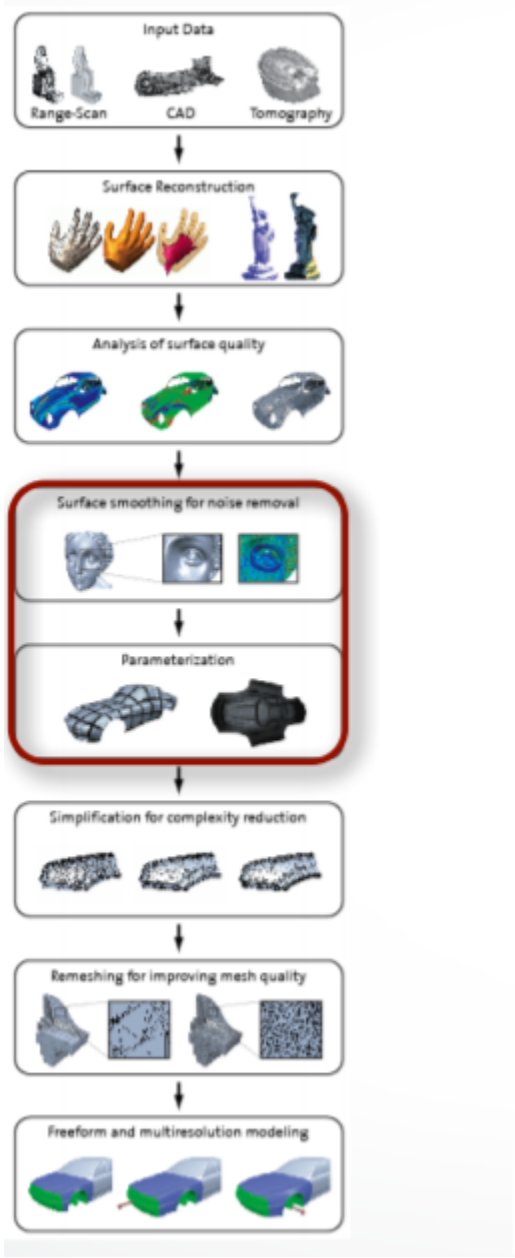

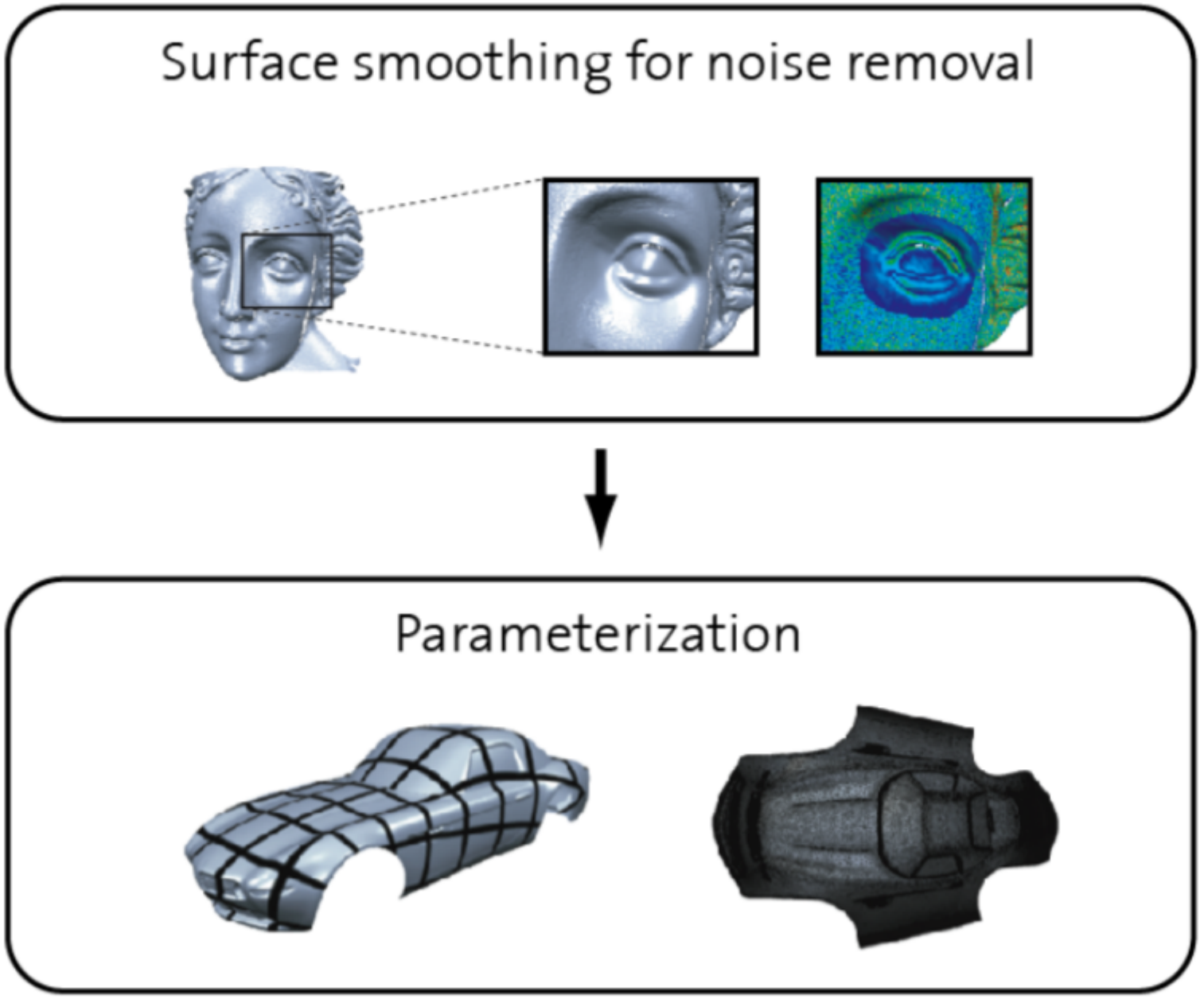

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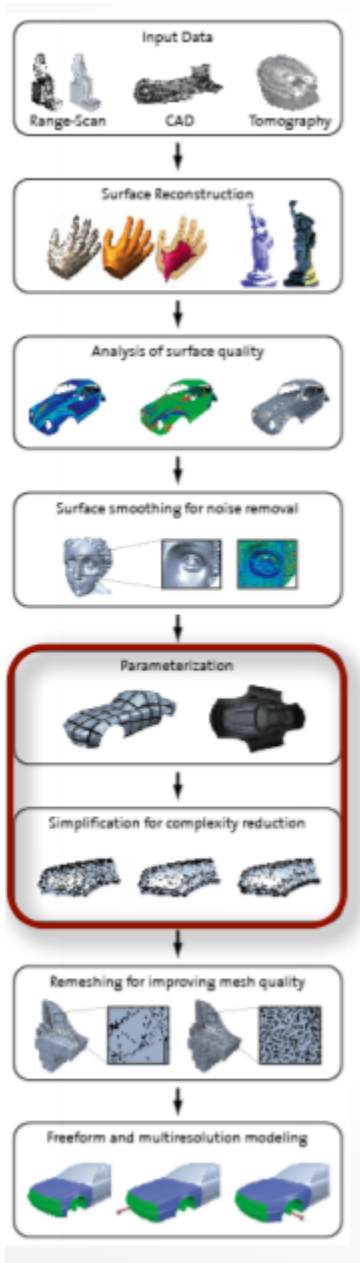

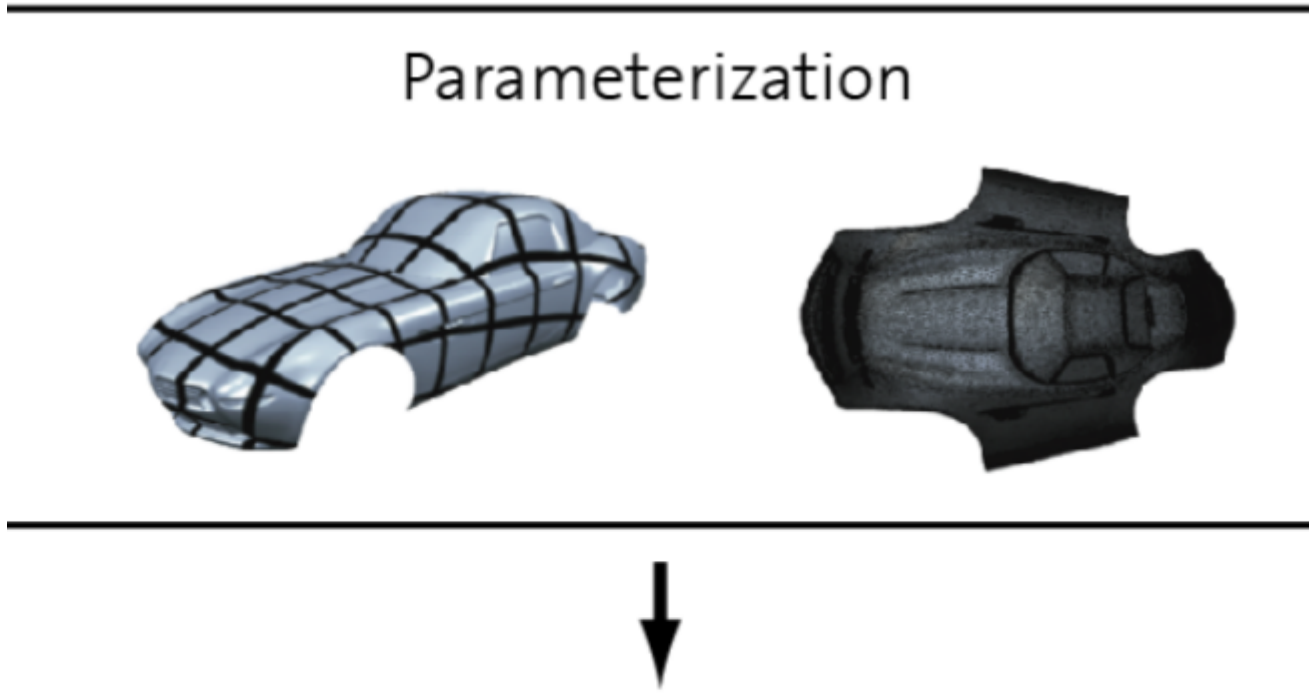

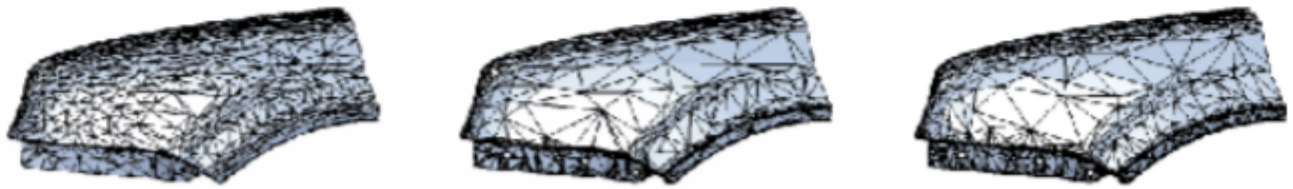

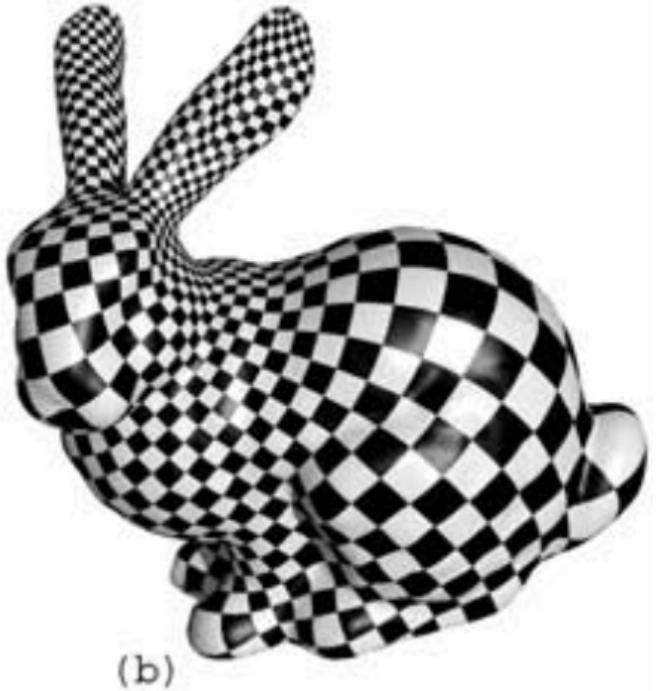

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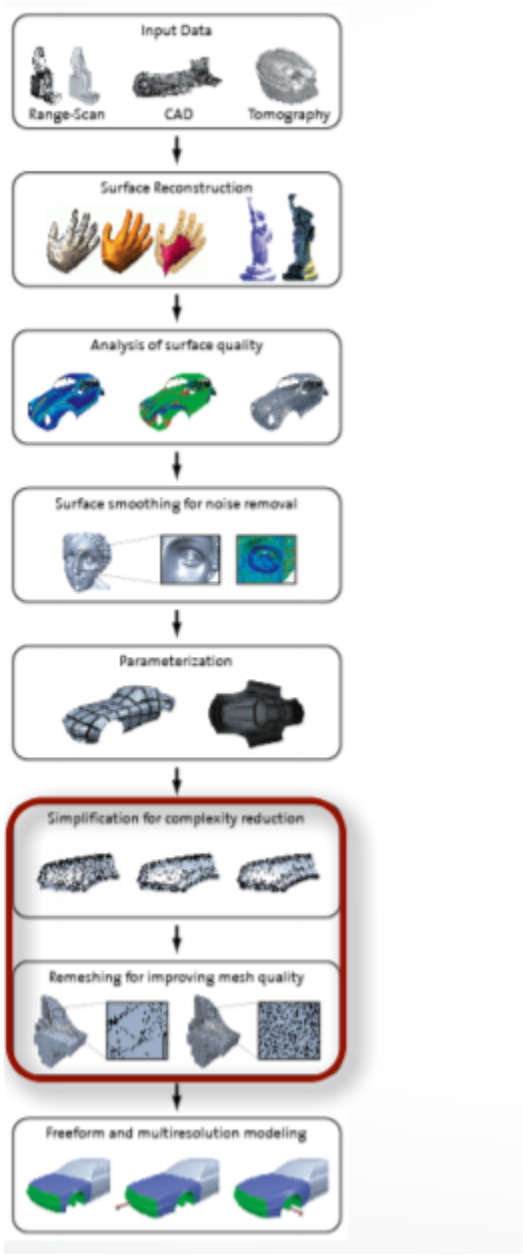

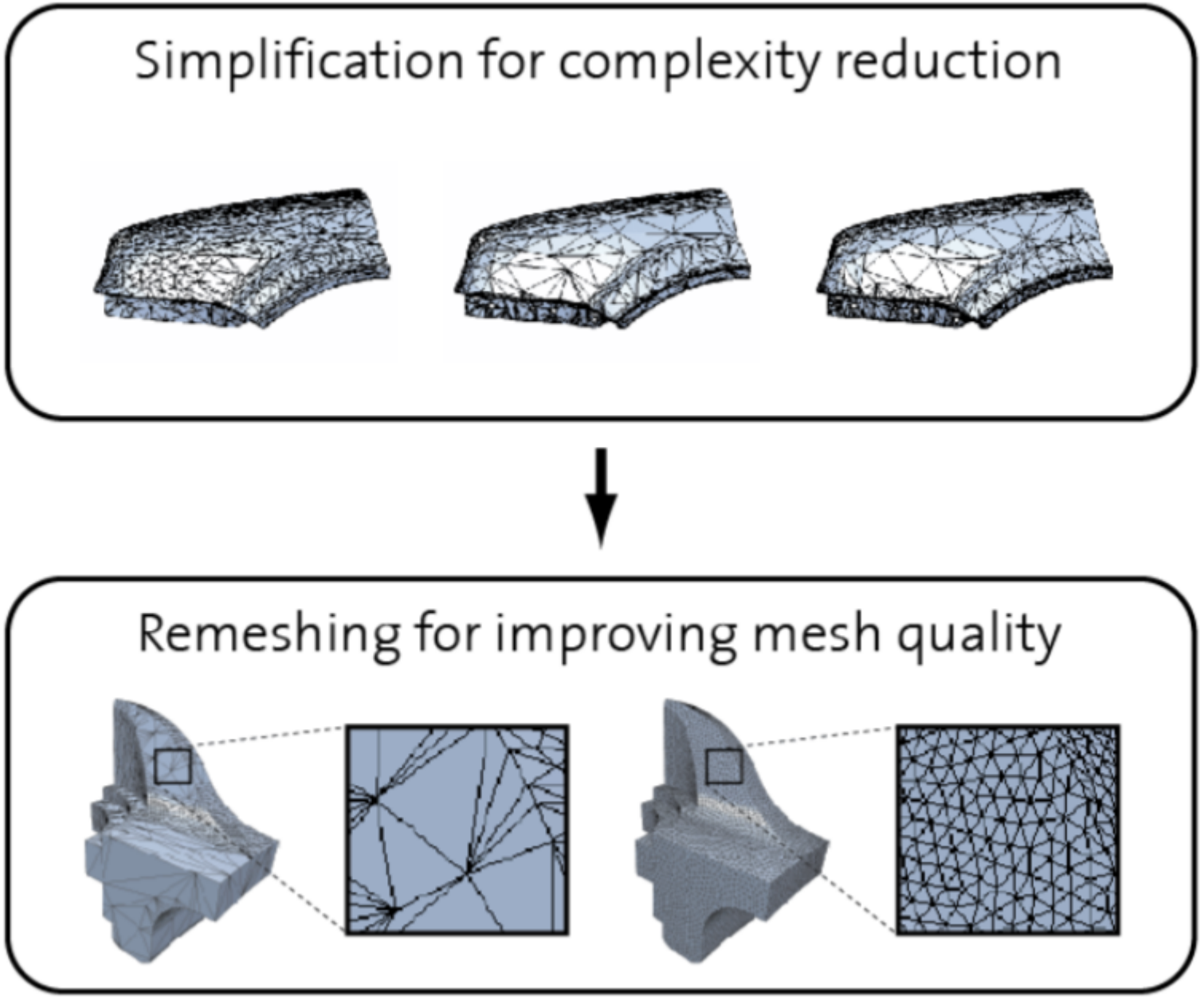

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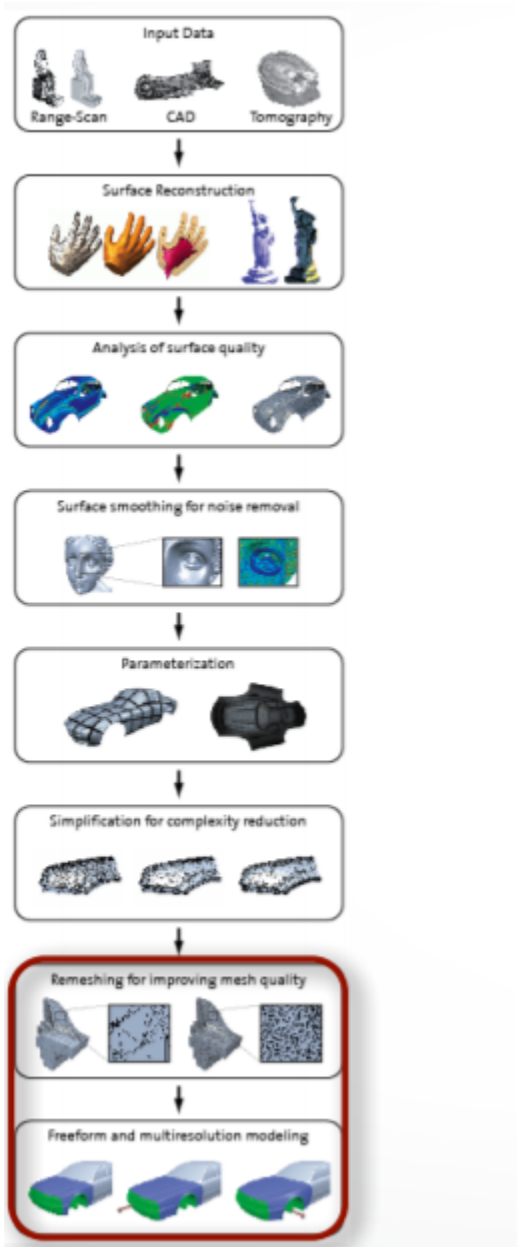
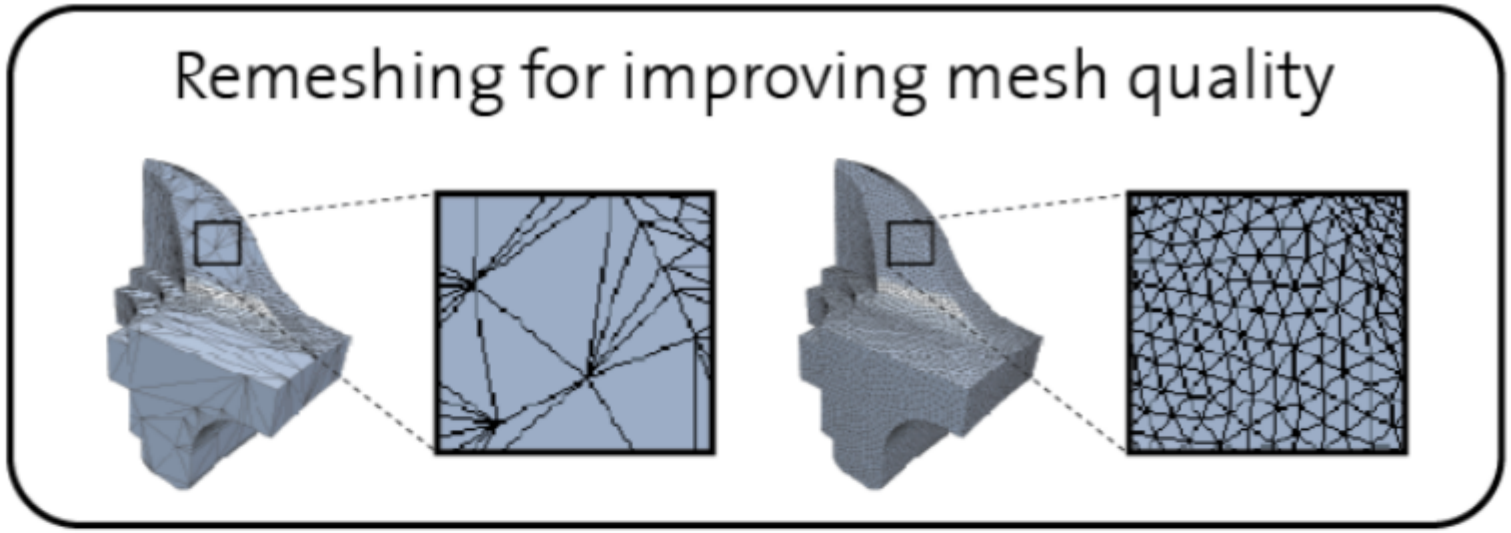
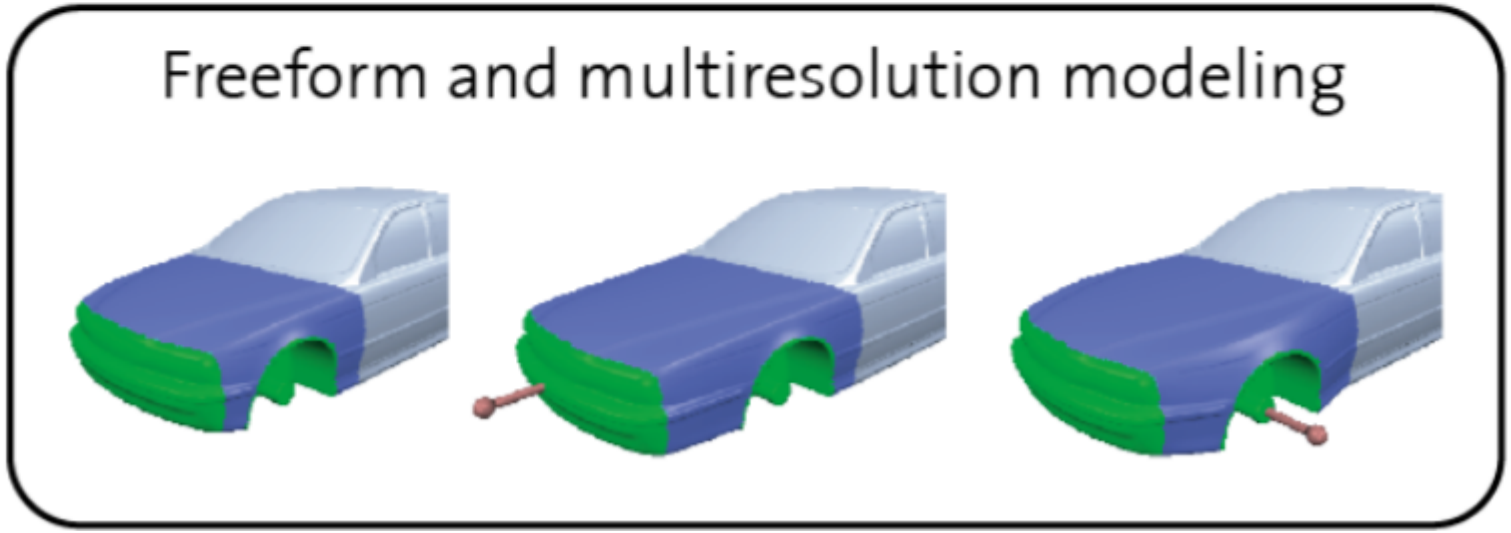
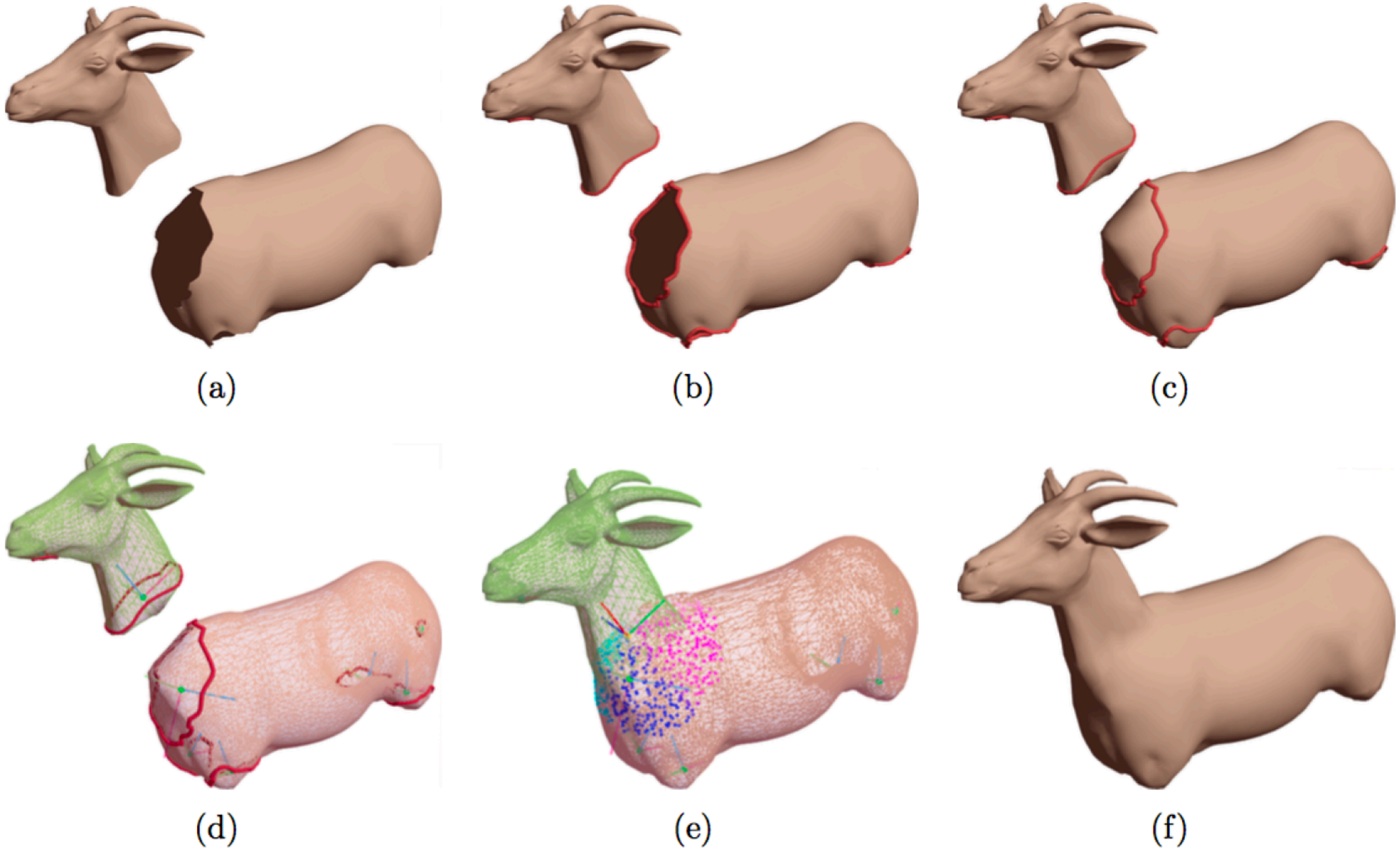


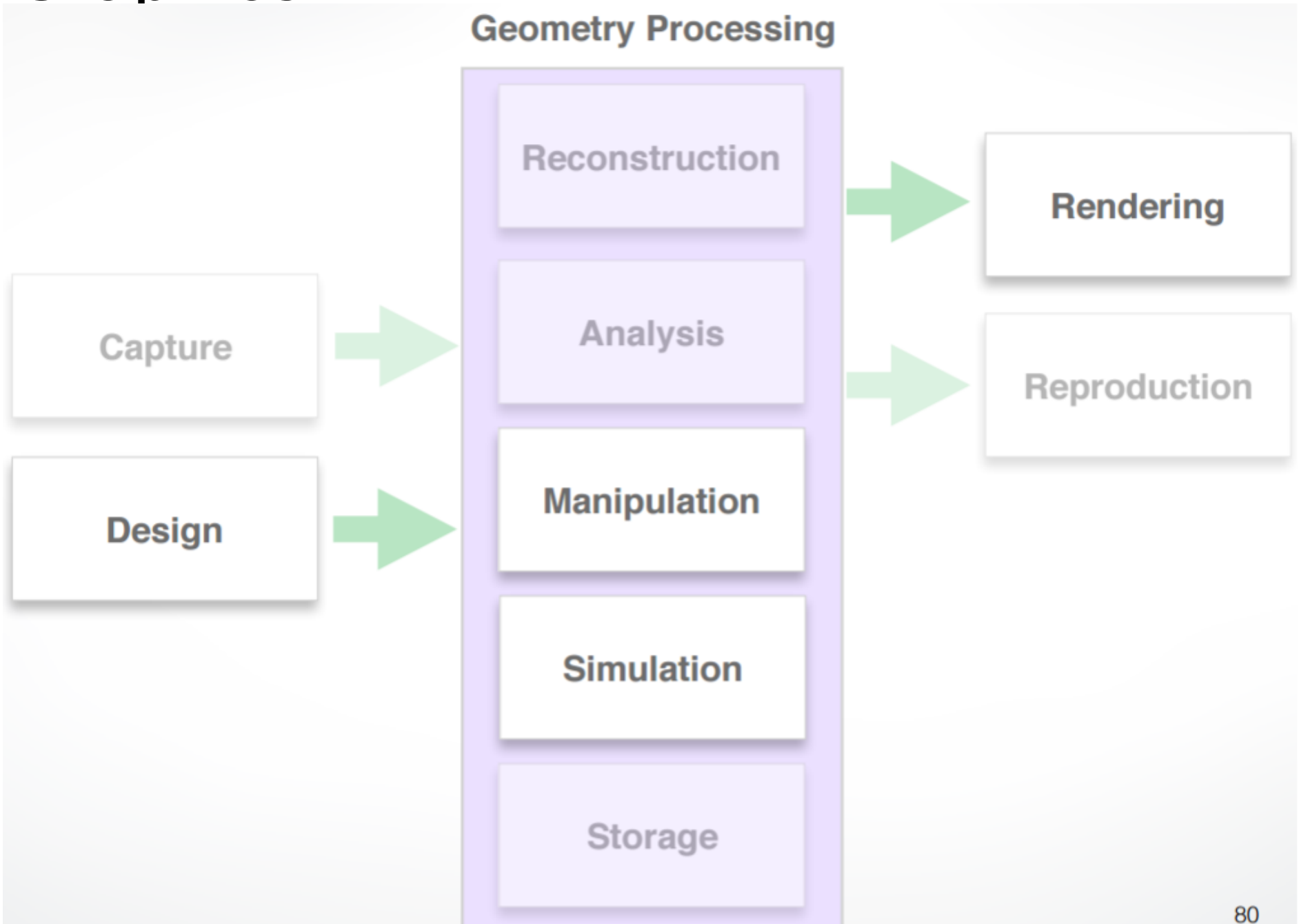




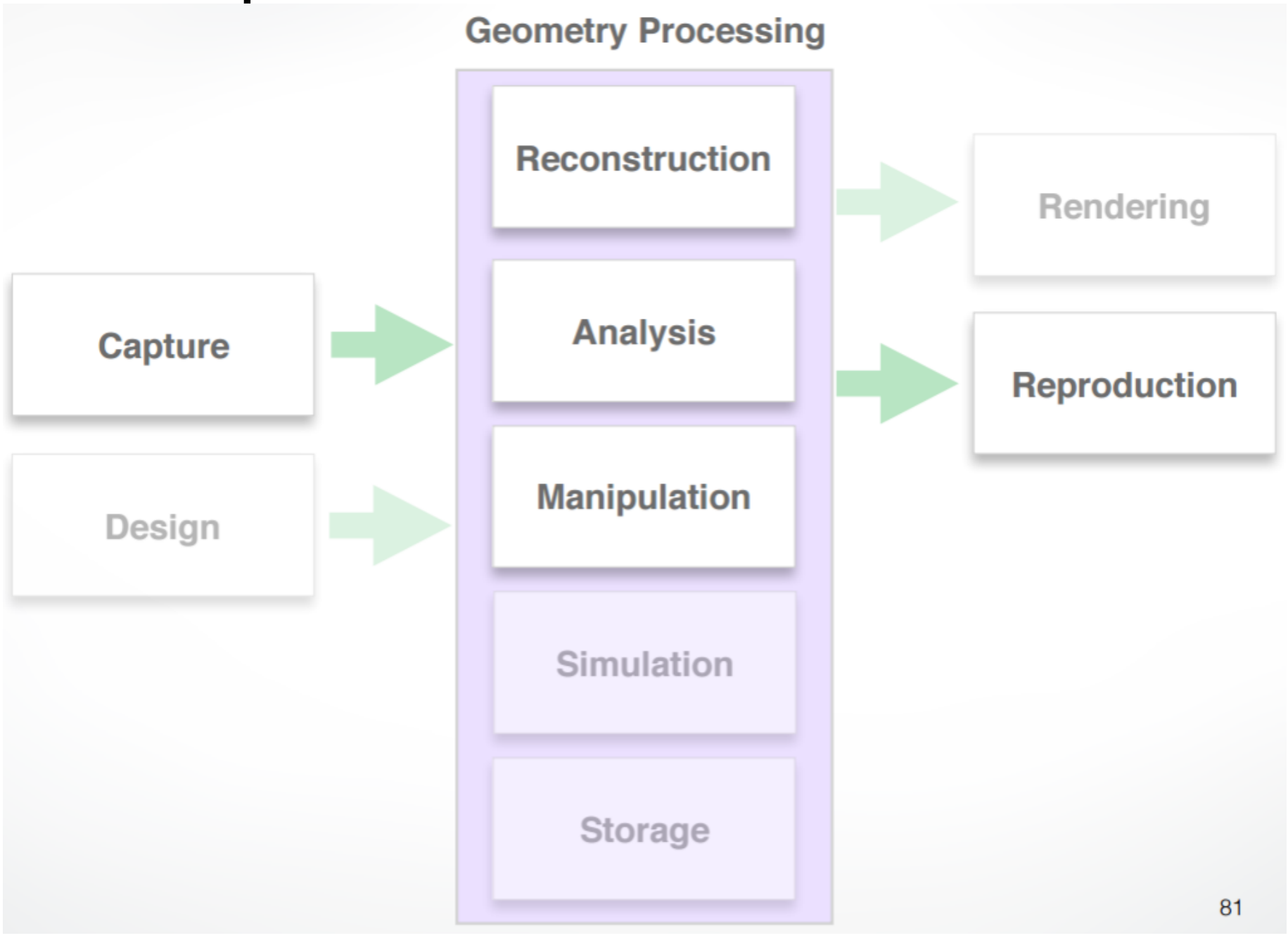
Shape Editing



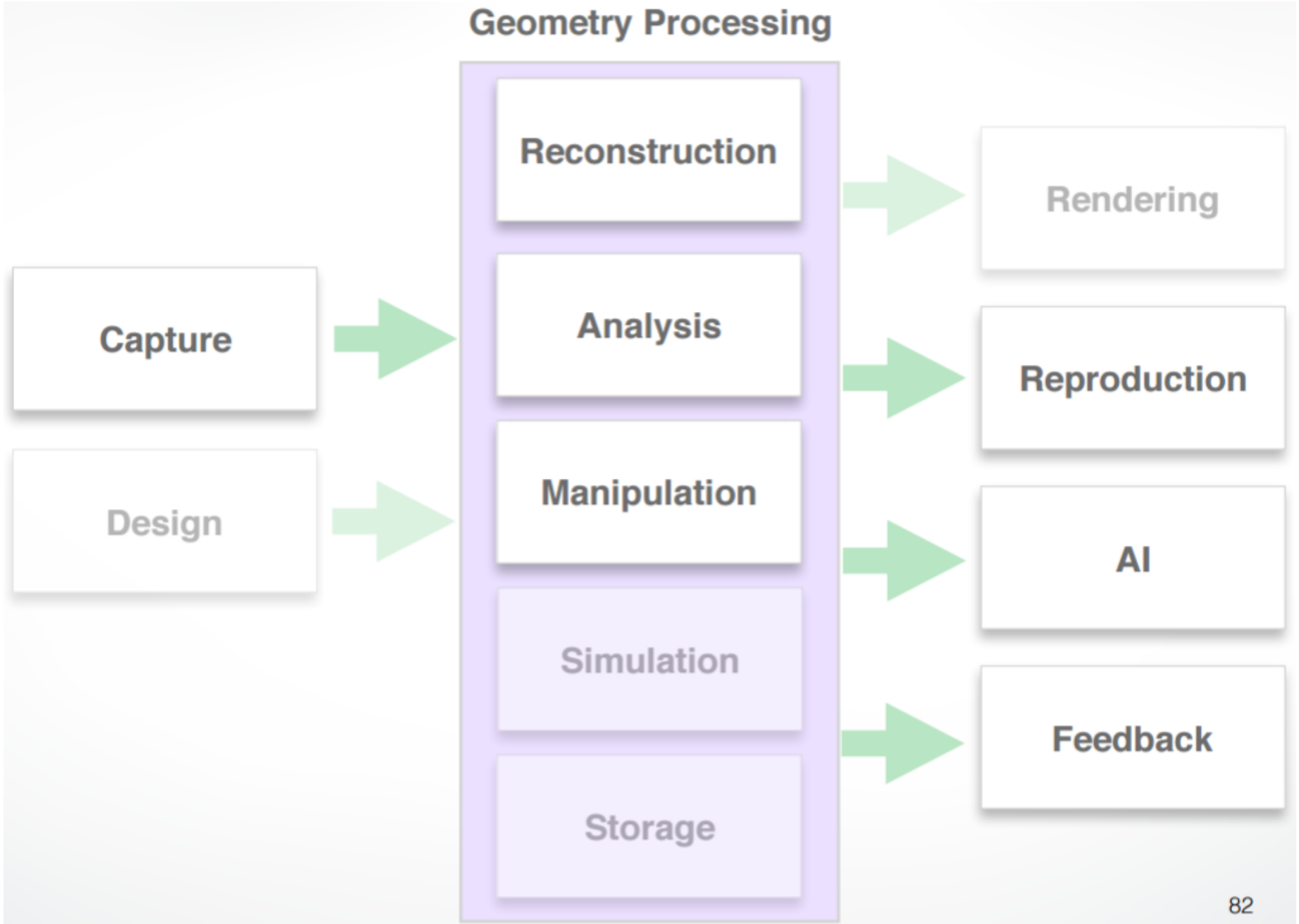
Classic Graphics



Modern Graphics/Vision



The Future: Big Data / Robotics



About the course

Target Audience

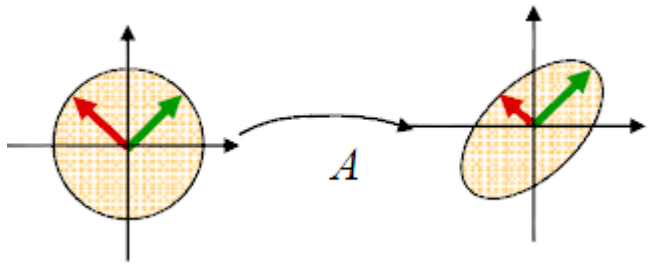
- PhD students, MSc students, Advanced undergraduates

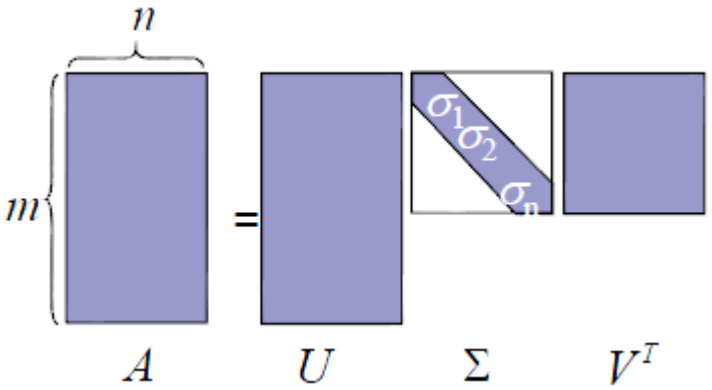
- **Computer Science**, Computer Engineering, **Mathematics**, Physics, Game Program, Biomedicine, Bioengineering, etc.

- Computer Graphics, Computer Vision, Robotics, Machine Learning, Signal and Image Processing, Medical Imaging

Prerequisites

- Differential Geometry
- Liner algebra: transformations, spectral decomposition, PCA, SVD
- Graph theory
- …





- **Combined with a lot of intuition …**
- **Work on real data = Write/use a lot of code!**

Prerequisites

- Familiarity with a graphics API (e.g. OpenGL)
  - If not, learn quickly (for the sake of visualization)
  - http://jjcao.github.io/ComputerGraphics/
- C++/Matlab coding skills
  - If Java is preferred, you will be on your own
- Capability to search Google and forums for useful information

Coding

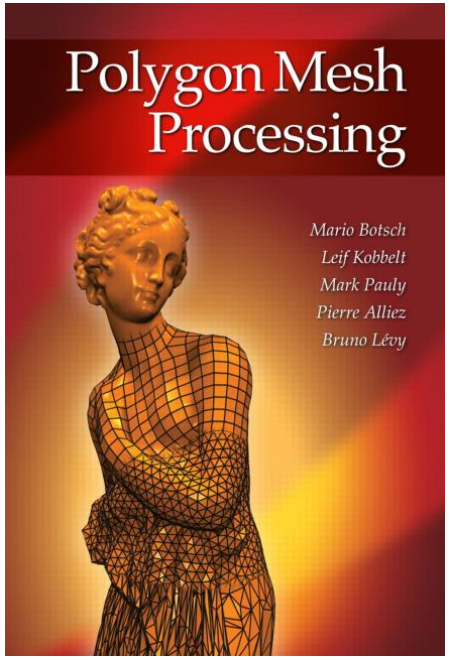
Coding is very import in this area!

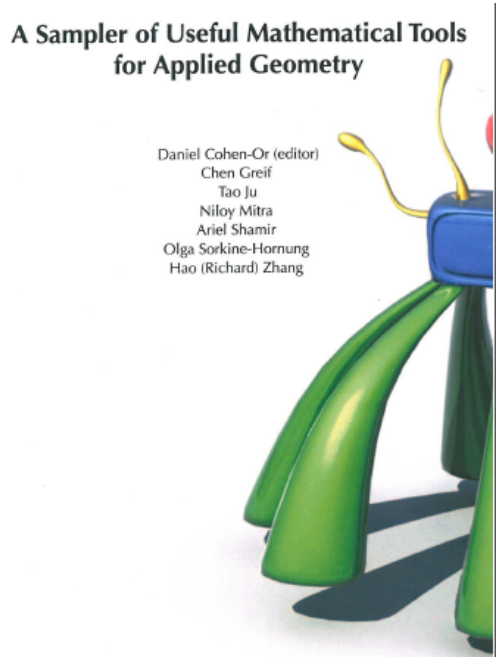
If you can not program, you will study nothing in this subject!

Recommented Textbooks

- **Botsch, Kobbelt, Pauly, Alliez, Levy: Polygon Mesh Processing, AK Peters, 2010, http://www.pmp-book.org/**

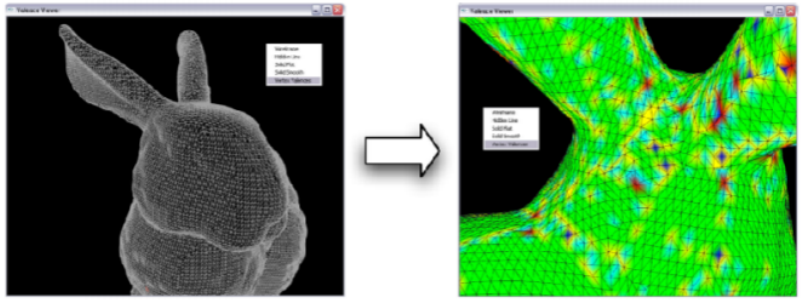
- **A Sampler of Useful Computational Tools for Applied Geometry, Computer Graphics, and Image Processing, 2015**

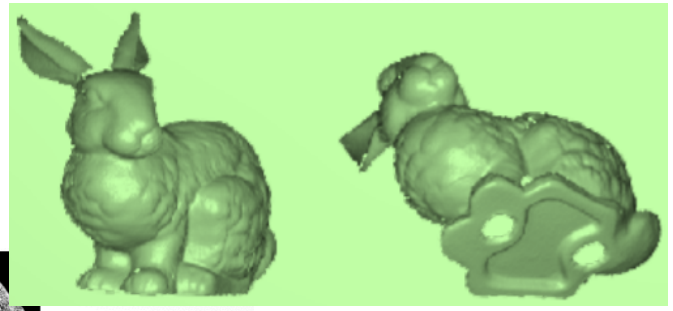


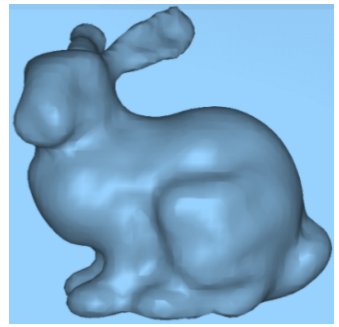


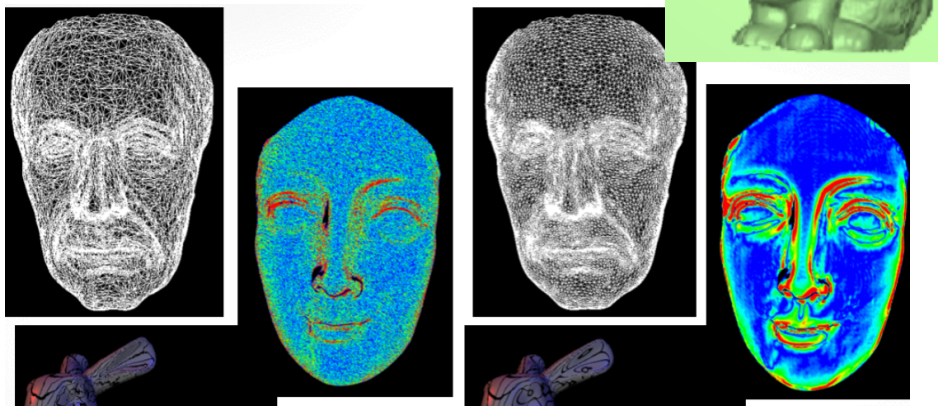
Exercises

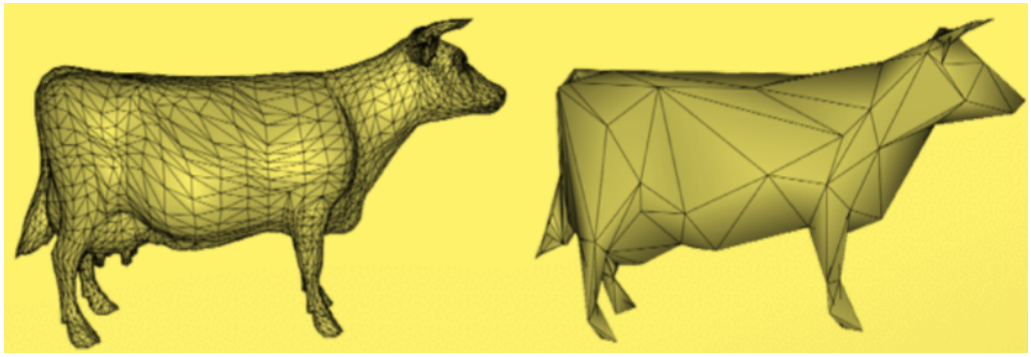
1. Introduction to **OpenMesh** (display mesh)
2. Registration
3. Implicit Surface Reconstruction
4. Surface Smoothing
5. Mesh Decimation
6. Remeshing

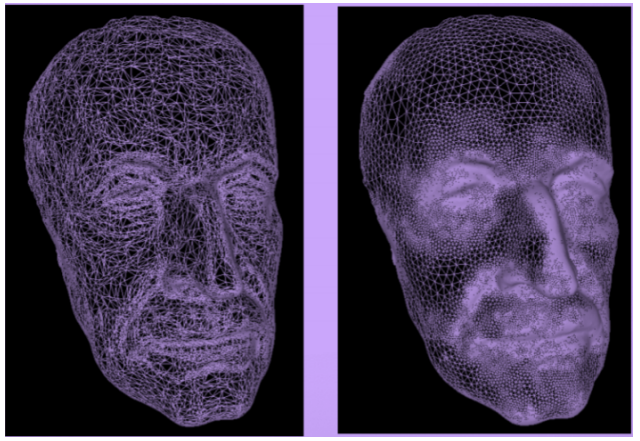






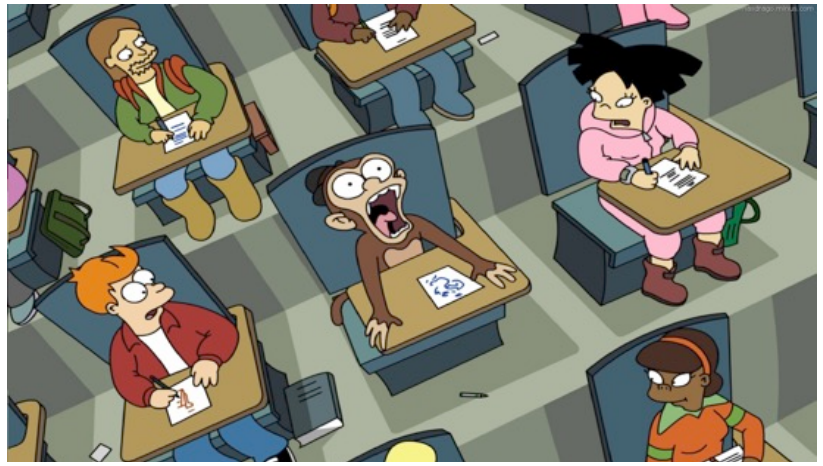






Grading

- Homework
  - **Contribute to 70% of the final grade :**
    - Functions 60 + Document 20 + Compliable code 10 + Executable file 10
  - 2-registration,3-reconstruction,4-smoothing, 5-decimation,6-remeshing
- Oral Reports:
  - **20%**
- Class performance
  - **10%**
- Two students a team



Document in A4 & electronic:
functions (required + optional)

RF1
Text description;
Code segment for the function
Image illustration;

…

OF1
Text description;
Code segment for the function
Image illustration;

Code in electronic:

- I can open *.sln and build it successfully and without modify setting and anything outside the folder.
- Compress whole folder into a zip
- Run **packing.bat** before compression
- Good function name and proper comments

Exe in electronic:

- A folder with exe, dll, and input data.
- Compress whole folder into a zip.

Oral Reports:

- **20%(Paper)**
  - **Problem solved**
  - **Contribution**
  - **Pros & cons**
  - **Core ideas**

- **10%(HW)**
  - **Show results (run software > show video > show pictures)**
  - **Report pipeline, main algorithms, main theory behind**

Related courses @ dlut math

- C++ http://jjcao.github.io/cPlusPlus/
- Computer Graphics http://jjcao.github.io/ComputerGraphics/
- Computer Vision http://jjcao.github.io/ComputerVision/

- 2120040081, Digital Media Processing, 数字媒体处理方法选讲
- 3120033010, New Topics in Computational Geometry, 计算几何新专题

Course Objectives

- **Basic concepts**, for polygon mesh processing

- **Basic coding training**: **Design** and **implement** individual components of geometric modeling system

- **Apply** the proposed methods in your own work

Video demos

Acknowledgement

- **Course material taught at:**
  - University of Southern California, Hao Li