Digital Geometry -Introduction

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Spring 2018

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

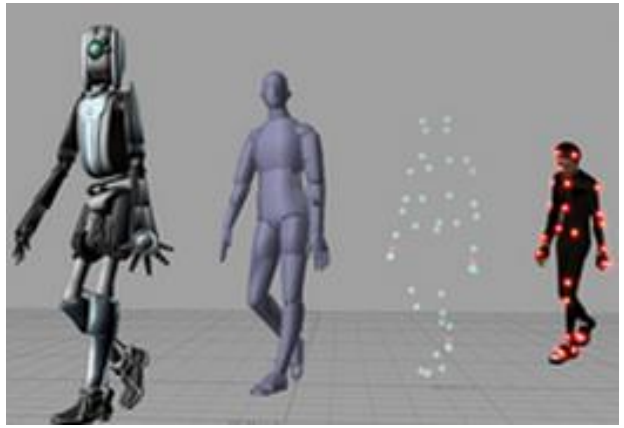
Pleasure may come from illusion, but happiness can come only of reality.

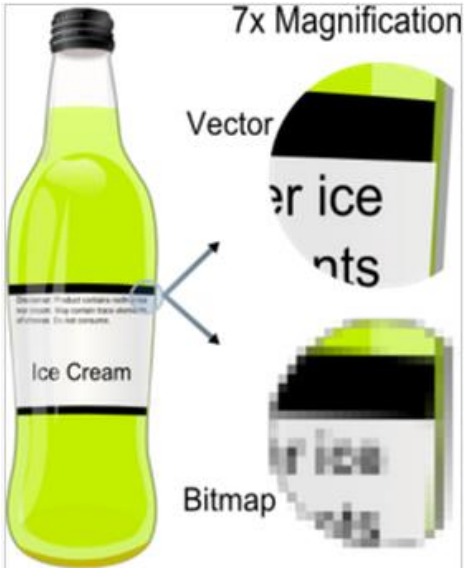
Contents

What is CG?

- The study of computer graphics is a sub-field of computer science which studies methods for digitally synthesizing and manipulating visual content.
  - 3D
  - Image processing

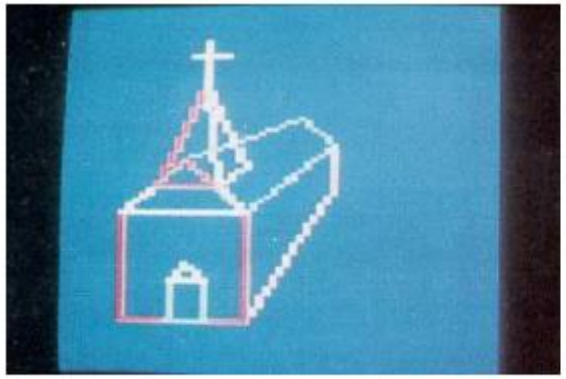
- CG studies the manipulation of **visual** & **geometric** information using *mathematical & computational* techniques.
- CG vs. Visualization





Computer Graphics
The big picture

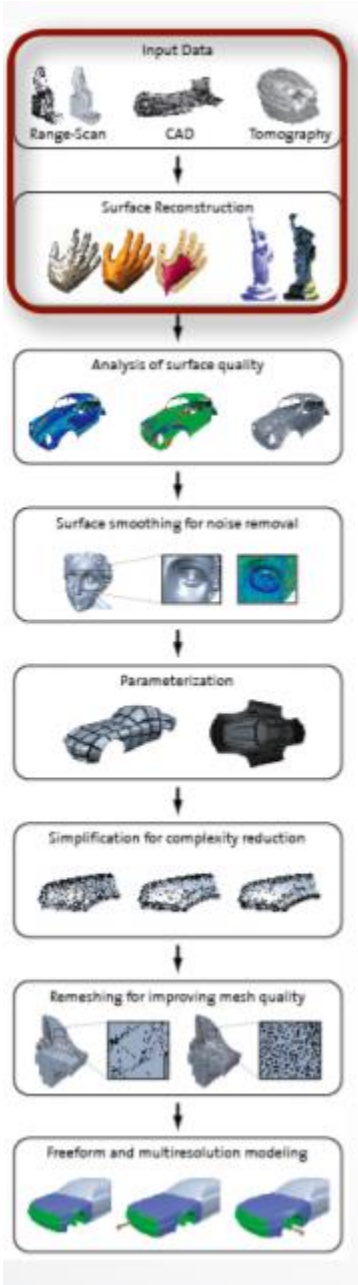
- 3D graphics programming in 1979

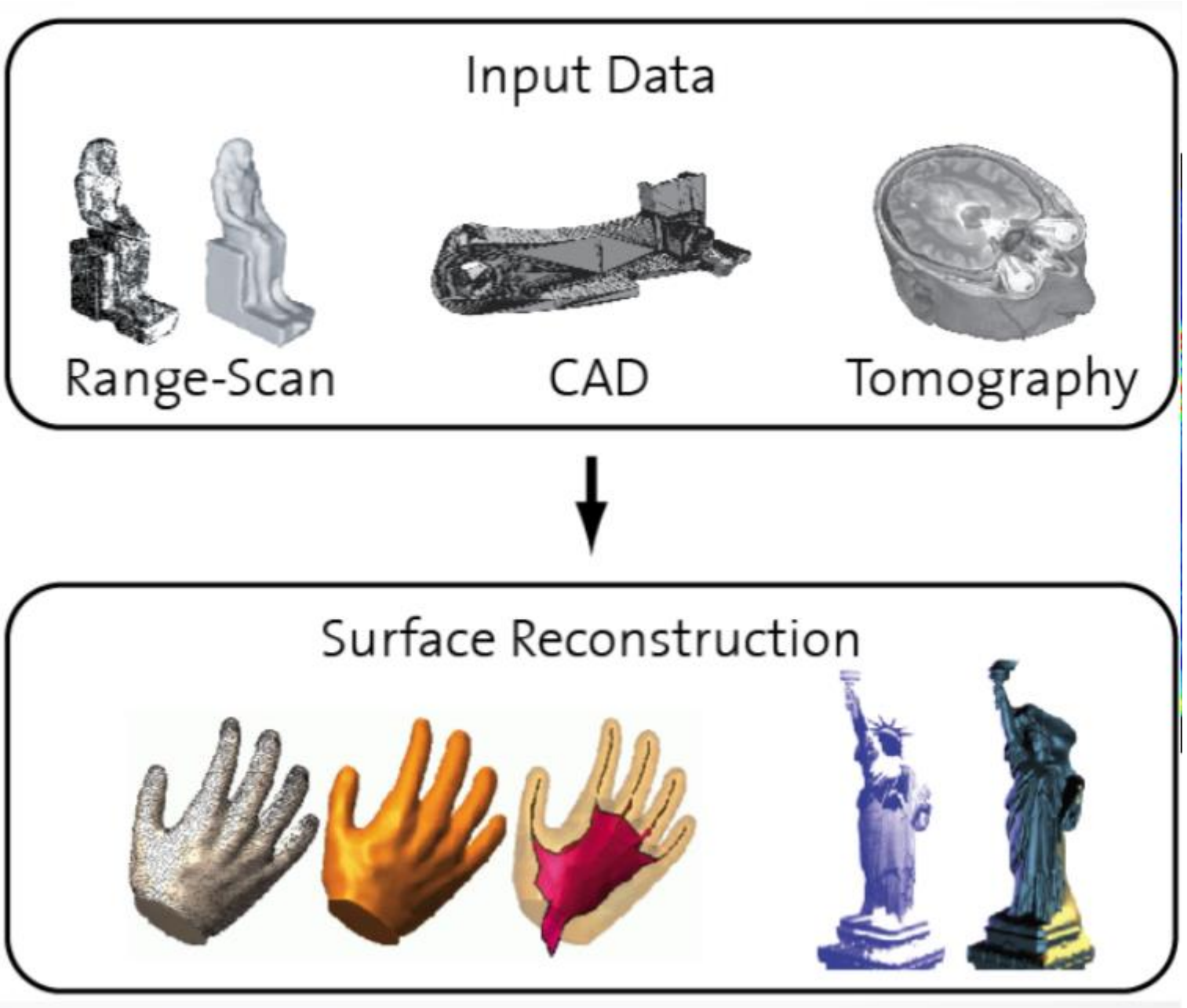


approx. 25 triangles

approx. 50 x 100 pixels

Geometry Processing Pipeline





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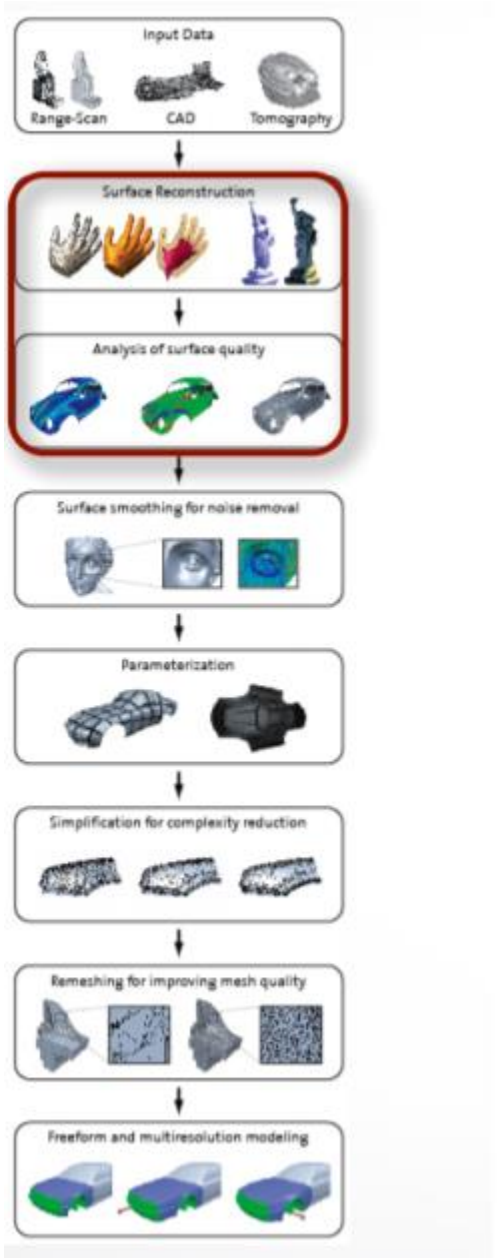

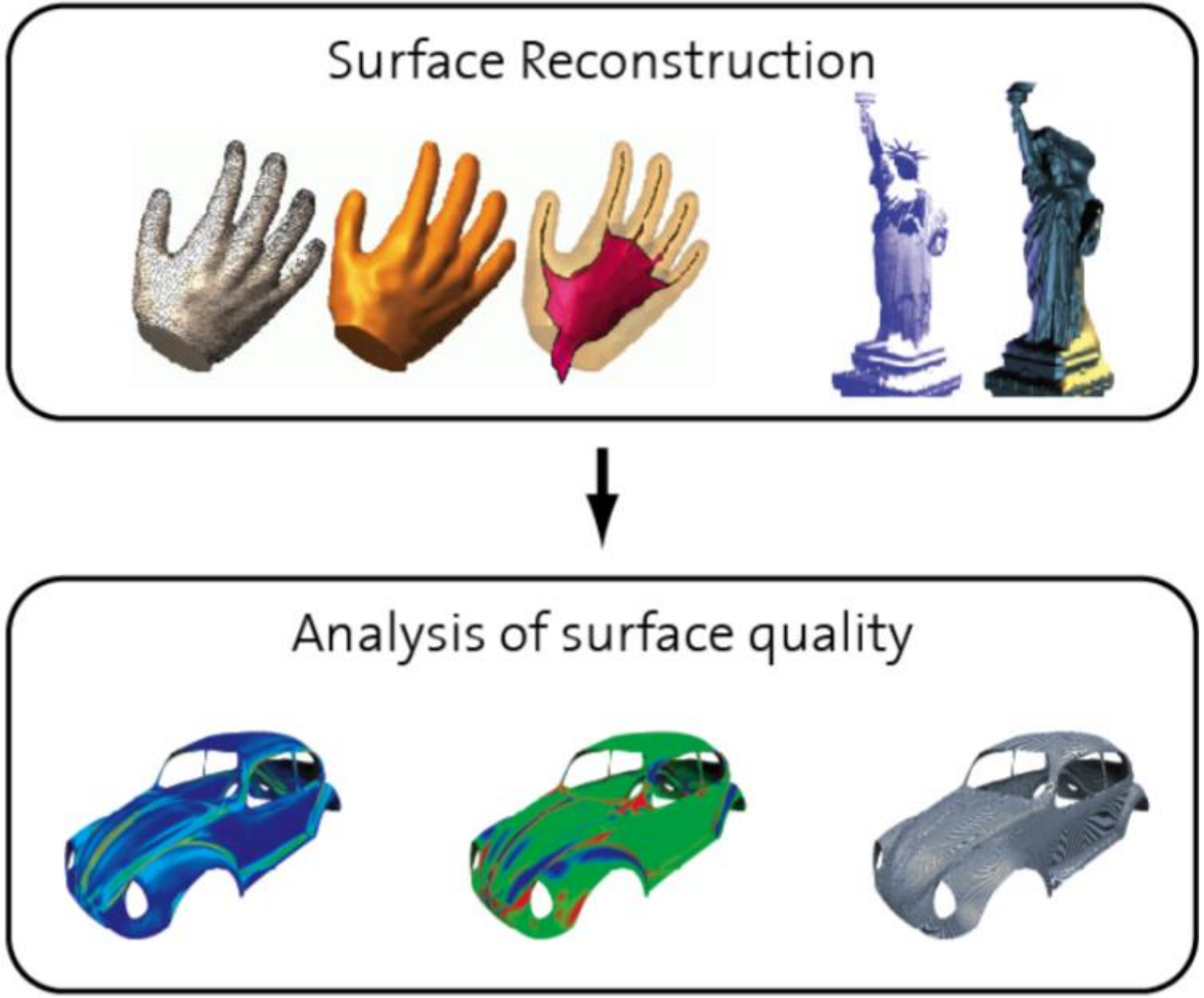

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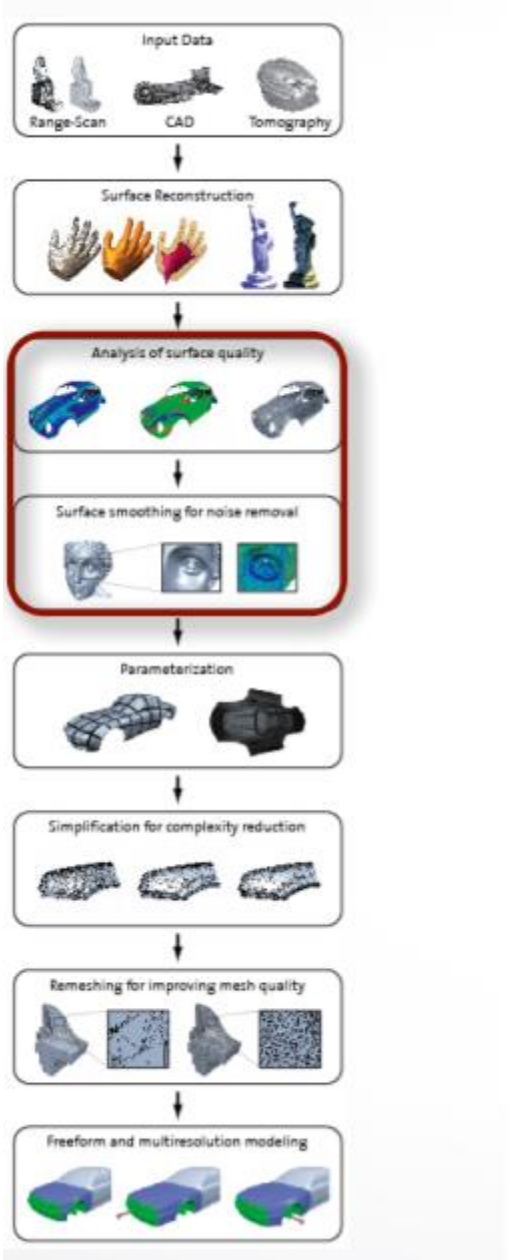

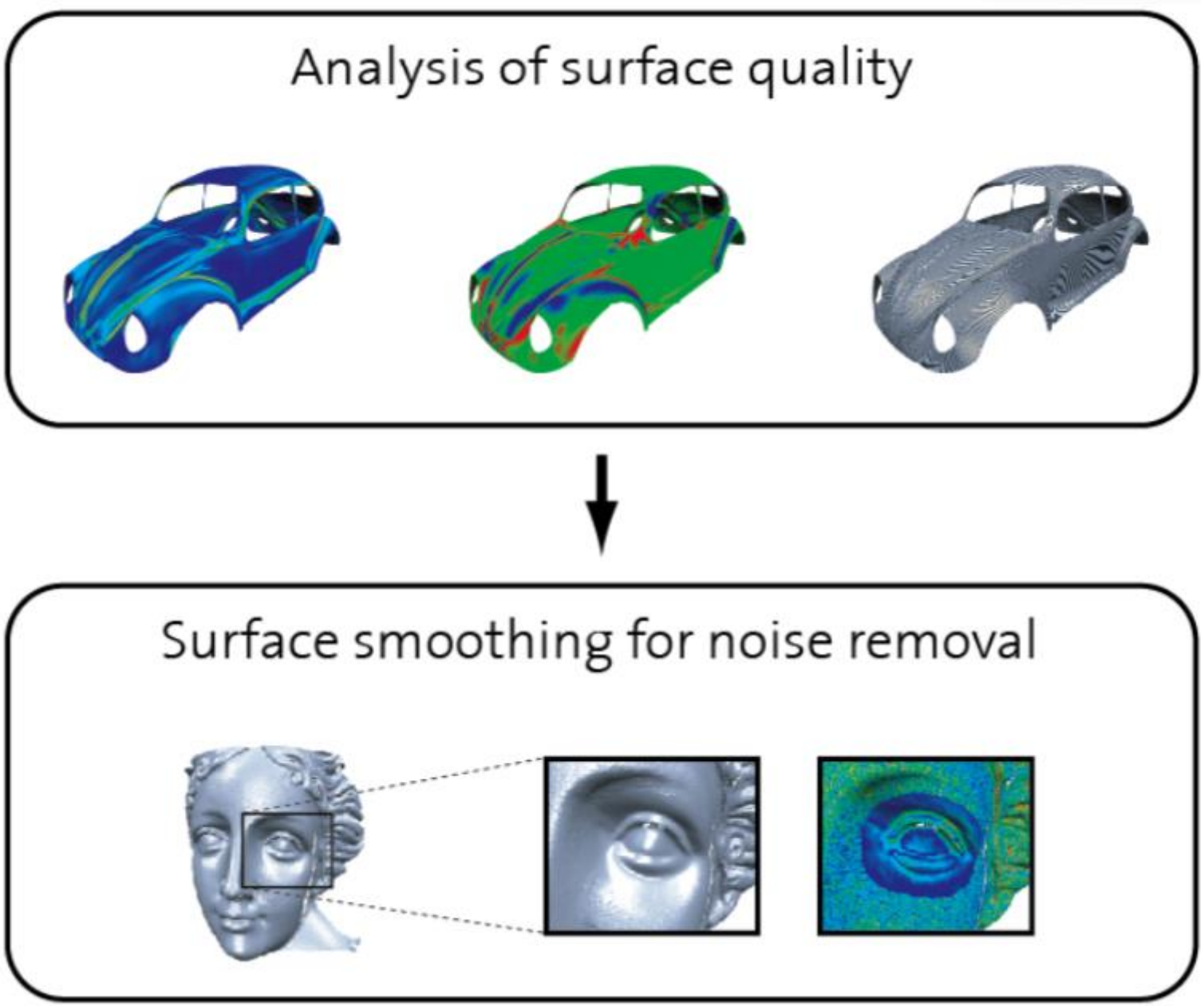

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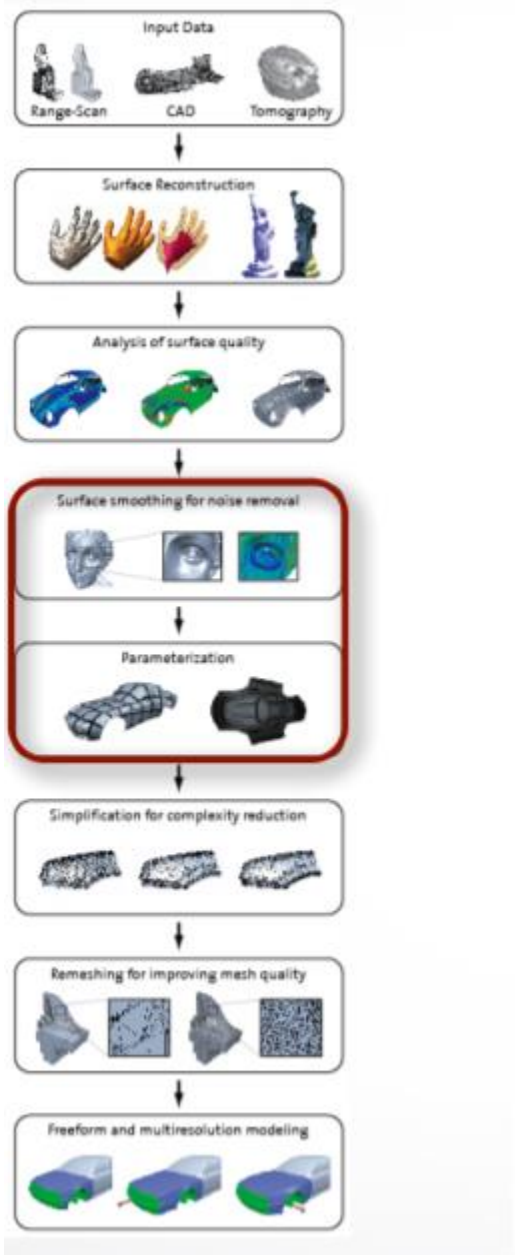

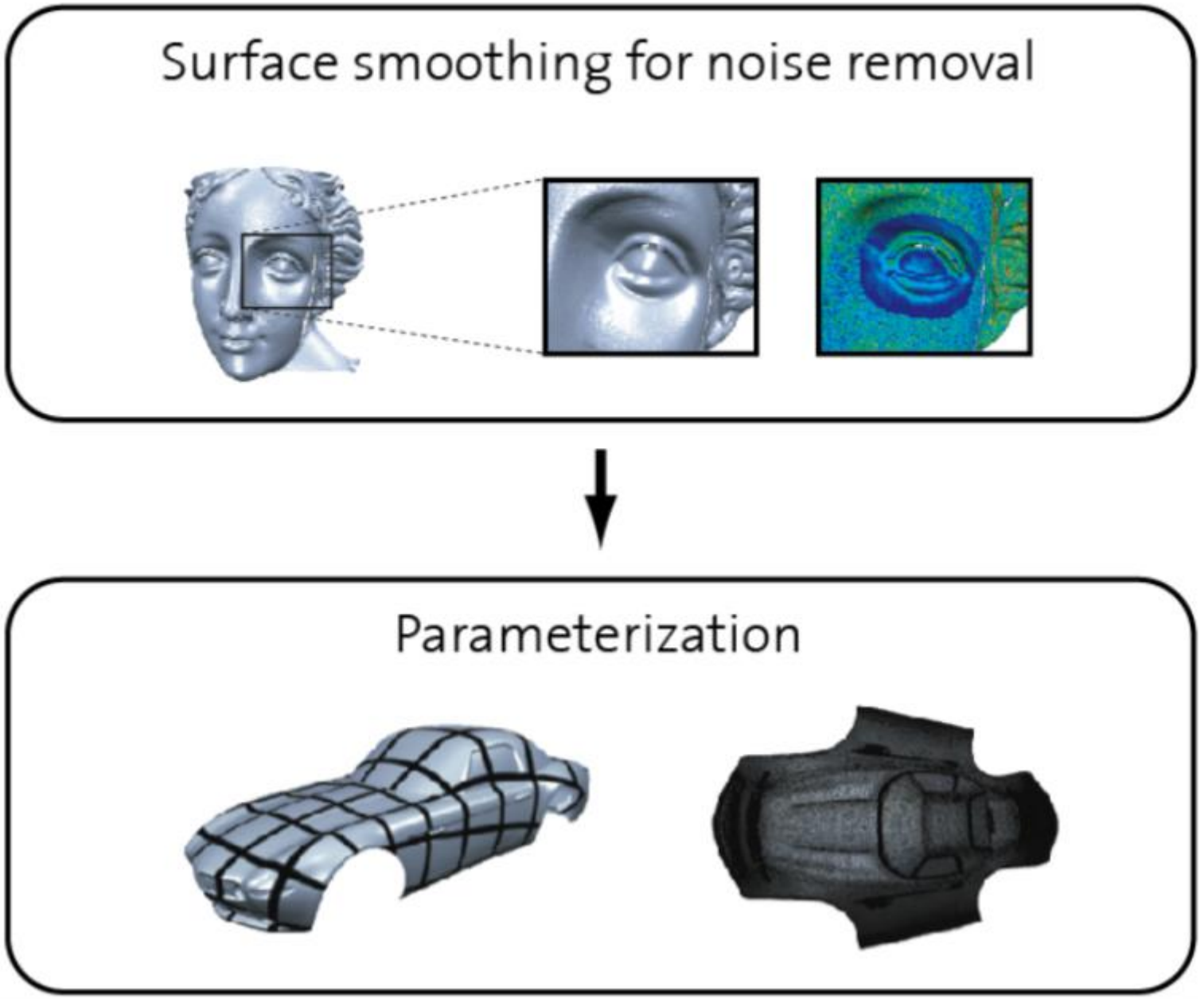

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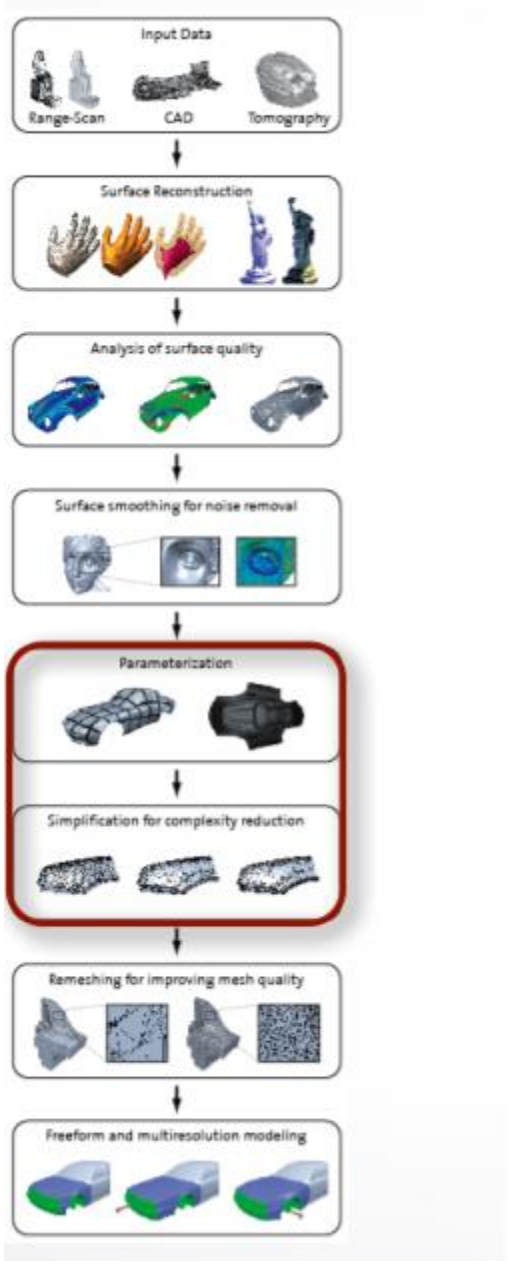

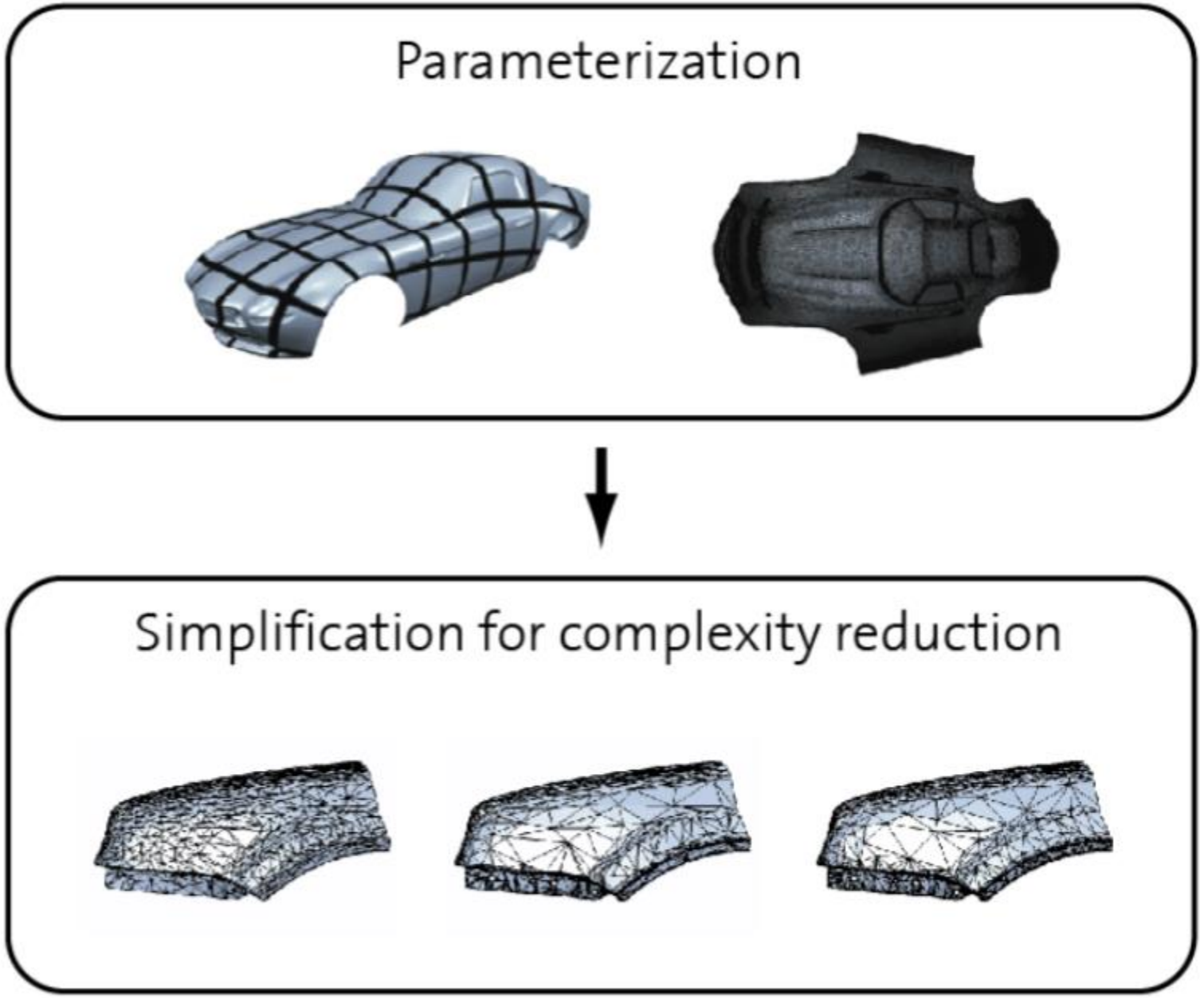

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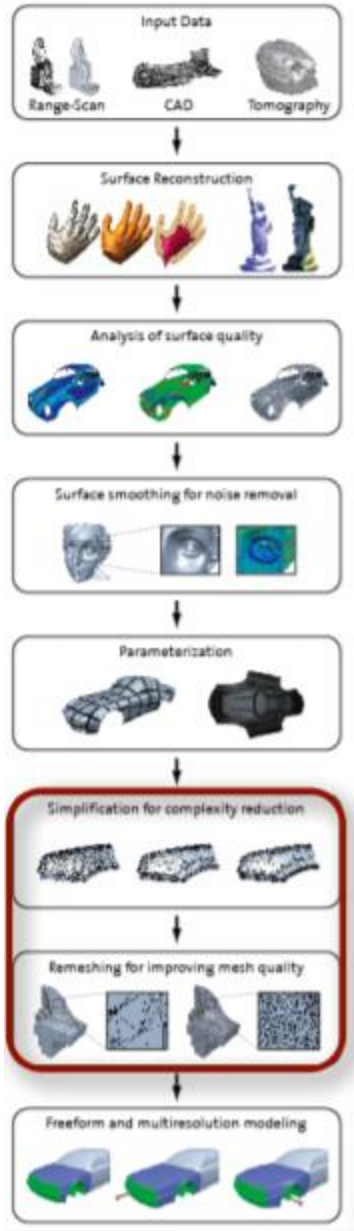

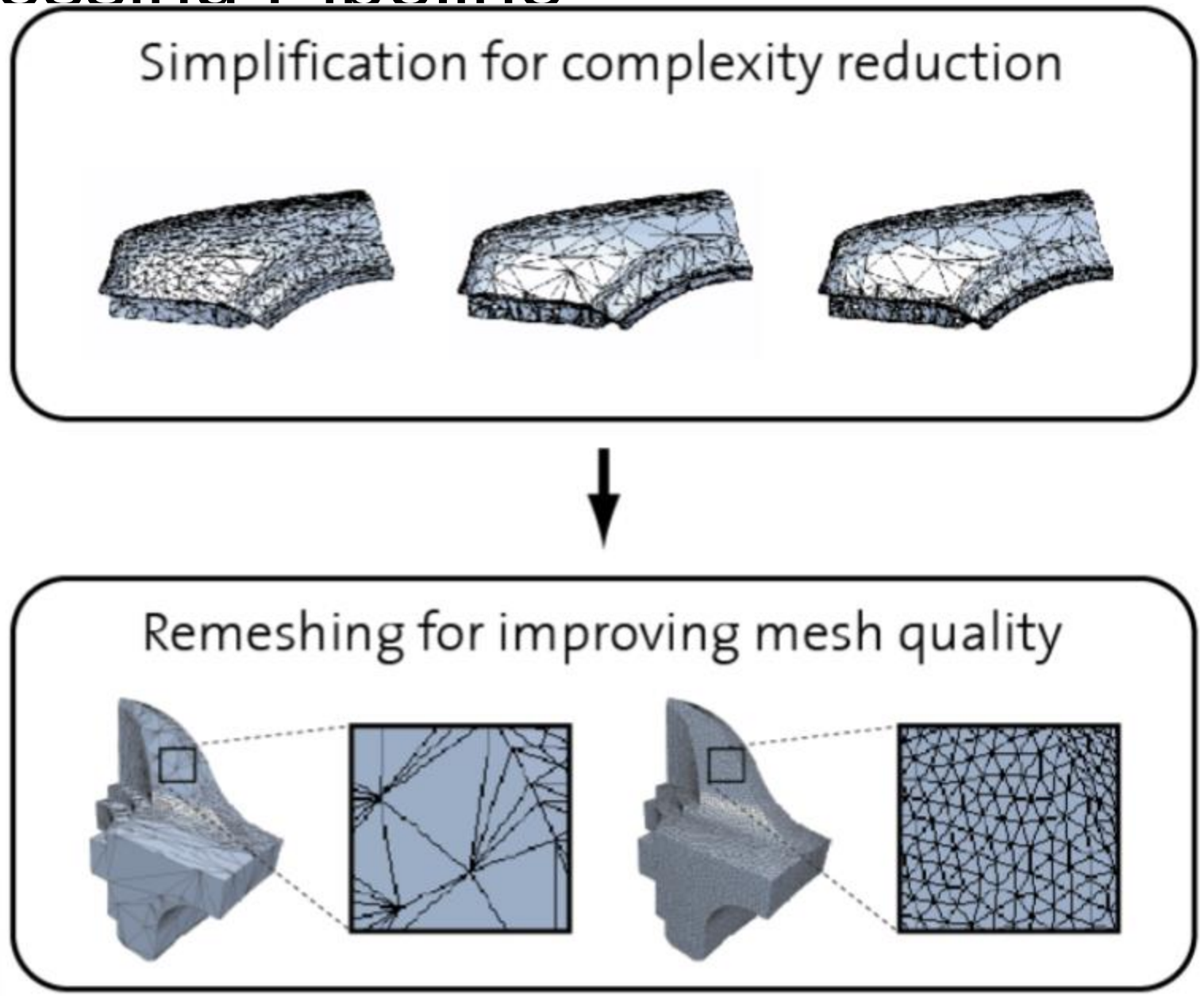

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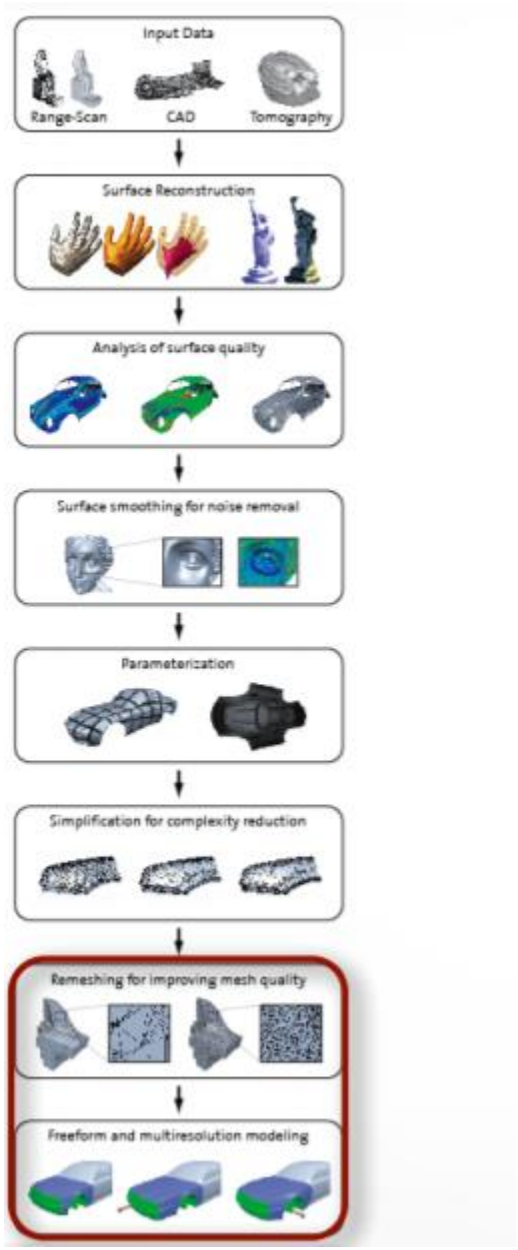
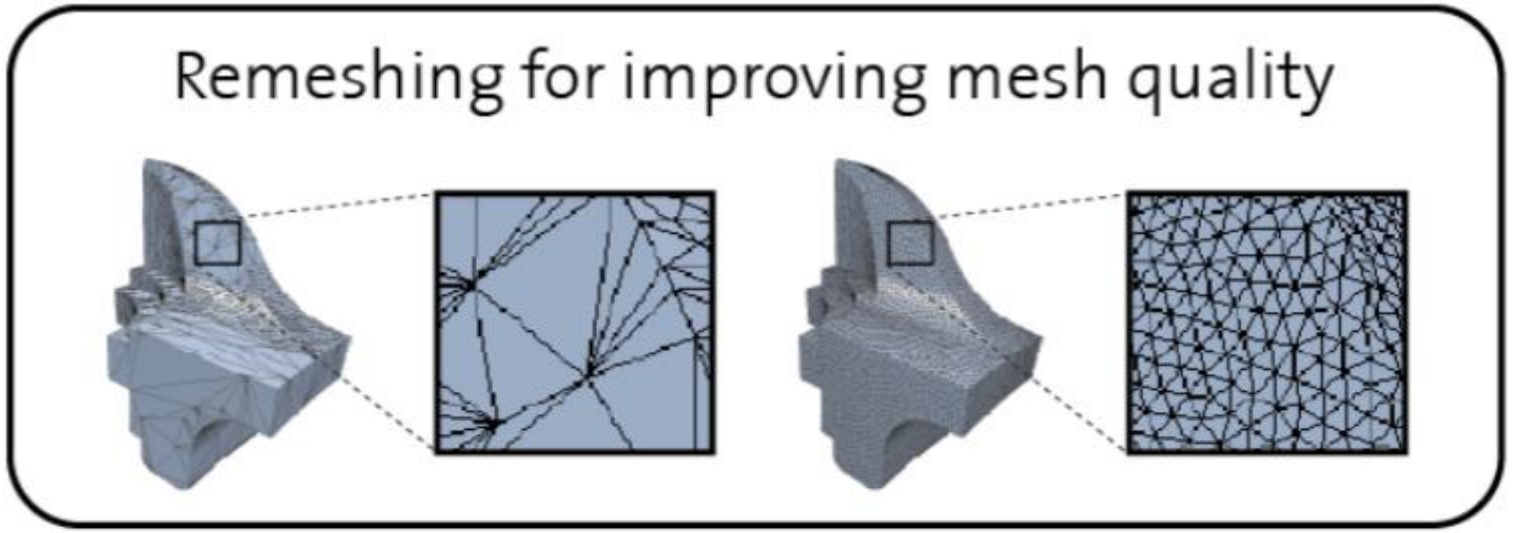
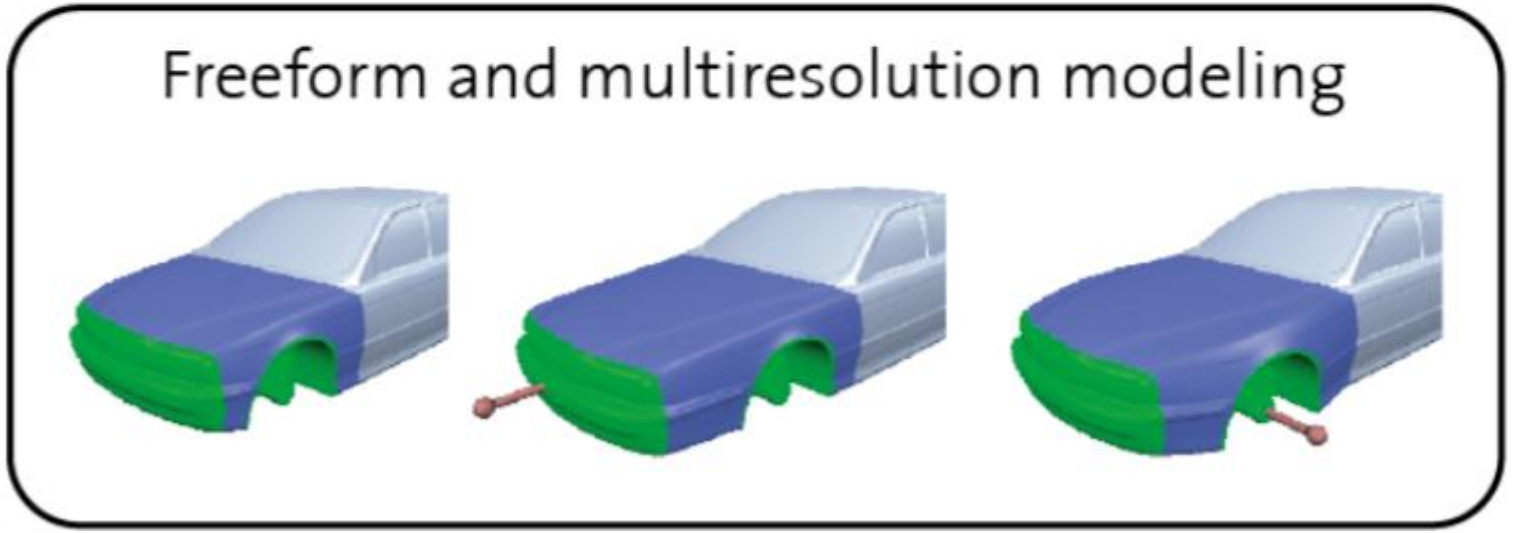






About the course

Target Audience

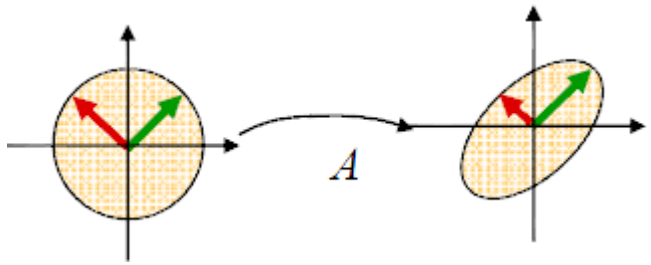
- PhD students, MSc students, Advanced undergraduates

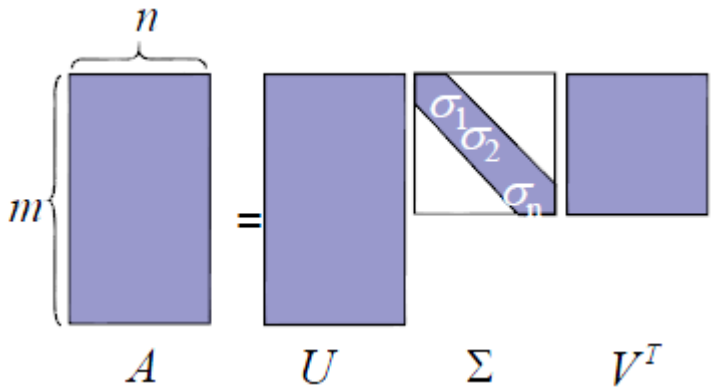
- **Computer Science**, Computer Engineering, **Mathematics**, Physics, Game Program, Biomedicine, Bioengineering, etc.

- 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

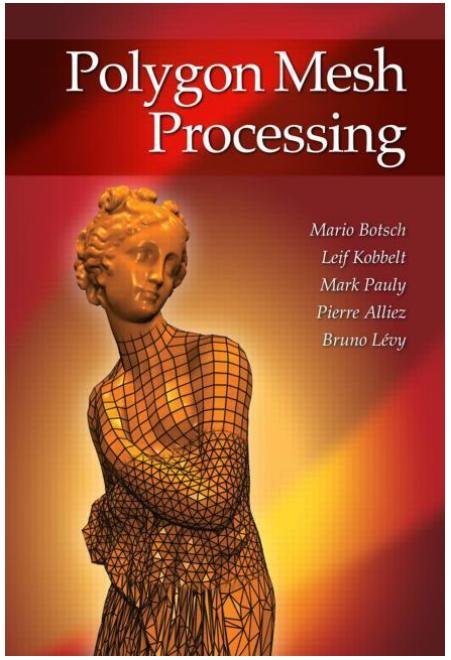
Coding is very import in this area!

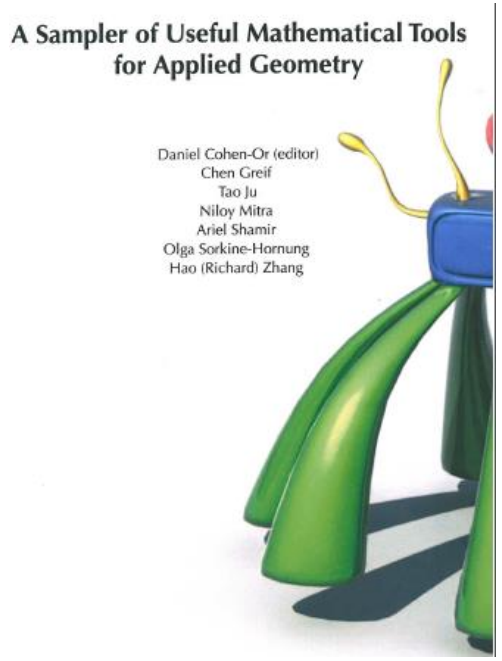
If you can not program, you will study nothing in this subject!

Recommented Textbooks

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

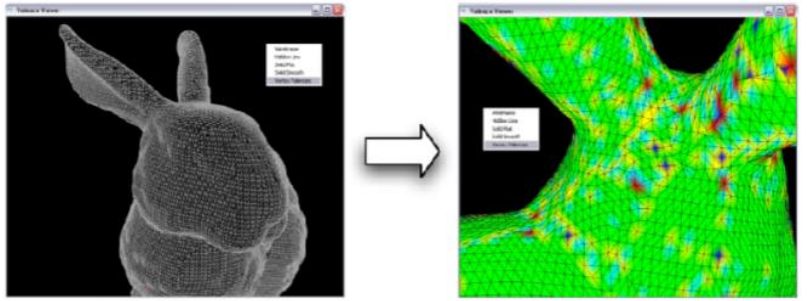
- **A Sampler of Useful Computational Tools for Applied Geometry, Computer Graphics, and Image Processing, 2015**

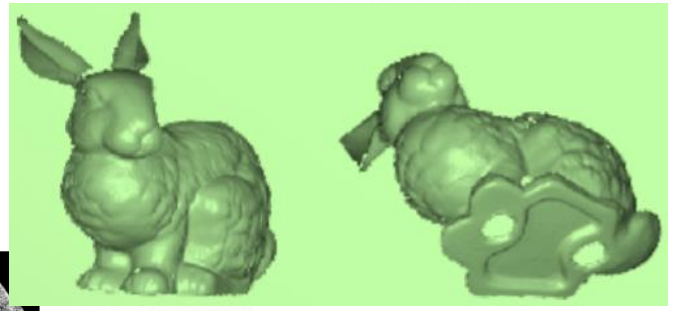


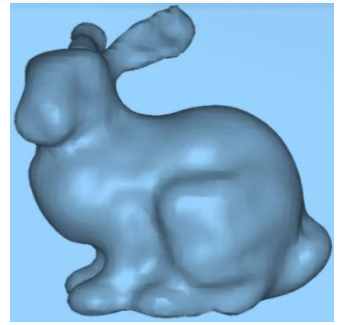


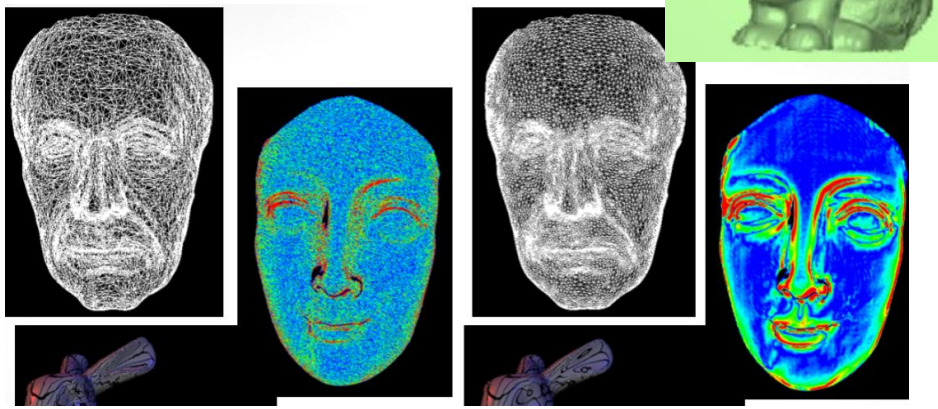
Exercises

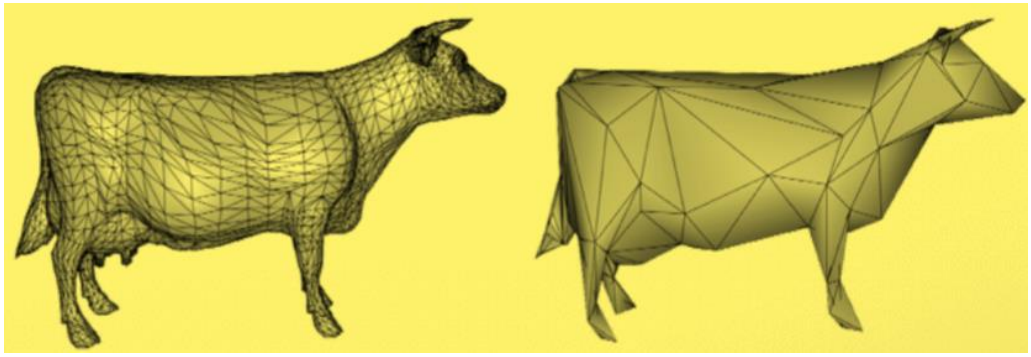
1. Introduction to **OpenMesh** (display mesh)
2. Registration
3. Implicit Surface Reconstruction
4. Surface Smoothing
5. Mesh Decimation
6. Remeshing

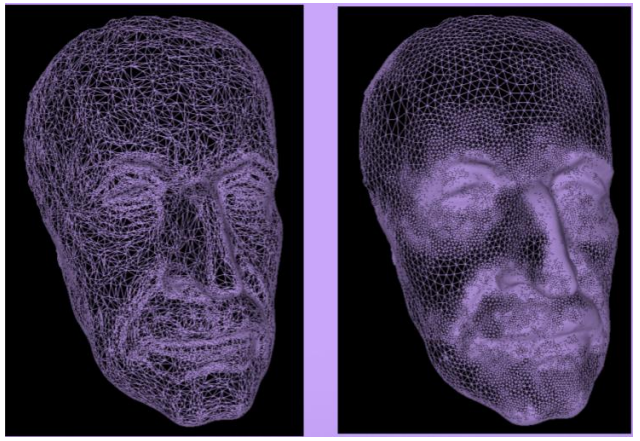












Grading

- Exercises
  - Best 4 out of 2--6 exercises contribute to **80%** of the final grade
  - Each exercise counts 20 points:
    - Document 10 + Compilable code 5 + Executable file 5
  - Submit after deadline: -10%
- Oral Reports:
  - **20%**
- 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.

Related courses @ dlut math

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

- **Relate** the basic concept, tools, and algorithms in geometric modeling and digital geometry processing
- **Design** and **implement** individual components of geometric modeling system
- **Apply** the proposed methods in your own work

Video demos

Thanks

Acknowledgement

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