Digital Geometry -Introduction

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http://jjcao.github.io/digital-geometry/

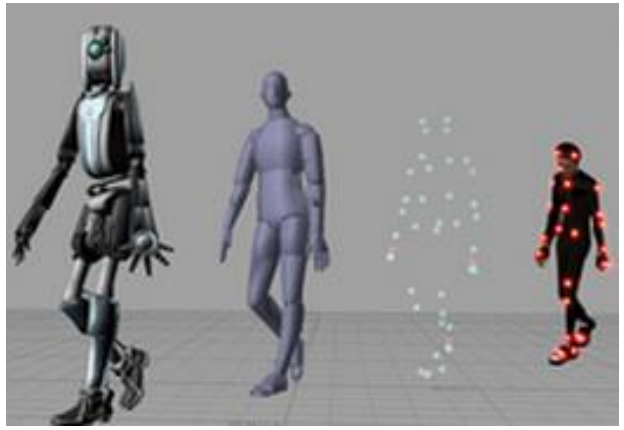
Pleasure may come from illusion, but happiness can come only of reality.

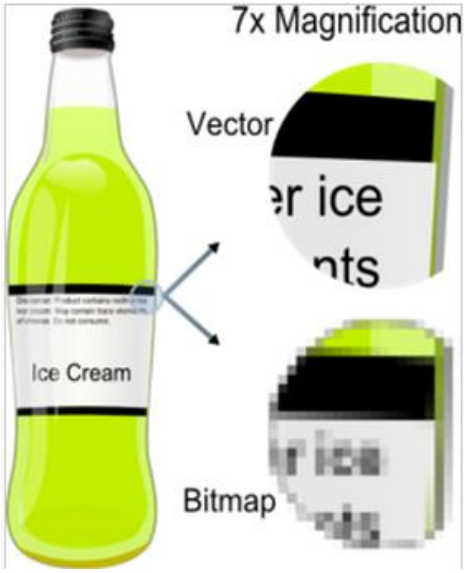
Contents

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

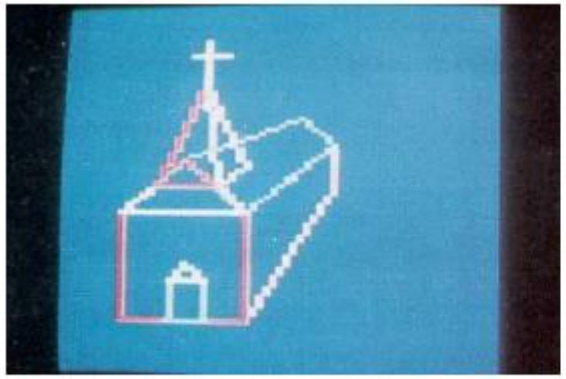
- CG studies the manipulation of **visual** & **geometric** information using *mathematical & computational* techniques.
- CG vs. Visualization





Computer Graphics
The big picture

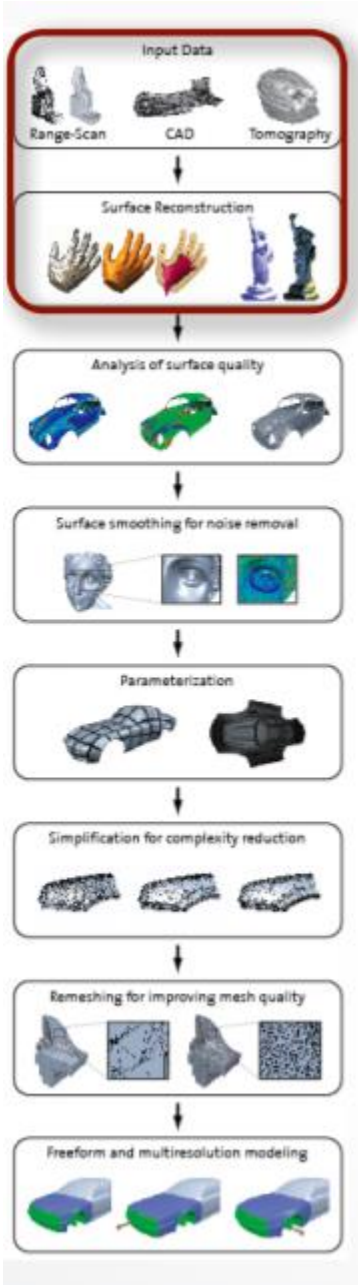
- 3D graphics programming in 1979

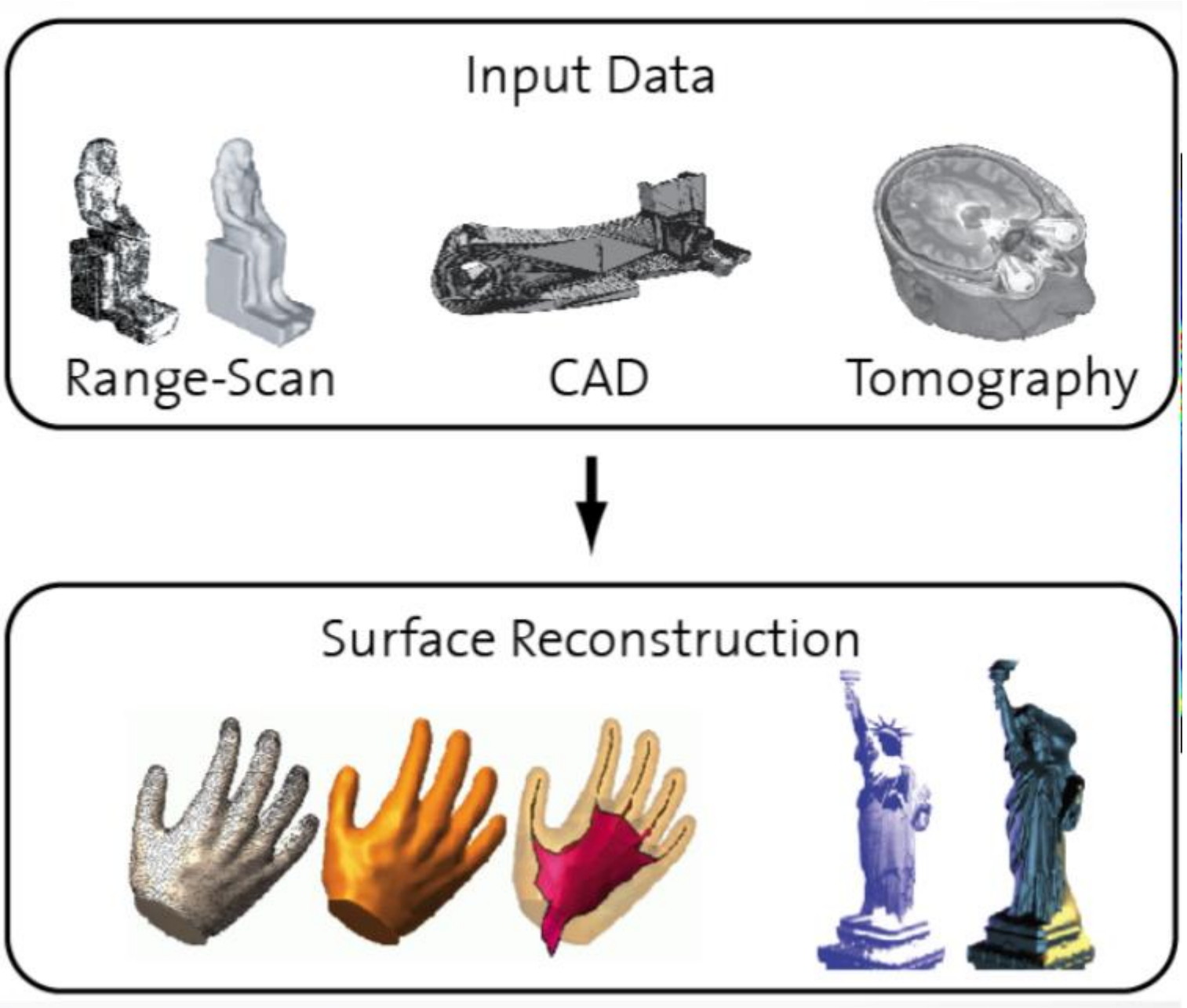


approx. 25 triangles

approx. 50 x 100 pixels

Geometry Processing Pipeline





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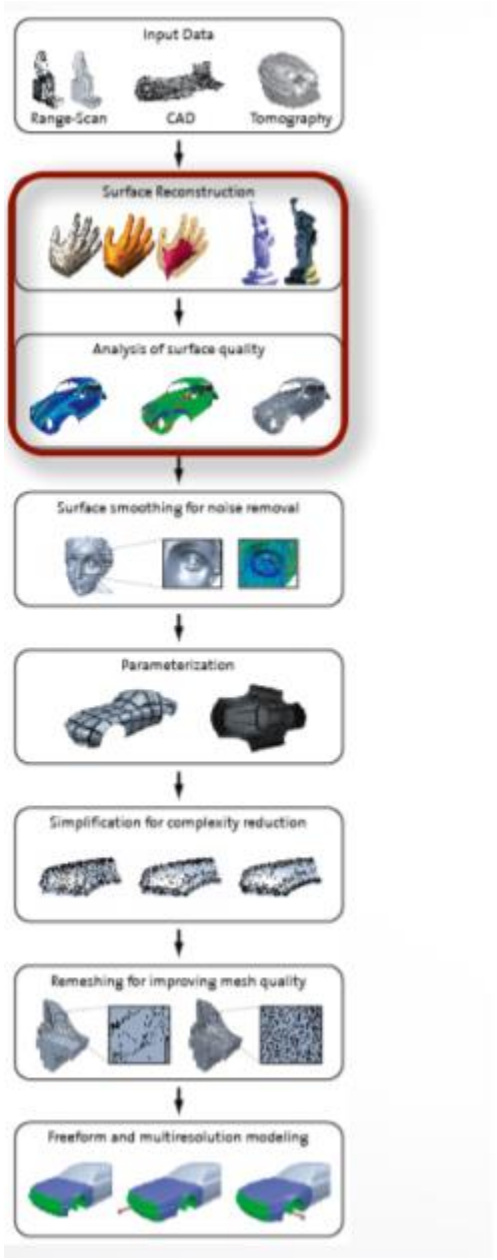

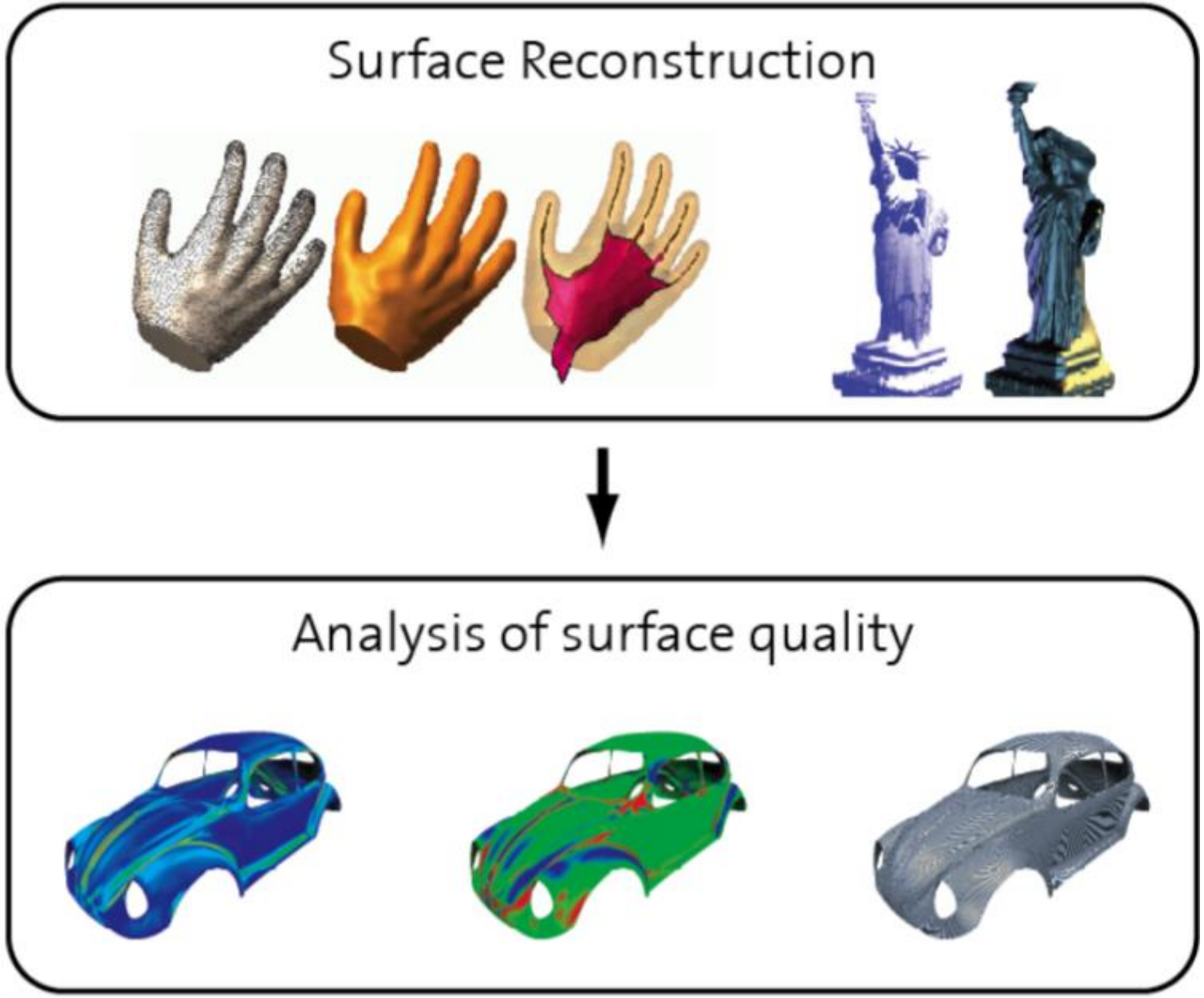

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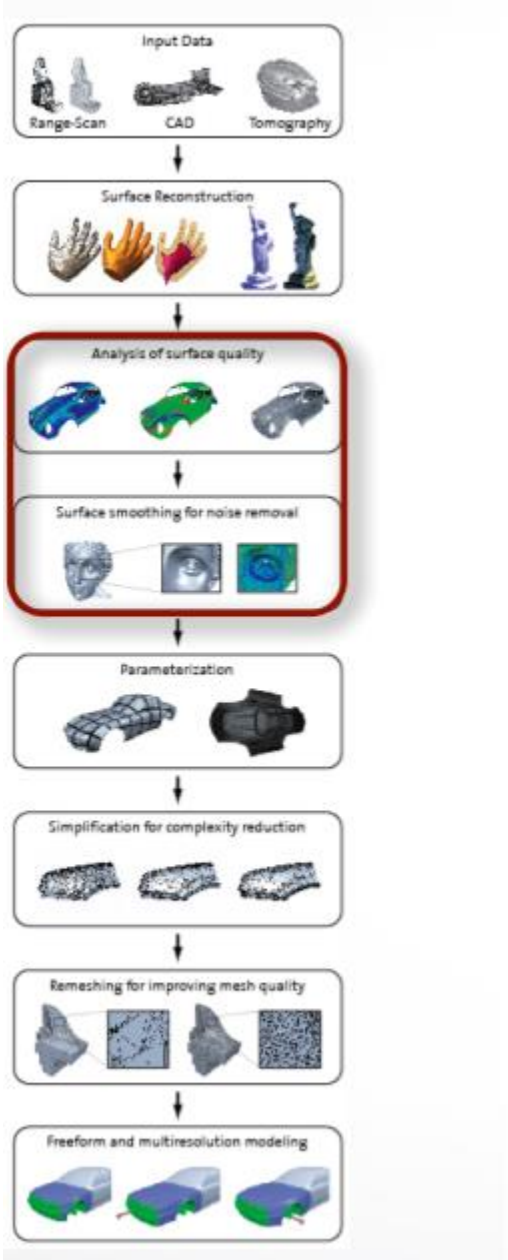

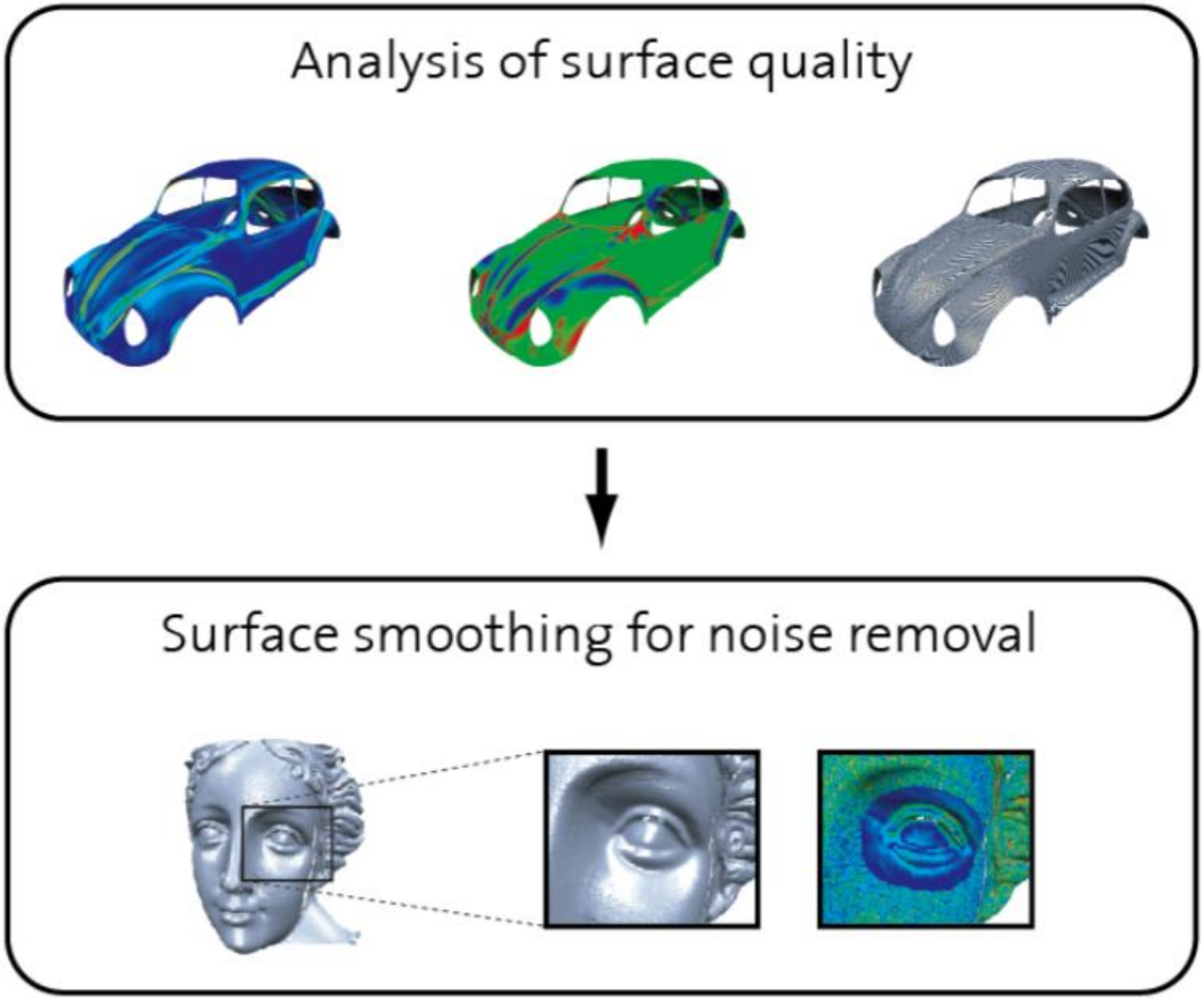

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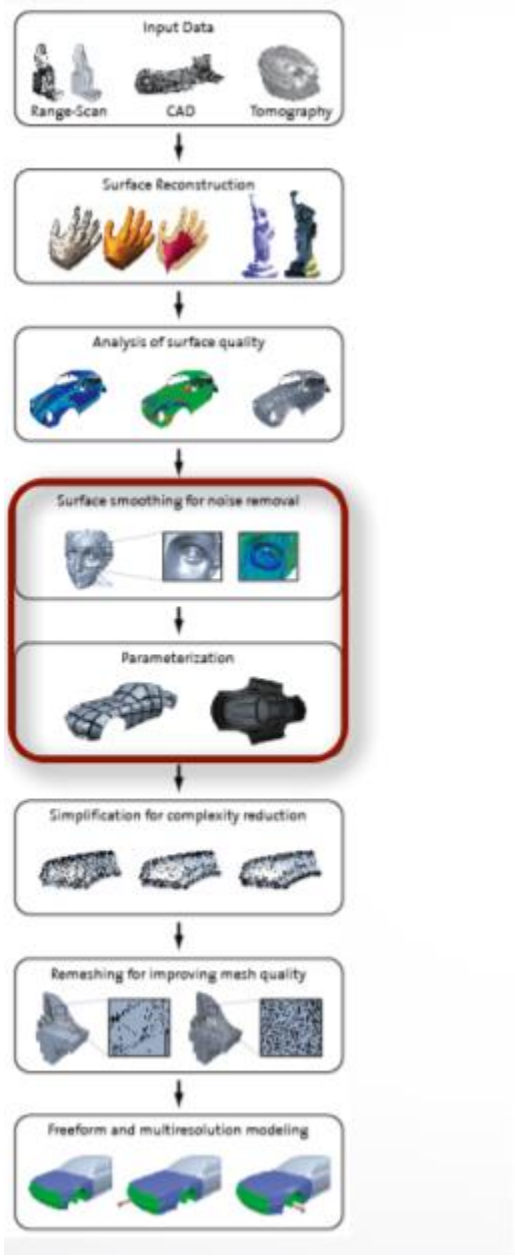

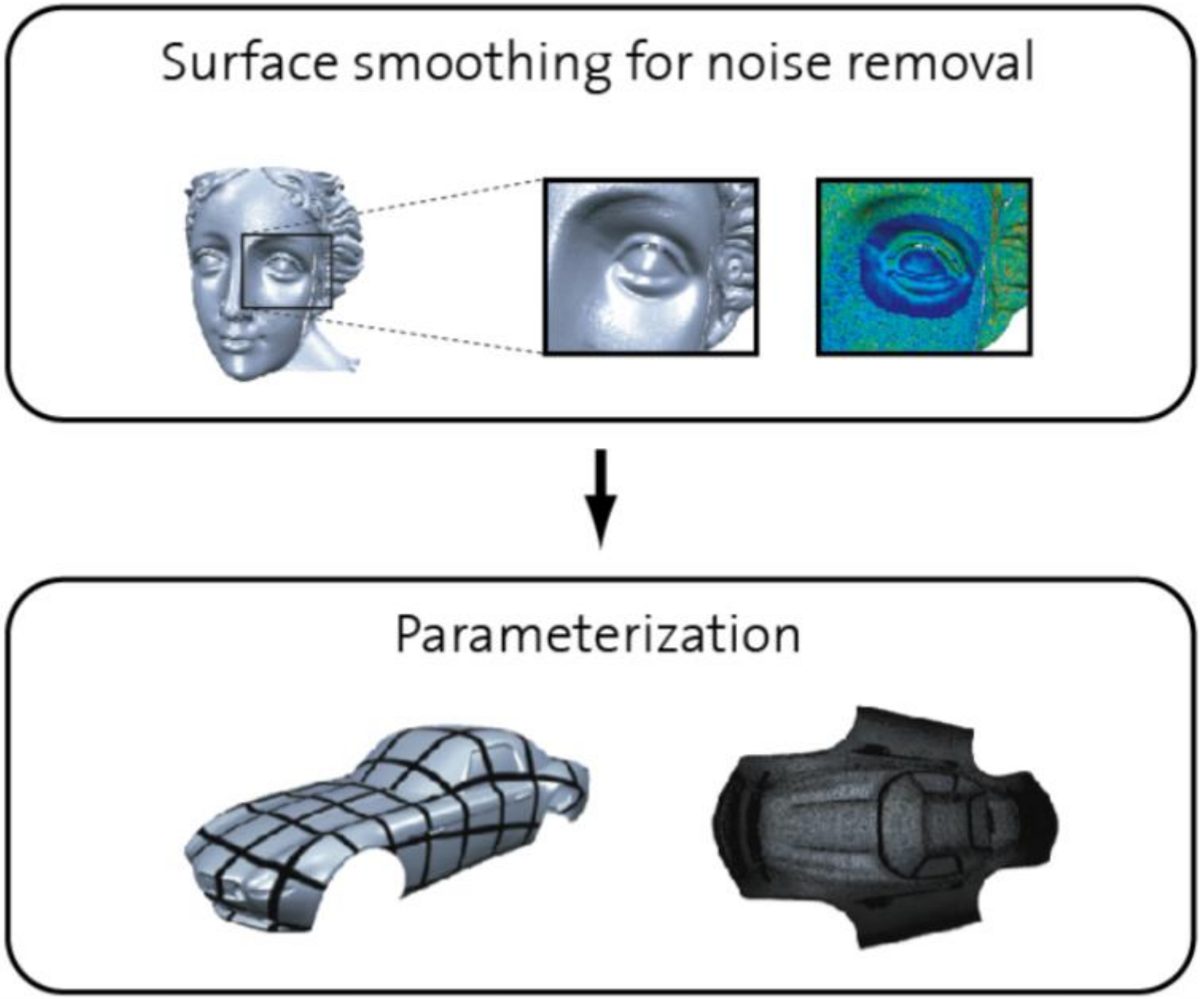

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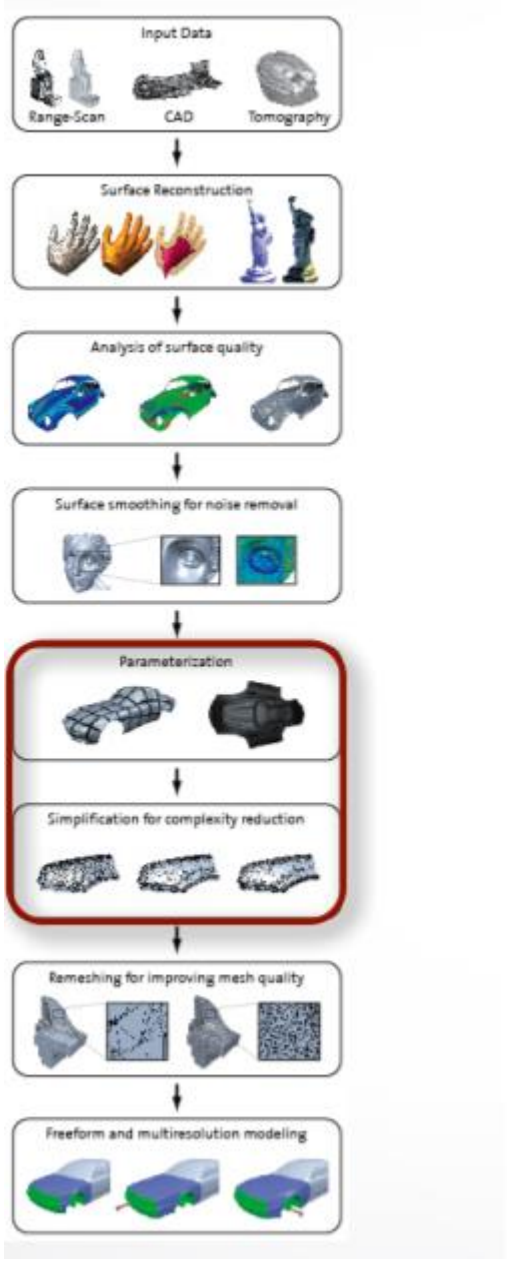

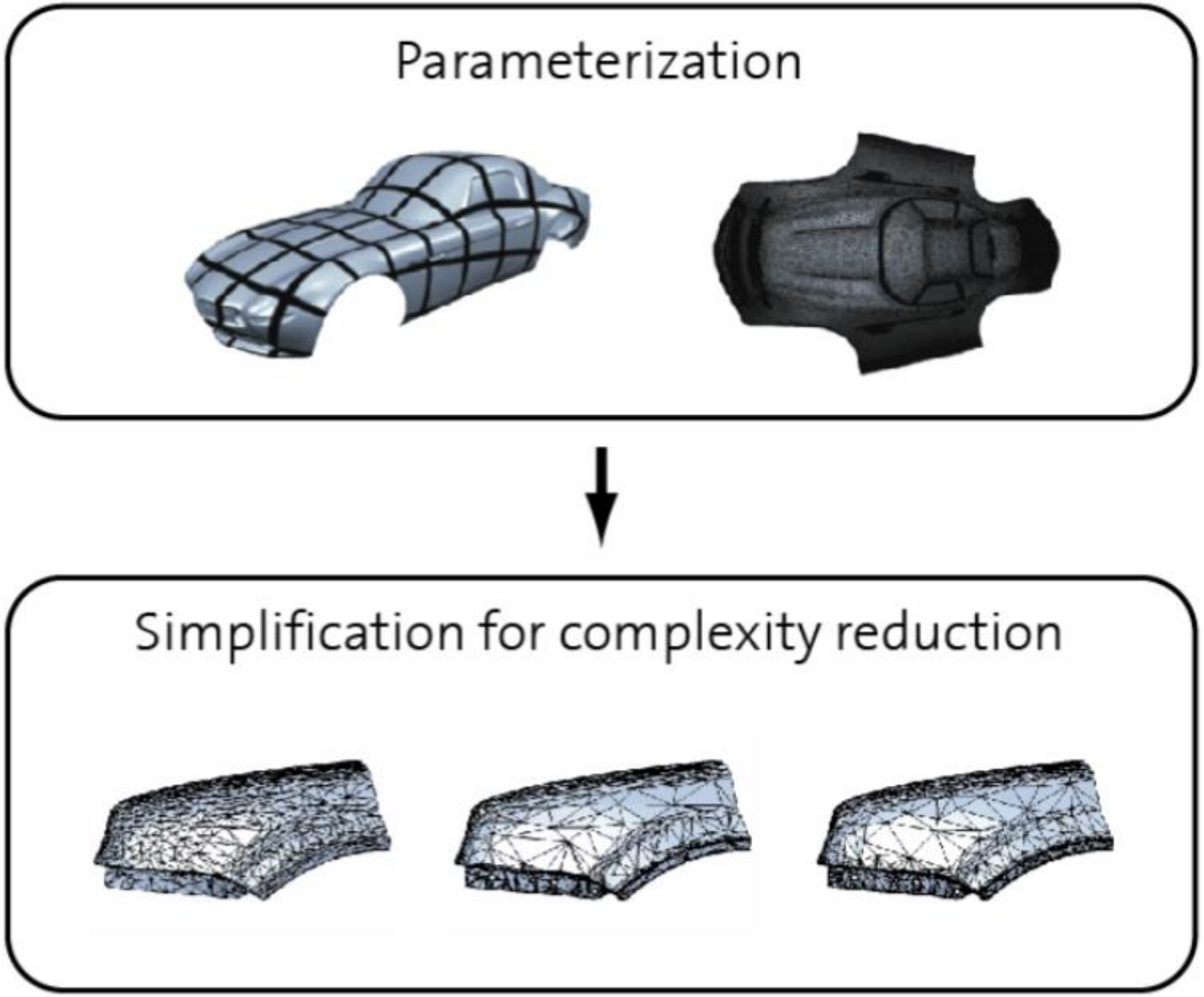

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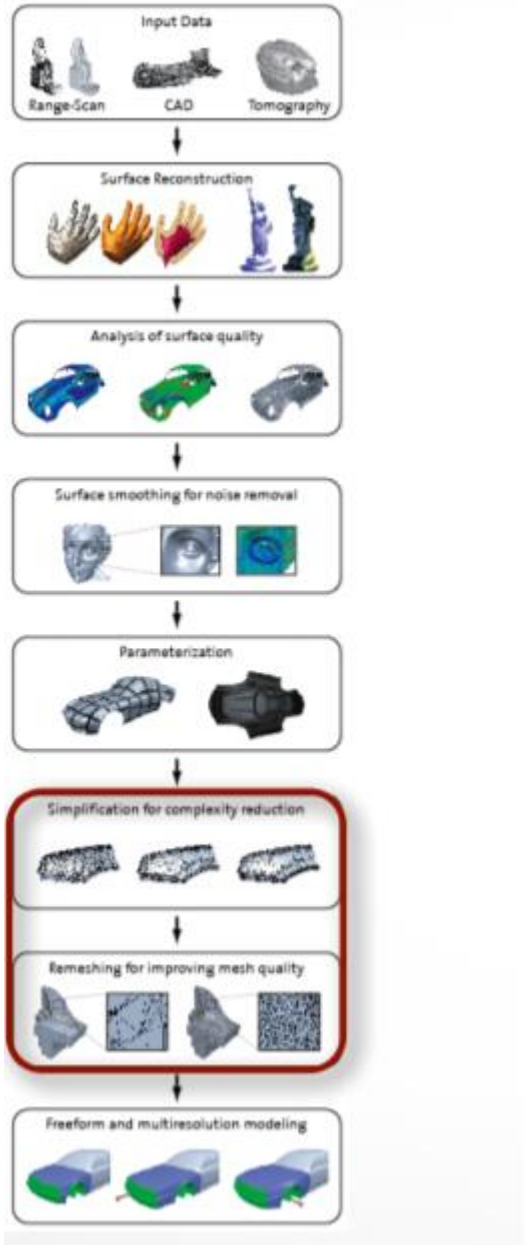

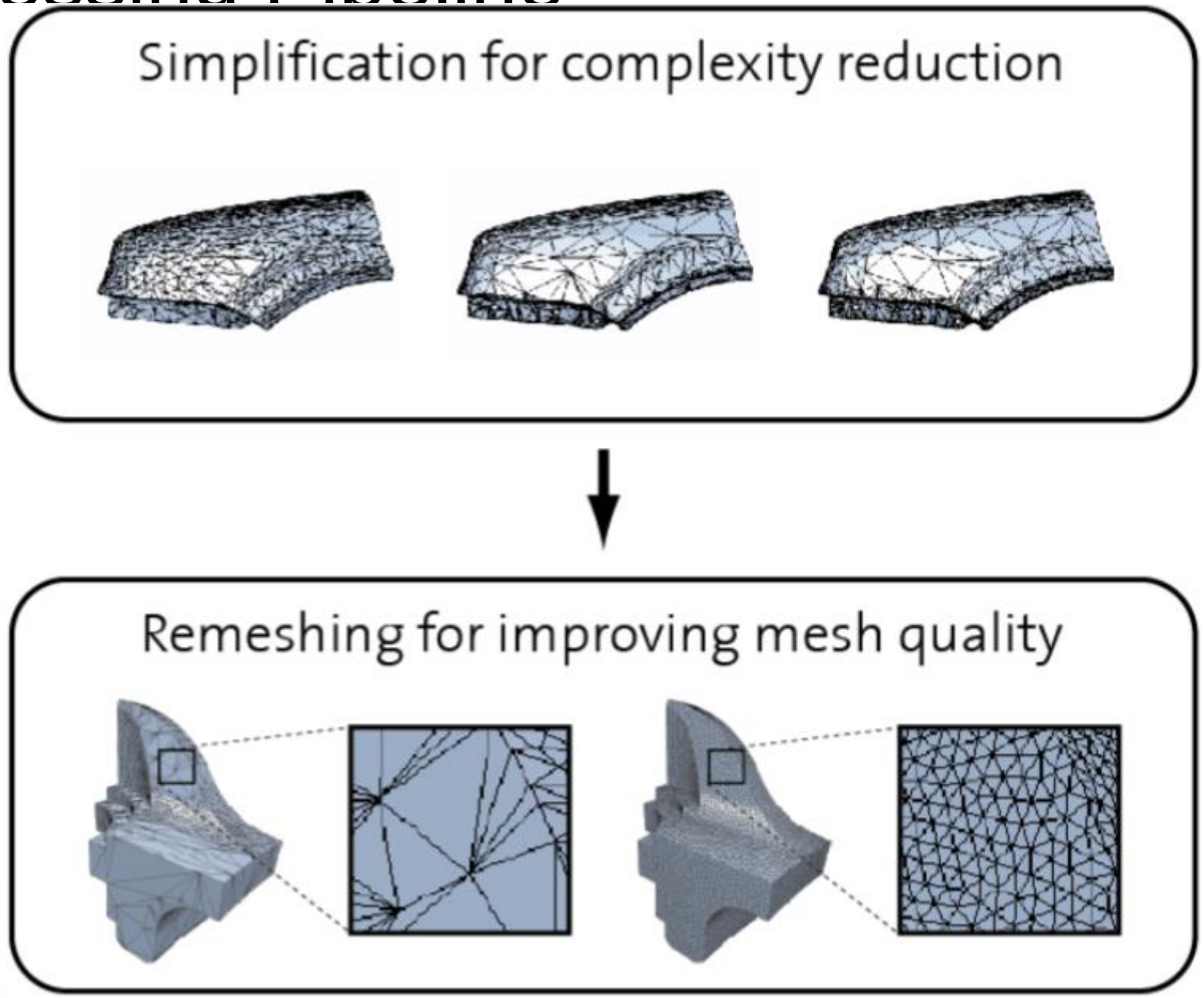

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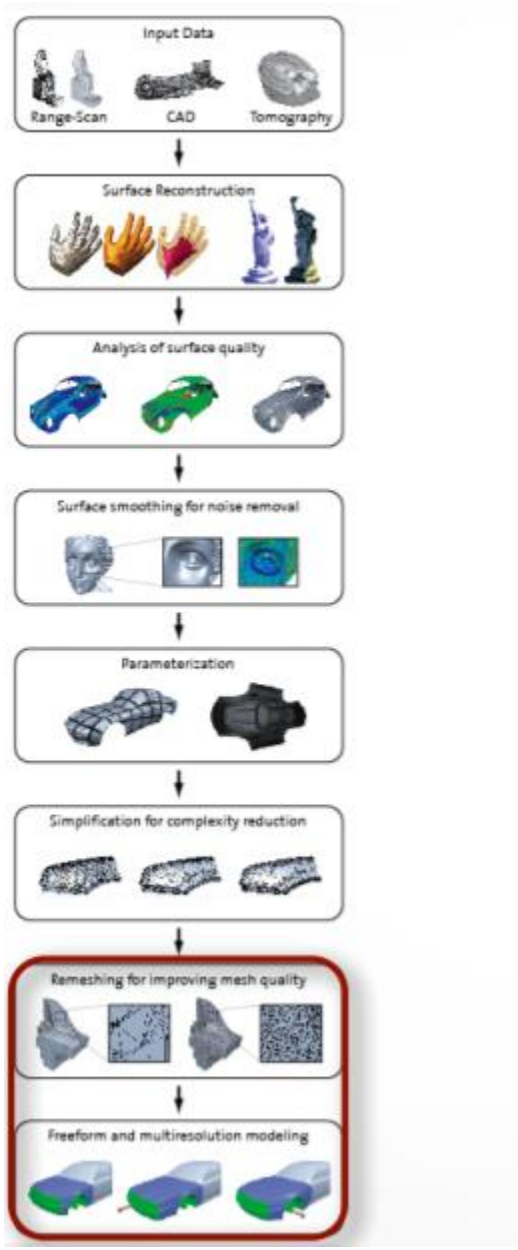
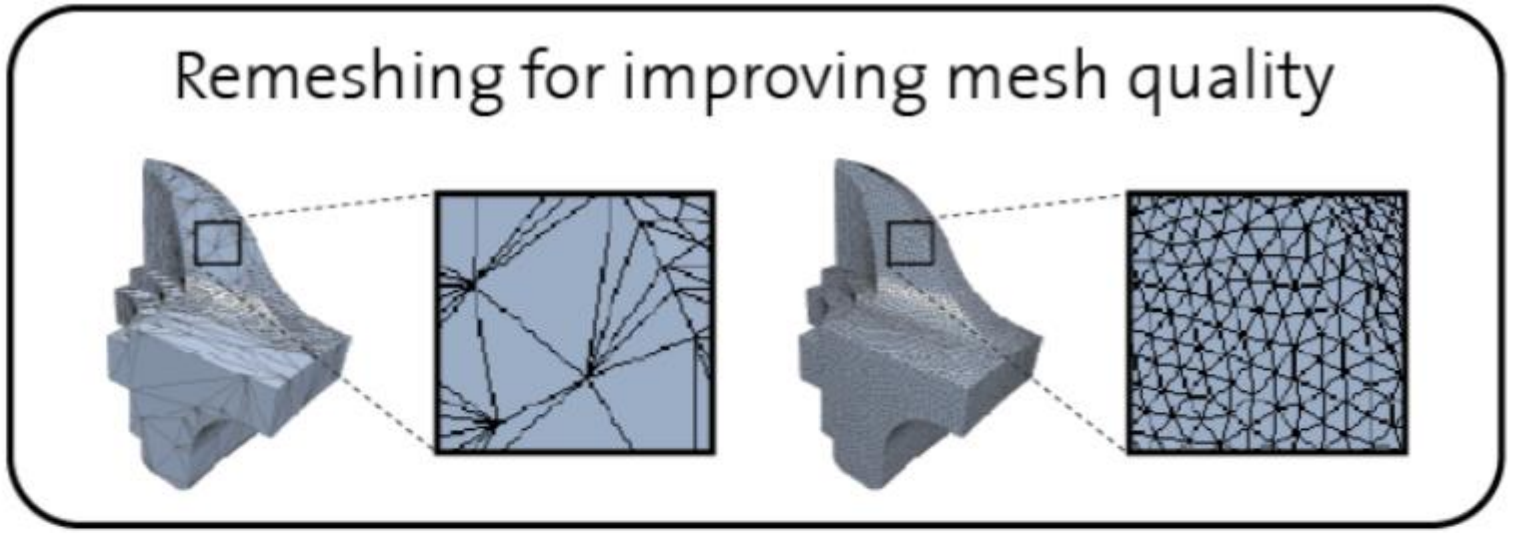
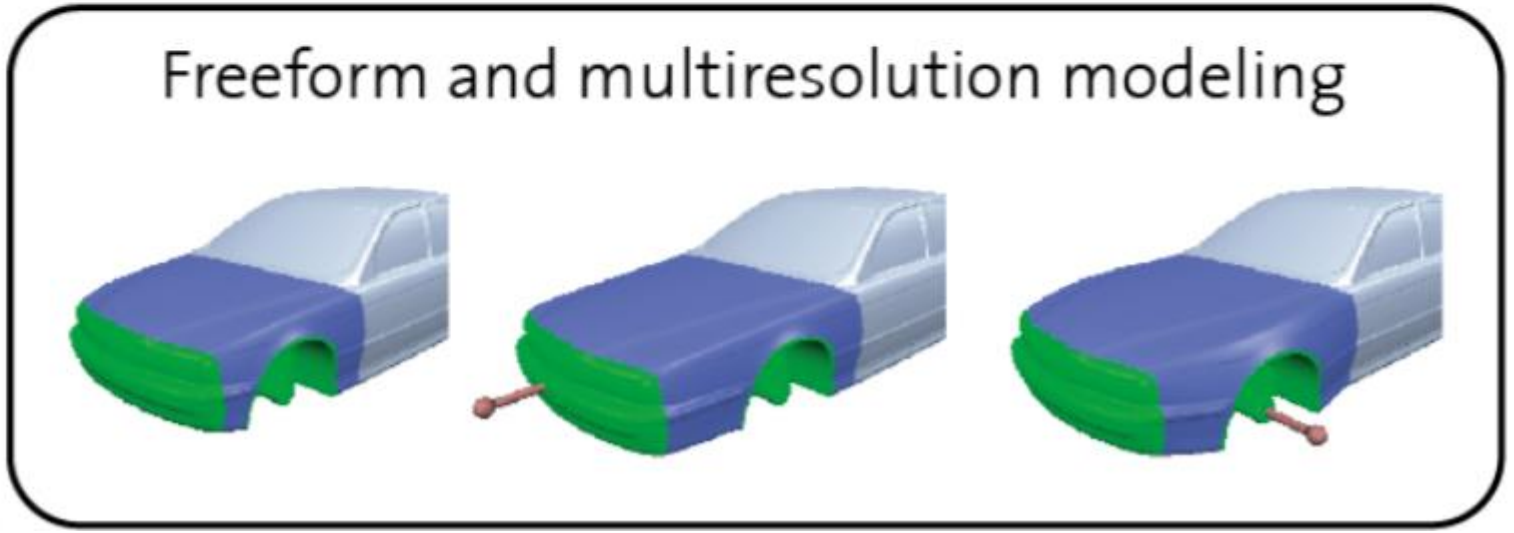






Stuff

Target Audience

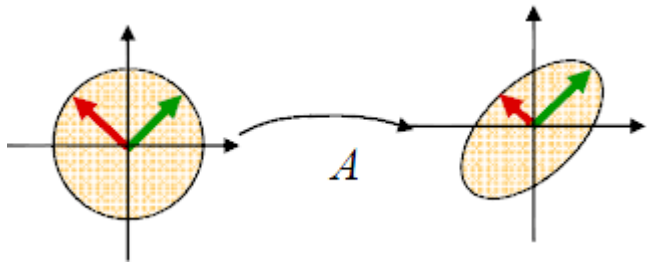
- PhD students, MSc students, Advanced undergraduates

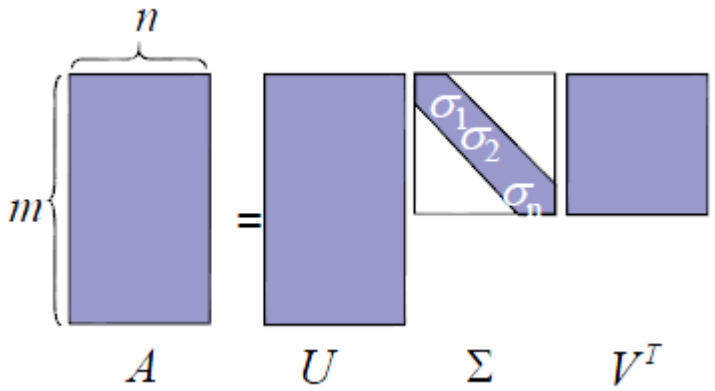
- Computer Science, Computer Engineering, Mathematics, Physics, Game Program, Biomedicine, Bioengineering, etc.

- 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

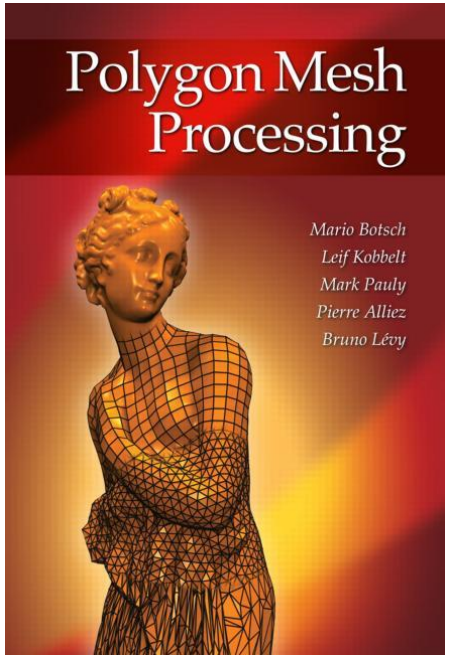
Coding is very import in this area!

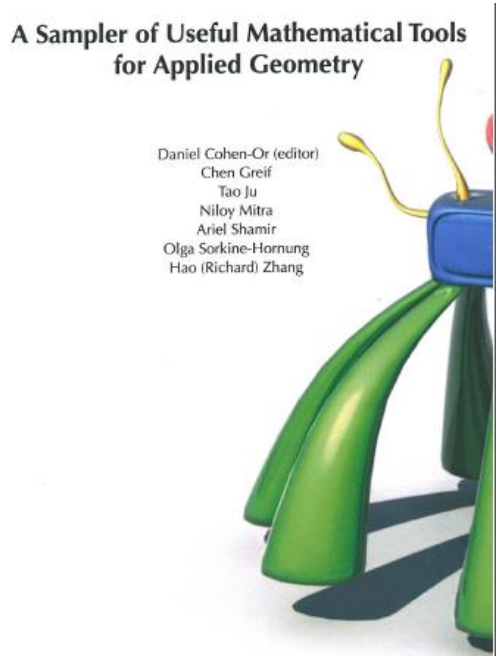
If you can not program, you will study nothing in this subject!

Textbooks

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

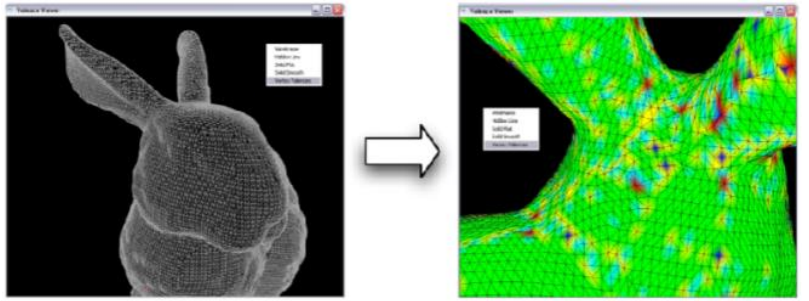
- **A Sampler of Useful Computational Tools for Applied Geometry, Computer Graphics, and Image Processing, 2015**

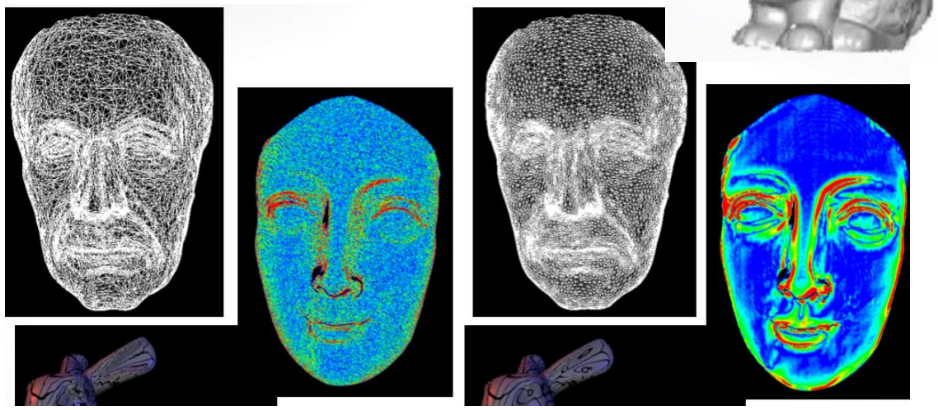


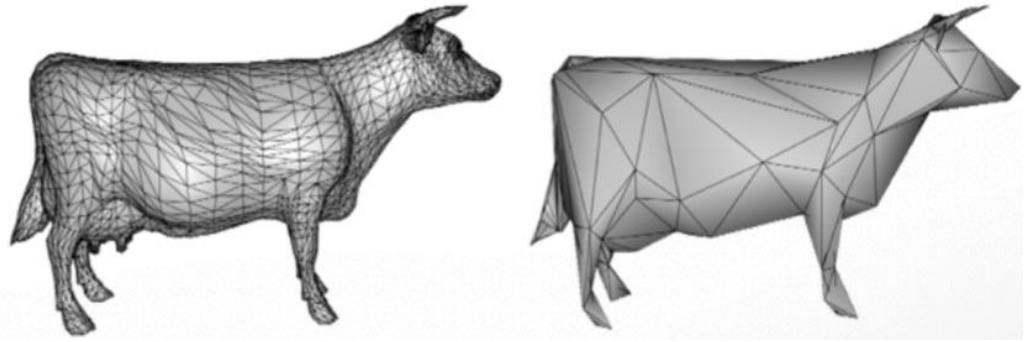


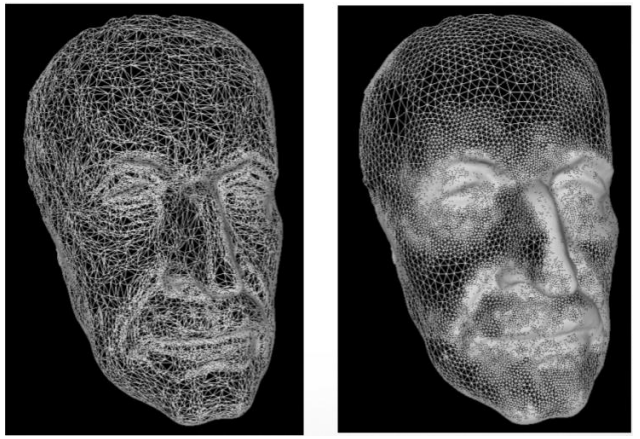
Exercises

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









Grading

- Homework 60%: Document + Compilable code + Executable files
- 40% Oral Reports:
  - famous paper 1:
    - http://www.cs.ubc.ca/~sheffa/dgp/papers.html
    - http://mesh.brown.edu/DGP/references.html
  - New paper1: Siggraph, Siggraph Asia, EG, SGP 2016 (http://kesen.realtimerendering.com/)
- 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

Video demos

Thanks