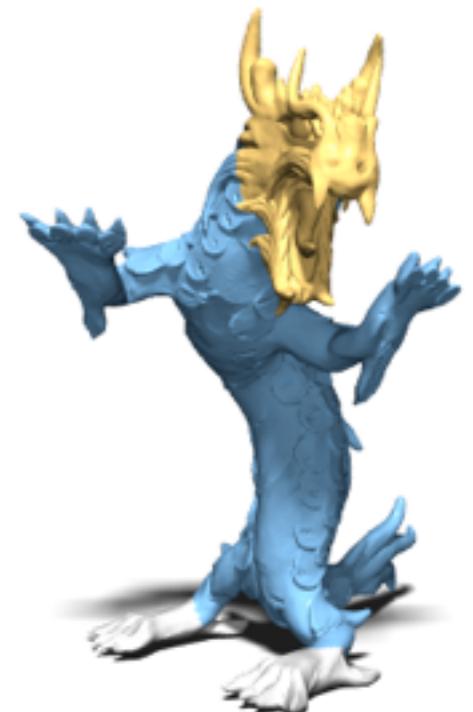


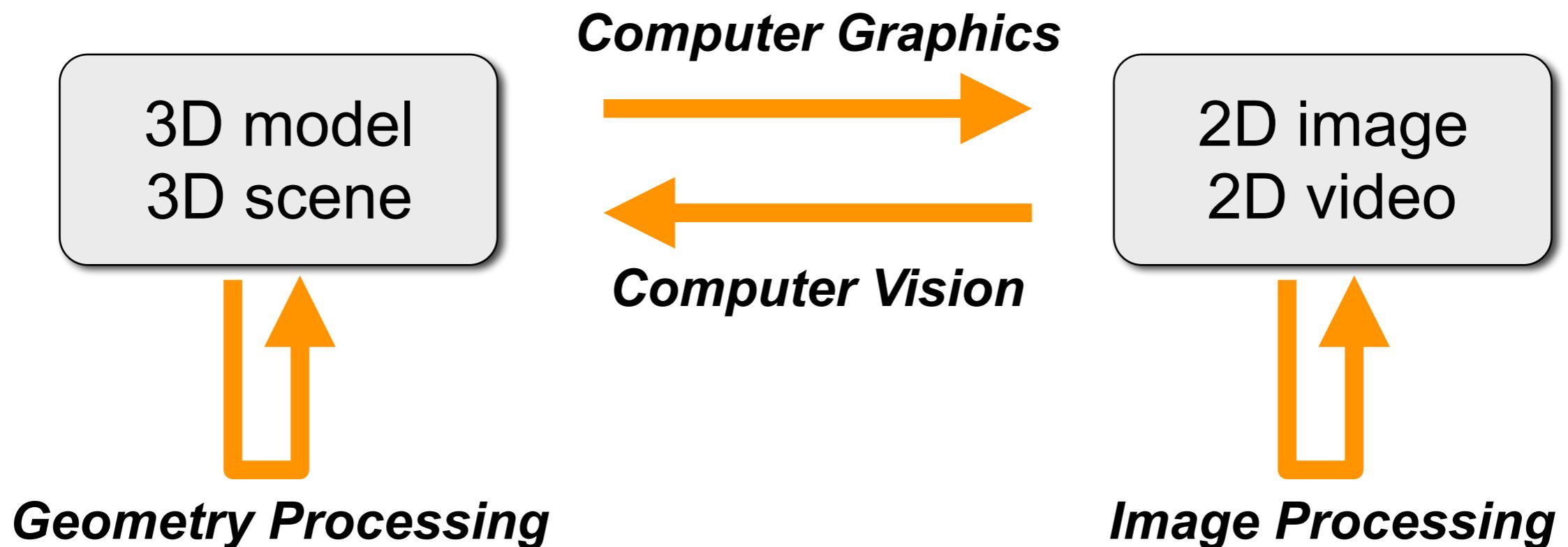
Computer Graphics & Geometry Processing



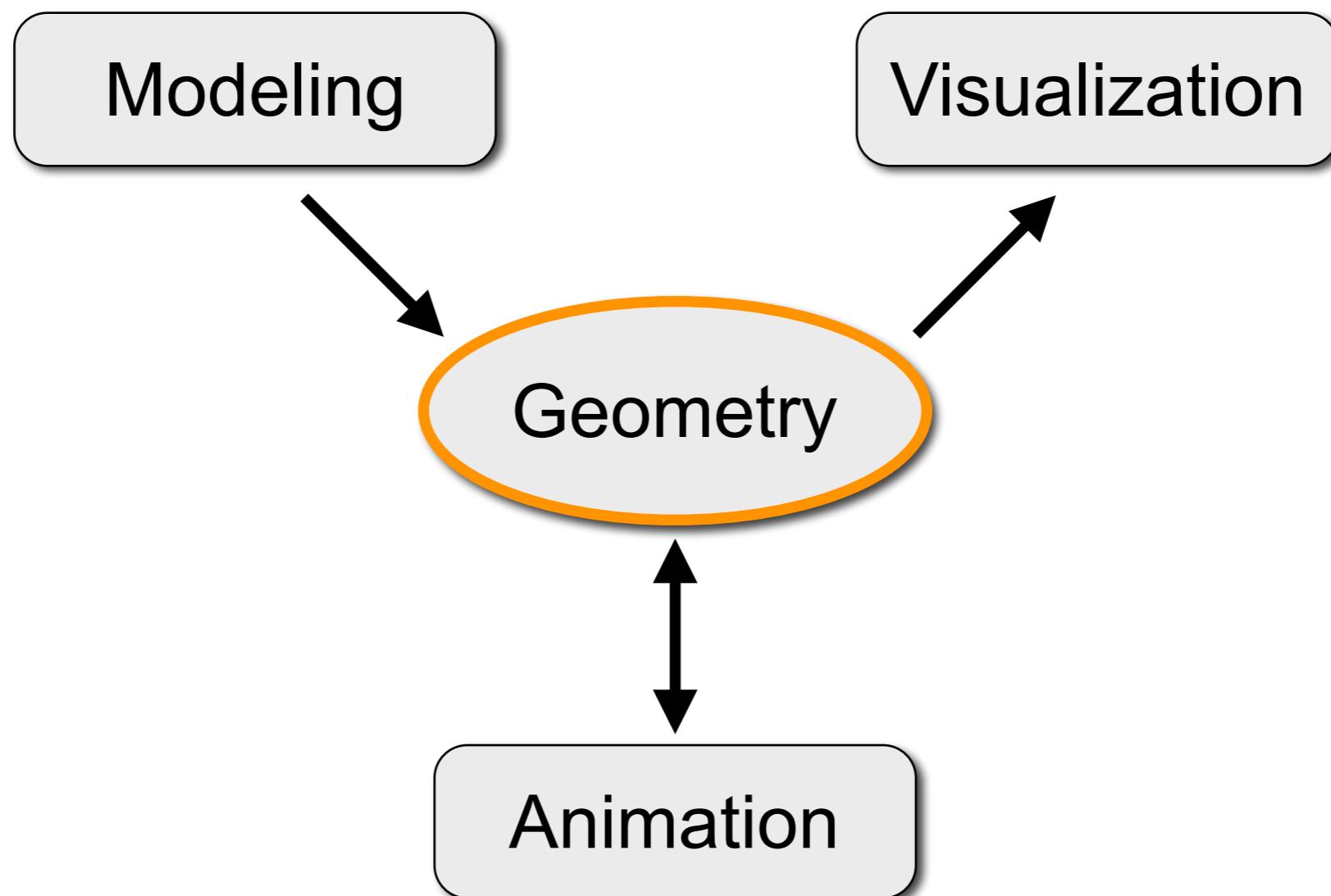
Prof. Dr. Mario Botsch
<http://graphics.uni-bielefeld.de>



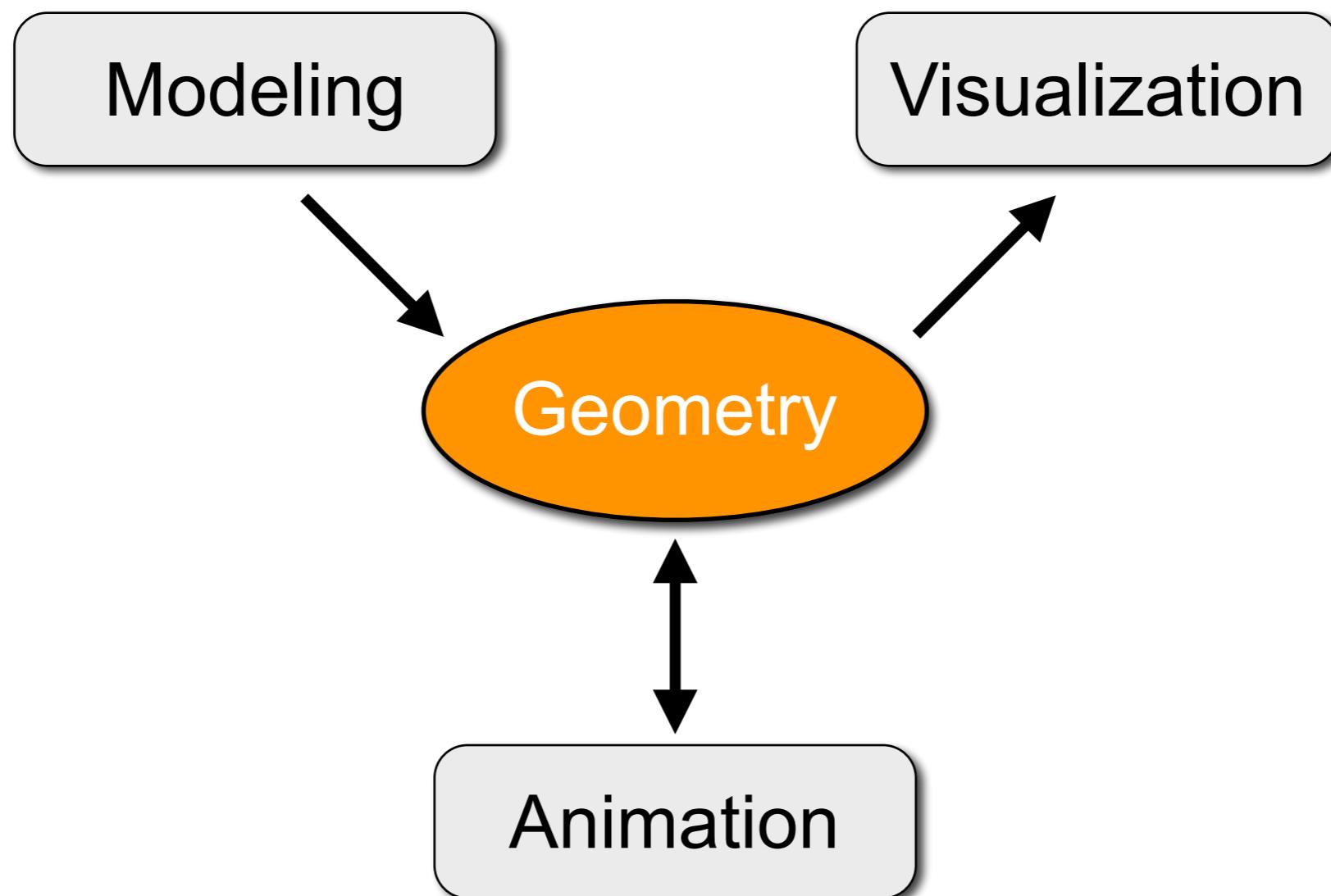
Graphics & Co.



Geometry Processing

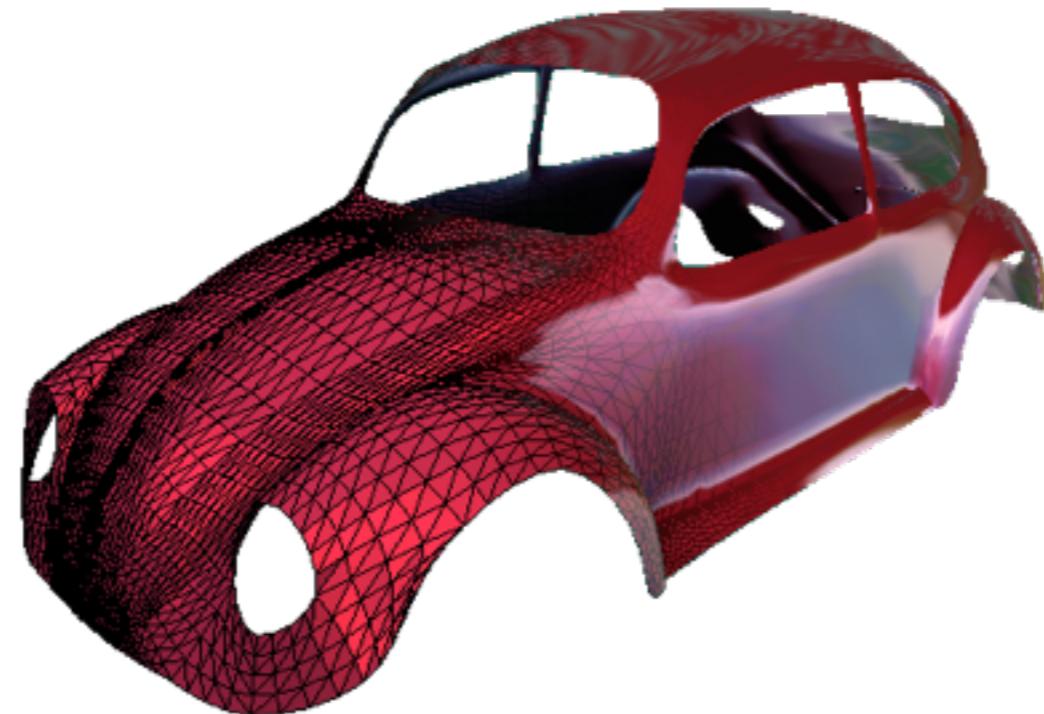


Geometry Processing



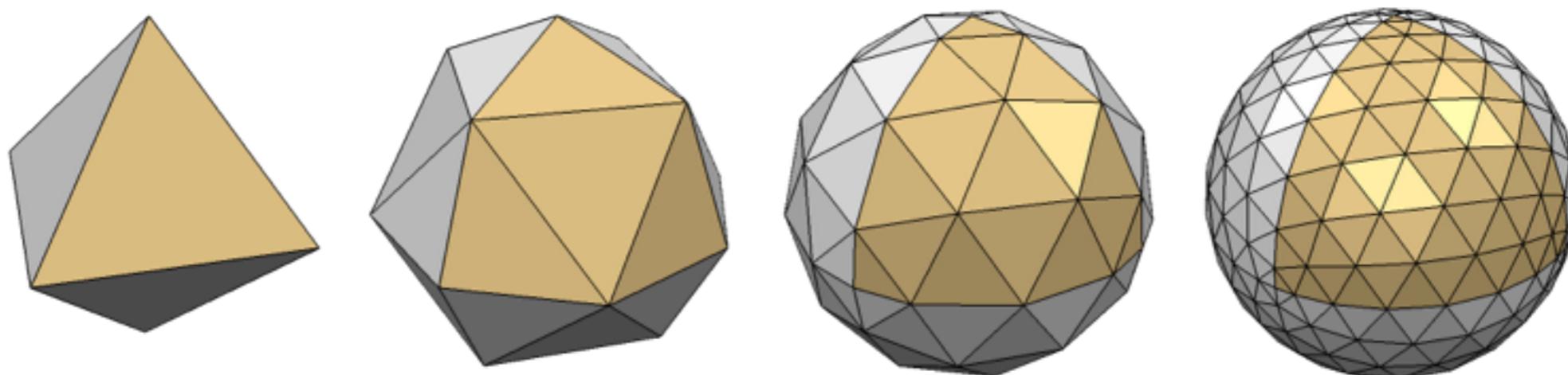
Triangle Meshes!

- Advantages
 - Flexible → Arbitrary topology surfaces



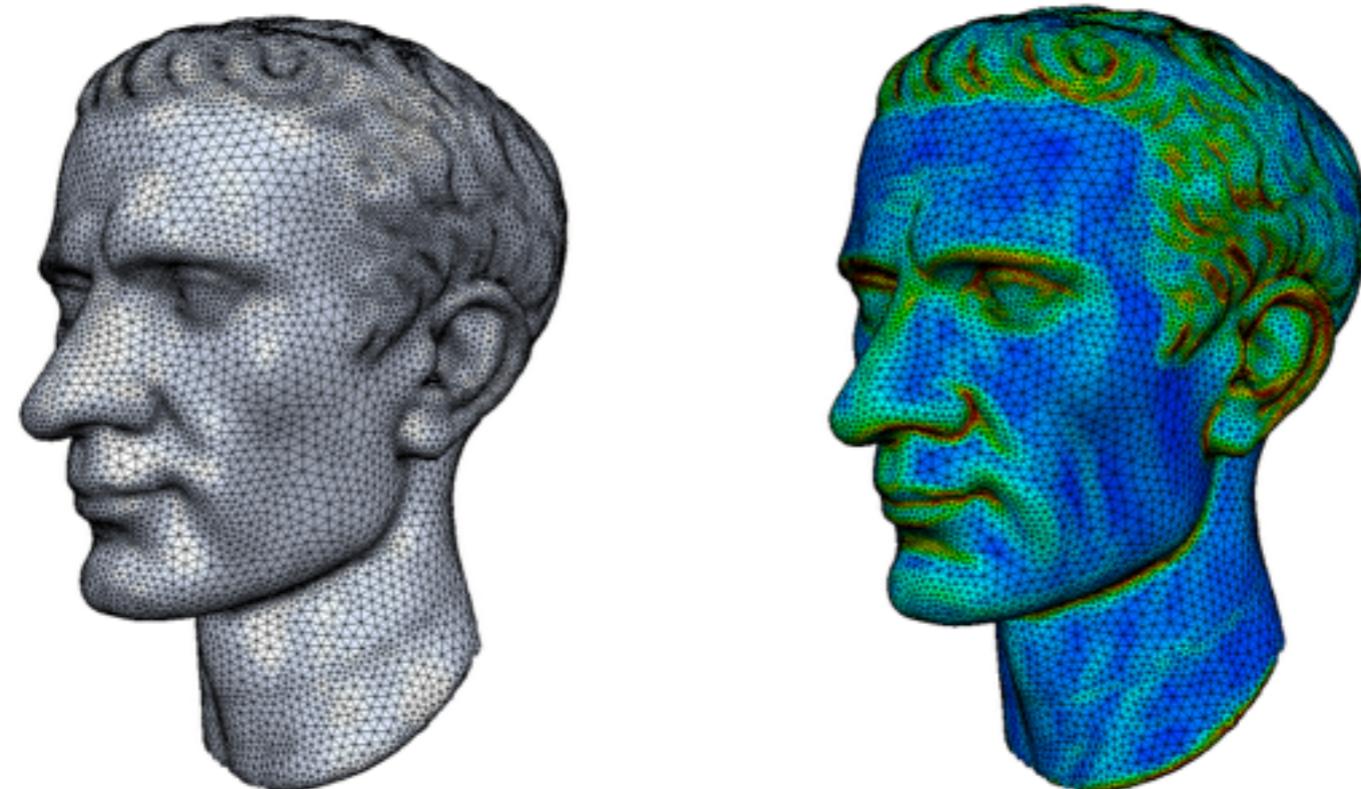
Triangle Meshes!

- Advantages
 - Flexible → Arbitrary topology surfaces
 - Accurate → $\text{Error} \propto 1/\#\text{triangles}$



Triangle Meshes!

- Advantages
 - Flexible → Arbitrary topology surfaces
 - Accurate → $\text{Error} \propto 1/\#\text{triangles}$
 - Adaptive → Adapt sampling to curvature

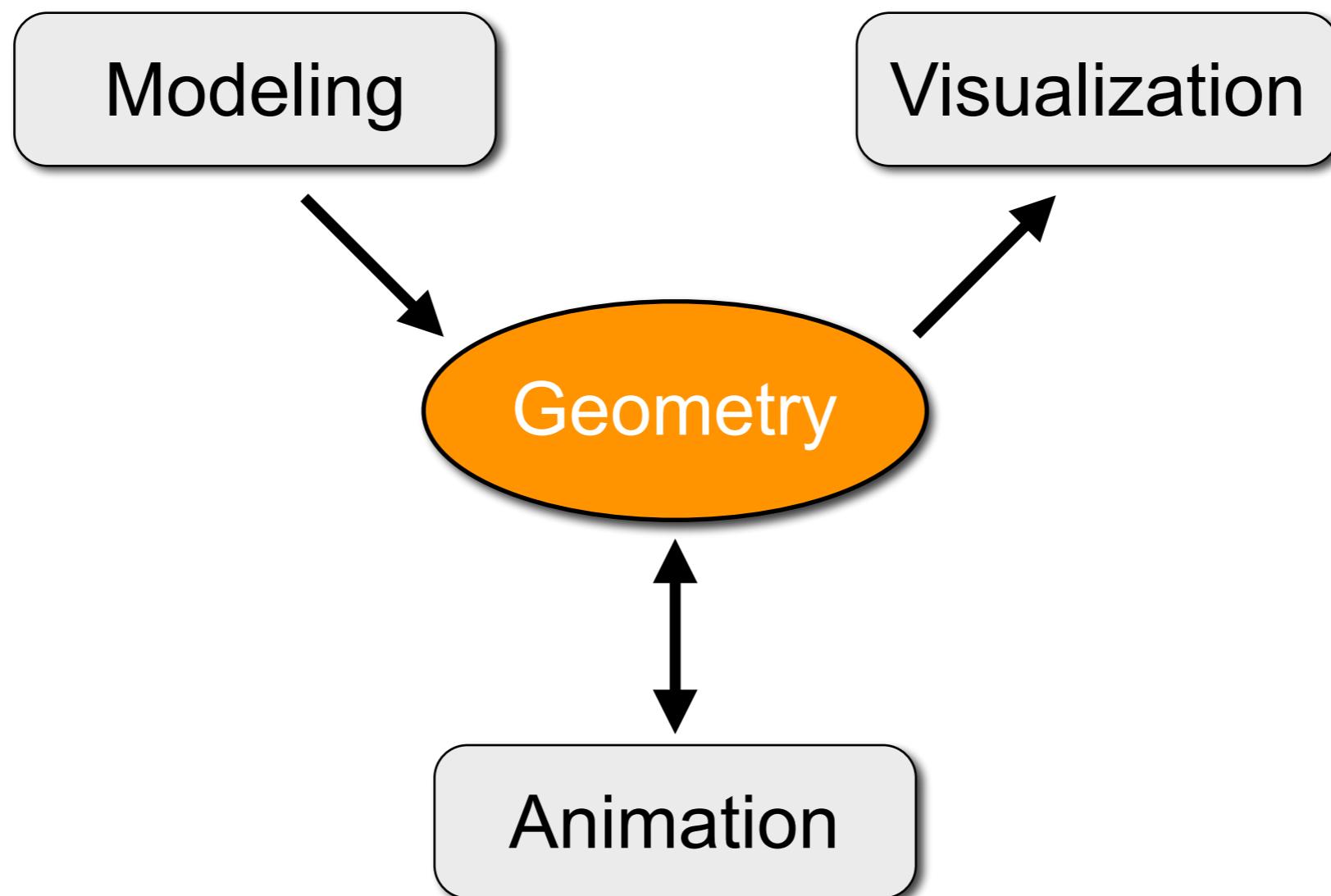


Triangle Meshes!

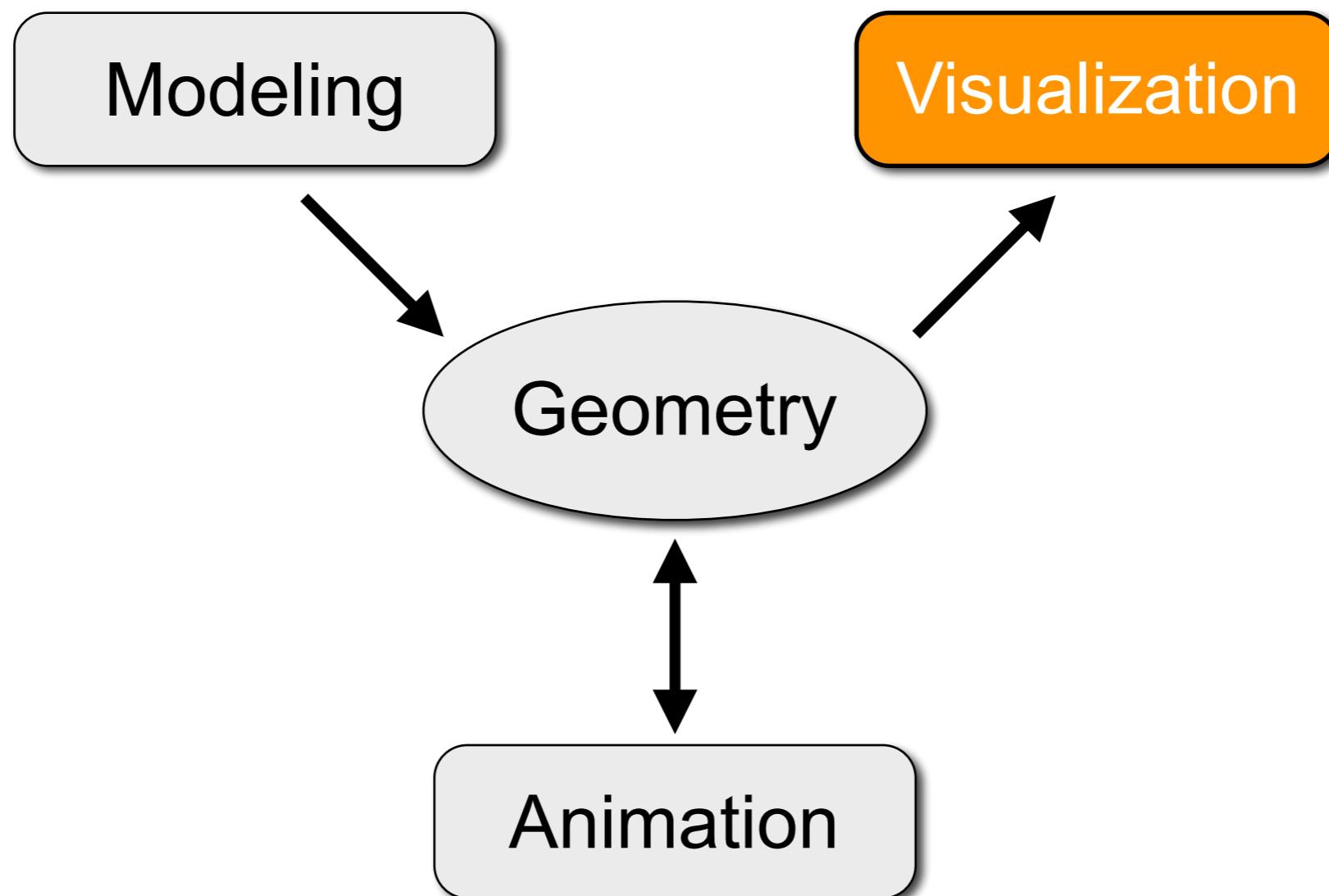
- Advantages
 - Flexible → Arbitrary topology surfaces
 - Accurate → $\text{Error} \propto 1/\#\text{triangles}$
 - Adaptive → Adapt sampling to curvature
 - Efficient → Simple primitives are easy to process



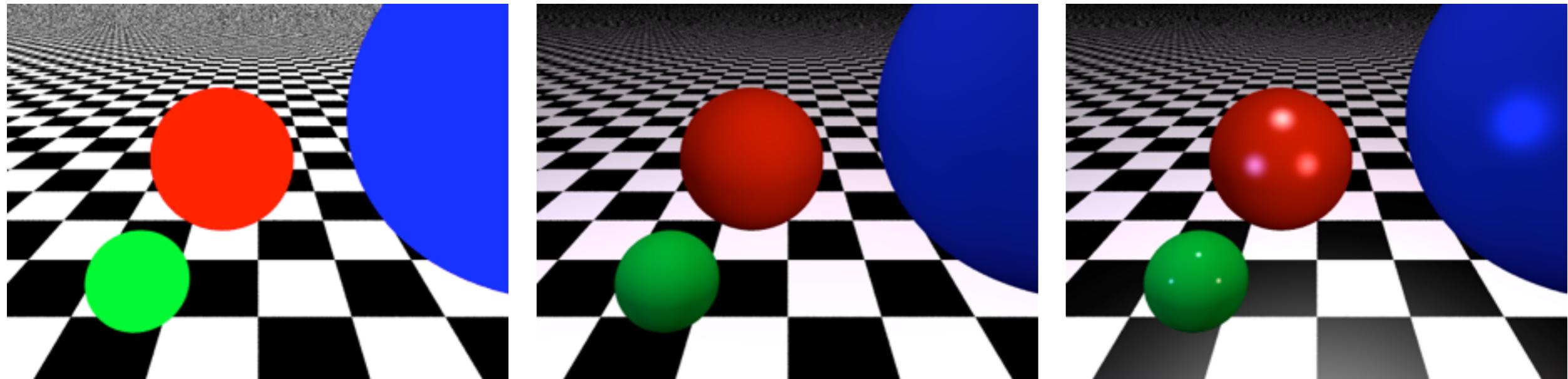
Geometry Processing



Geometry Processing



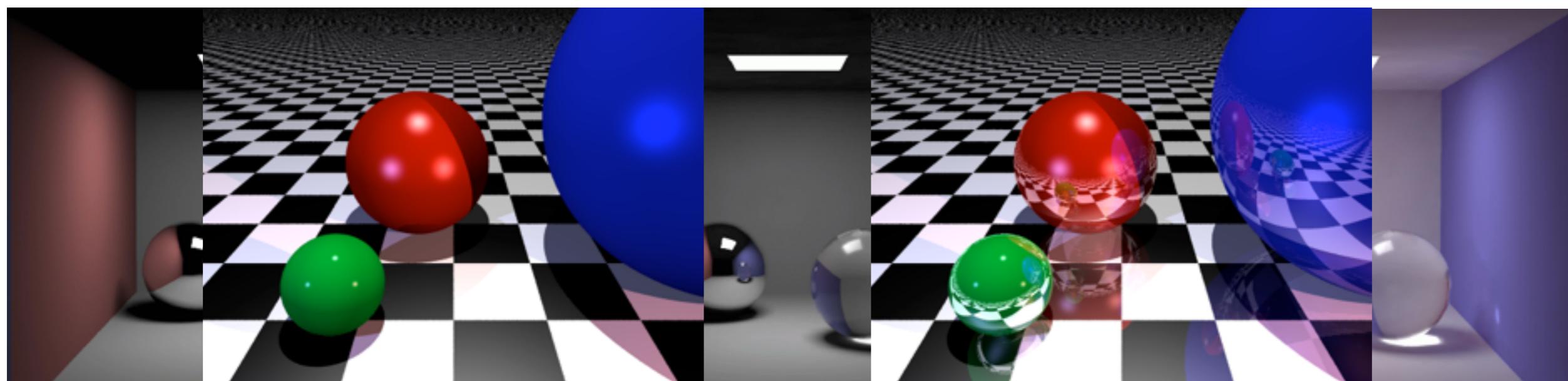
Realistic Rendering



Color only

+ Diffuse lighting

+ Specular lighting

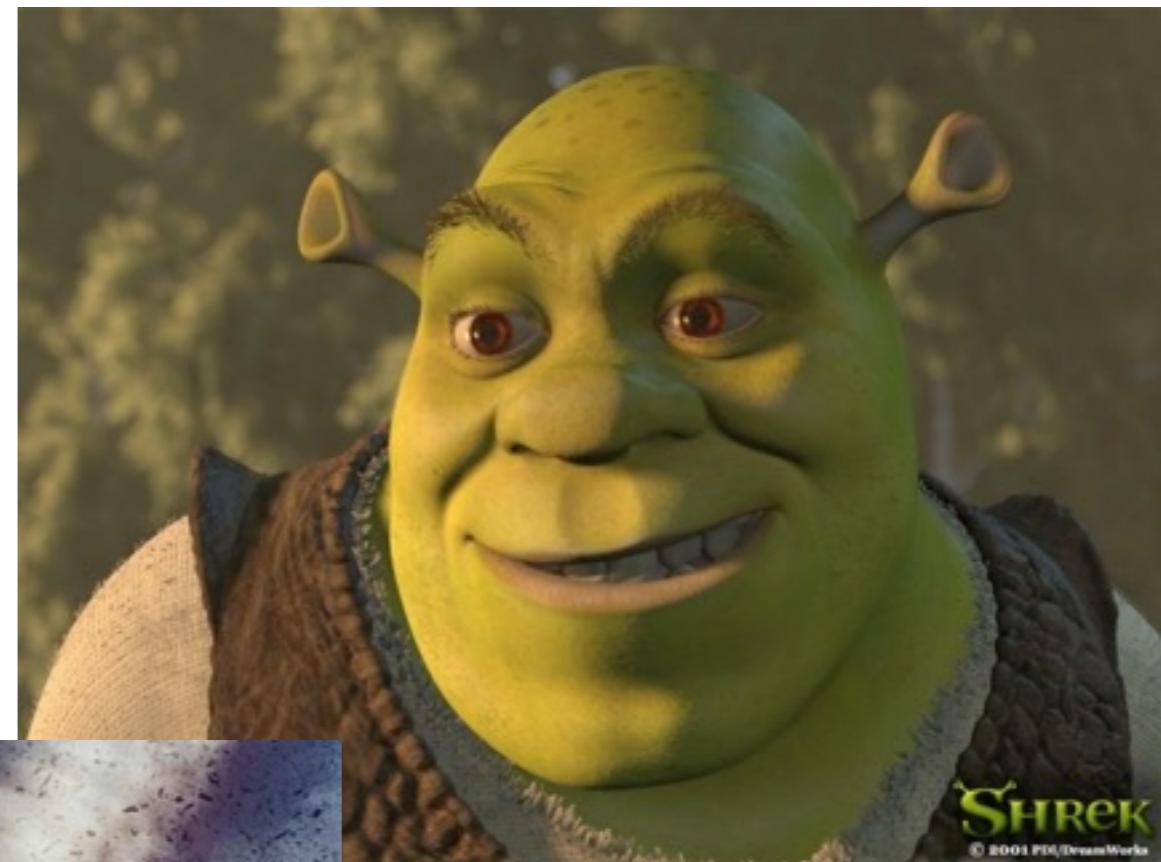


+ Refraction Shadows

+ Caustics

+ Reflections + Indirect Lighting

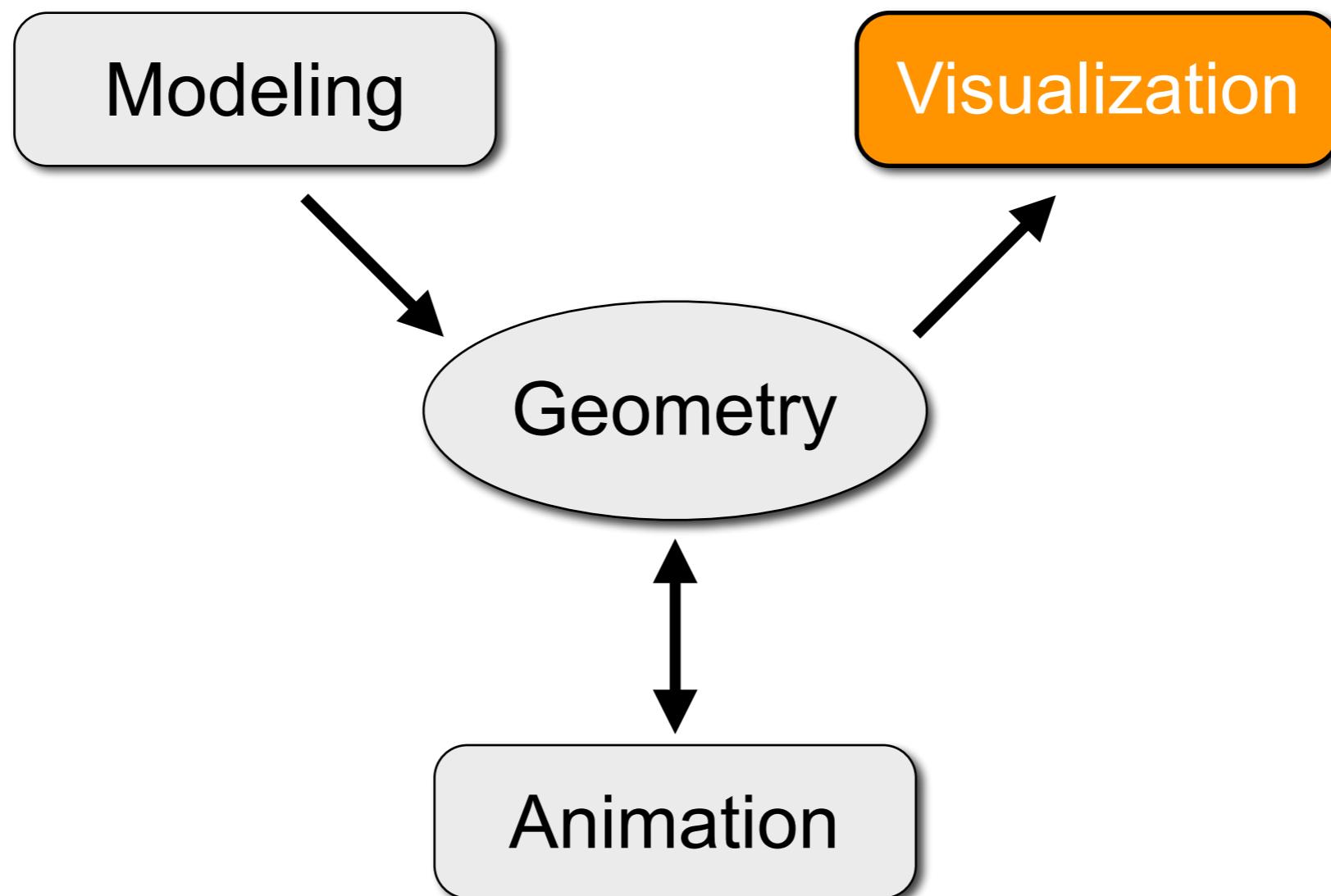
Feature Films



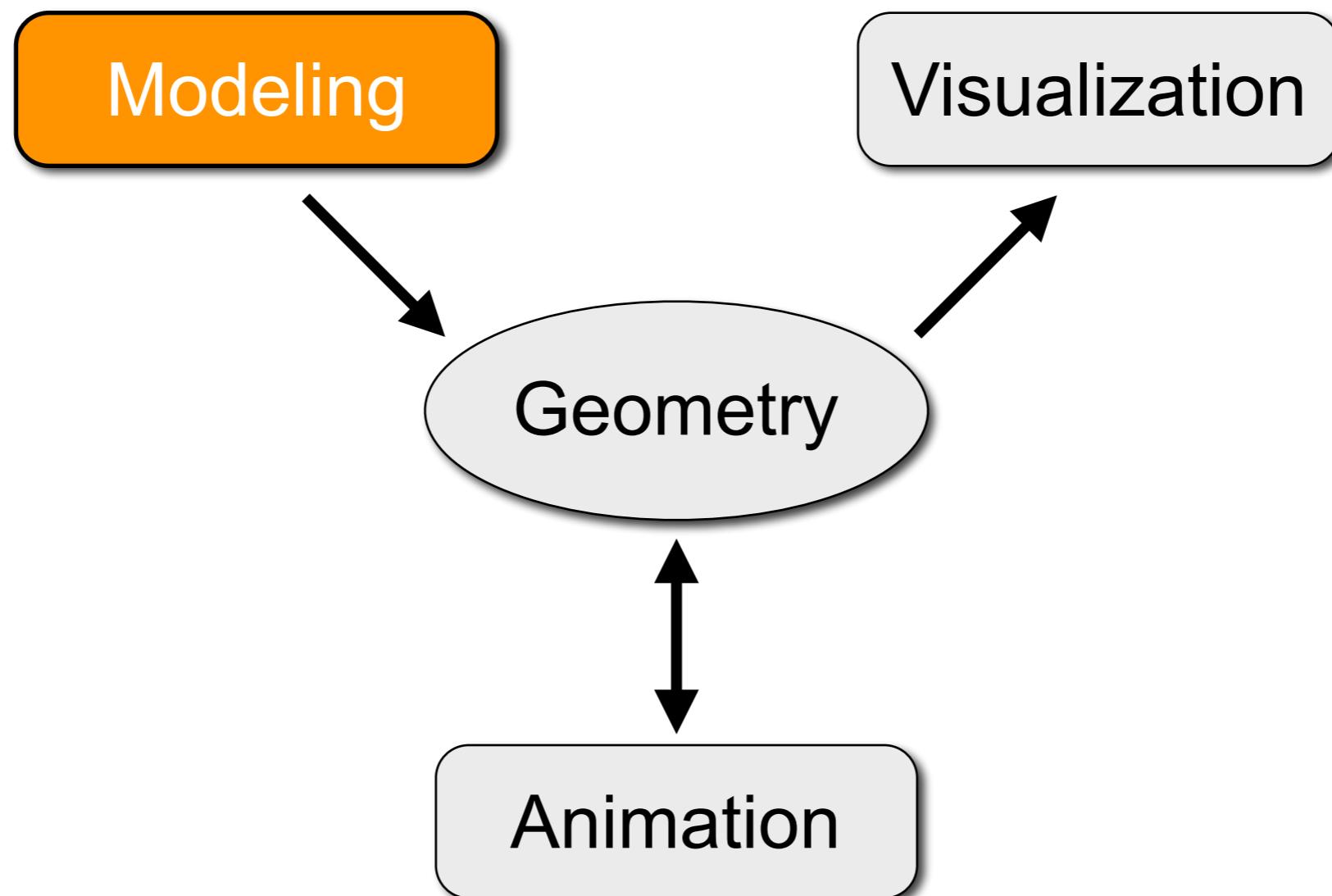
Computer Games



Geometry Processing



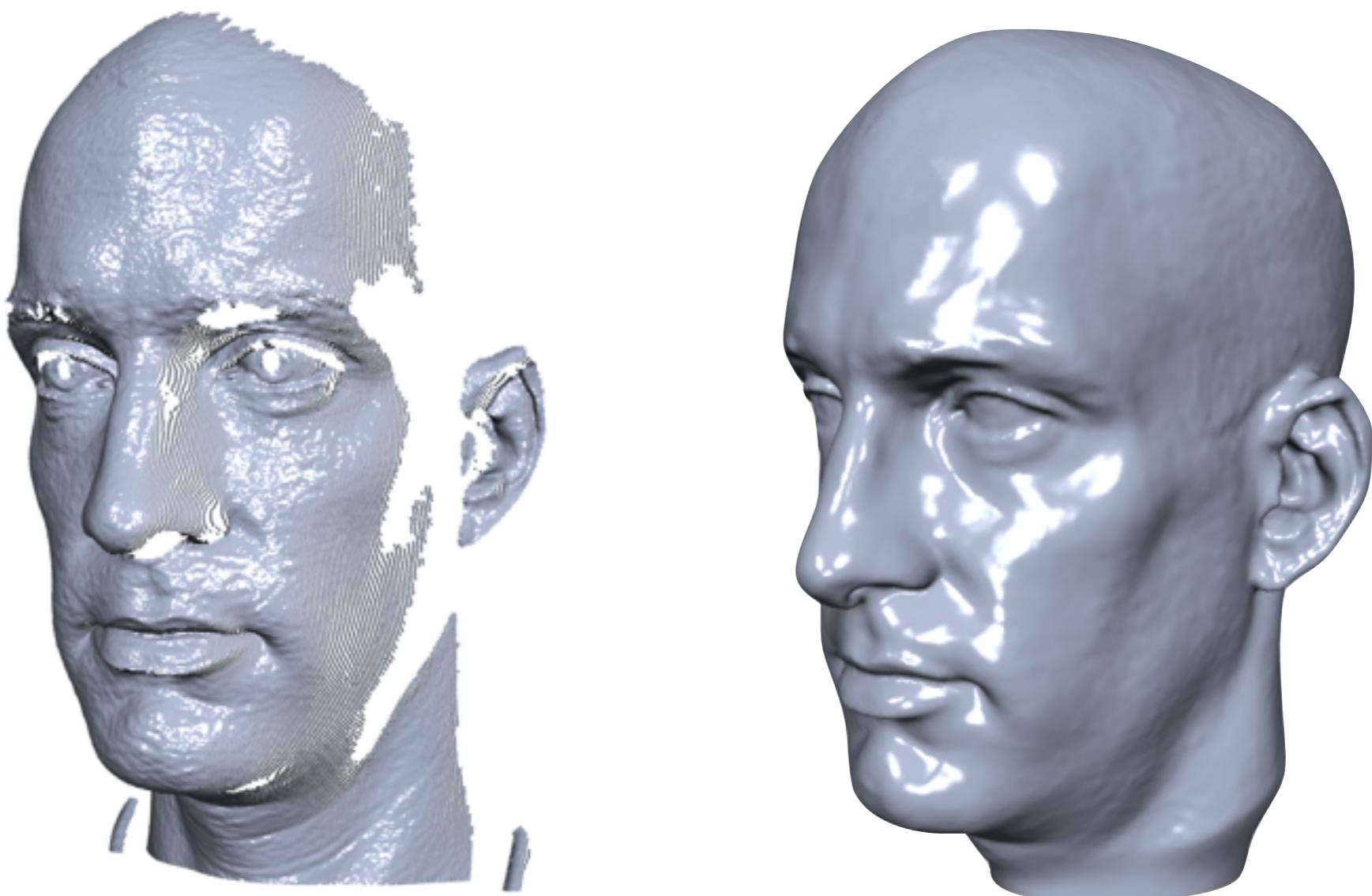
Geometry Processing



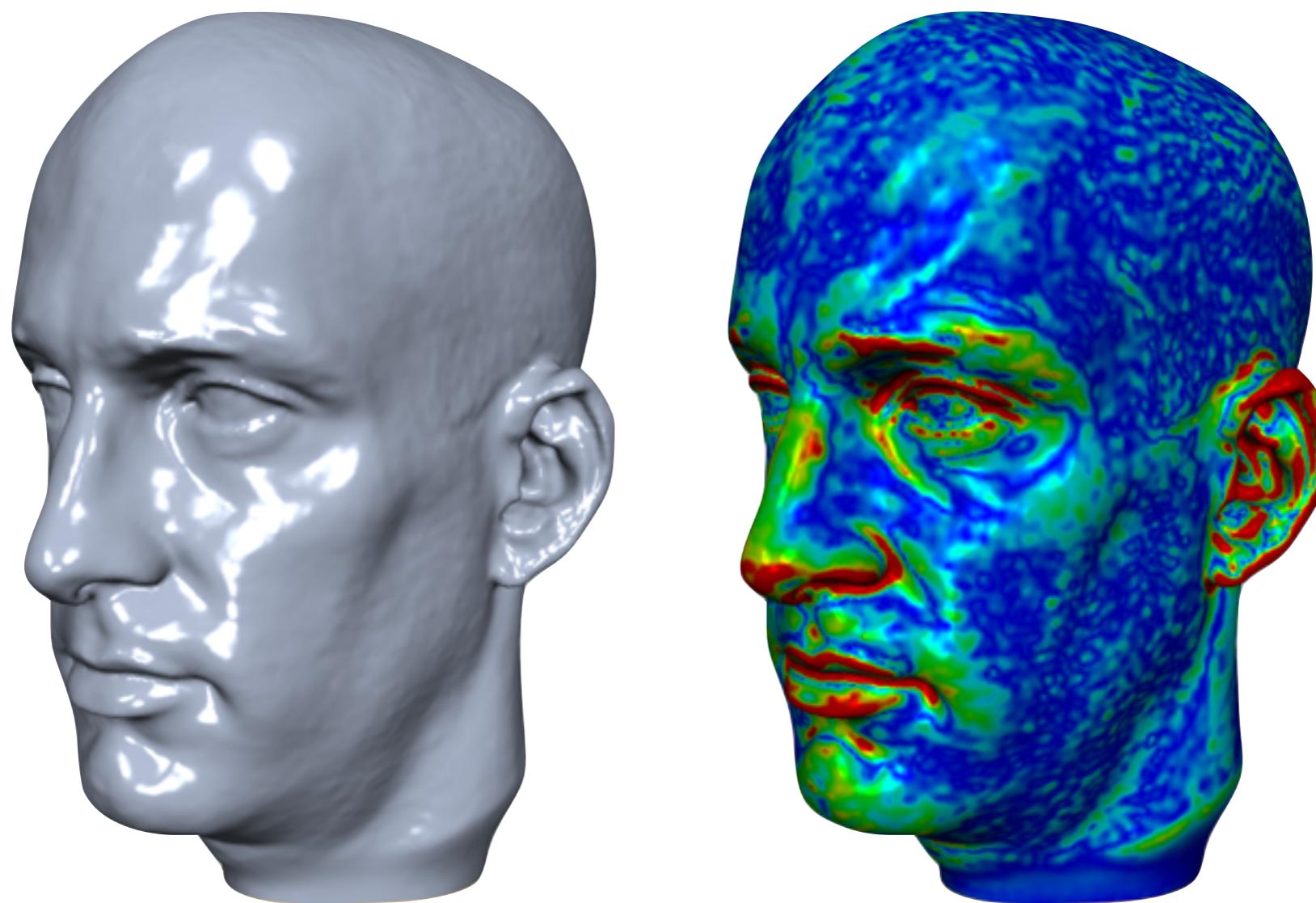
3D Scanning



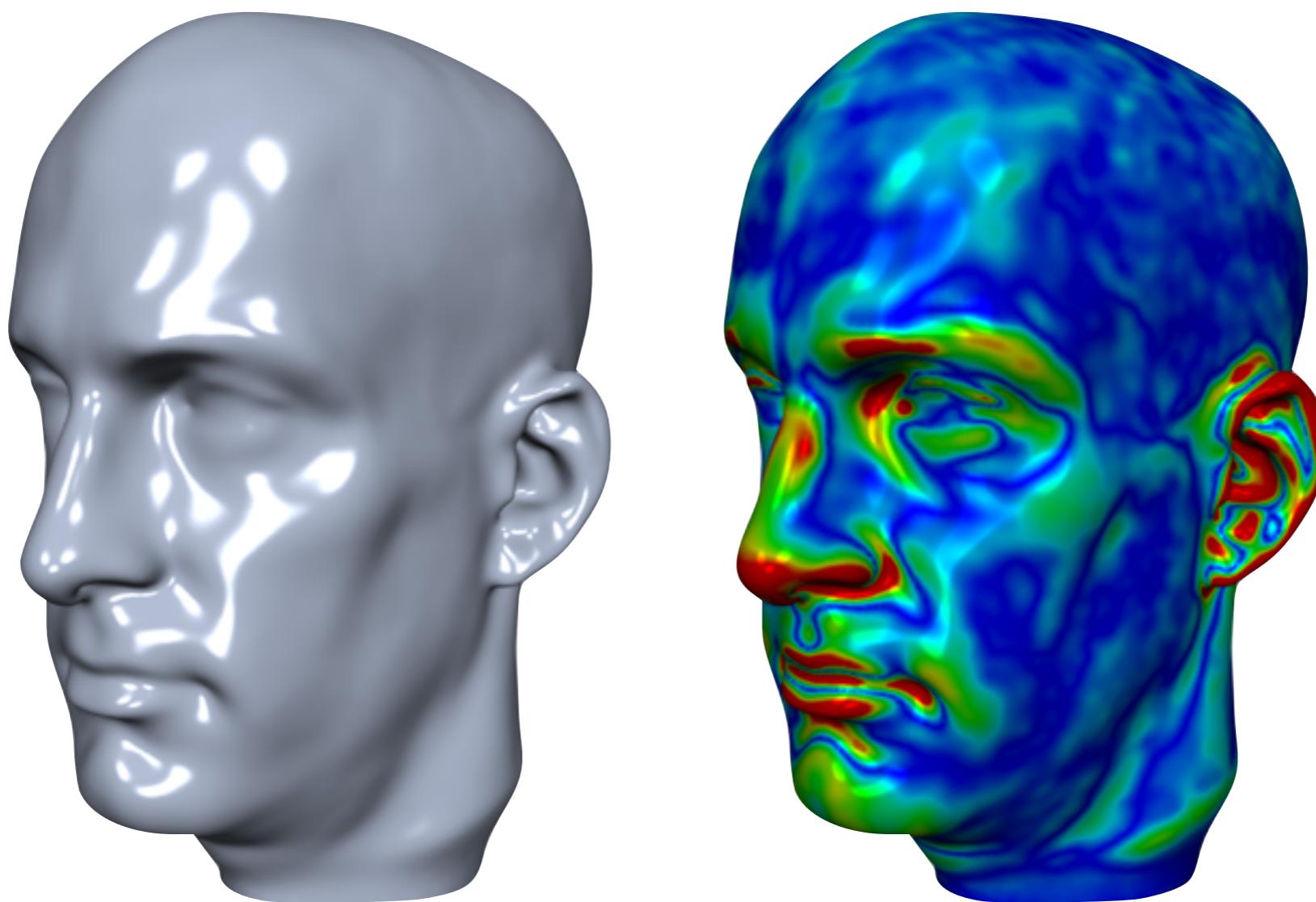
Mesh Reconstruction



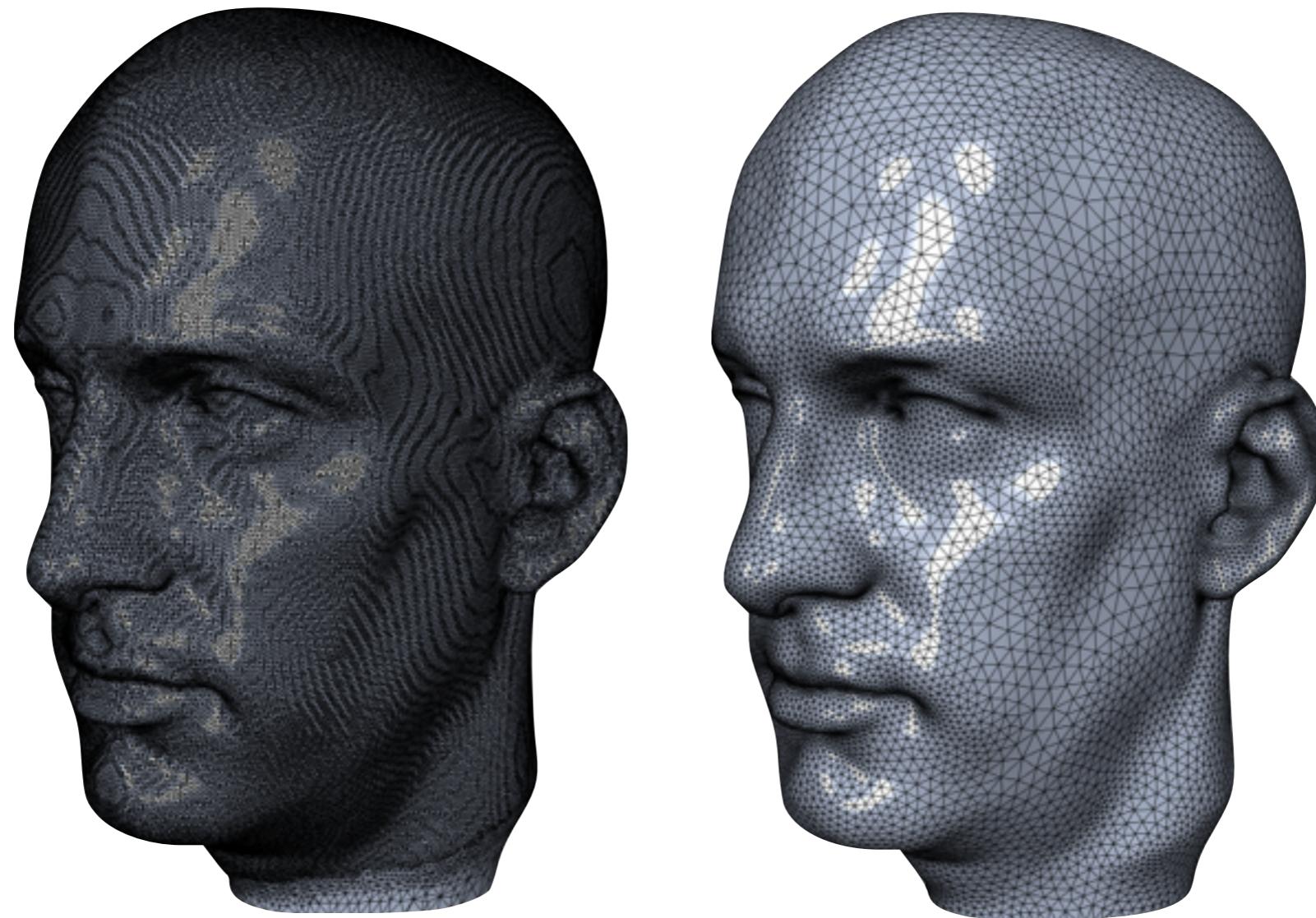
Mesh Smoothing



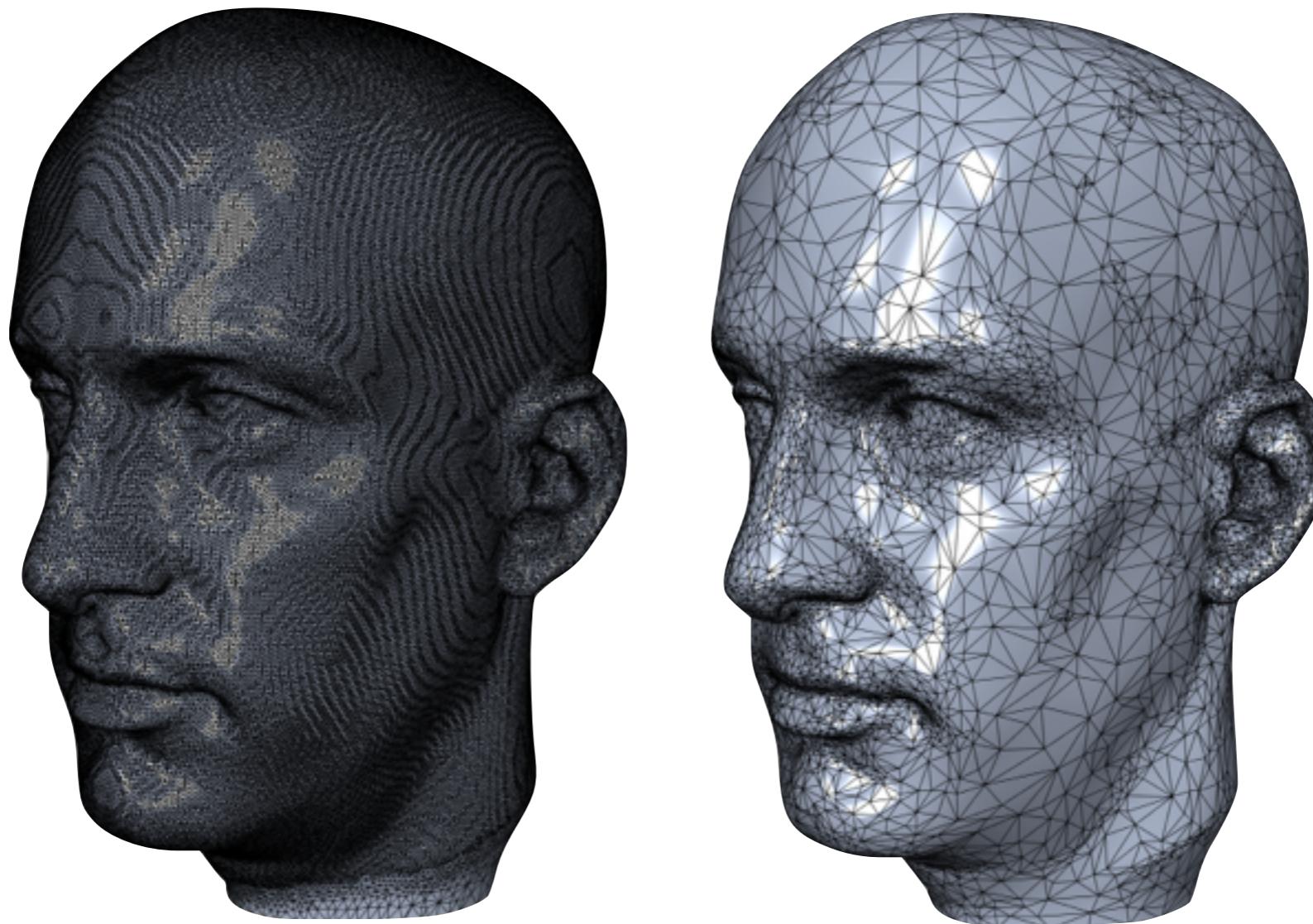
Mesh Smoothing



Remeshing



Mesh Decimation



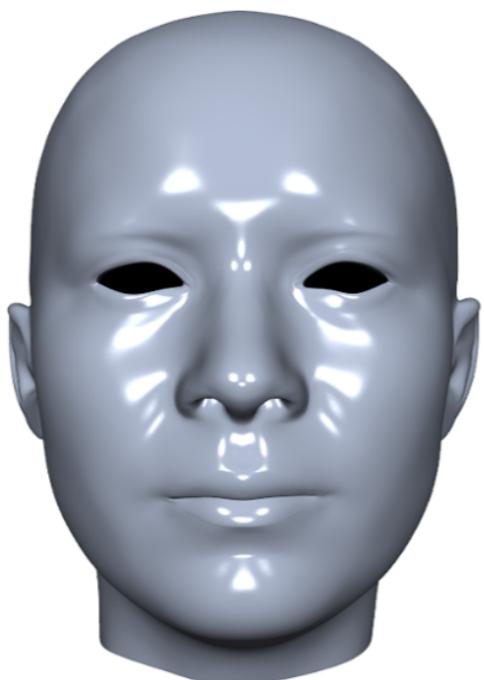
Face Scanning



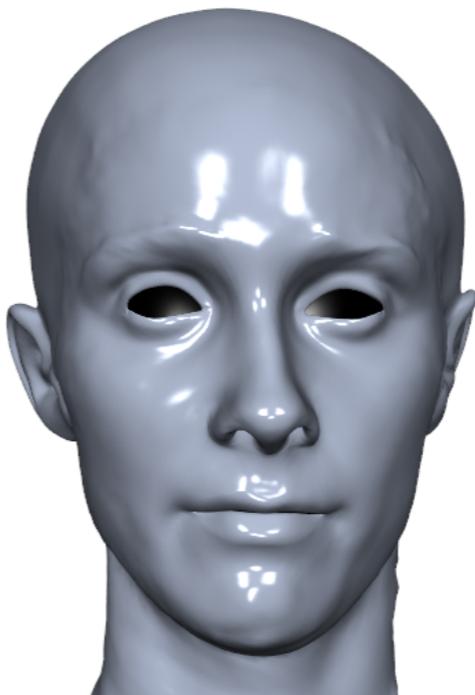
Face Scanning



Point cloud



Template

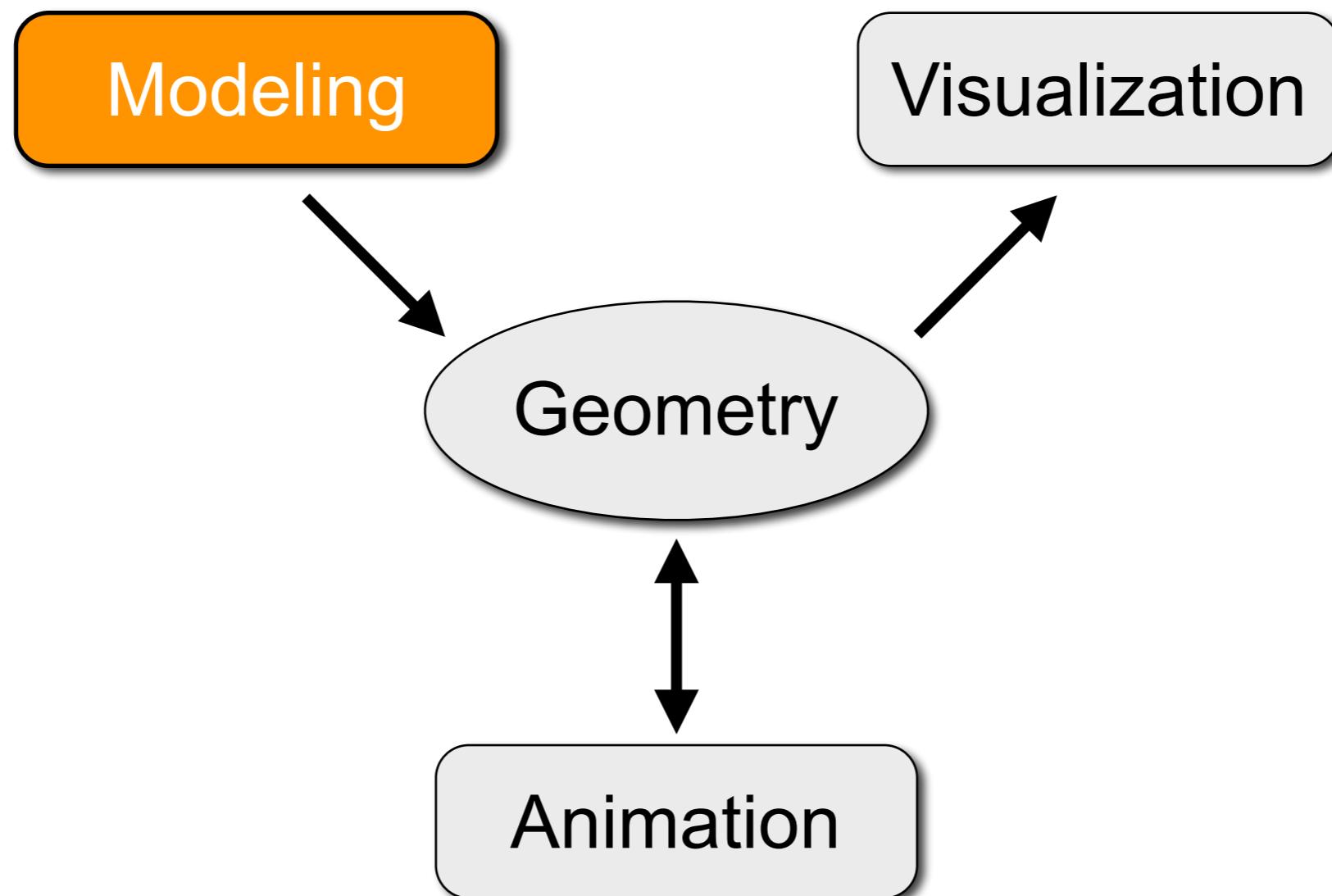


Fit

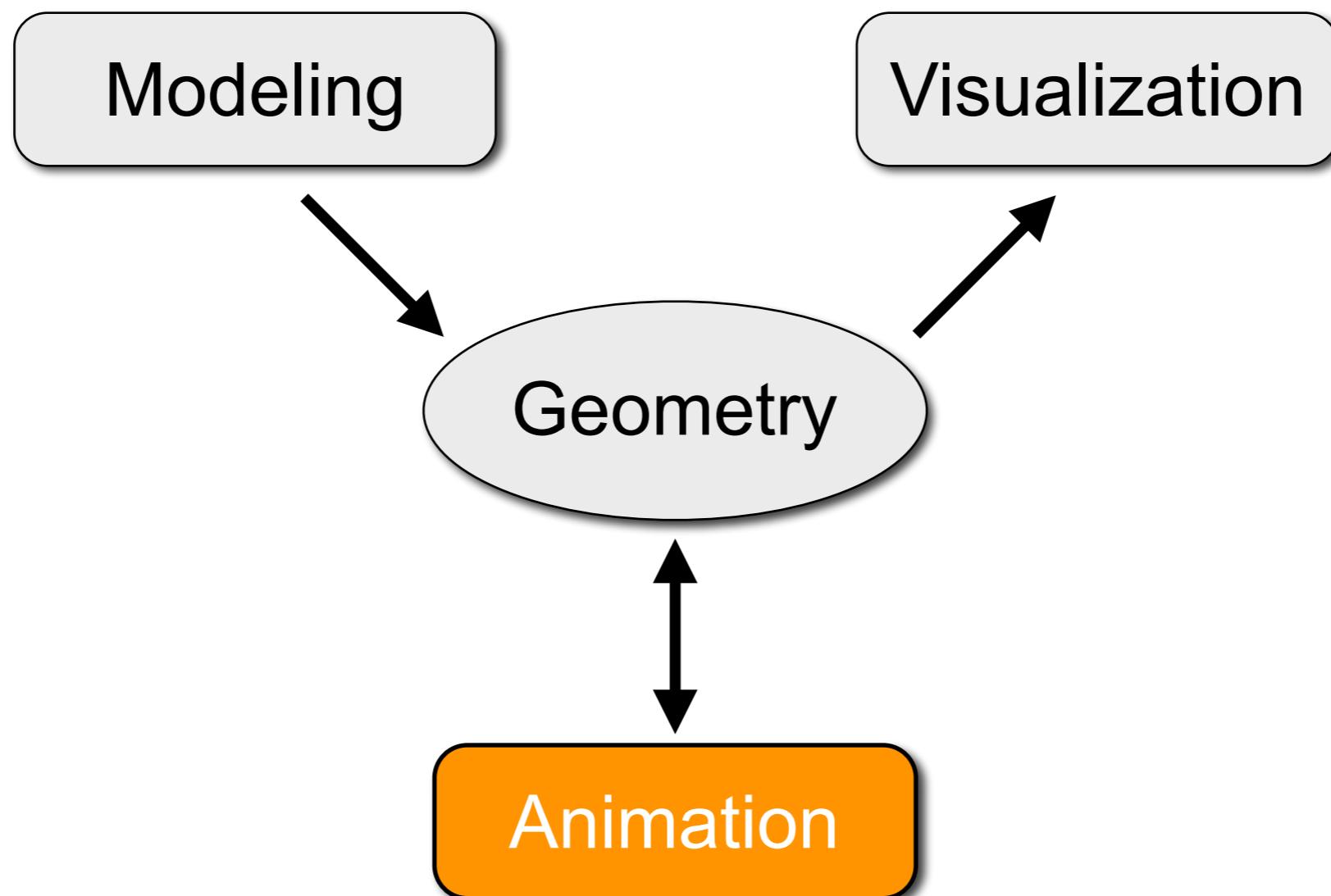


Clone

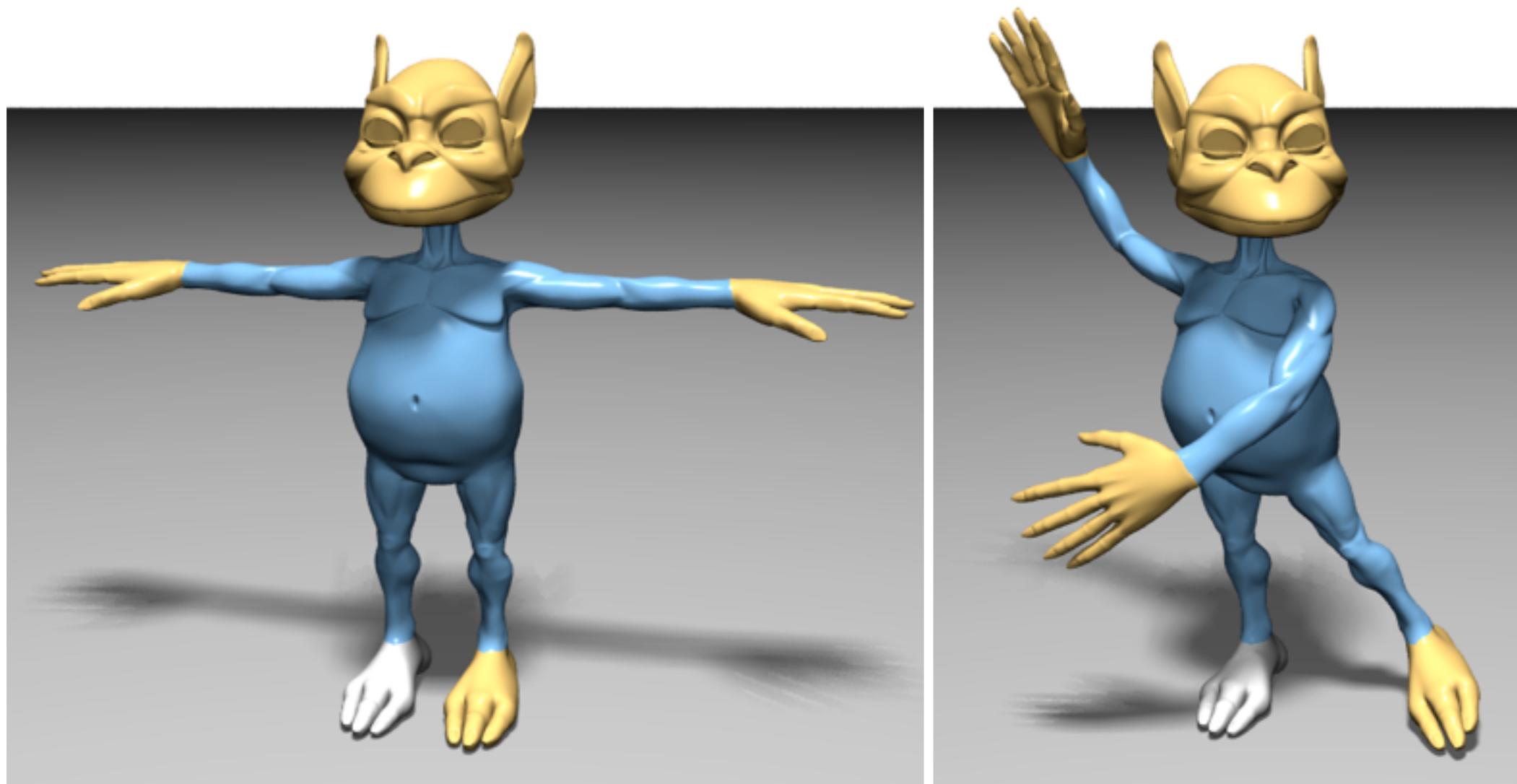
Geometry Processing



Geometry Processing



Character Animation



Cloth



Face Animation

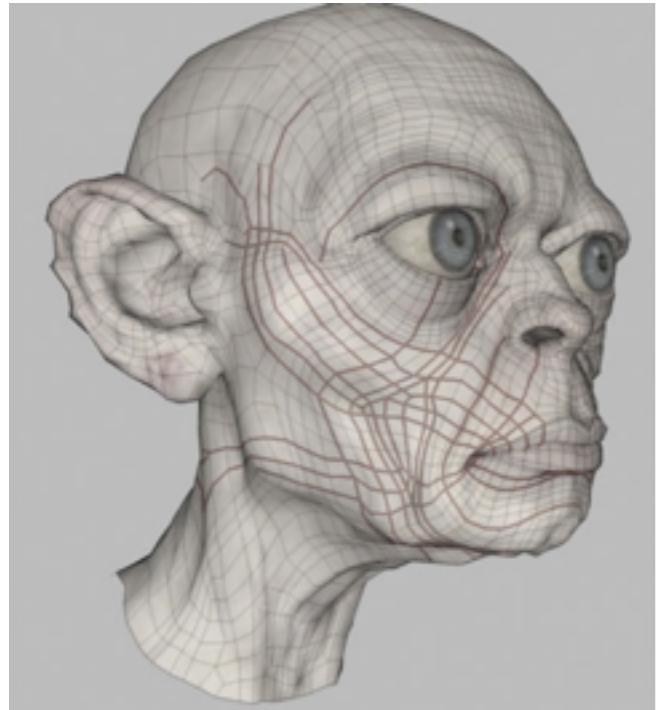


Capturing Sequence

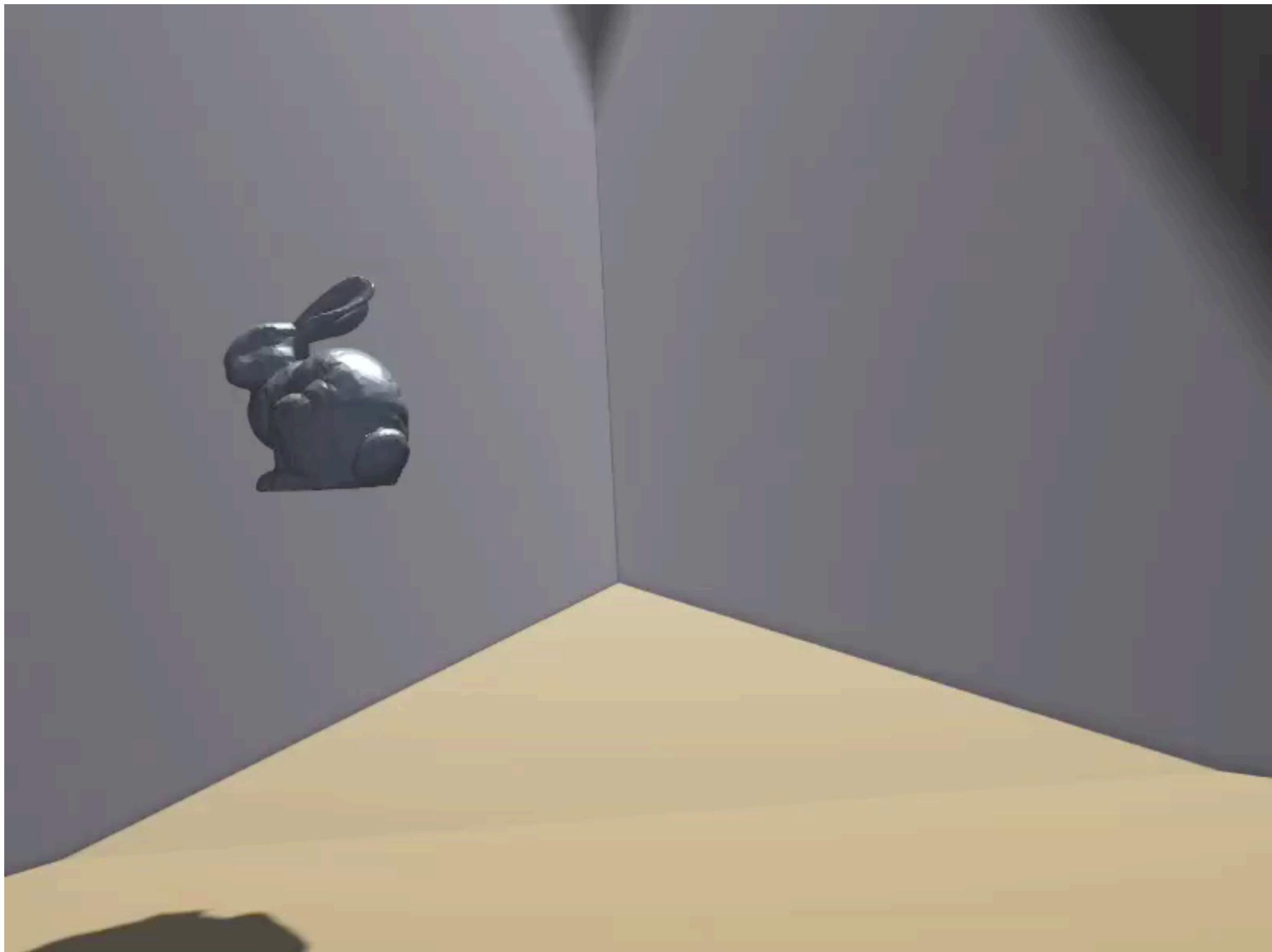


Real-Time Animation

Motion Capturing



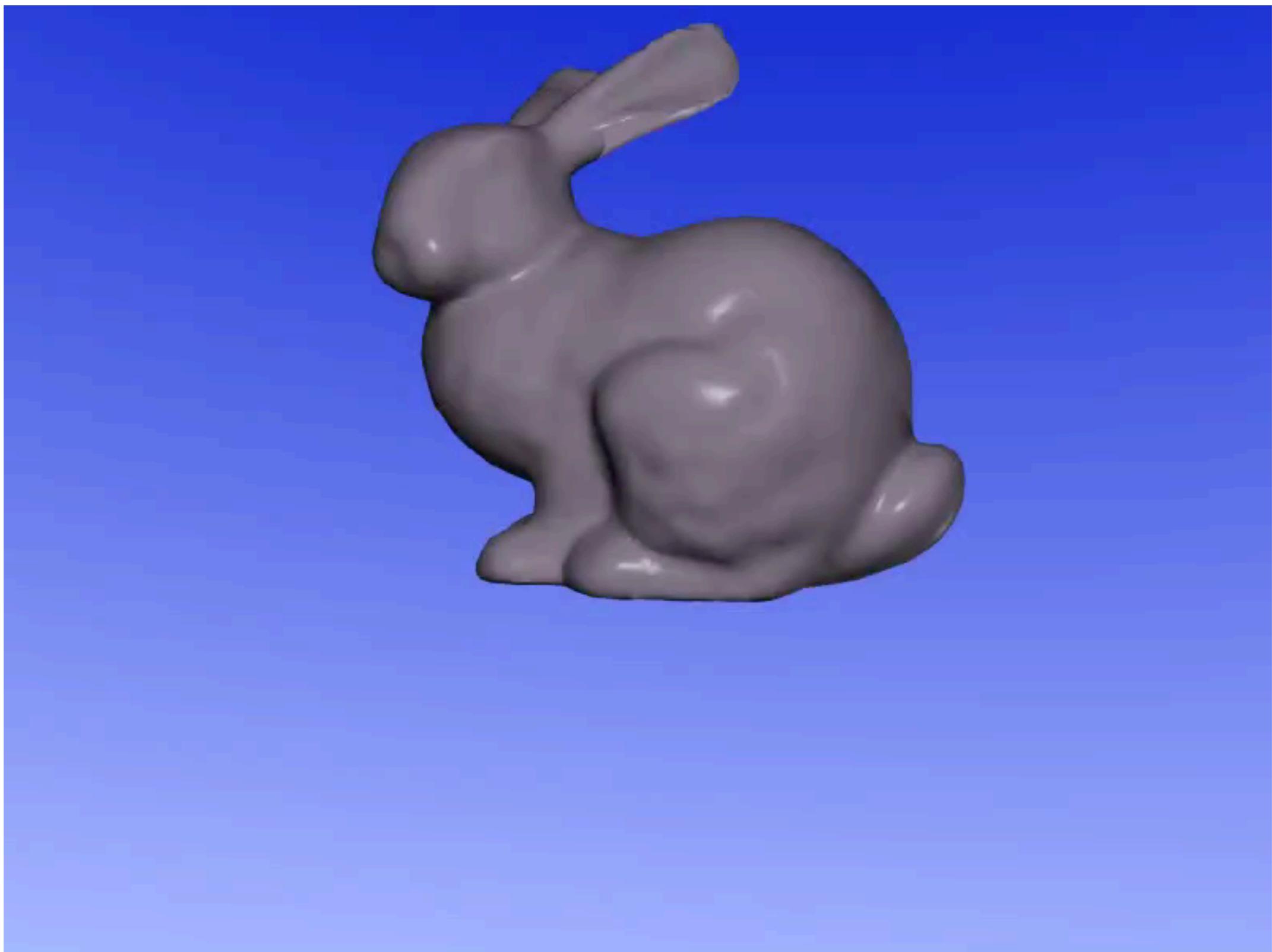
Elastic Deformations



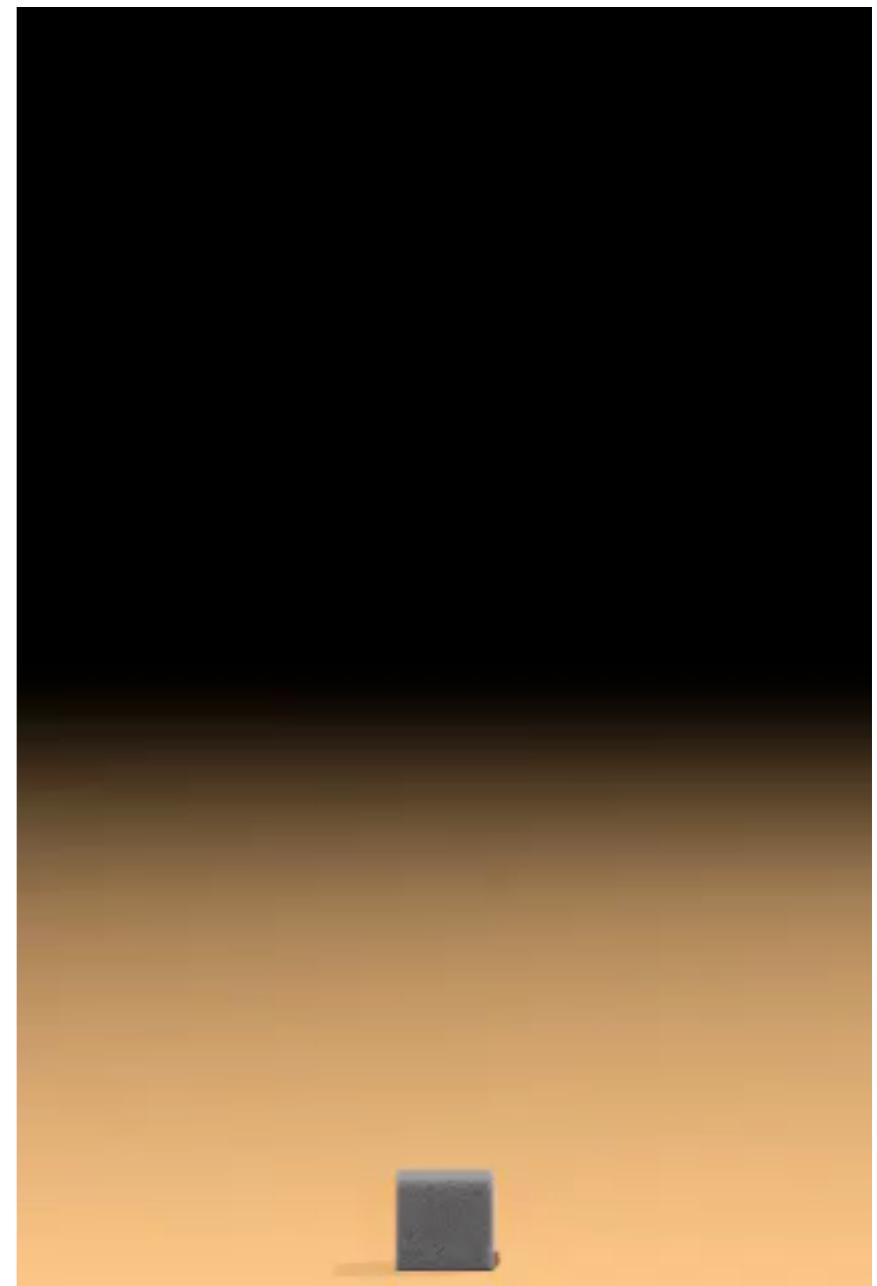
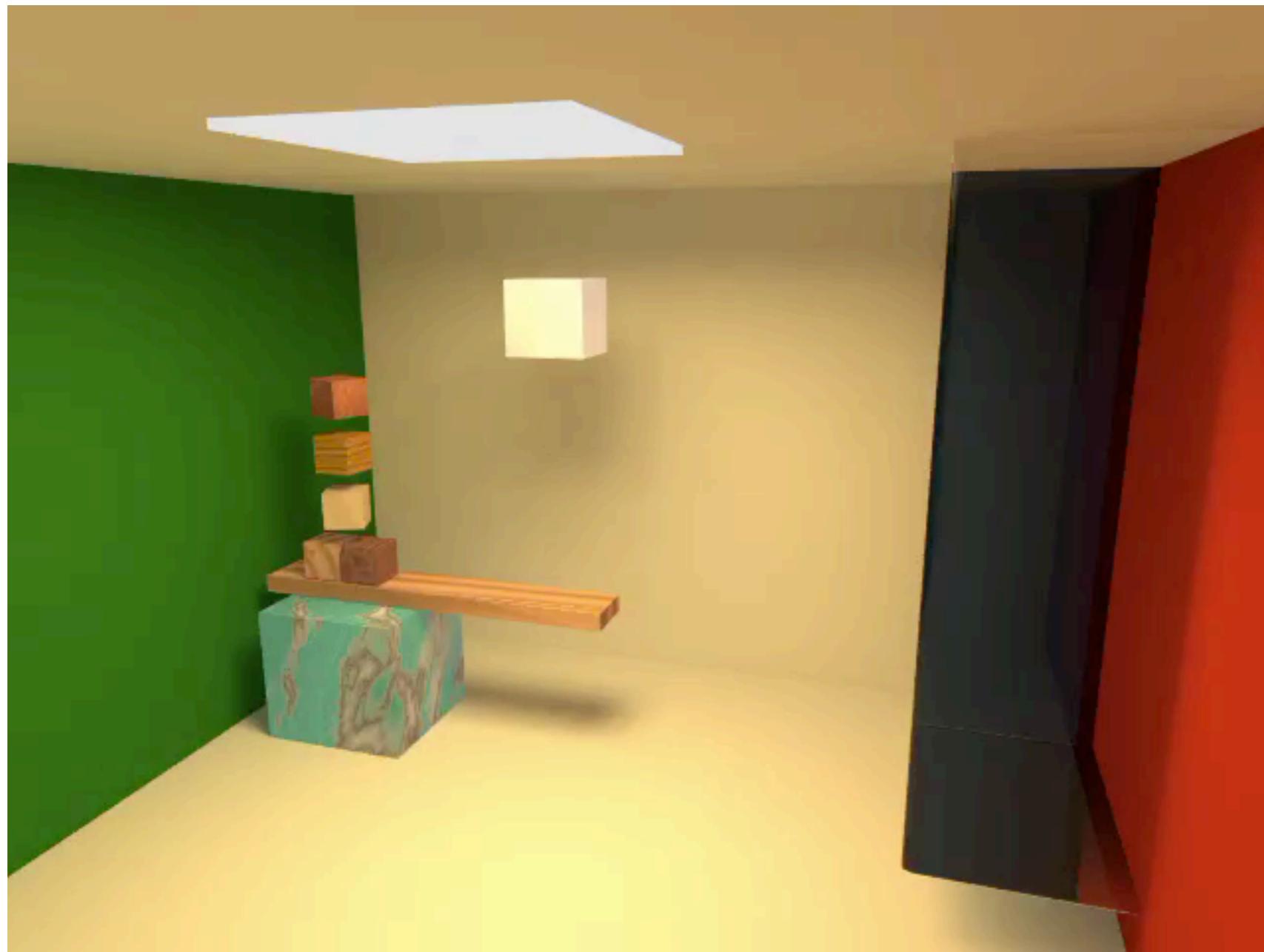
Plastic Deformations & Fracture



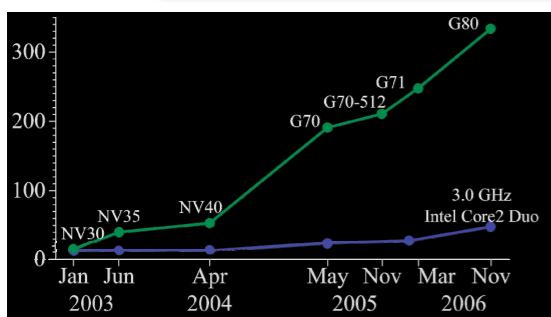
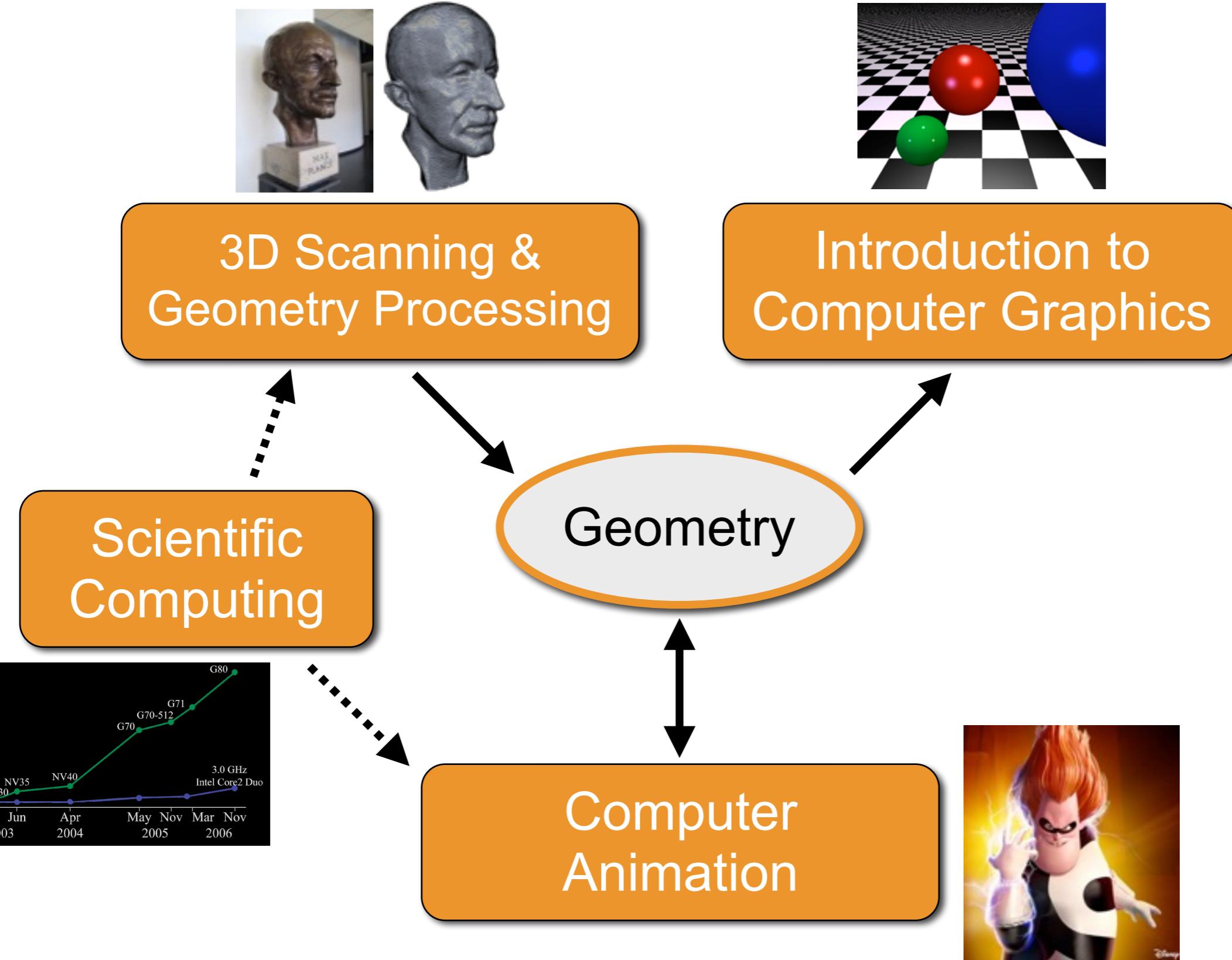
Cutting



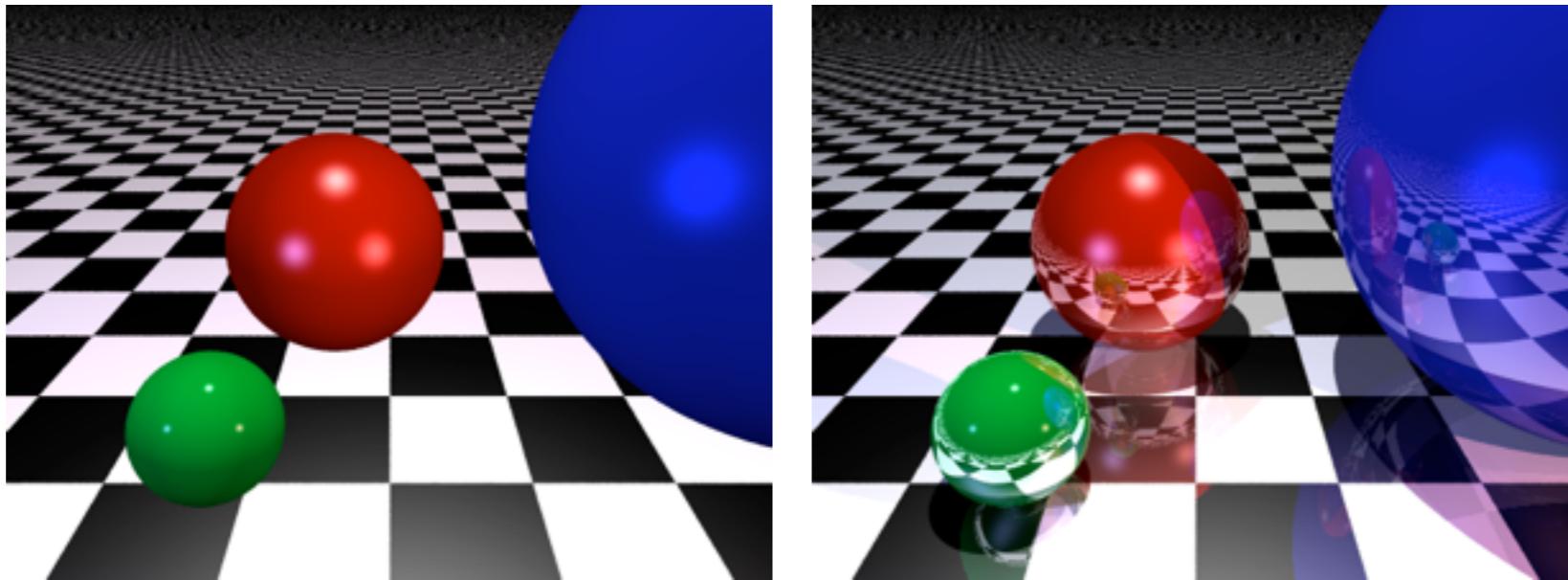
Fluid Simulation



AG CG Lectures



Introduction to Computer Graphics



Prof. Dr. Mario Botsch
Computer Graphics & Geometry Processing

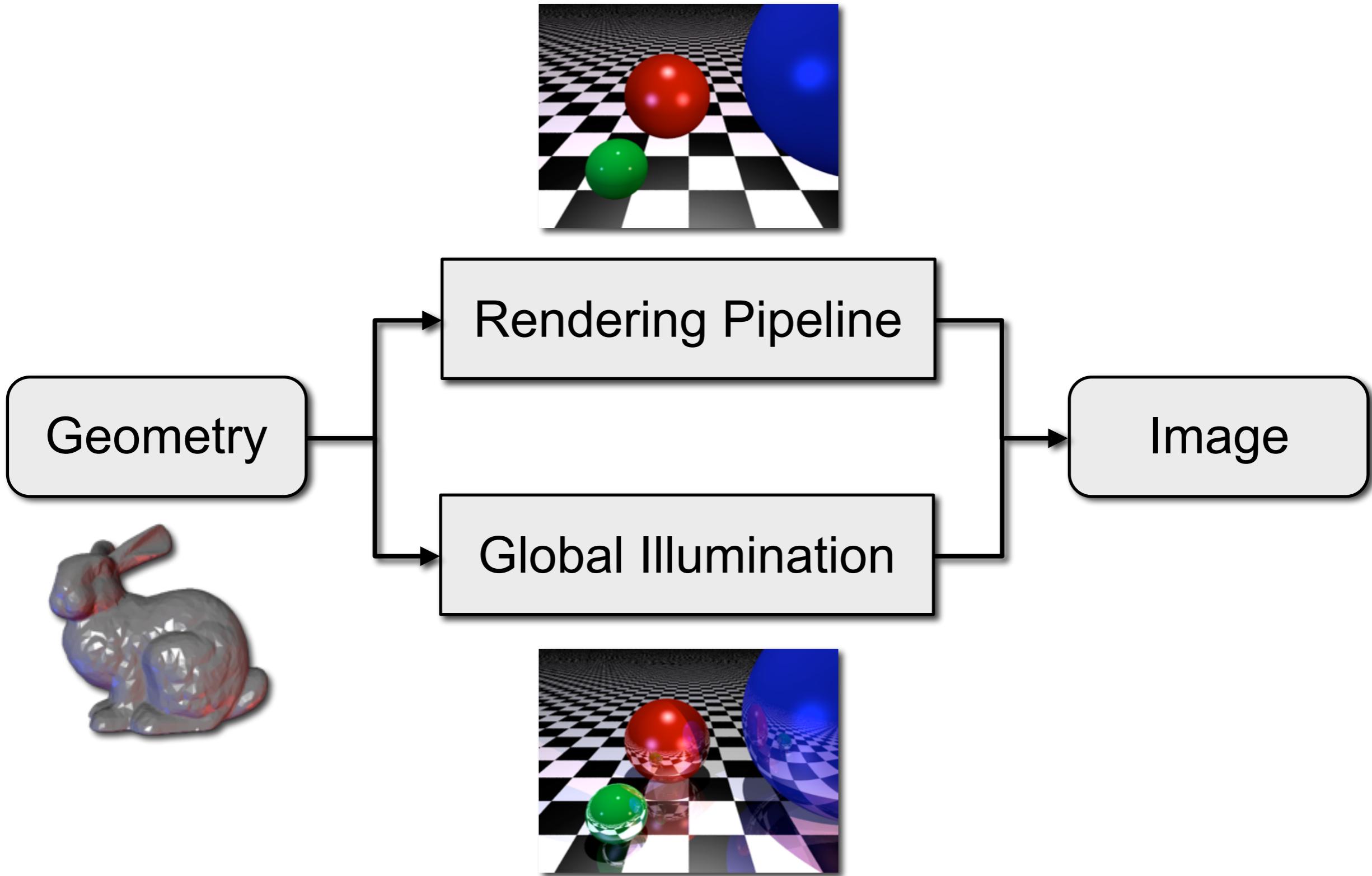
Organization

- **Schedule**
 - Tue, 14 - 16: Lecture
 - Thu, 16 - 18: Lecture
 - Thu, 14 - 16: Exercise
- **Course website**
 - <http://graphics.uni-bielefeld.de/teaching/ws15/graphics/>
 - Download lecture slides
 - Download programming exercises

Organization

- **Exercises**
 - 4 programming exercises (in C++)
 - work on your own or in a group
 - project presentations and discussions
 - get help from tutor
 - not mandatory, but required for exam!
- **Exam**
 - oral examination, about 20–30 minutes
 - 10 credit points
 - material is lecture and exercises

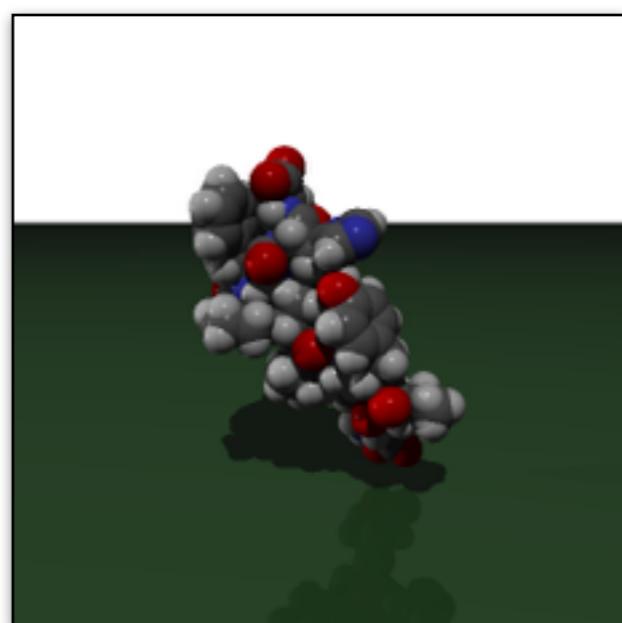
Overview



Course Content

- **Global Illumination**

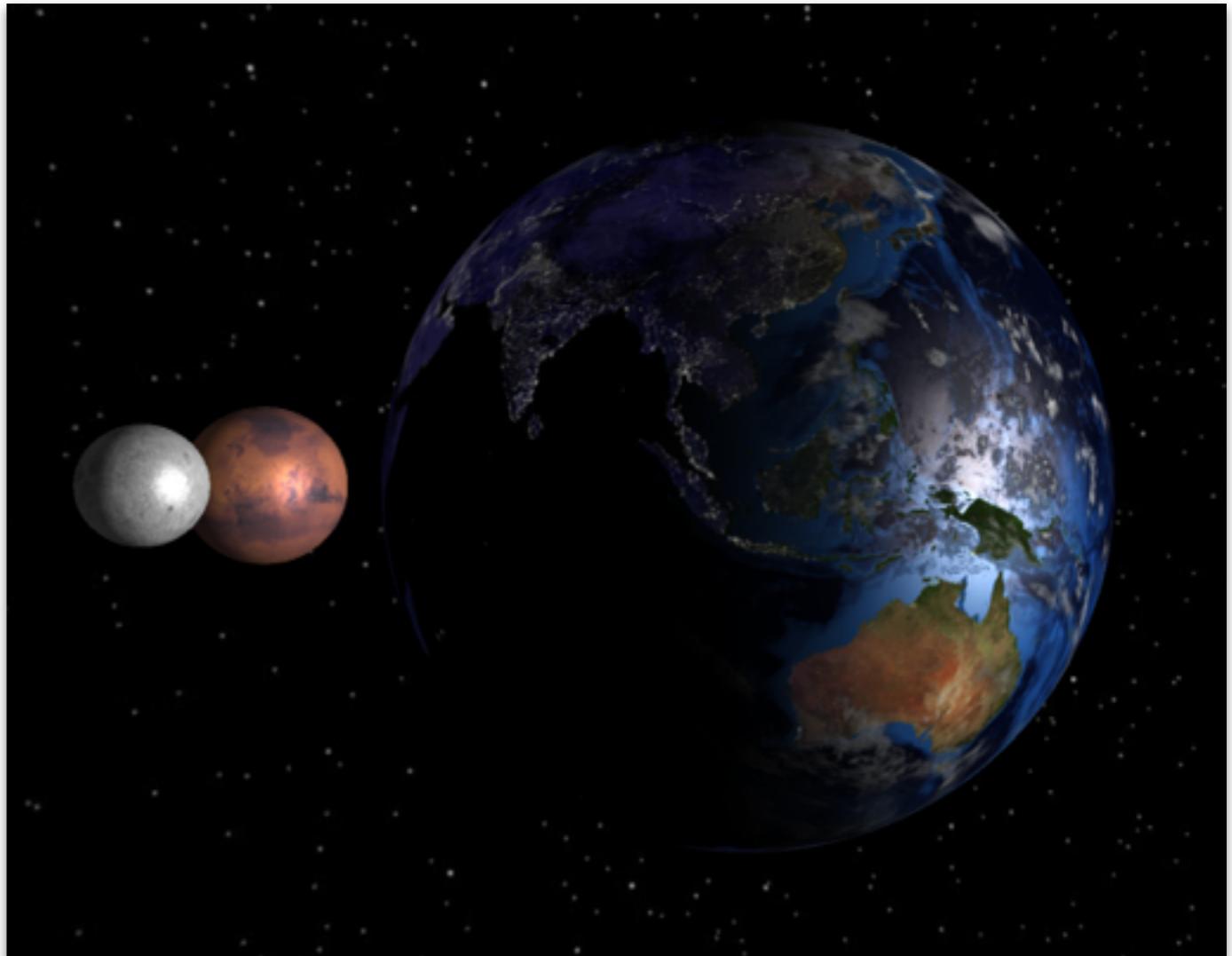
- ray tracing, ray intersections
- colors & lighting
- acceleration
- implementation in C++
- rendering equation, path tracing



Course Content

- **Rendering Pipeline**

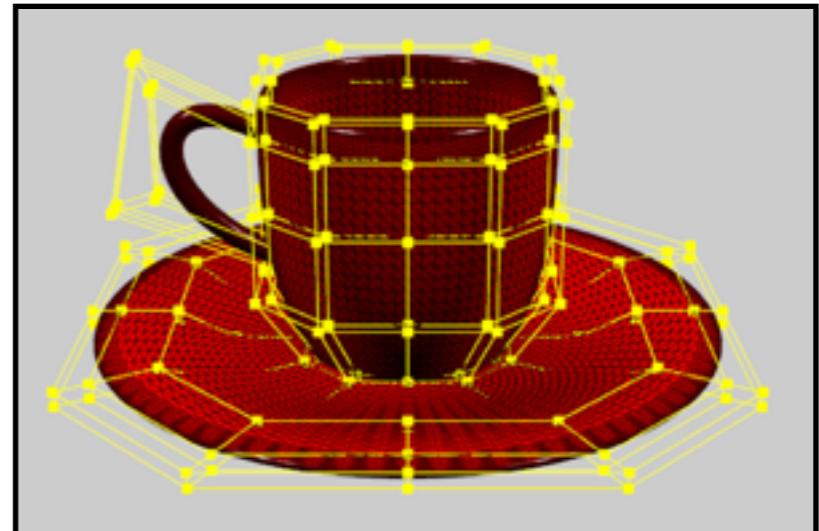
- transformations
- projections
- textures
- shadows
- shaders
- OpenGL



Course Content

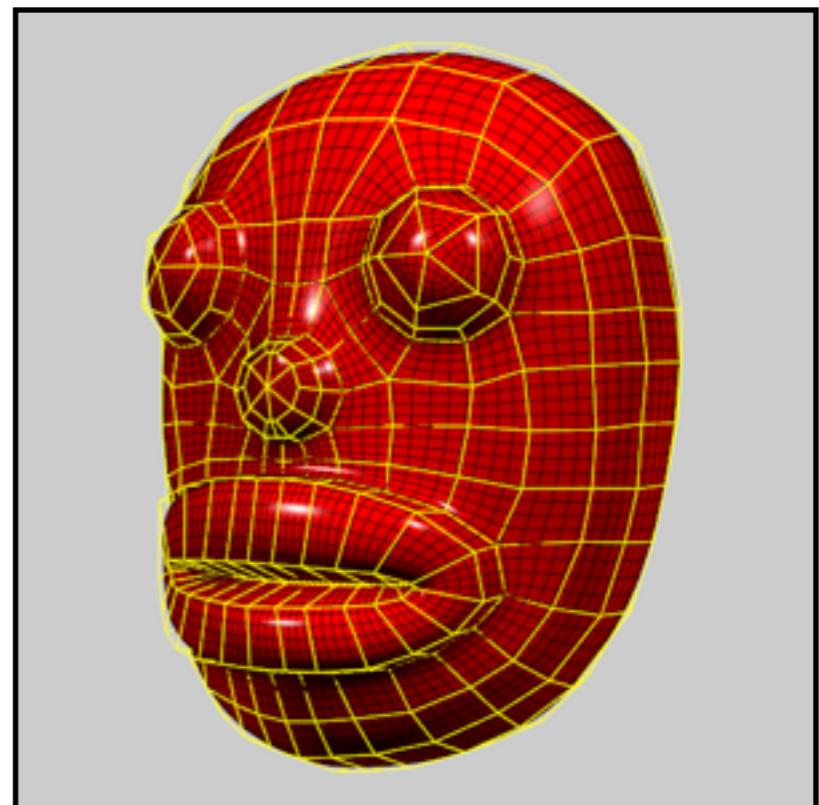
- **Geometry Representations**

- freeform curves & surfaces
- freeform deformation
- subdivision surfaces
- volume rendering



- **Computer Animation**

- skeleton-based animation
- face animation
- face rendering

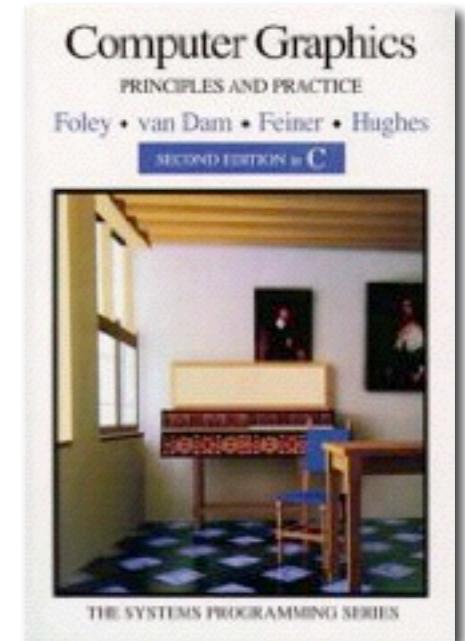


Tentative Schedule

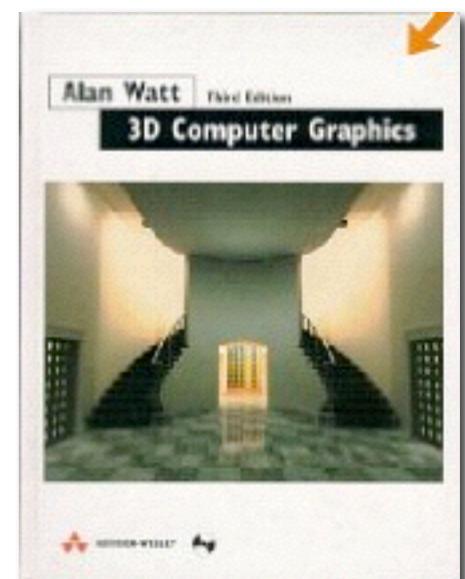
Week	Lecture (Tuesday)	Lecture (Thursday)	Exercise (Thursday)
43	Ray Intersections	Colors and Lighting	
44	Triangle Meshes	Acceleration Techniques	
45	Ray Tracing in C++	Efficient Ray Tracing in C++	
46	Rendering Equation	Path Tracing	Exercise 1: Ray Tracing
47	<i>no lecture</i>		
48	Transformations	Projections	
49	Rasterization	Visibility	Exercise 2: Rasterization Pipeline
50	OpenGL	Textures	
51	<i>no lecture</i>	Sampling and Antialiasing	
52	Shadows	<i>no lecture</i>	
53	<i>no lecture</i>		Exercise 3: OpenGL Solar System
1	<i>no lecture</i>	Advanced OpenGL	
2	Freeform Curves 1	Freeform Curves 2	
3	Freeform Surfaces	Subdivision	
4	Implicit Surfaces and CSG	Character Animation	Exercise 4: Bezier Surfaces and Subdivision
5	Face Animation	Face Rendering	
6	Visual FX Pipeline	Conclusion	Conclusion

Literature

- Foley, van Dam, Feiner, Hughes:
Computer Graphics: Principles and Practice, Addison-Wesley Longman, 1996.

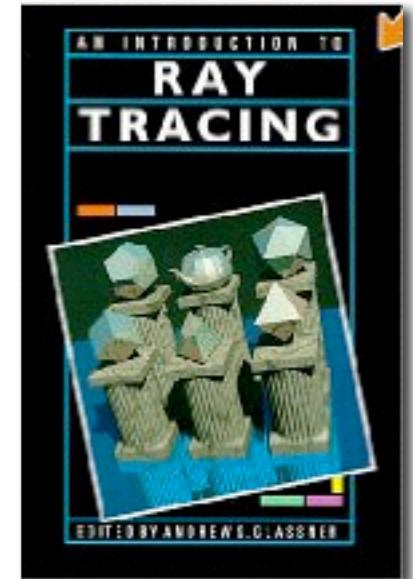


- Watt: ***3D Computer Graphics***, Addison-Wesley Longman, 1999.

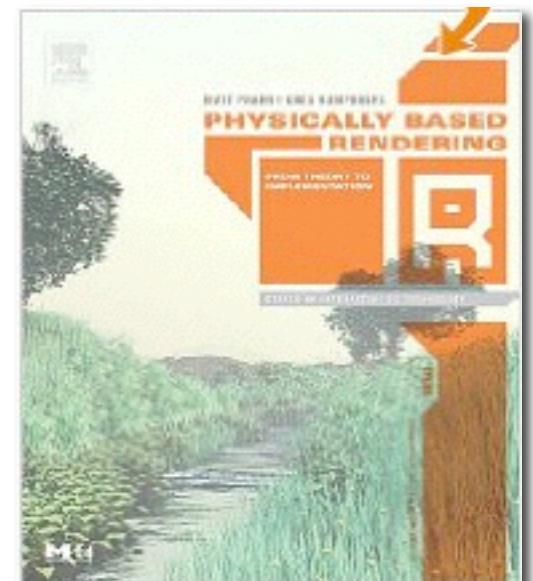


Literature

- Glassner: *An Introduction to Ray Tracing*, Academic Press, 1989.



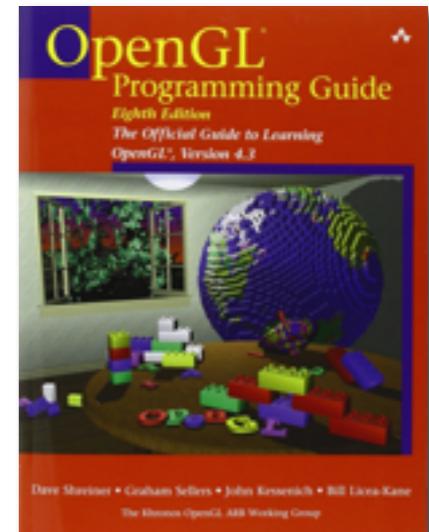
- Pharr, Humphreys: *Physically Based Rendering*, Morgan Kaufmann, 2004.



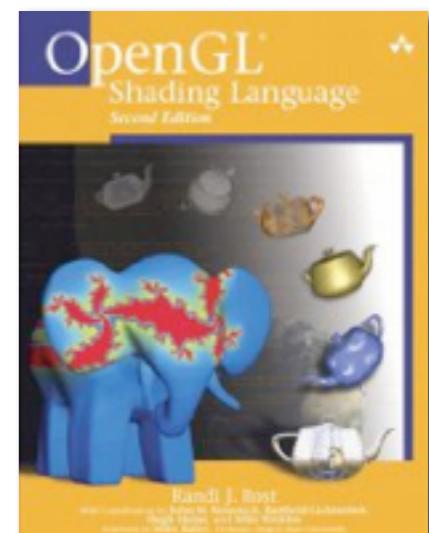
Literature

- Shreiner, Seller, Kessenich, Licea-Kane: ***OpenGL Programming Guide***, 8th edition, Addison-Wesley, 2013.

full of errors

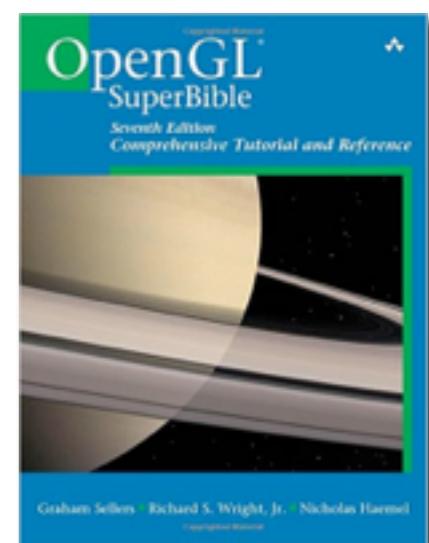


- Rost: ***OpenGL Shading Language***, 3rd edition, Addison-Wesley, 2009.



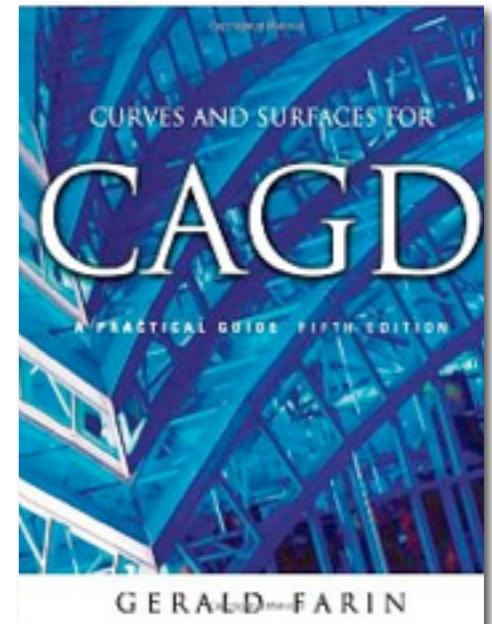
- Seller, Wright, Haemel: ***OpenGL SuperBible***, 7th edition, Addison-Wesley, 2015

no math



Literature

- Farin: ***Curves and Surfaces for CAGD. A Practical Guide***, Morgan Kaufmann, 2001



Acknowledgements

Thanks to these colleagues for
discussions and slides!



Leif Kobbelt
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ETH Zurich



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EPFL