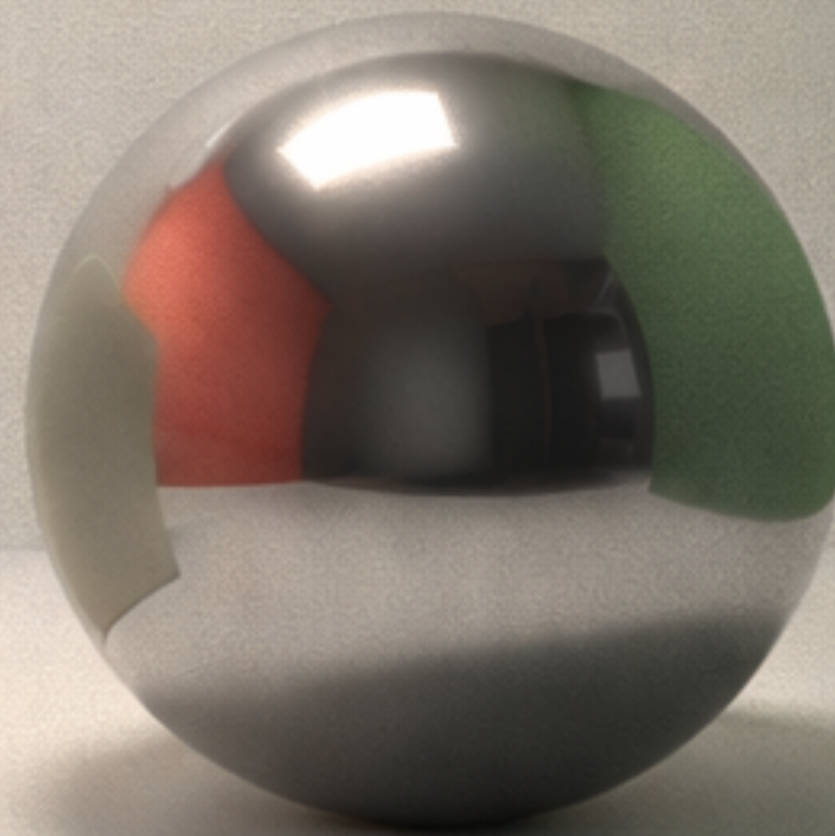
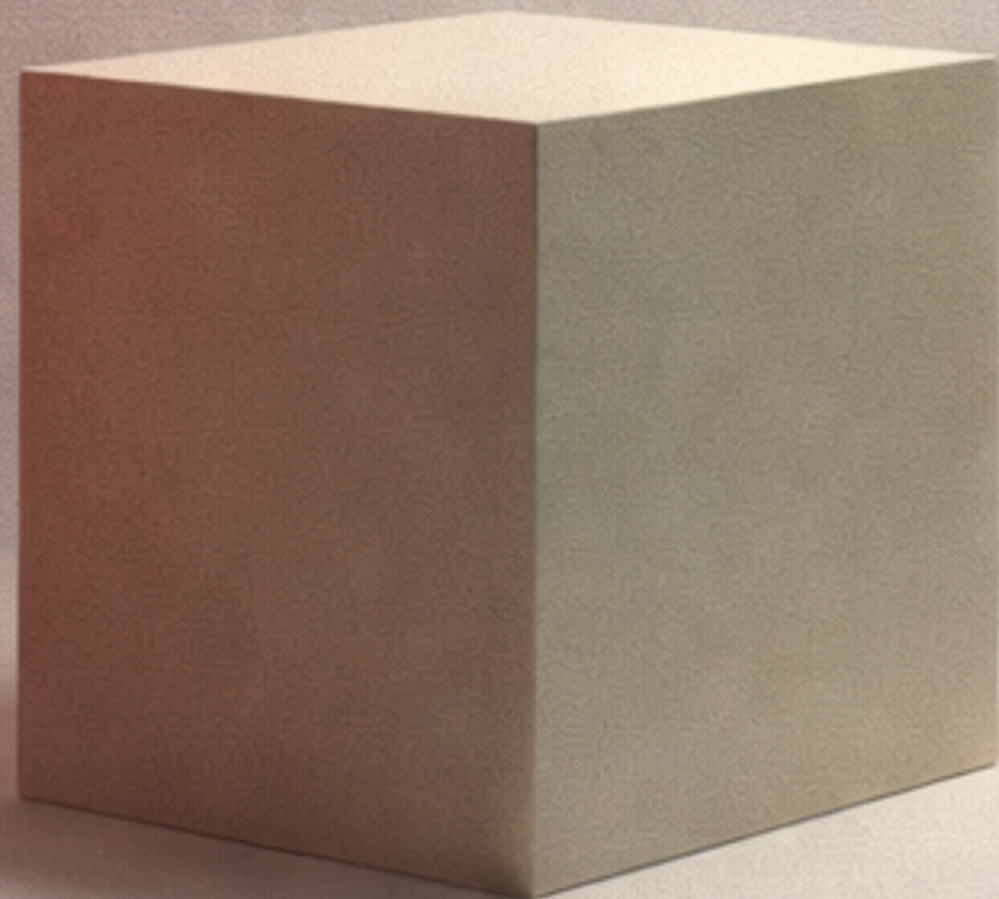


Computer

Graphics

COL781 / COL7681



Course Administration

- Instructor: Subodh Kumar, subodh@cse.iitd.ac.in, (Bharti 429)
- Website: www.cse.iitd.ac.in/~subodh/courses/COL781
- Assignments to be submitted on moodlenew
- Course discussion on MS Teams (2502-COL781)

Evaluation

- Assignments: 38% (including viva)
- Minor: 26%
- Major: 26%
- Quizzes: 10%
- 10+ in practical and 15+ in theory required for D
 - In addition, total of 40 marks required of NP

Assignments

1. Ray and Path tracing with lighting (8 marks) DUE JAN 26
2. Rasterization and Sampling (8 marks) DUE FEB 16
3. Shading with Texture (8 marks) DUE MAR 16
4. Game/VR application (14 marks) DUE MAY 6 (with additional milestones)

Assignment policies

This is a very programming-heavy course!

All assignments are to be done in C/C++

(Groups of two for the project)

Plagiarism policy: Similar codes will result in all receiving negative of the assignment.

Late policy: 5 free late days over whole semester, then 1.5 mark penalty per extra late day

No late submission for the project

Textbooks

No required text, but the following are highly recommended for reference:

- Hughes et al., *Computer Graphics: Principles and Practice*, 3rd Ed.
- Marschner and Shirley, *Fundamentals of Computer Graphics*, 4th or 5th Ed.

Other useful online references will be linked on the course webpage

What is computer graphics?

Novel Image Generation

Entertainment



(Many slides borrowed from Rahul Narain)

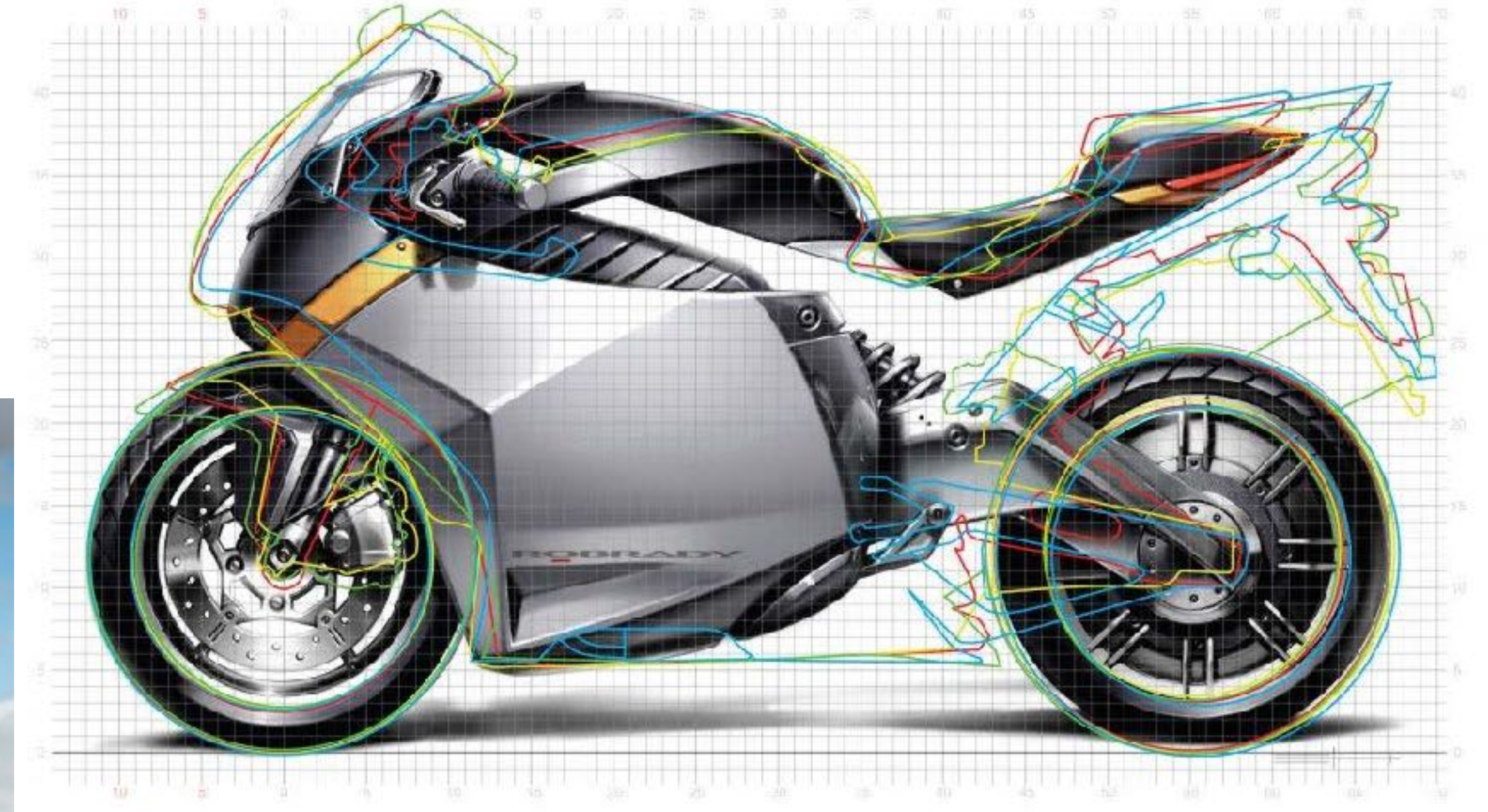
Art, design, architecture



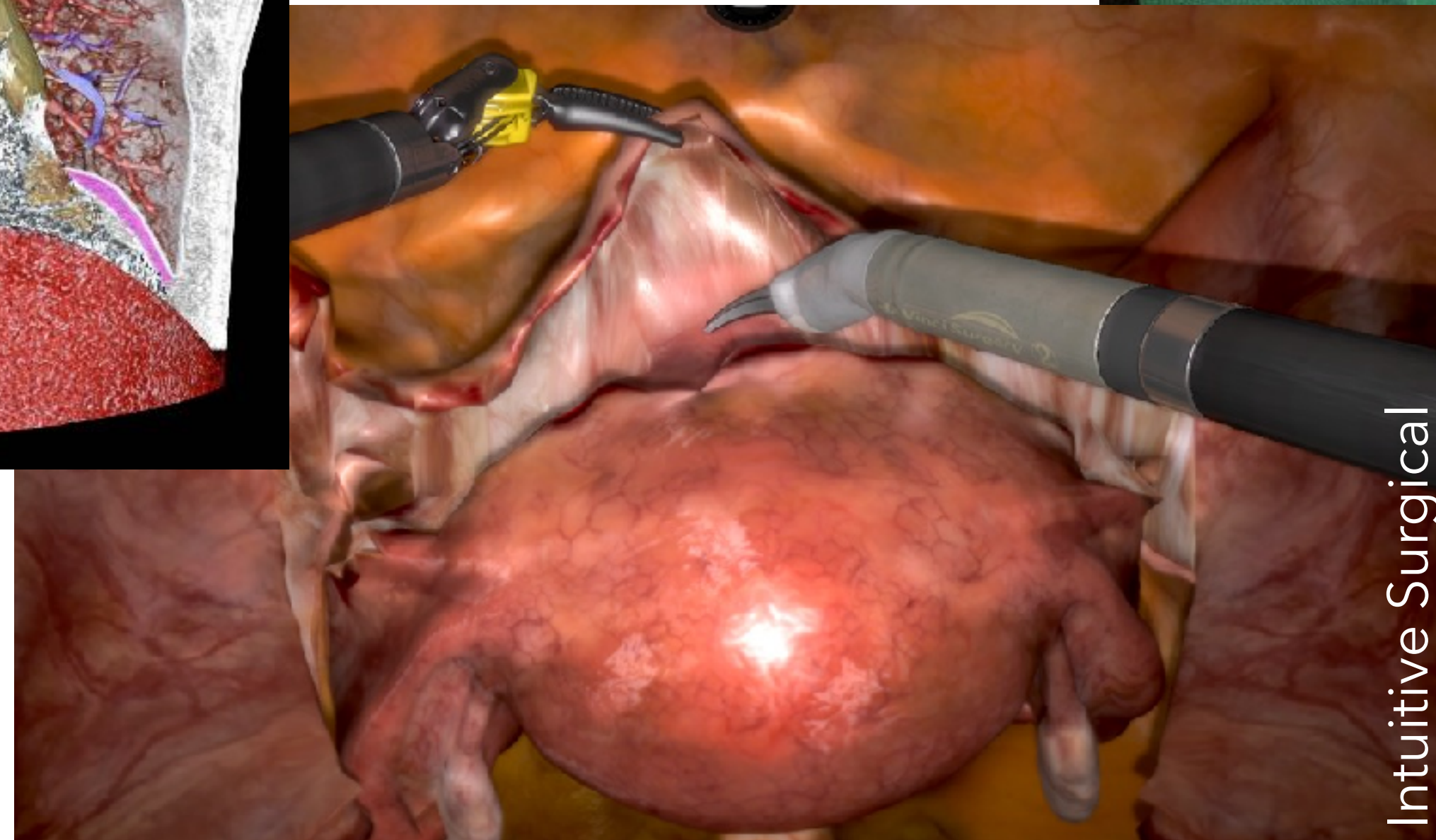
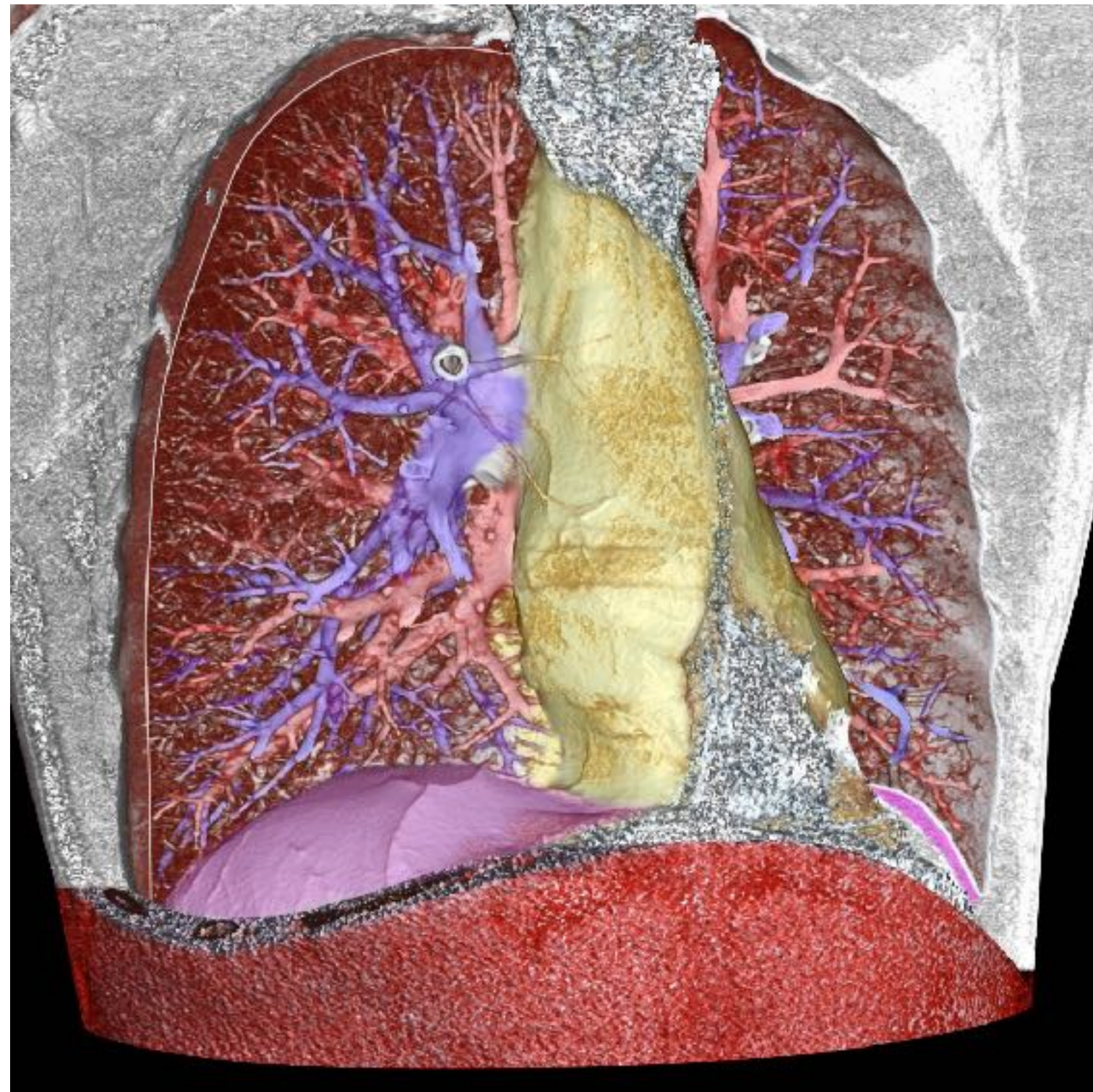
Bathsheba Grossman



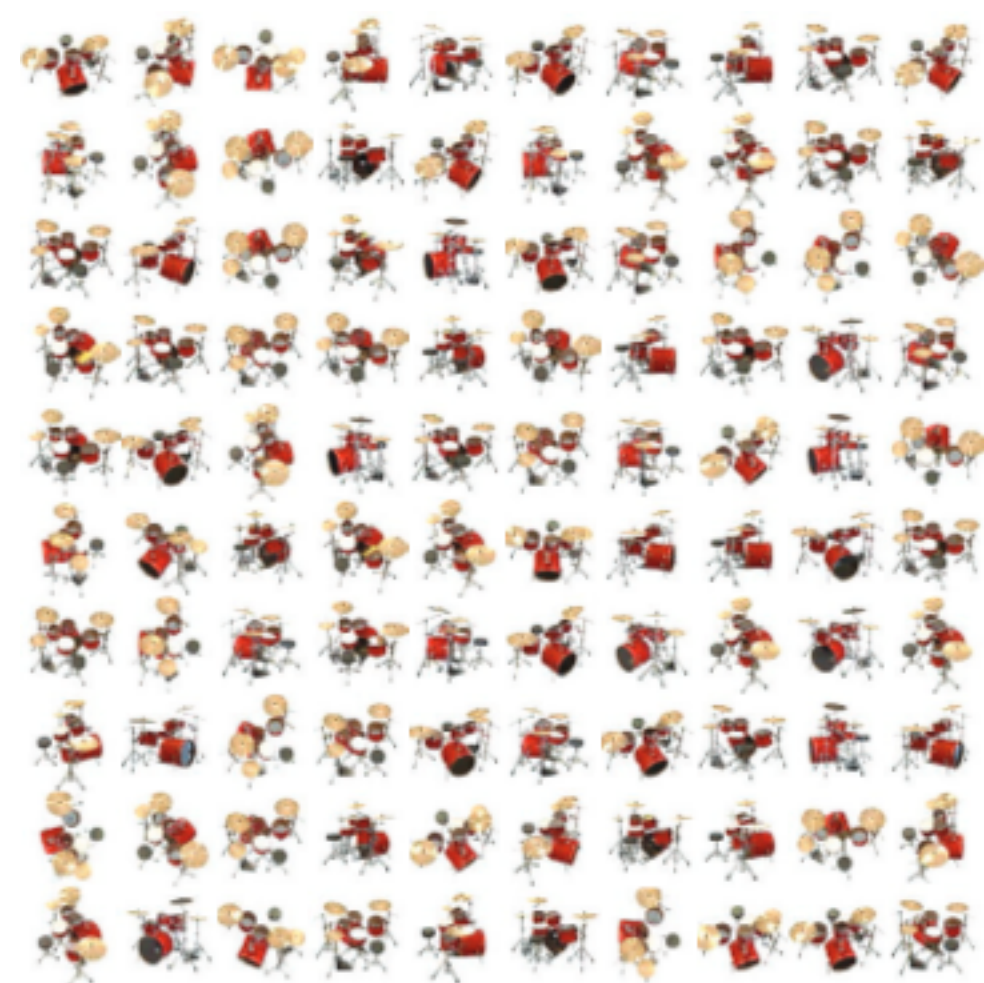
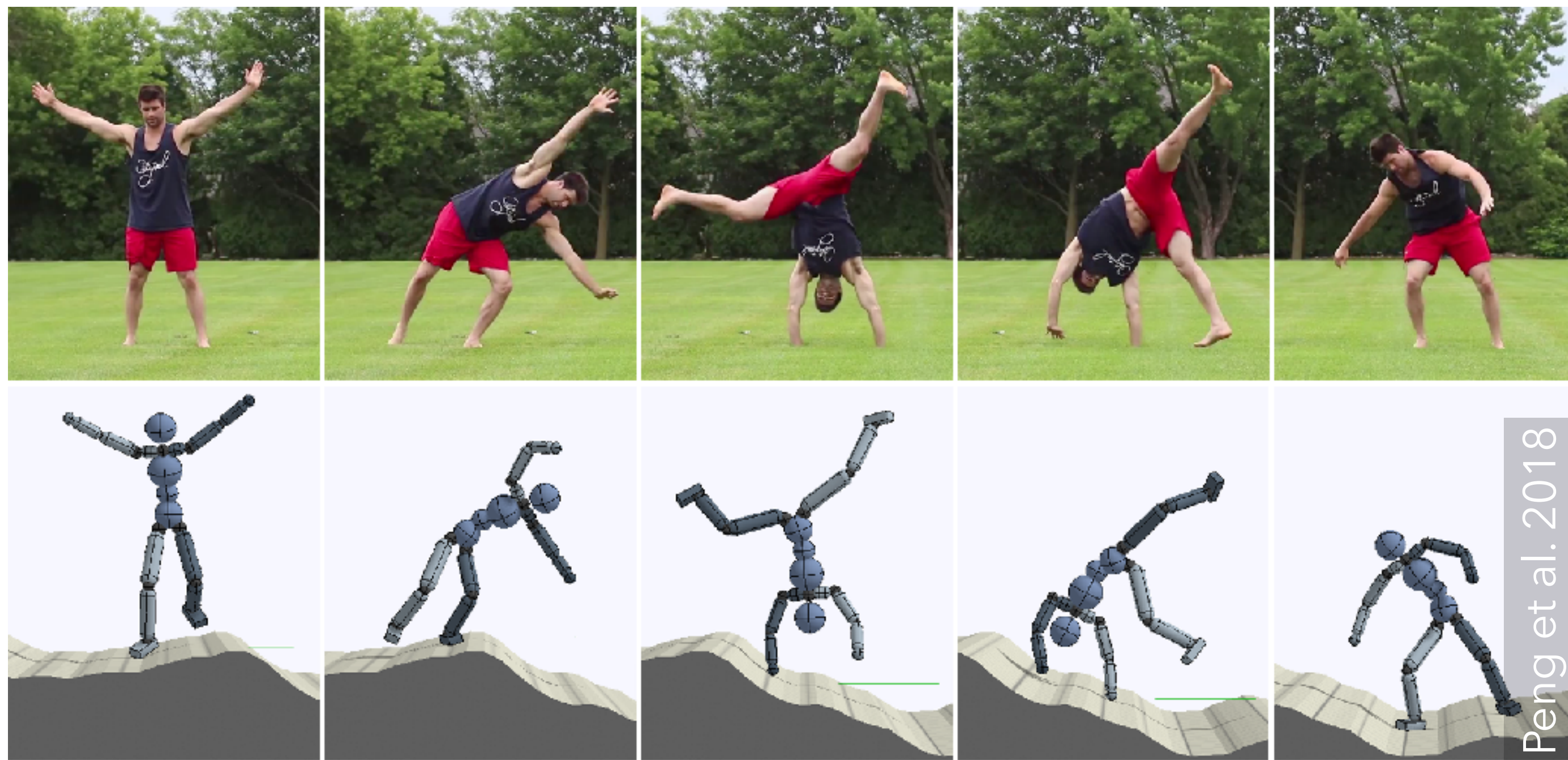
Sage Gateshead



Scientific visualization and training



Inverse graphics



Mildenhall et al. 2020

Virtual and augmented reality



Oculus Quest 2

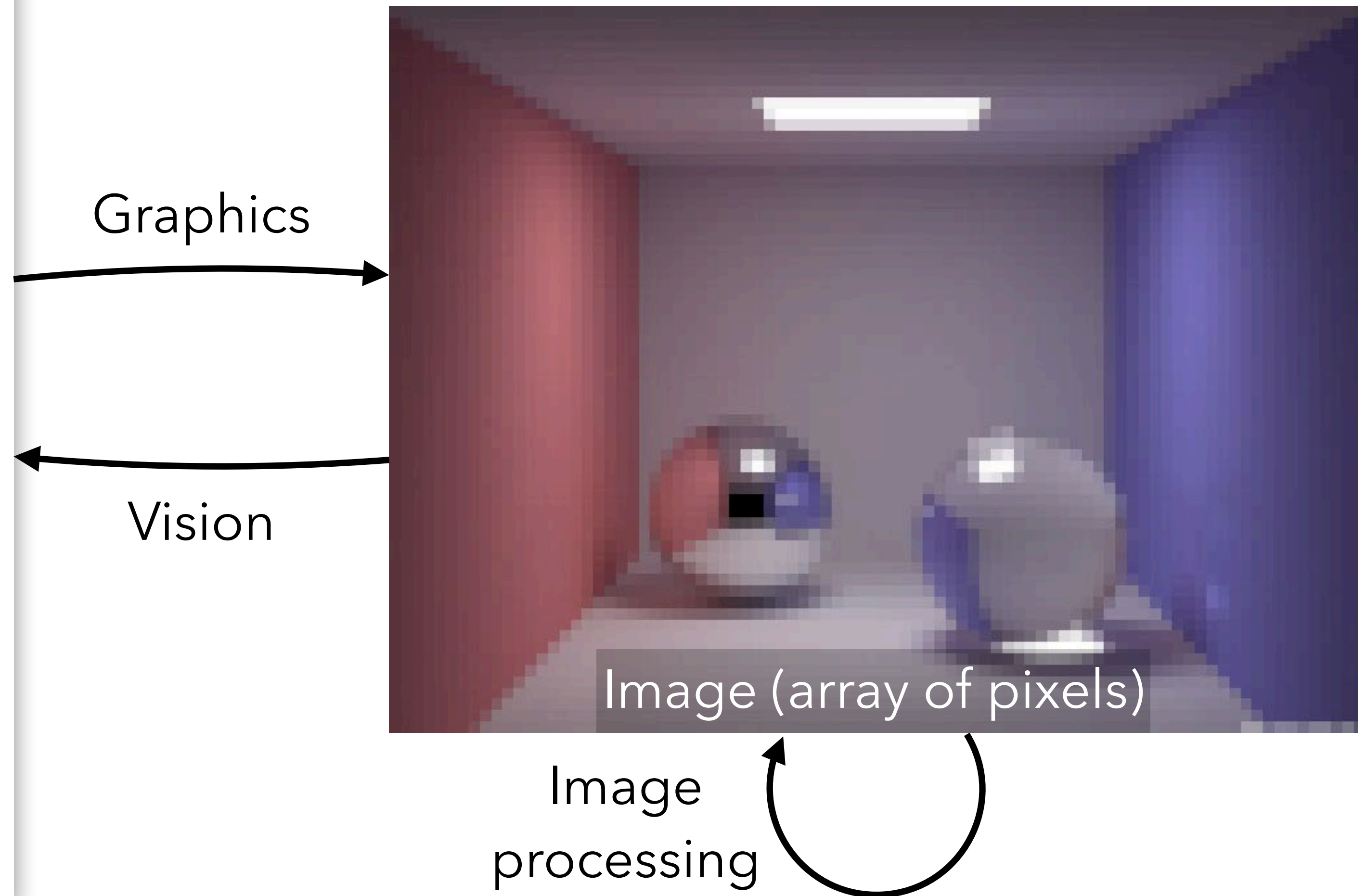


Microsoft HoloLens concept art



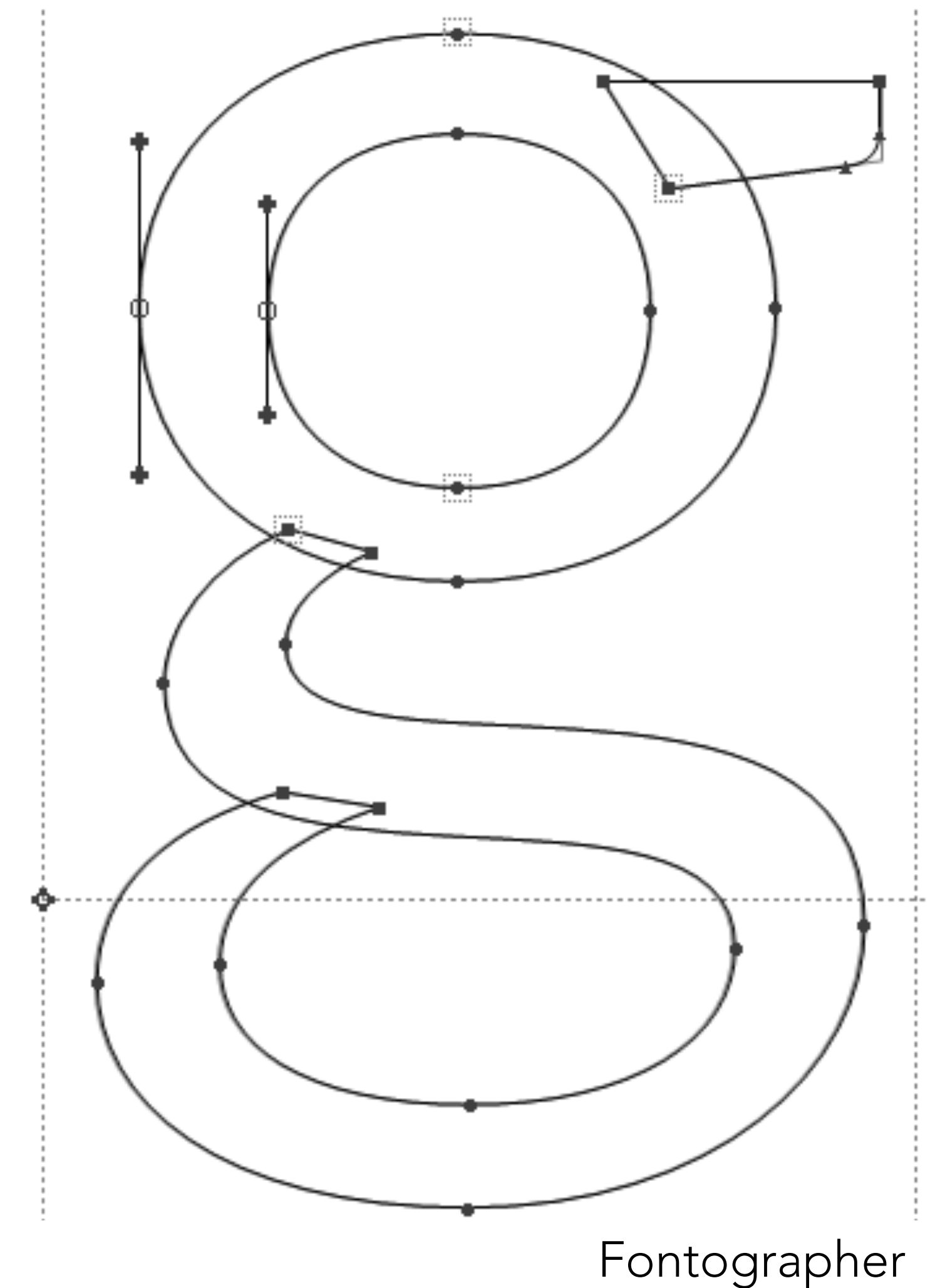
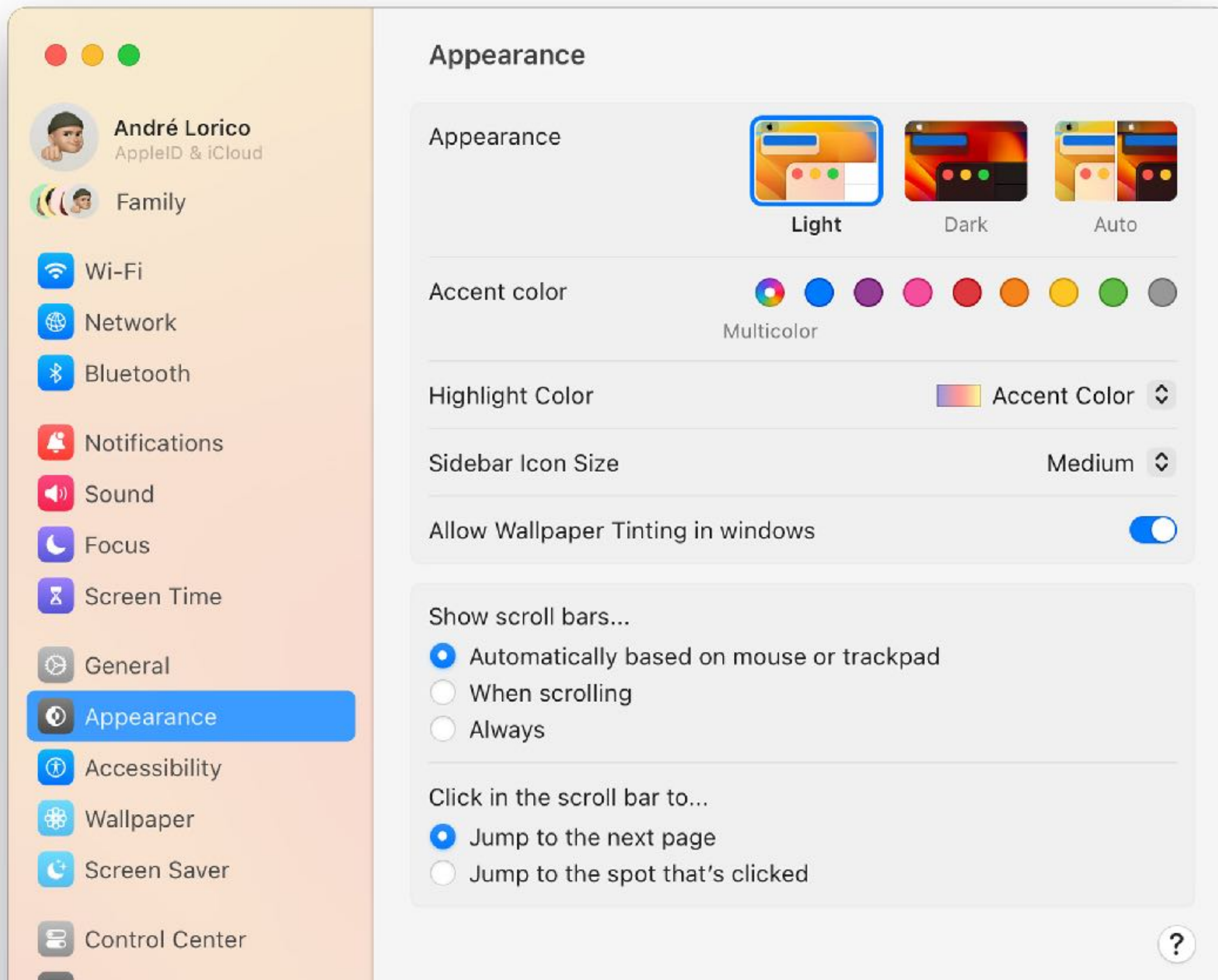
Graphics and other areas

light:
 shape: box [-0.5,0.5] ...
 intensity: 10
sphere:
 center: (-0.5,0.5,-0.5)
 radius: 0.5
 material: mirror
sphere:
 center: (0.5,0.5,0.5)
 radius: 0.5
 material: glass
wall:
 x: -1
 colour: rgb(0.8,0.2,0.2)
...

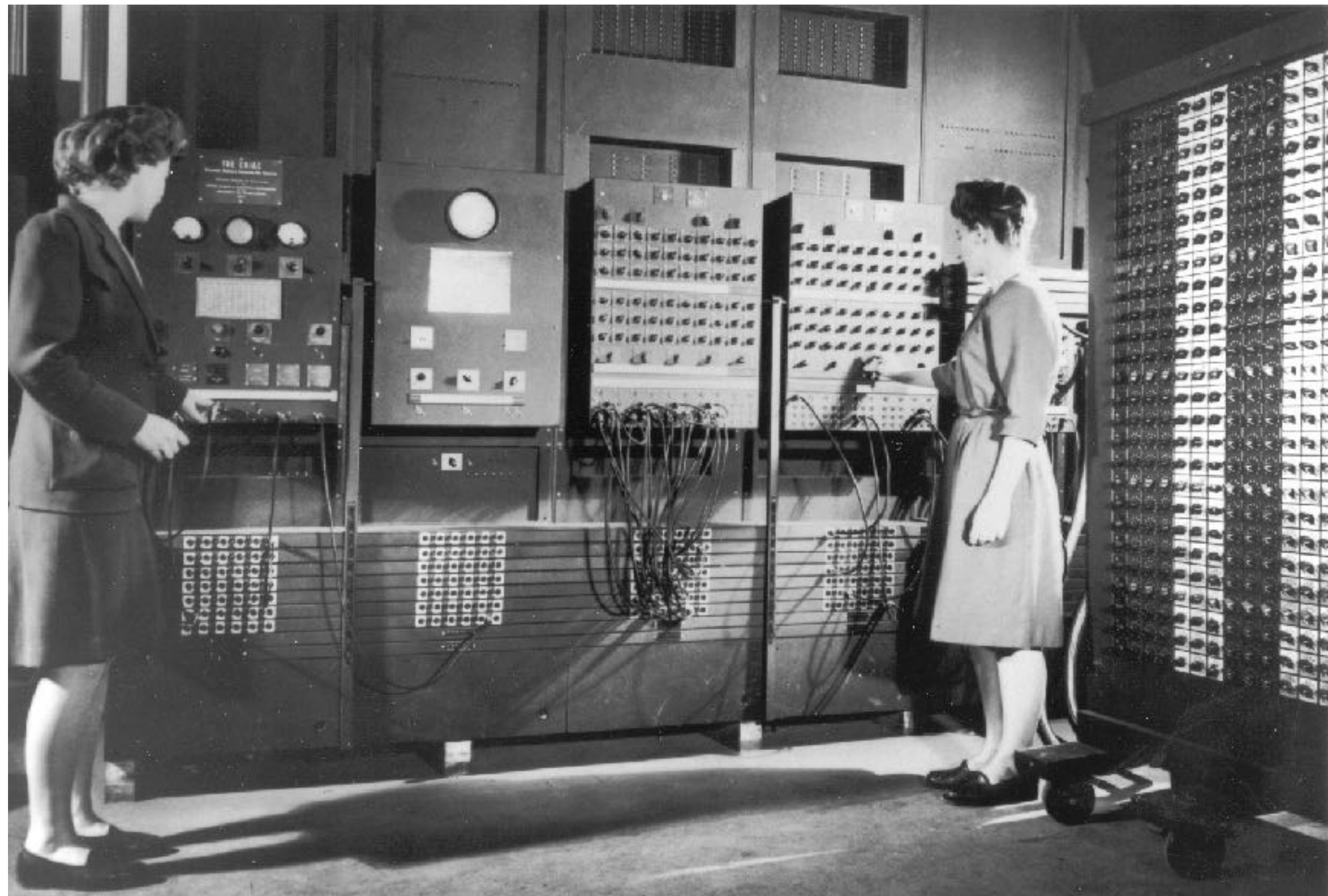


Computer graphics is **omnipresent** in how all of us interact with computers today!

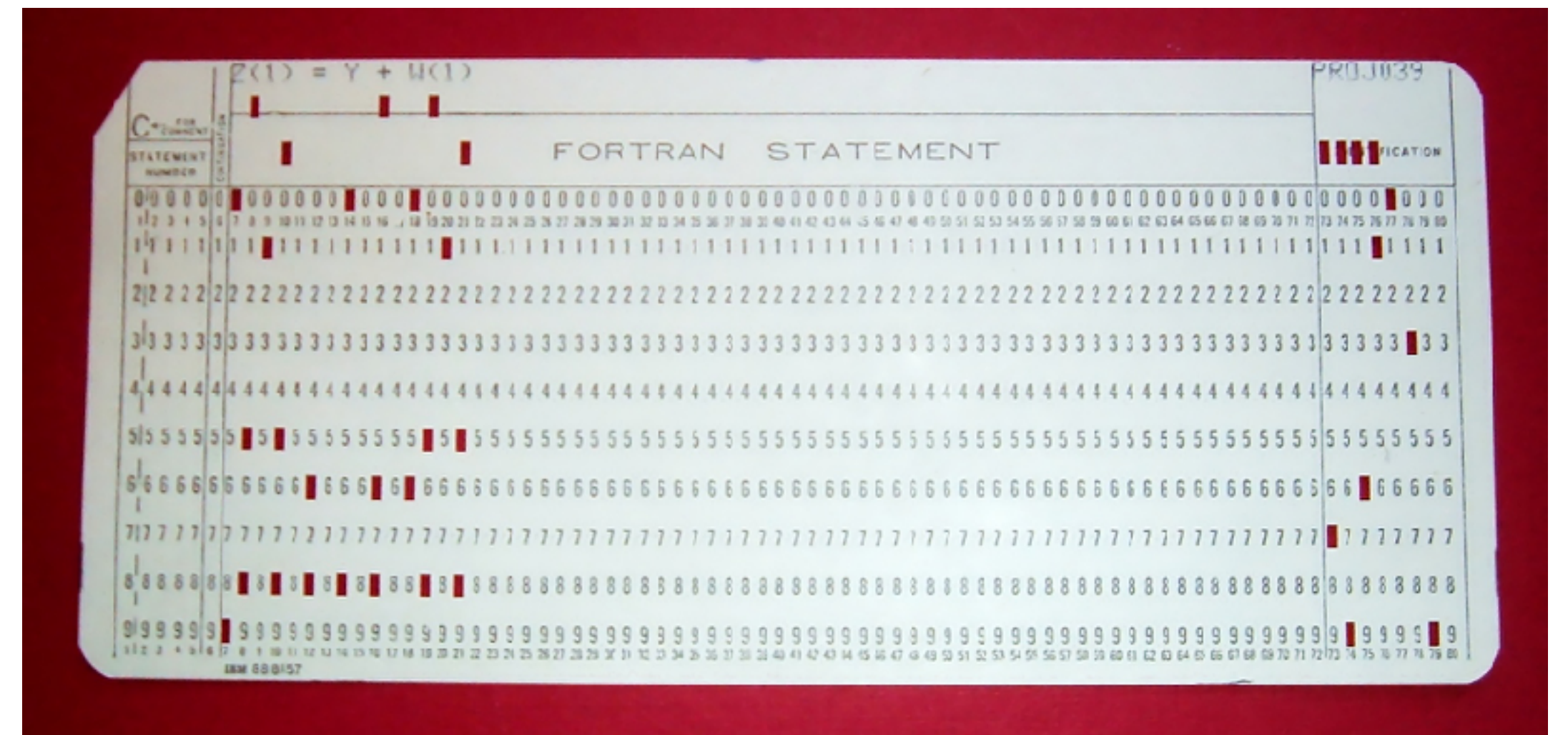
Graphical user interfaces, typography



Computing without graphics



ENIAC (1945)



Punched card from a
Fortran program

Computing without graphics

```
[root@localhost ~]# ping -q fa.wikipedia.org
PING text.pmtpa.wikimedia.org (208.80.152.2) 56(84) bytes of data.
^C
--- text.pmtpa.wikimedia.org ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.585/0.526/0.411/0.280 ms
[root@localhost ~]# pwd
/root
[root@localhost ~]# cd /var
[root@localhost var]# ls -la
total 72
drwxr-xr-x. 18 root root 4096 Jul 30 22:43 .
drwxr-xr-x. 23 root root 4096 Sep 14 20:42 ..
drwxr-xr-x.  2 root root 4096 May 14 00:15 account
drwxr-xr-x. 11 root root 4096 Jul 31 22:26 cache
drwxr-xr-x.  3 root root 4096 May 18 16:03 db
drwxr-xr-x.  3 root root 4096 May 18 16:03 empty
drwxr-xr-x.  2 root root 4096 May 18 16:03 games
drwxrwx--T.  2 root gdm  4096 Jun  2 18:39 gdm
drwxr-xr-x. 38 root root 4096 May 18 16:03 lib
drwxr-xr-x.  2 root root 4096 May 18 16:03 local
lrwxrwxrwx.  1 root root    11 May 14 00:12 lock -> ../run/lock
drwxr-xr-x. 14 root root 4096 Sep 14 20:42 log
lrwxrwxrwx.  1 root root    10 Jul 30 22:43 mail -> spool/mail
drwxr-xr-x.  2 root root 4096 May 18 16:03 nis
drwxr-xr-x.  2 root root 4096 May 18 16:03 opt
drwxr-xr-x.  2 root root 4096 May 18 16:03 preserve
drwxr-xr-x.  2 root root 4096 Jul  1 22:11 report
lrwxrwxrwx.  1 root root     6 May 14 00:12 run -> ../run
drwxr-xr-x. 14 root root 4096 May 18 16:03 spool
drwxrwxrwt.  4 root root 4096 Sep 12 23:50 tmp
drwxr-xr-x.  2 root root 4096 May 18 16:03 yp
[root@localhost var]# yum search wiki
Loaded plugins: langpacks, presto, refresh-packagekit, remove-with-leaves
rpmfusion-free-updates | 2.7 kB | 00:00
rpmfusion-free-updates/primary_db | 206 kB | 00:04
rpmfusion-nonfree-updates | 2.7 kB | 00:00
updates/metalink | 5.9 kB | 00:00
updates | 4.7 kB | 00:00
updates/primary_db 73% [=====] 62 kB/s | 2.6 MB | 00:15 ETA
```

What this course is about

Scientific and mathematical foundations of graphics

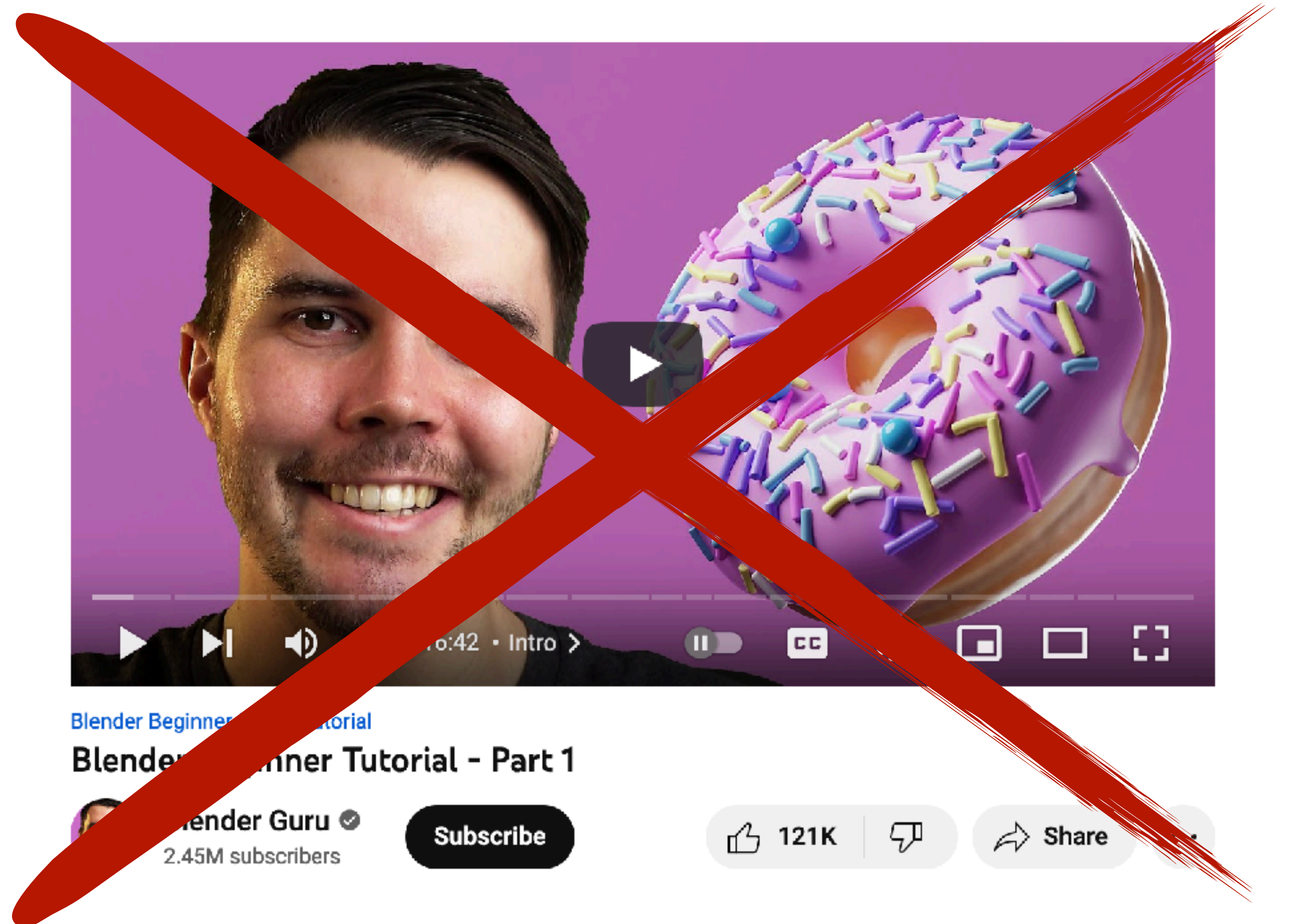
- Physics of light and colour, materials, dynamics for animation, ...
- Mathematics of curves and surfaces, perspective projection, sampling, ...

Representations, algorithms, and systems

- Modelling geometry, images, transformations, ...
- Mesh subdivision, ray tracing, time integration, ...
- GPUs, hardware rendering pipeline, ...

What this course is *not* about

- How to use 3D software
- How to be a graphics artist
- How to make a game



Course content



Modelling

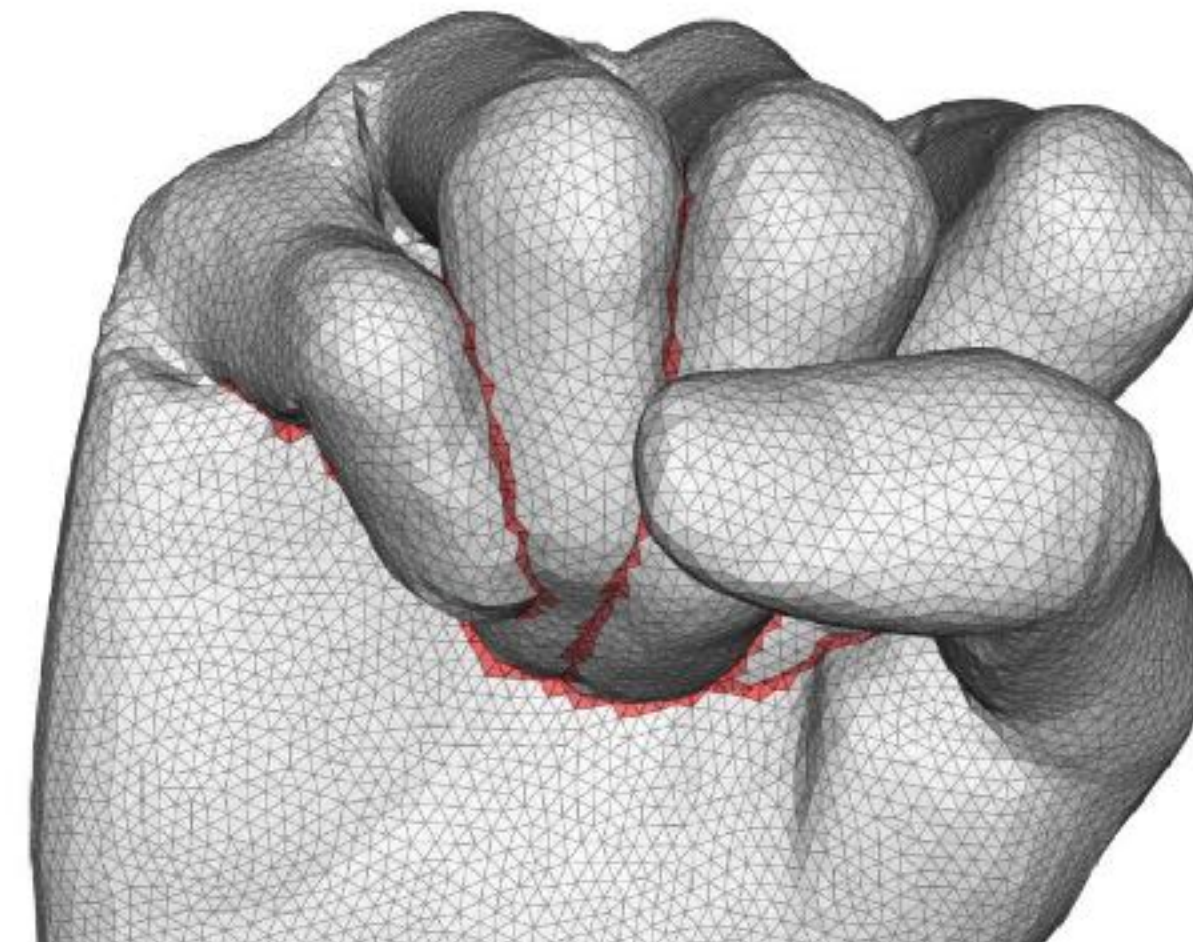
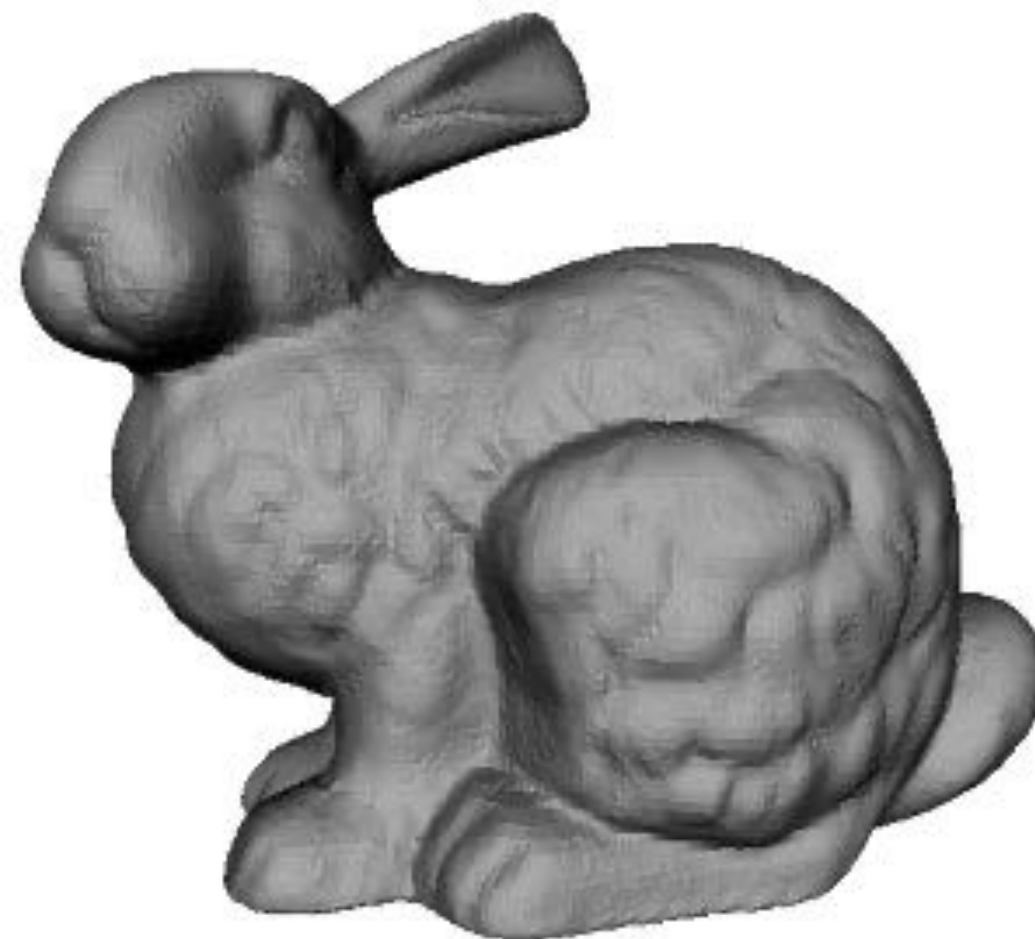
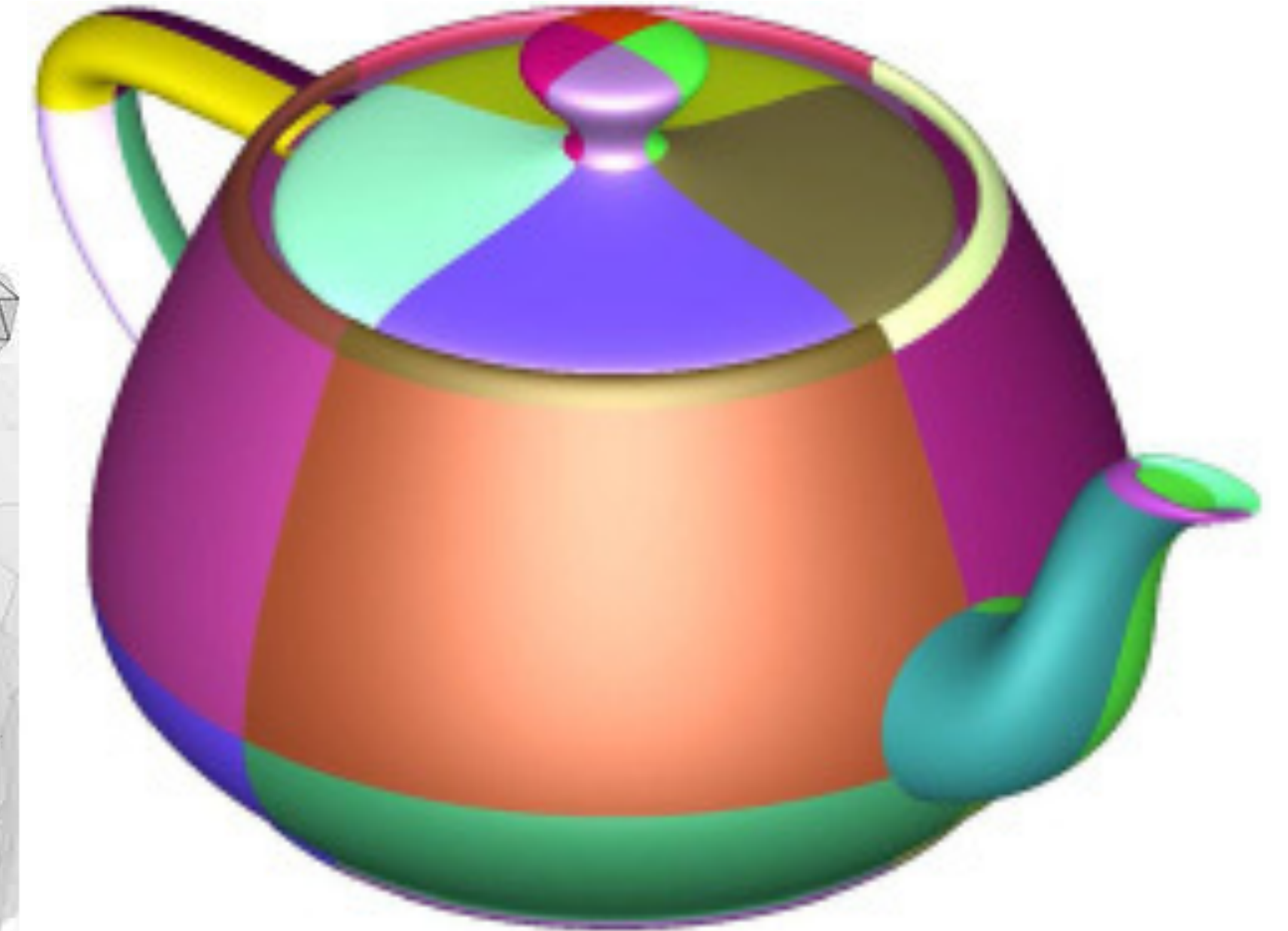
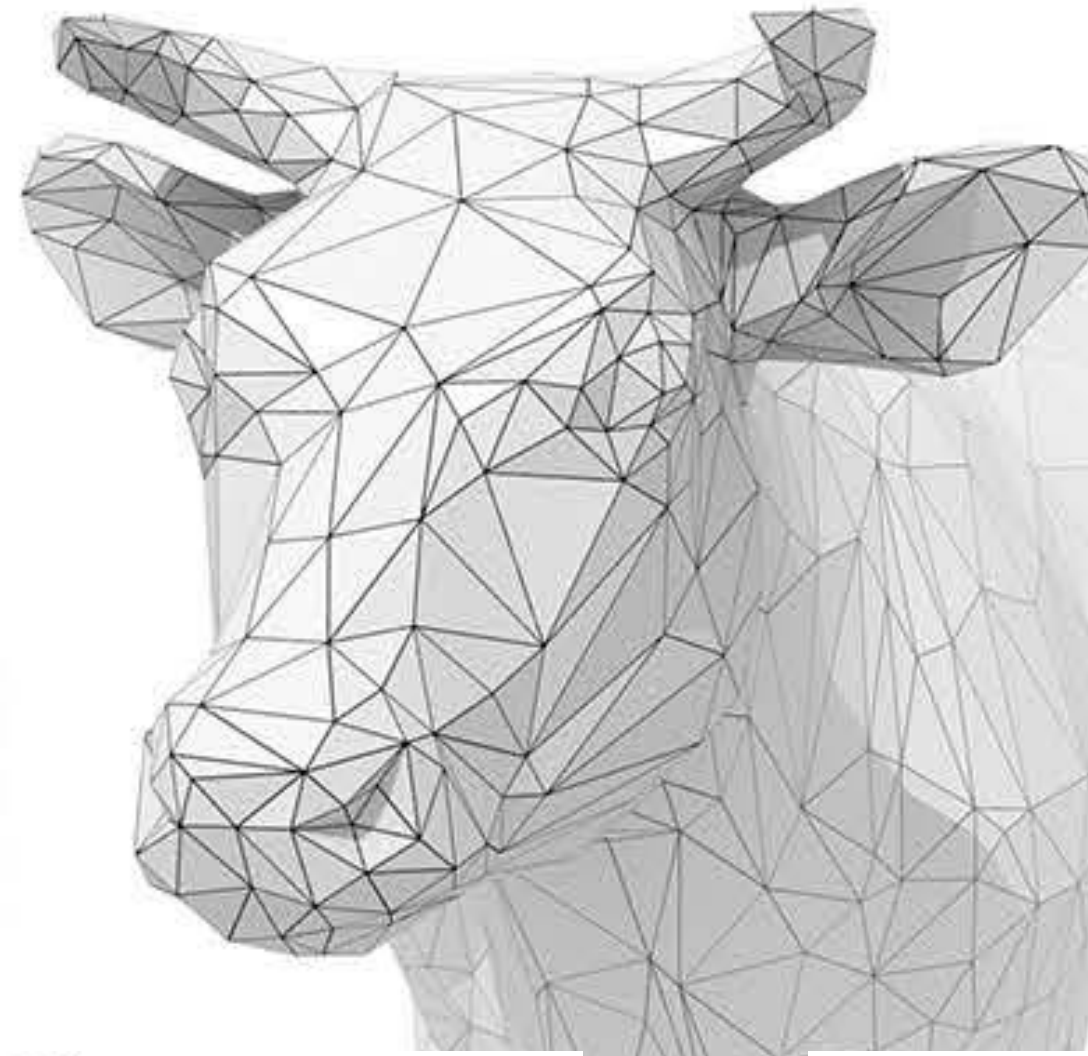
Rendering

*Physically Based
Rendering book cover*

Modelling the World as 'Data'

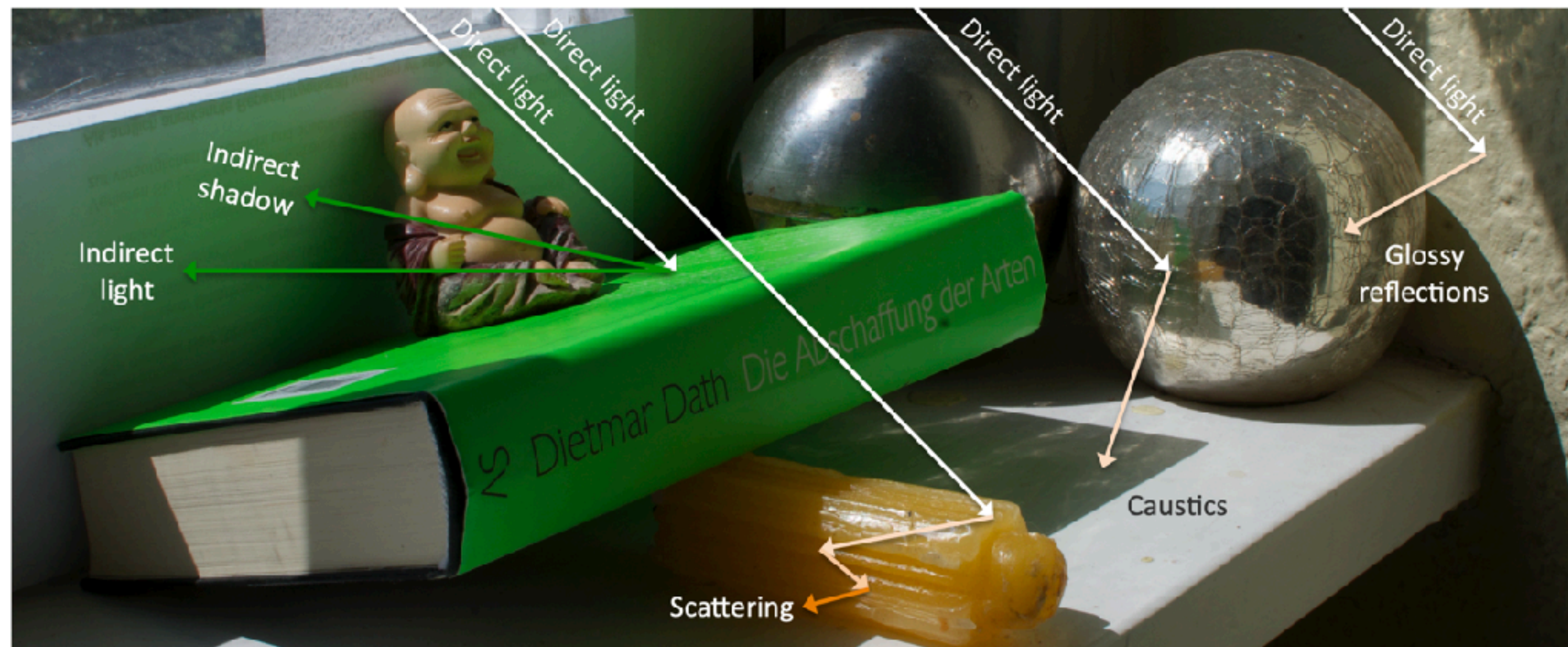
How to work with geometry?

- Representation
- Manipulation and editing
- Geometric properties



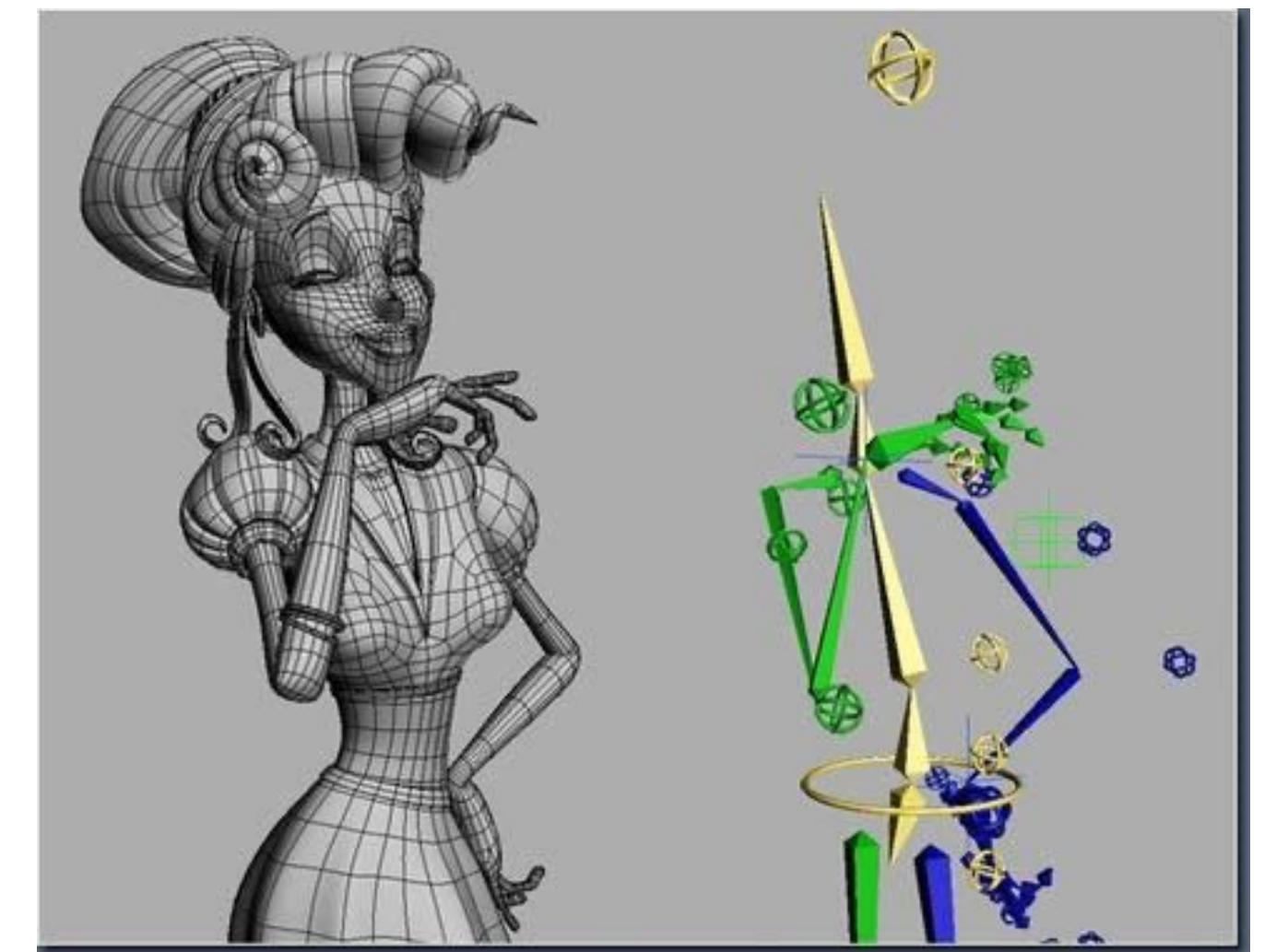
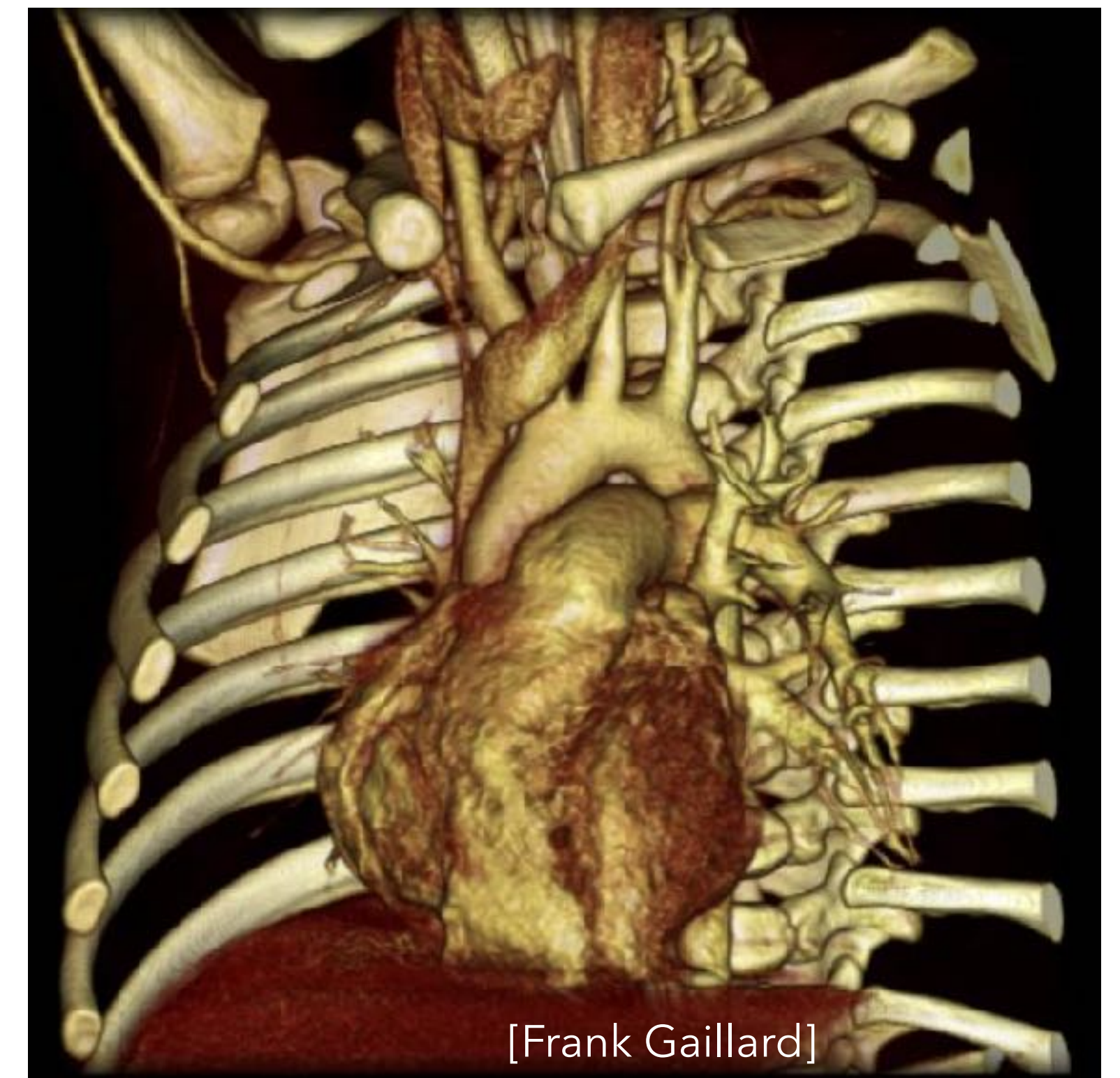
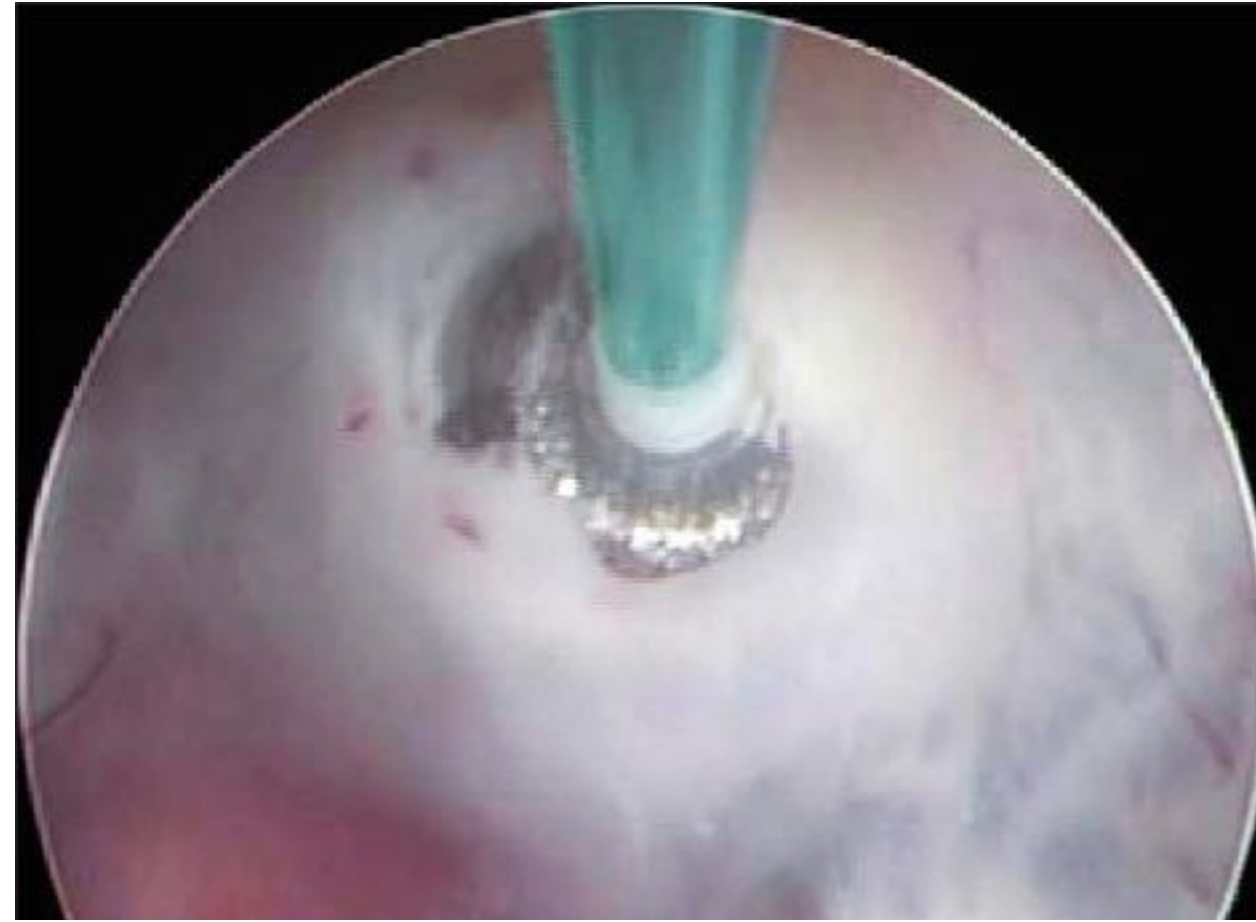
Rendering the Data

- Quantifying light and materials
- Computing light transport in a scene
- Real-time approximations and Textures



Applications

- Virtual reality
- Stereo rendering
- 2D and 3D interfaces
- Volumetric models and rendering
- Animation



Course content



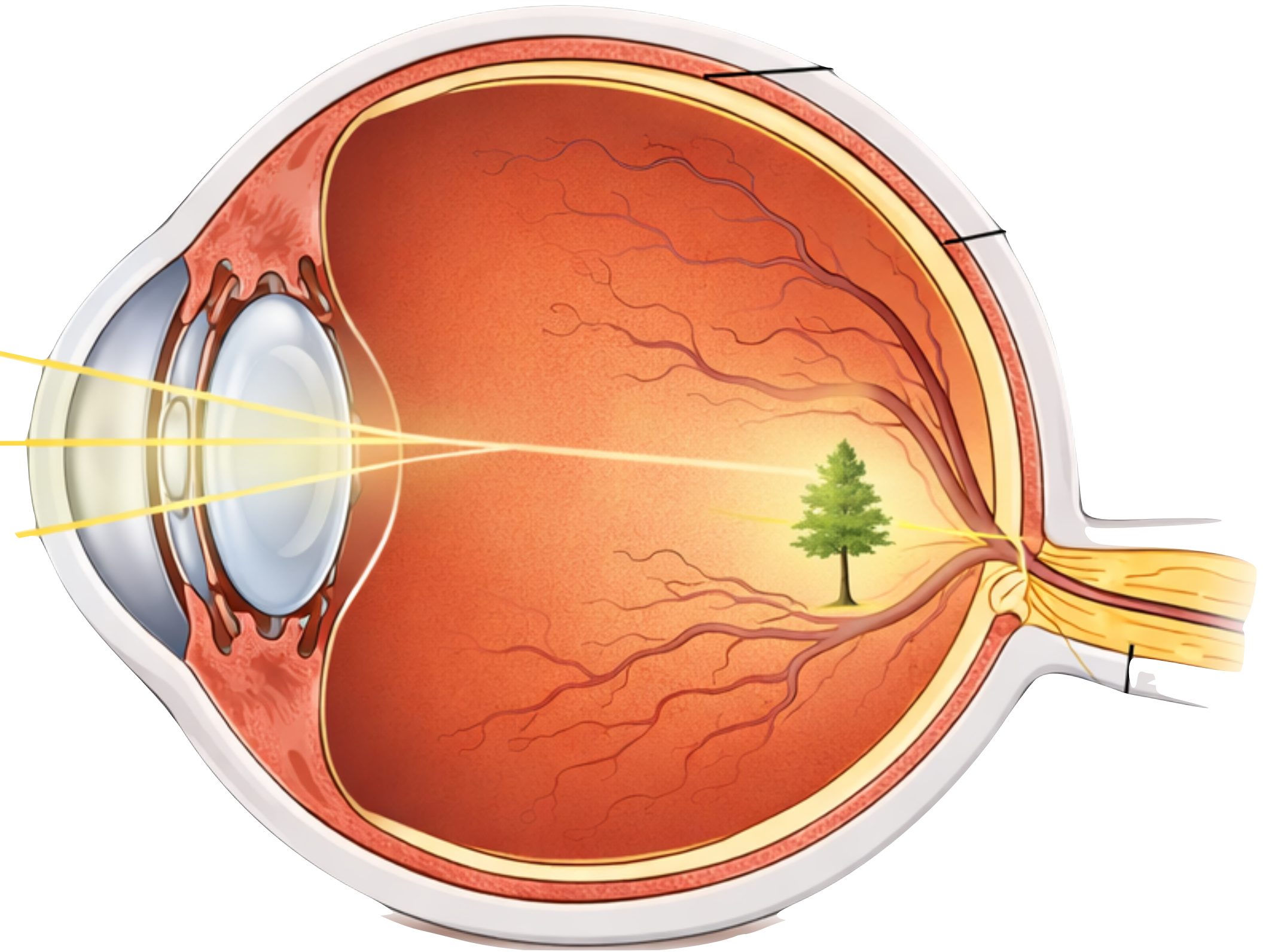
Modelling

Rendering

Light and Illumination
Ray and path tracing
Camera and Views
Geometry and Transformations
Image as samples
Textures
Simulation of Illumination
Interaction
OpenGL-based rendering
Shaders
Volumetric graphics
Model editing and motion
AI generated graphics



What is an Image?



What you see!