

# CSE 457: Computer Graphics

Offered: Spring 2020

Instructor: Adriana Schulz

Objectives:

- Broad introduction to the field of computer graphics
- Combination of
  - underlying theoretical principles
  - technical implementation
  - artistic expression
- Many demonstrations of concepts in class

# **Great Group of TAs**

# Plan for Today

- **Zoom Test**
- What is Computer Graphics?
- Plan for Lecture Topics
- Administrative Things
- Projects and Homework

# Zoom Test

- Can you hear me well (Yes/No)
- How many seniors? (Say Yes)
- How many juniors? (Say Yes)
- Other? (Say Yes)
- Previous experience with Graphics?
  - raise hands to speak or type on chat

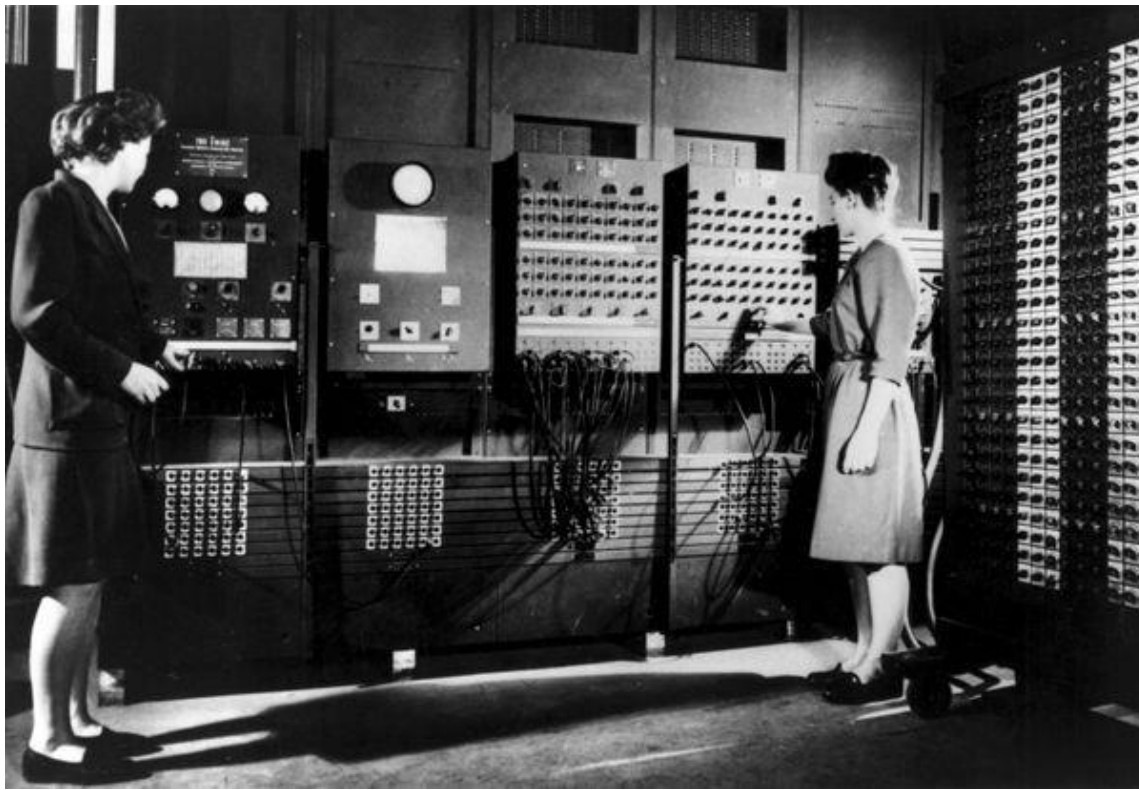
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- **What is Computer Graphics?**
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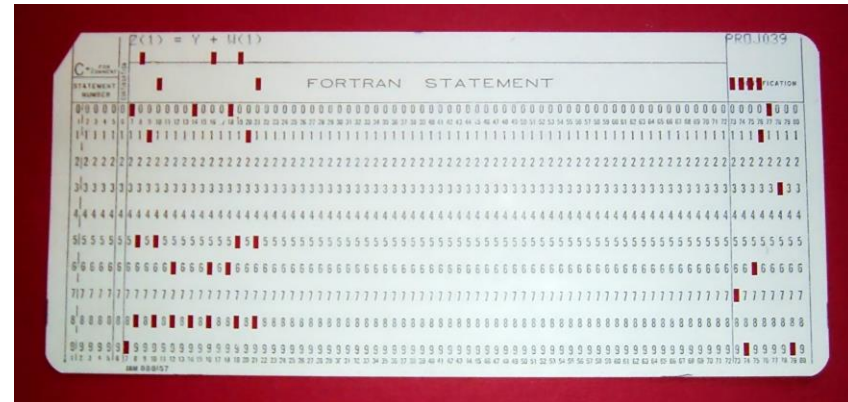
**Probably an image like this  
comes to mind:**



Q: ...ok, but more  
fundamentally: what is  
computer graphics (and  
why do we need it)?

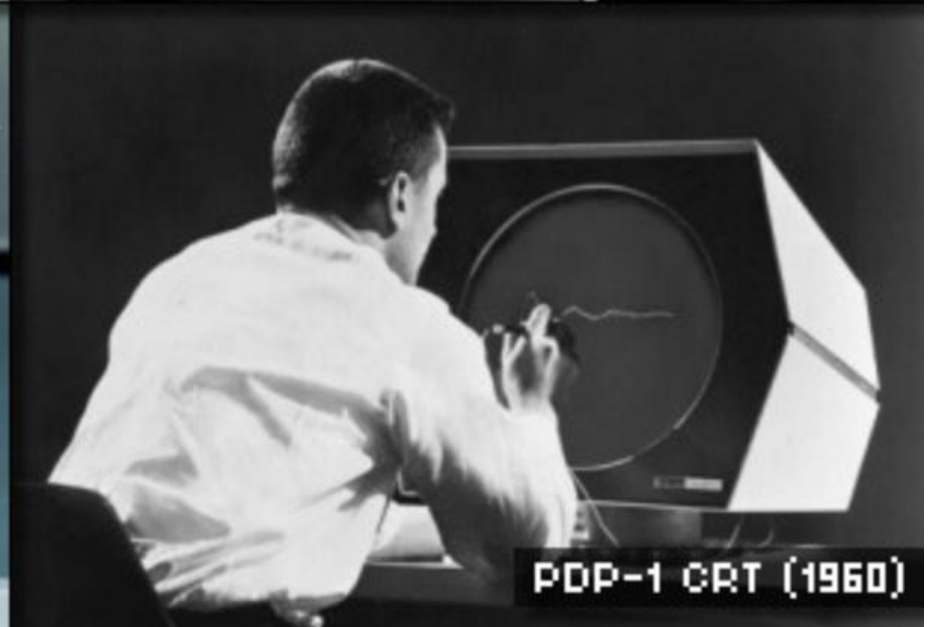


Early computer (ENIAC), 1945



punch card (~120 bytes)

There must be a better  
way!



# Sketchpad (Ivan Sutherland, 1963)



MACINTOSH (1984)



APPLECOLOR HIGH-RESOLUTION RGB  
AND MACINTOSH II (1987)



2018: Dell 8k monitor  
7680x4320 (~95MB)

# Coming down the pipe...

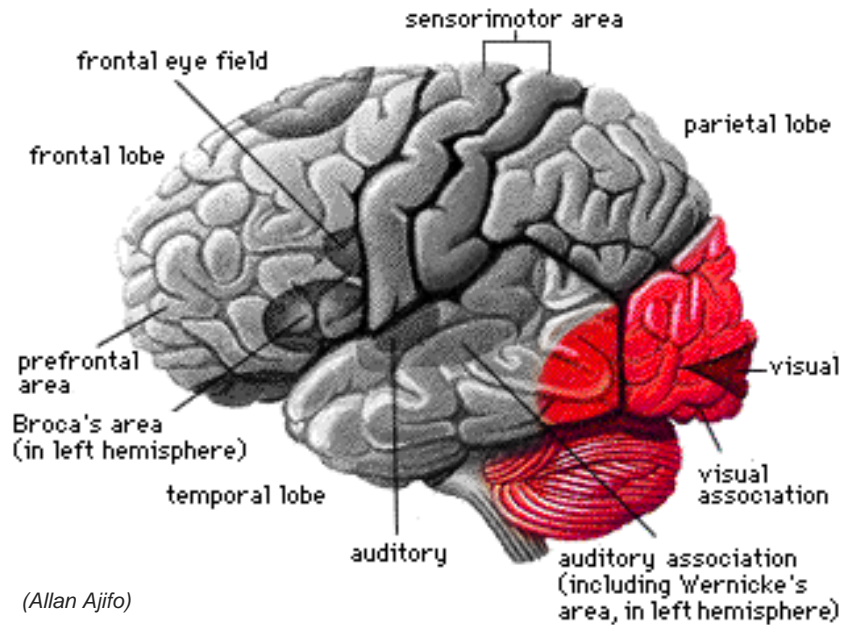


2018 Google/LG display: 2x 4800x3480 @ 120Hz => 11.2GB/s



# Why visual information?

About 30% of brain dedicated to visual processing...



...eyes are highest-bandwidth port into the head!

# What is computer graphics?

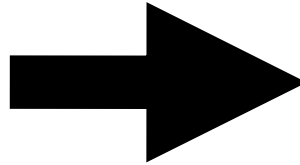
com•put•er      graph•ics      /kəm'pyoʊdər 'ɡrafiks/ *n.*

The use of computers to synthesize visual information.



digital  
information

computation



visual  
information



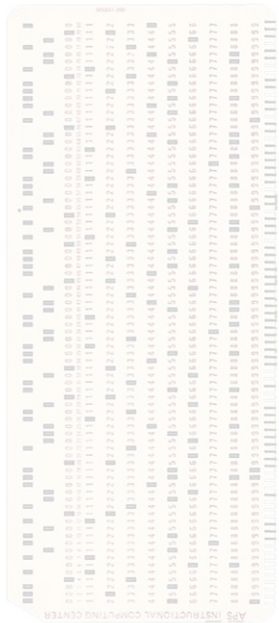
Graphics has evolved a lot  
since its early days... no  
longer just about turning  
on pixels!

# What is computer graphics?

com•put•er      graph•ics      /kəm'pyoʊdər 'ɡrafiks/ *n.*

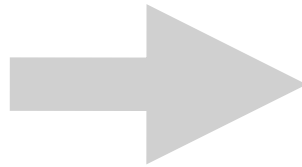
The use of computers to synthesize visual information.

**Why only visual?**



digital  
information

computation



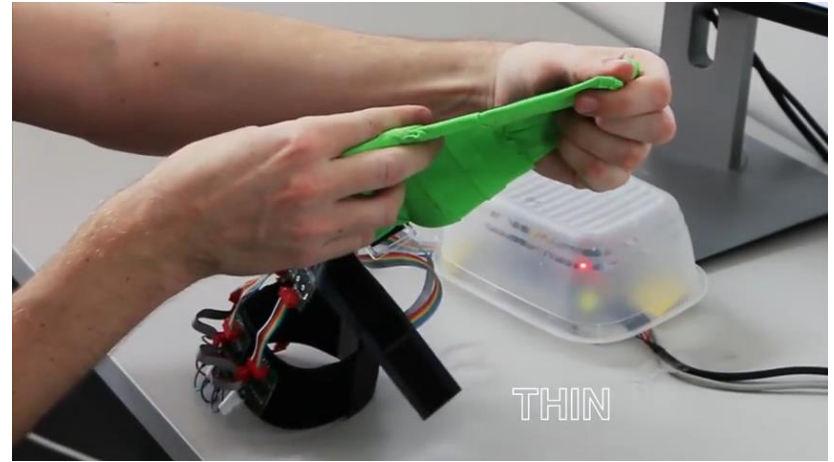
visual  
information



# Information into sensory stimuli

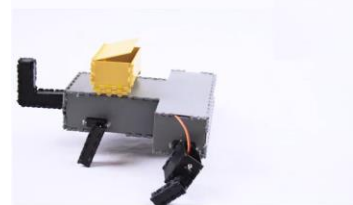
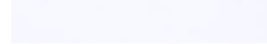


Sound



Touch

# Information into physical mater



# Definition of Graphics, Revisited

com•put•er      graph•ics      /kəm'pyoʊdər 'ɡrafiks/ *n.*

The use of computation to turn digital information into **sensory stimuli**.

Even this definition is too  
narrow...

# **SIGGRAPH Technical Papers Trailer**

- SIGGRAPH 2019

<https://www.youtube.com/watch?v=EhDr3Rs5fTU>

- SIGGRAPH 2018

<https://www.youtube.com/watch?v=t952yS8tcg8>

- SIGGRAPH 2017

<https://www.youtube.com/watch?v=5YvIHREdVX4>

- SIGGRAPH 2016

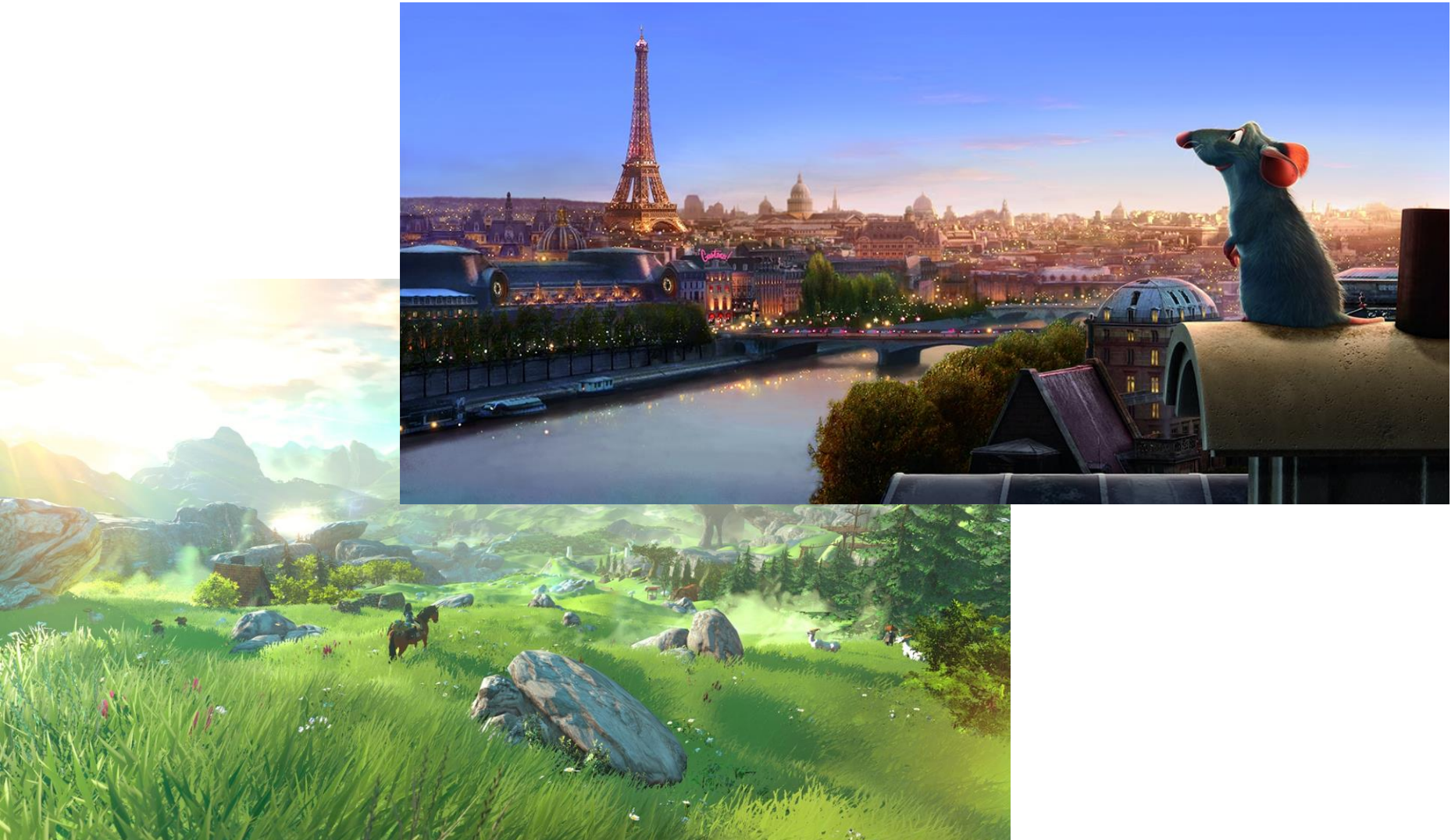
<https://www.youtube.com/watch?v=dQBJ0r5Pj5s>

- SIGGRAPH 2015

<https://www.youtube.com/watch?v=XrYkEhs2FdA>

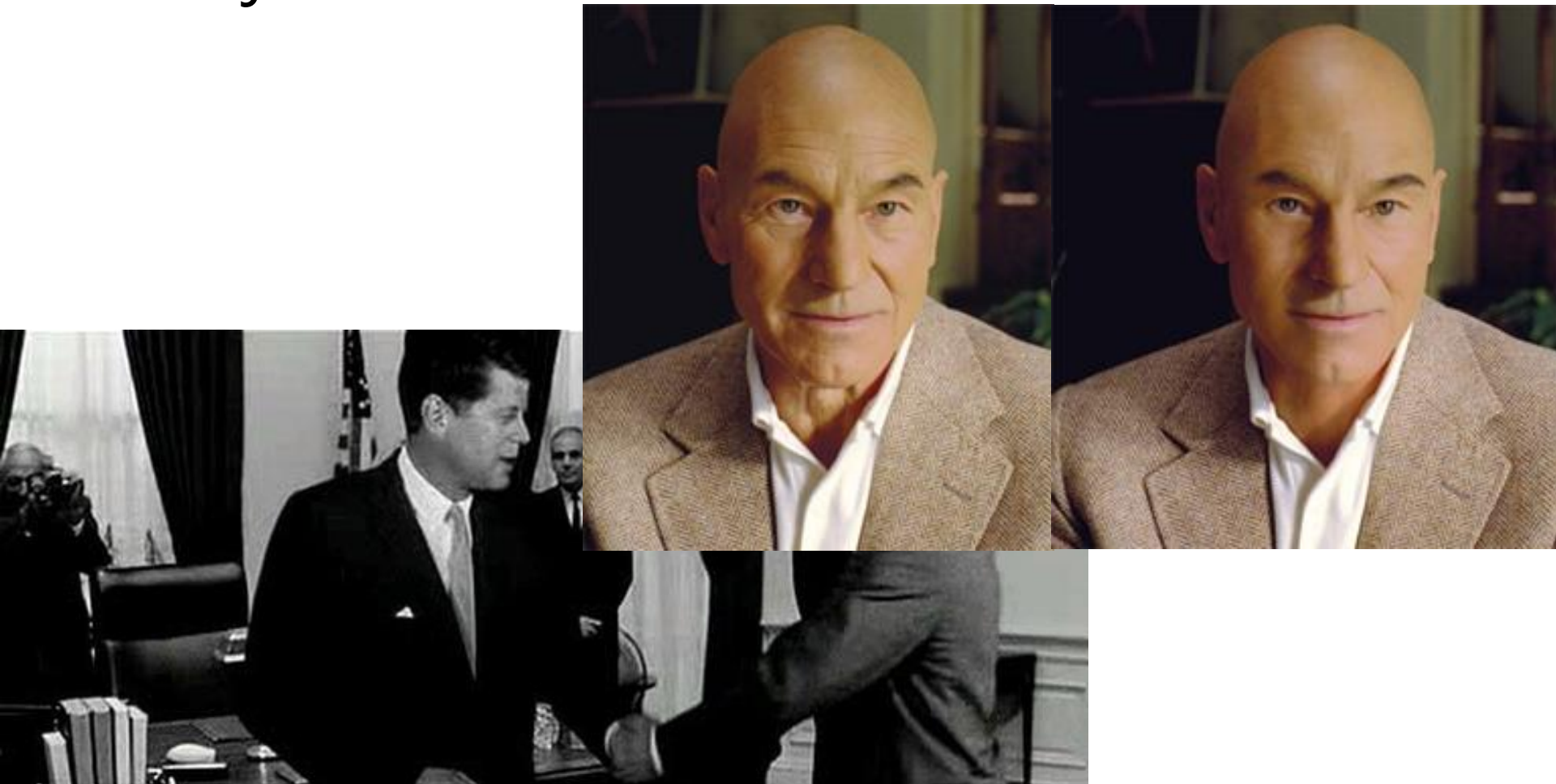
Computer graphics is  
everywhere!

# Entertainment (movies, games)



# Entertainment

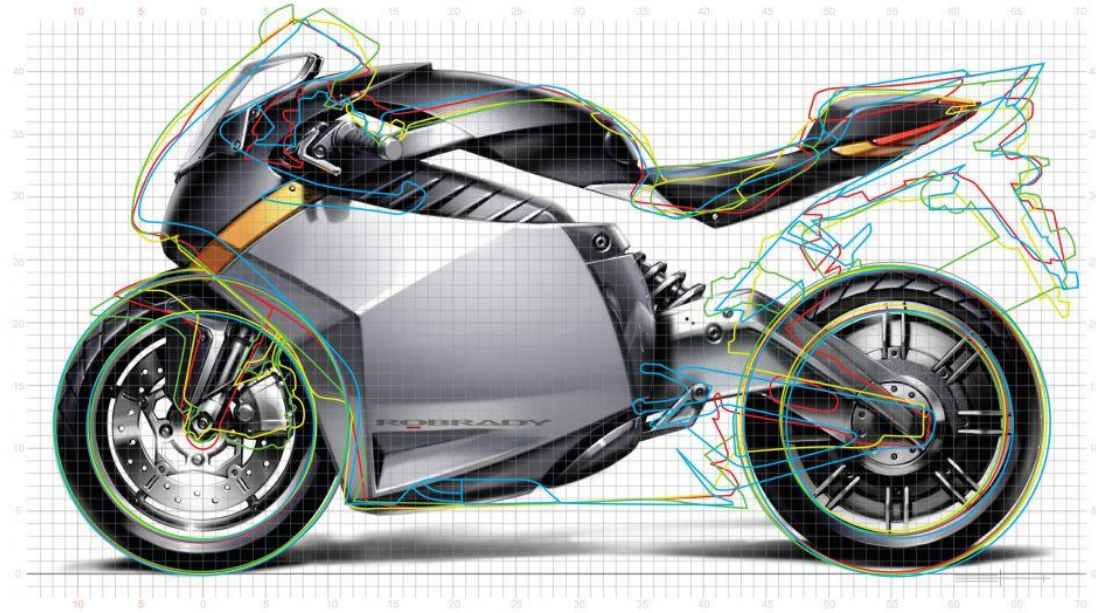
Not just cartoons!



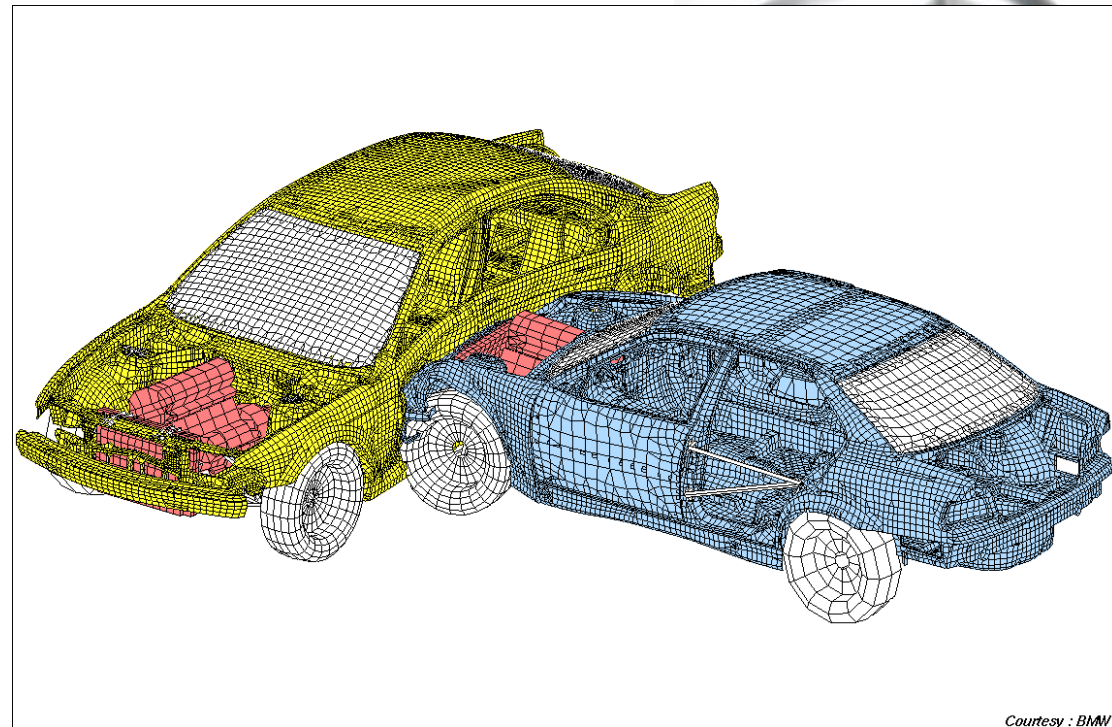
# Art and design



# Industrial design

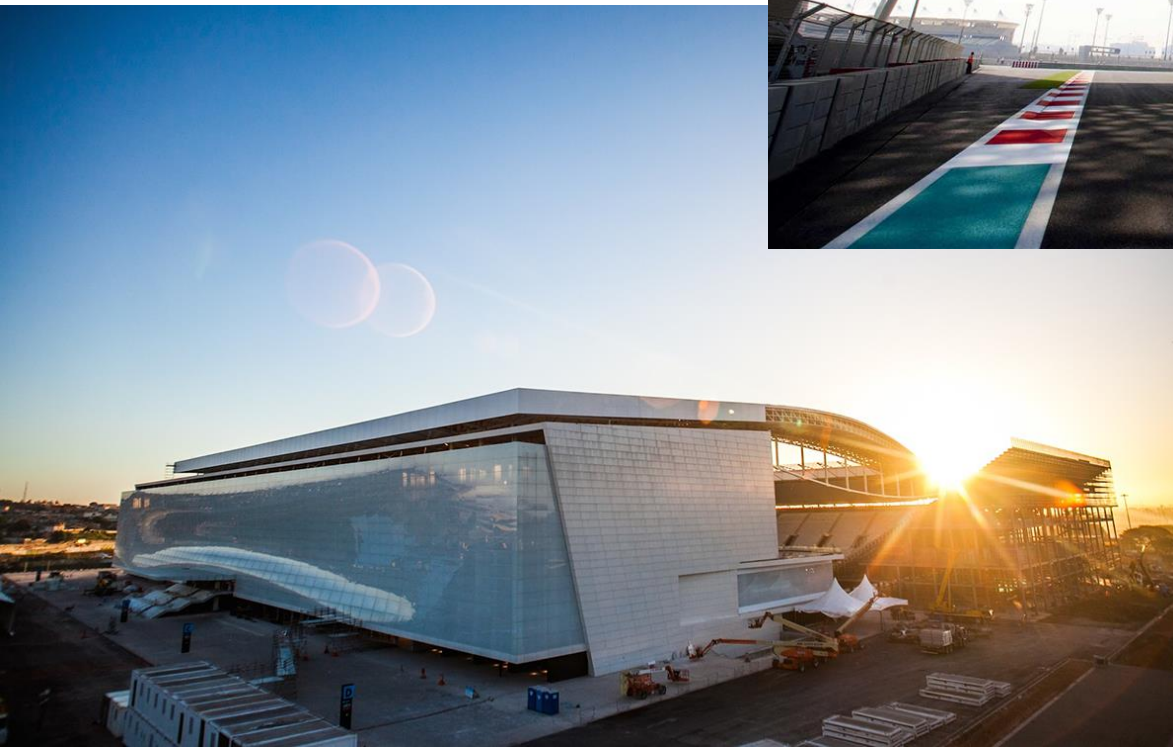
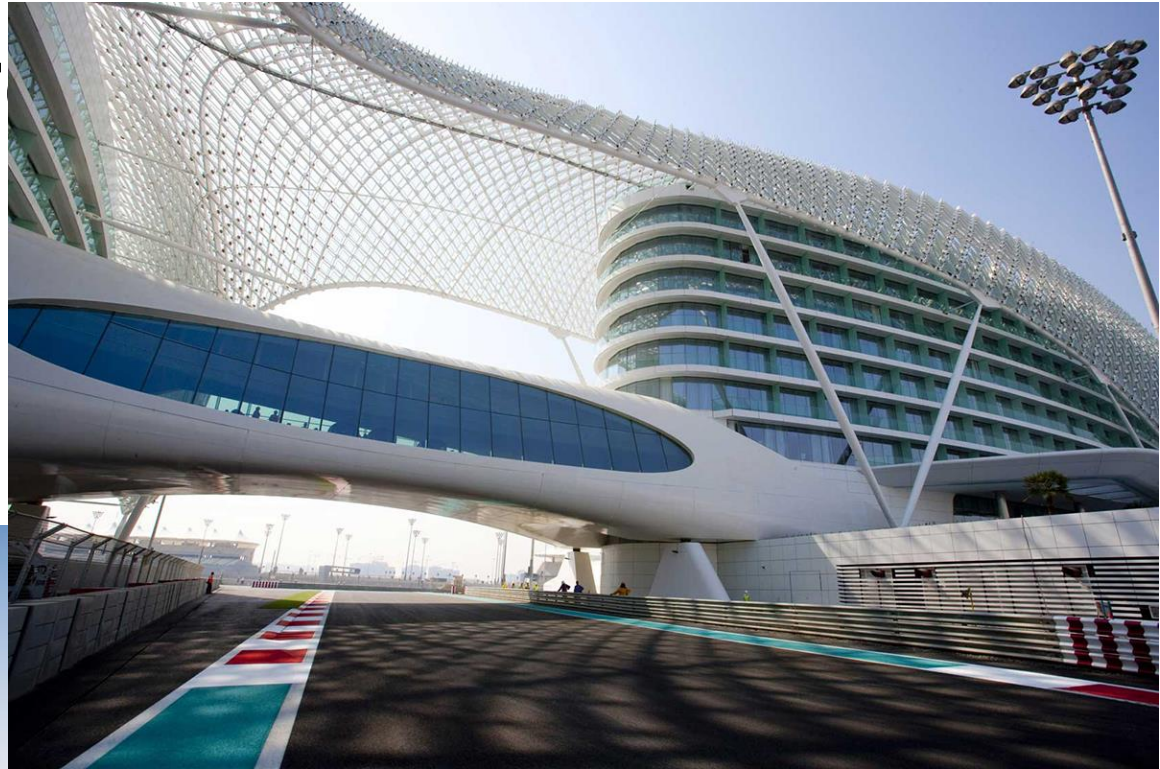


# Computer Aided Engineering (CAE)

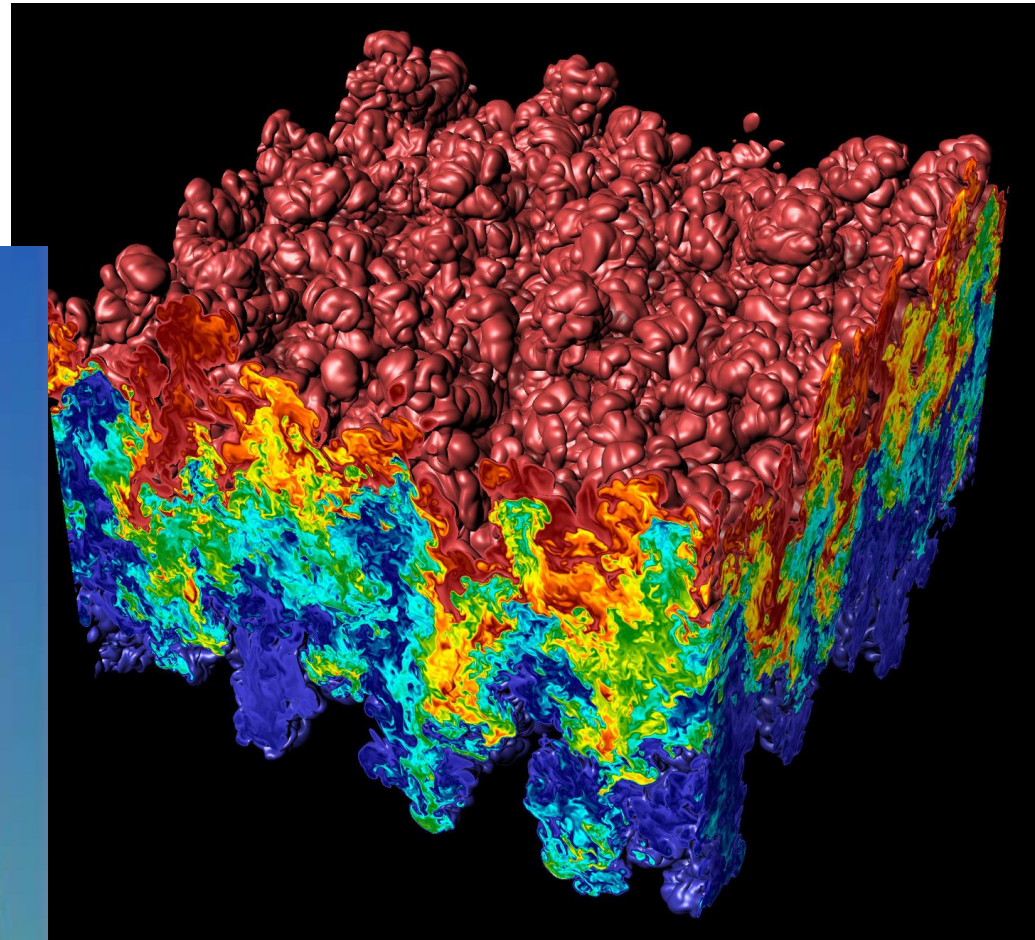
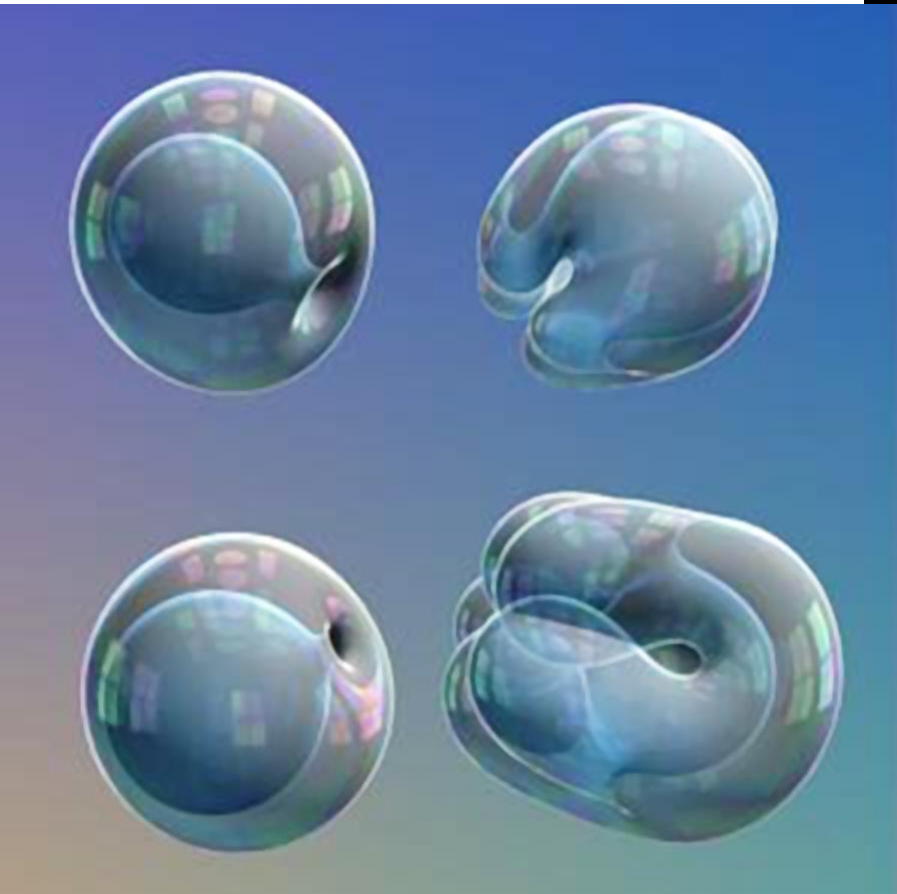


Courtesy : BMW

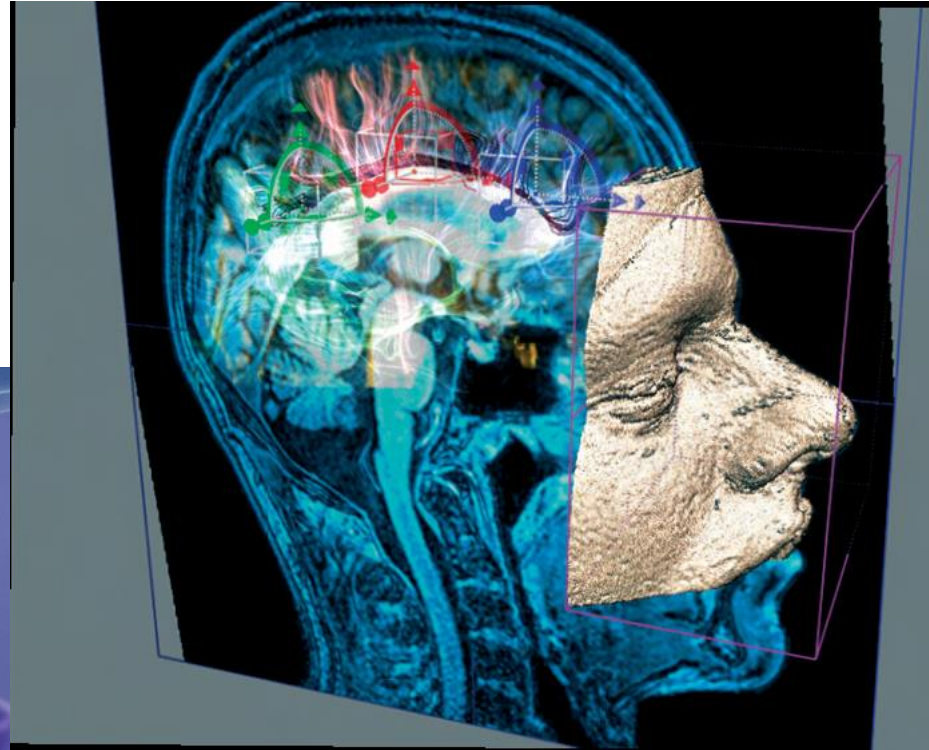
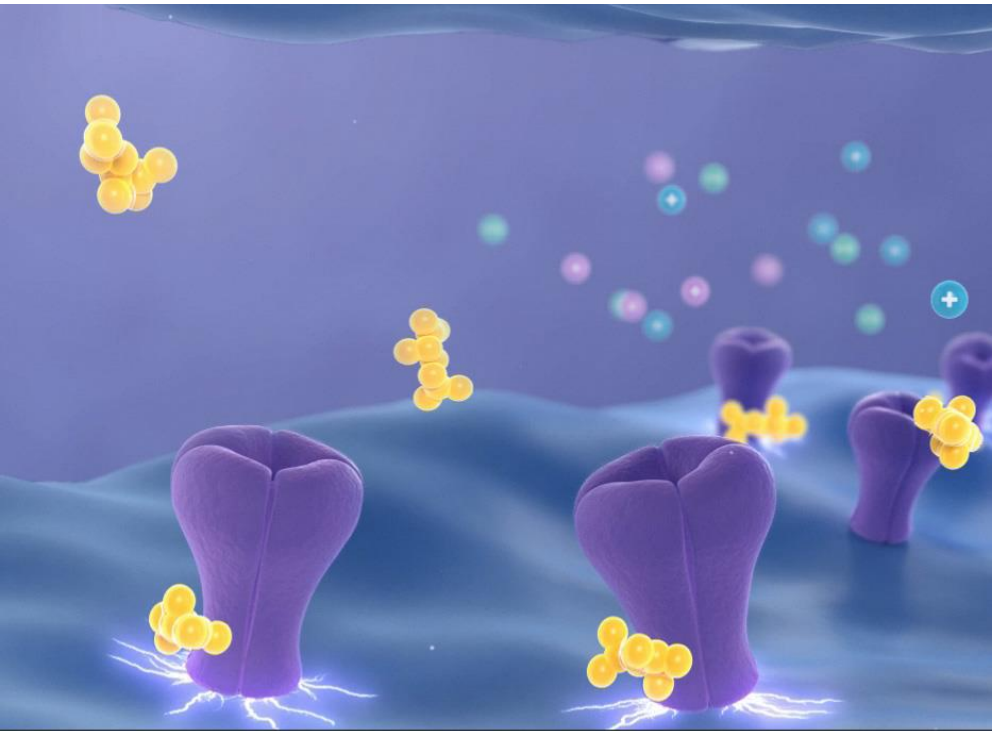
Ar



# Scientific/mathematical visualization



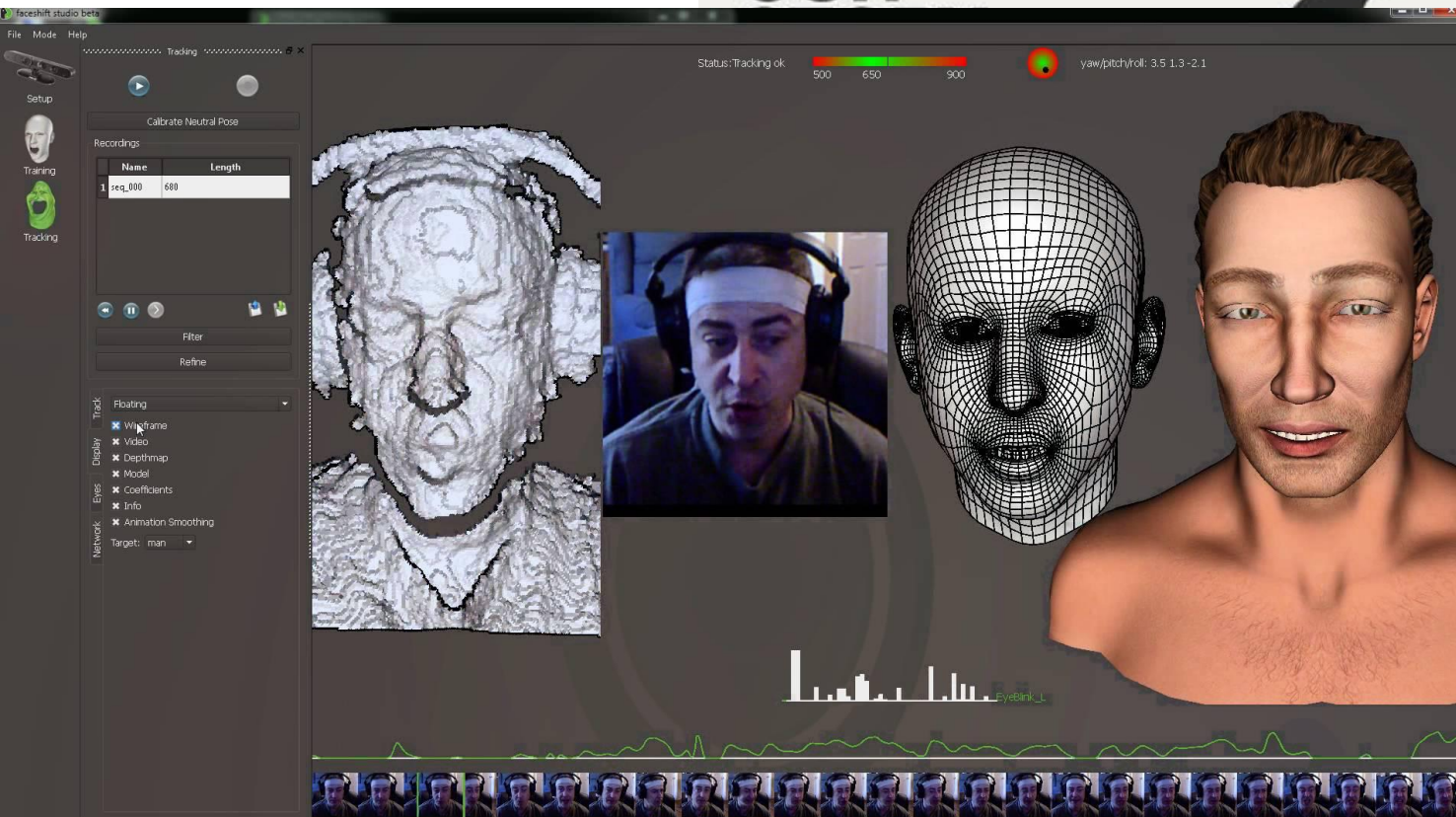
# Medical/anatomical visualization



# Navigation



# Communication



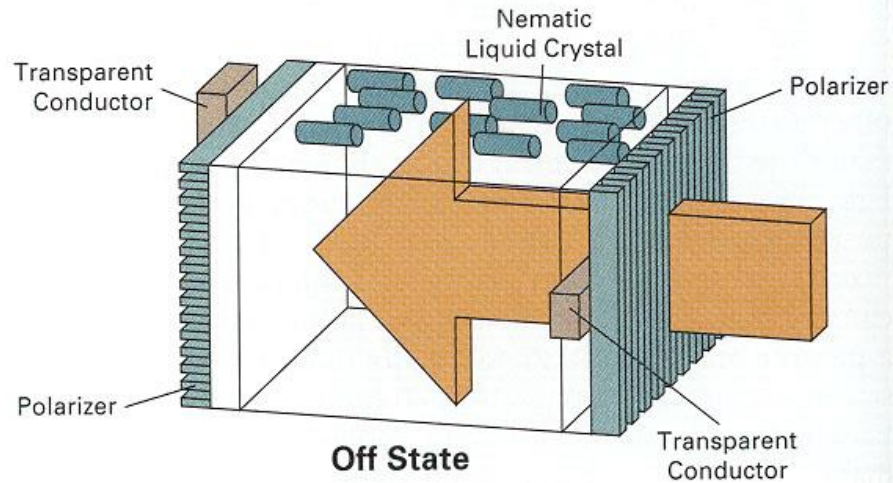
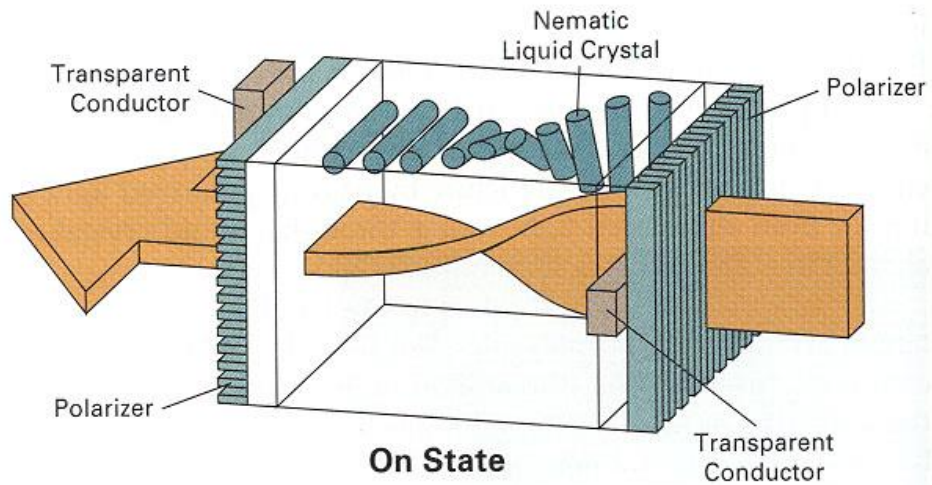
# Interdisciplinary!

- Algorithms
- Hardware
- Compilers
- HCI
- Visualization
- Image processing
- Computer vision
- Machine learning
- Computer Science
- Mathematics
- Physics
- Engineering
- Biology
- Psychology
- Art

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# Displays



# Image processing



Original



Smoothed



$S_x + 128$



$S_y + 128$



Magnitude

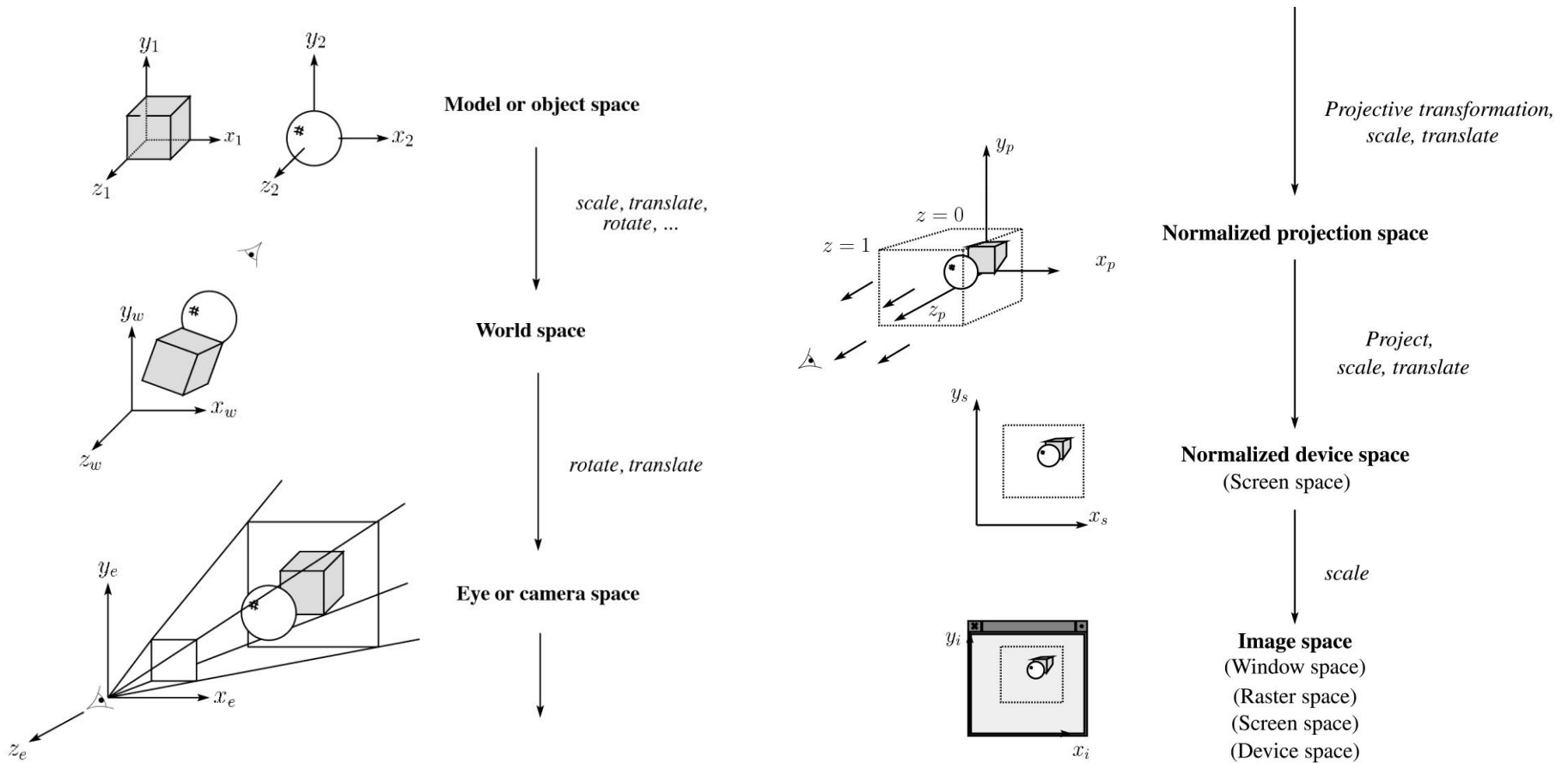


Threshold = 64

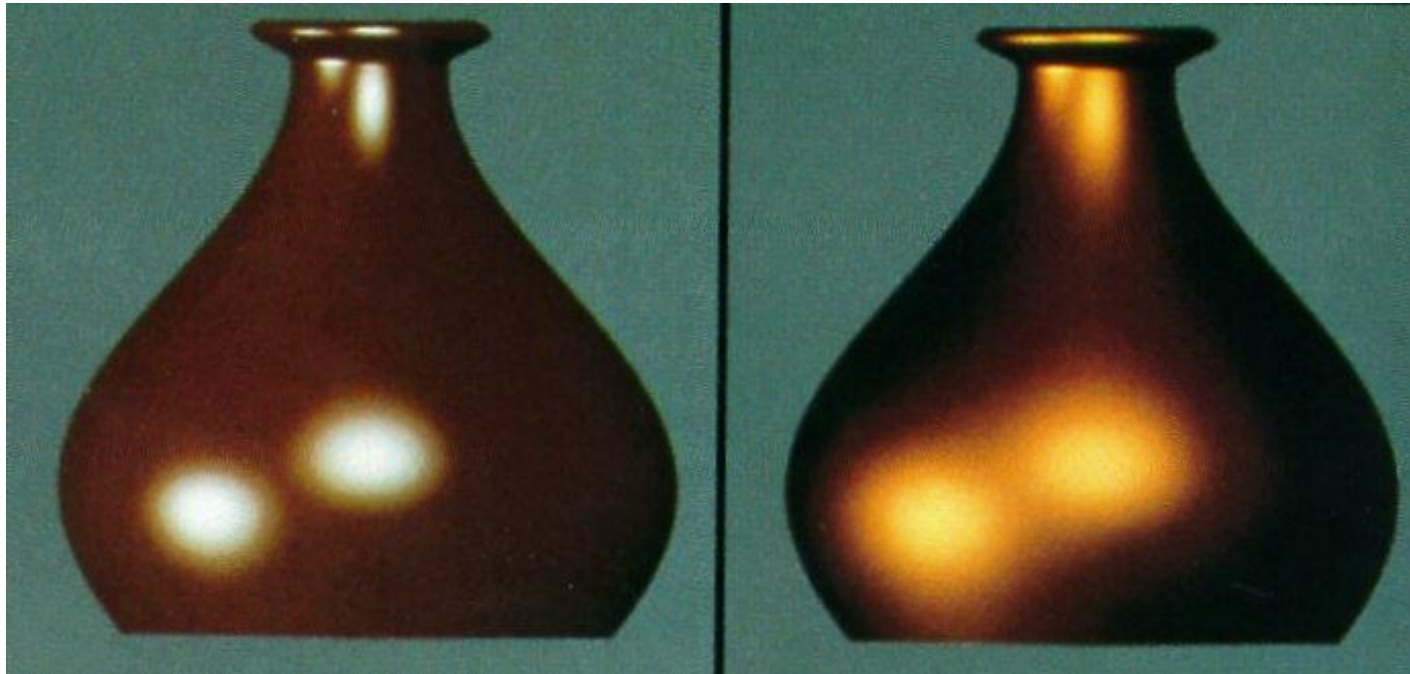


Threshold = 128

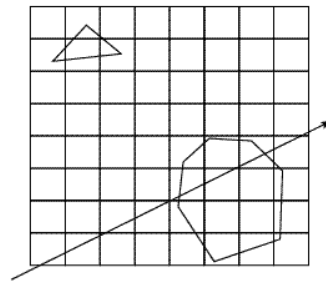
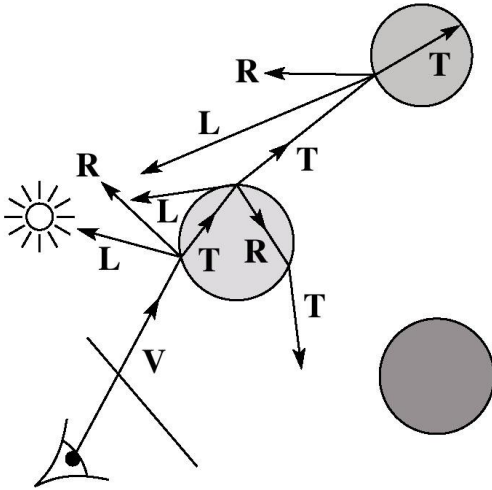
# Geometric transformations



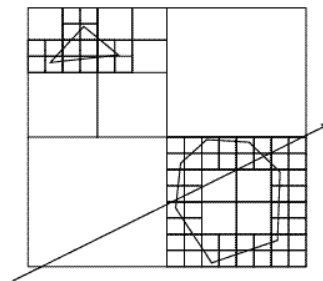
# Shading



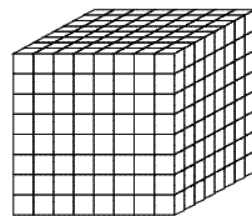
# Rendering



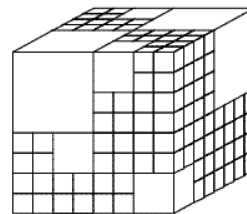
Uniform subdivision in 2D



Quadtree in 2D



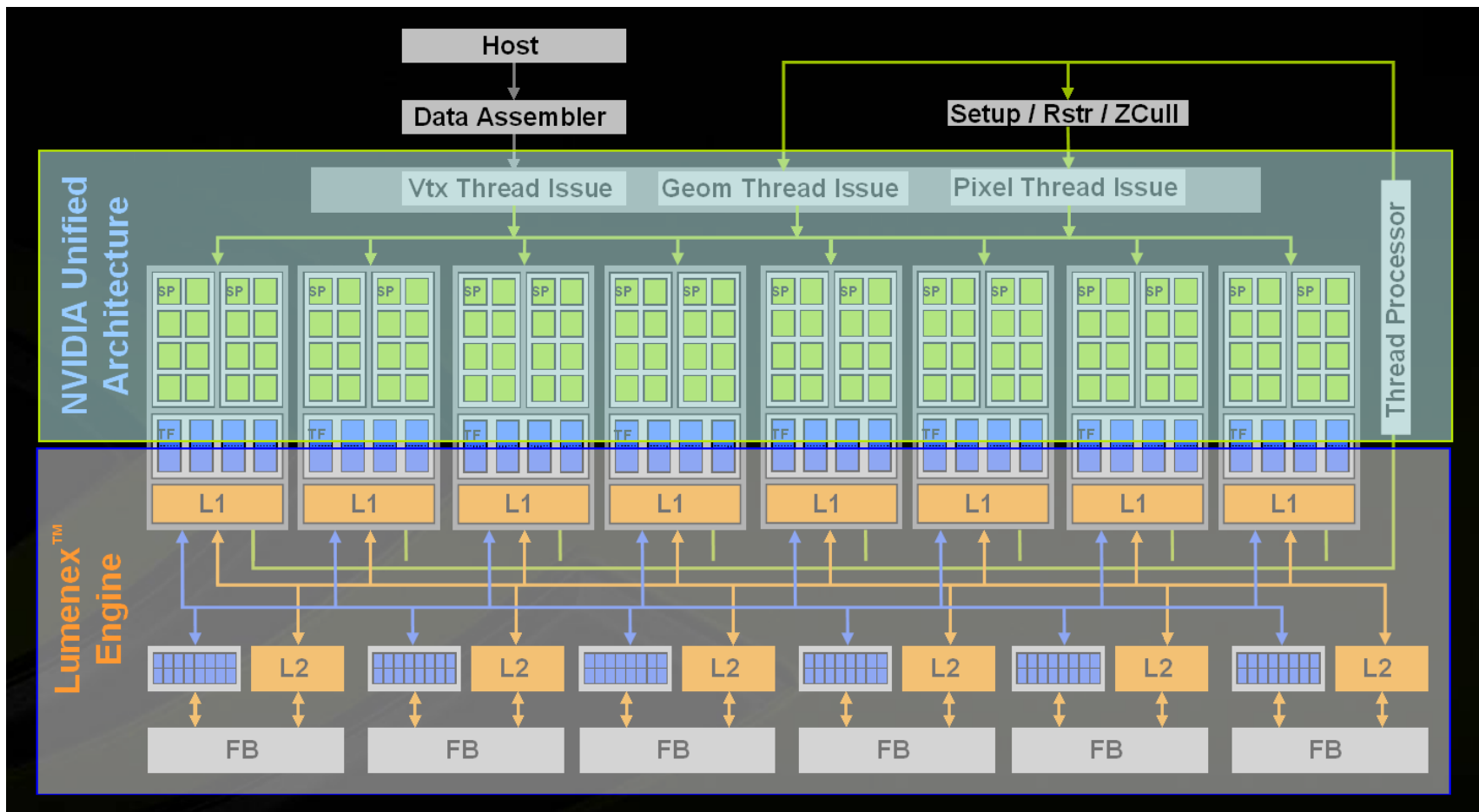
Uniform subdivision in 3D



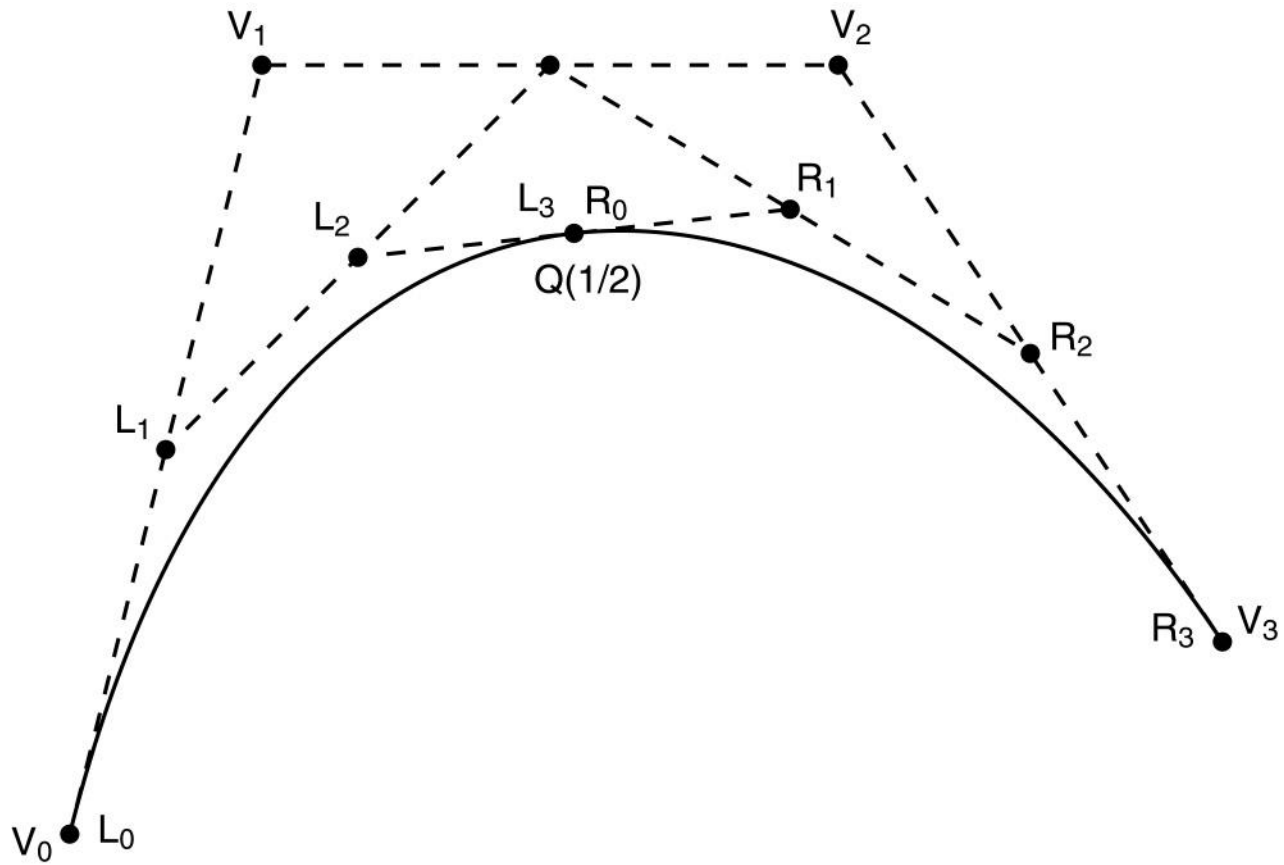
Octree in 3D



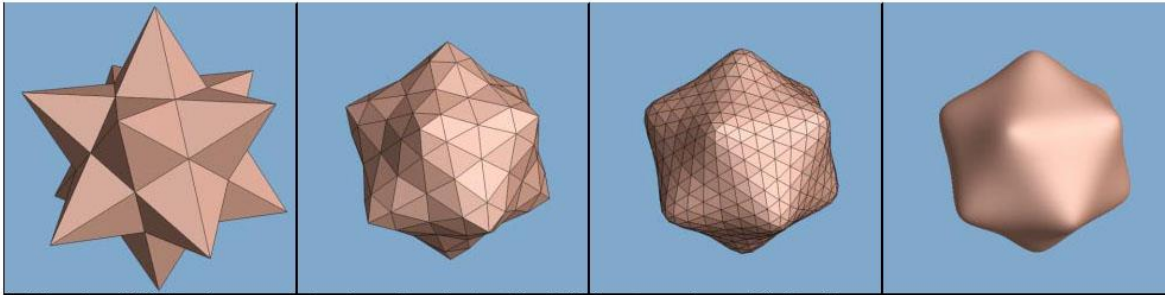
# Graphics Processing Units



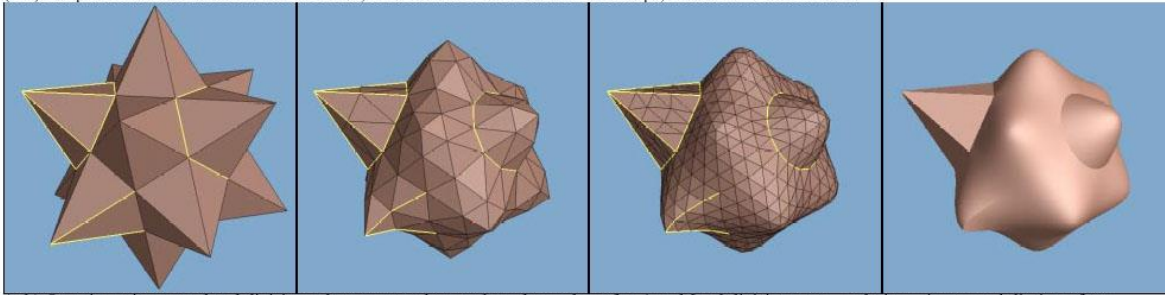
# Curves



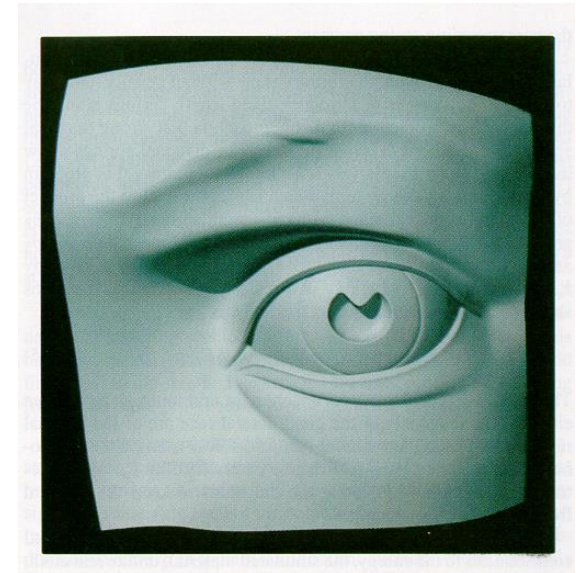
# Surfaces



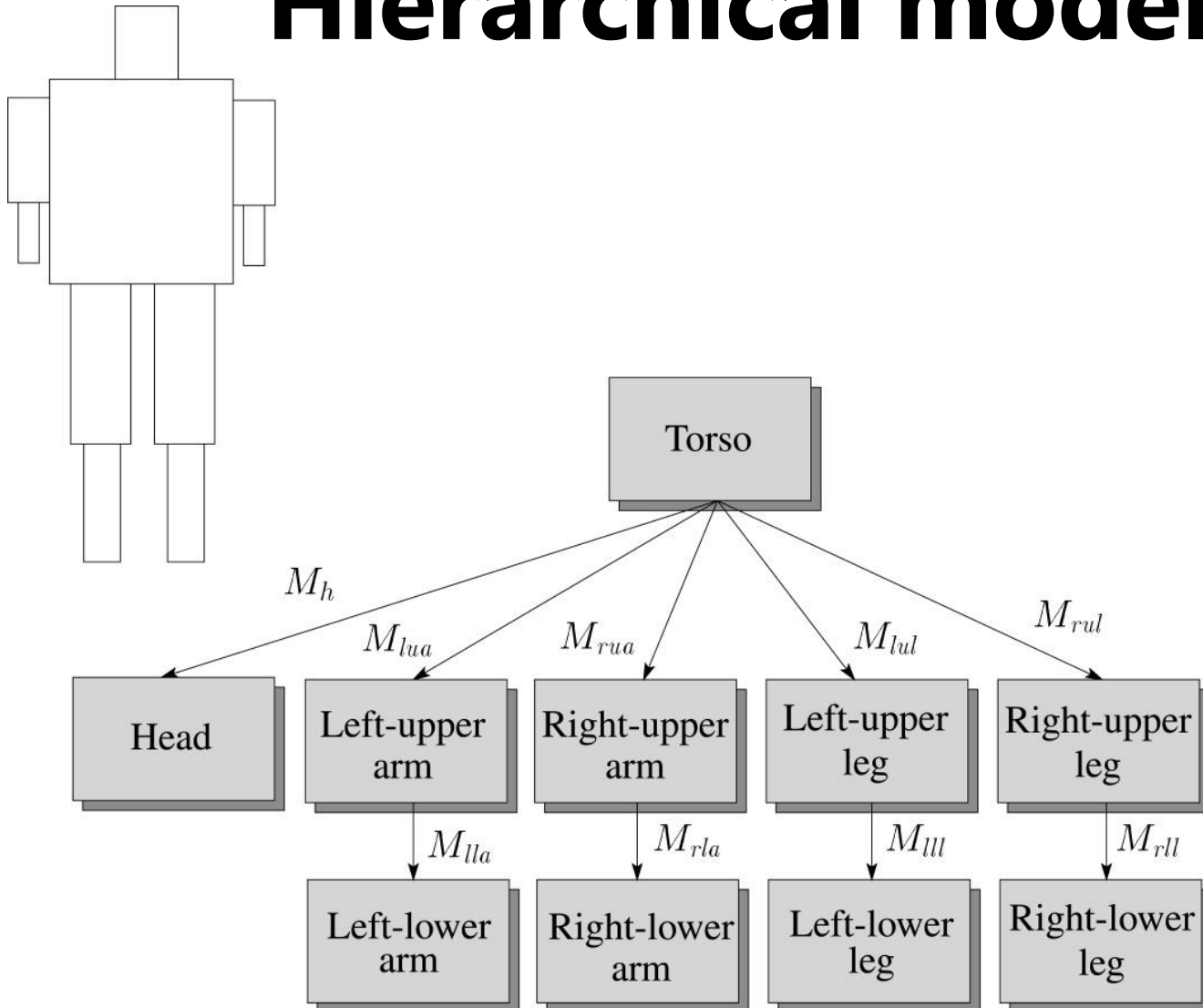
(a-d) Loop's subdivision scheme: control mesh, meshes after 1 and 2 subdivision steps, and smooth limit surface



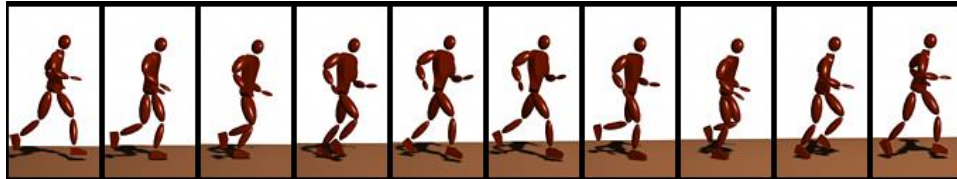
(e-h) Our piecewise smooth subdivision scheme: tagged control mesh, meshes after 1 and 2 subdivision steps, and piecewise smooth limit surface



# Hierarchical modeling



# Animation



- Keyframing
- Physical simulations

# Principles of character animation



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# Prerequisites

- Data structures
- C (C++) programming
- Linear algebra (very basic)
- Some mathematical sophistication
- No prior knowledge of graphics is assumed

# Communication

- Announcements: email
- Everything else: **main website**
  - Discussion Board
  - Canvas for Lectures/Grades/Submitting Homeworks
  - Gitlab for Projects
  - Calendar (office hours, help sessions, etc)

# Deliverables

- 4 Projects + Artifacts and 2 HWs
- No final
- Check calendar (main website)
- Released on Website (all info/or links)
- Late Policy:

All assignments (projects, artifacts, and homework) must be submitted by 10pm on the due date. Late assignments are marked down at a rate of 25% per day (not per lecture), meaning that if you fail to turn in an assignment on time it is worth 75% for the first 24 hours after the deadline, 50% for the next 24 hours, 25% for the next 24 hours, and then it is worth nothing after that. **Exceptions will be given only in extreme circumstances with prior instructor approval.**

# Projects

- Done in Pairs
  - You can pick or be auto-assigned
- Help Session (will be recorded)
- Virtual “in person” grading
- Artifact
- Opportunity for extra credit

# Summary

Broad view of graphics

Hands-on experience with focus on ideas and algorithms

Structured to allow you to budget time according to your interests and constraints

Balance of technical and artistic expression

You will see the world in a different way,