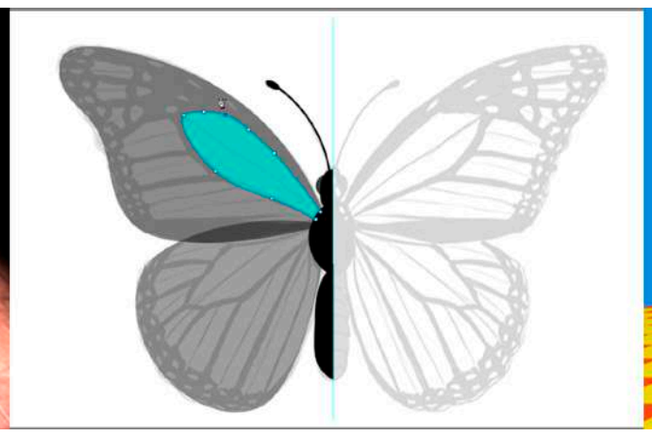
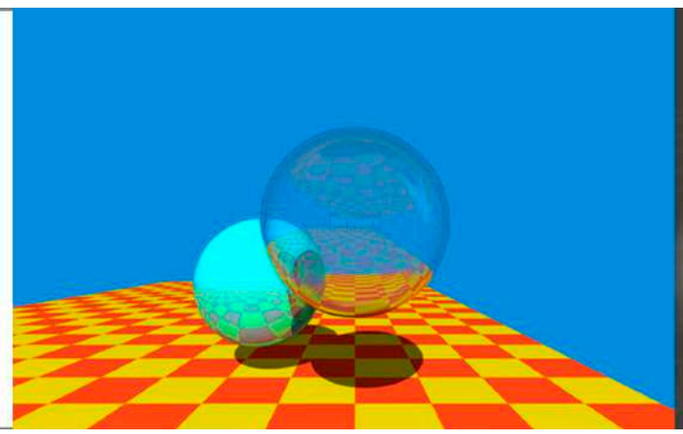
Introduction to Computer Graphics

GAMES101, Lingqi Yan, UC Santa Barbara

Lecture 1:
Overview of Computer Graphics

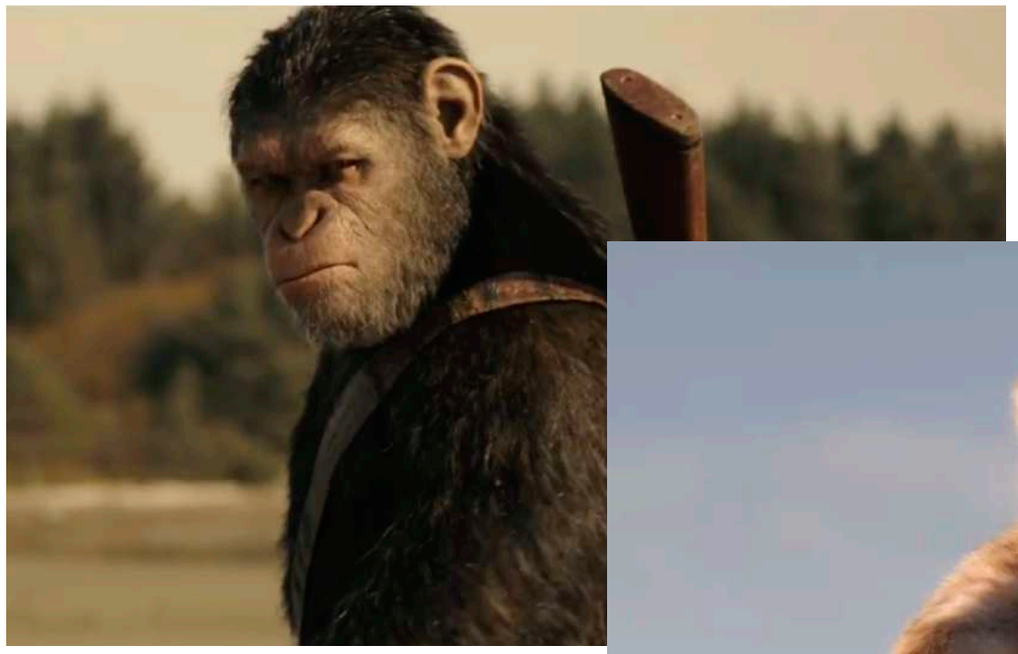

http://www.cs.ucsb.edu/~lingqi/teaching/games101.html

Welcome!

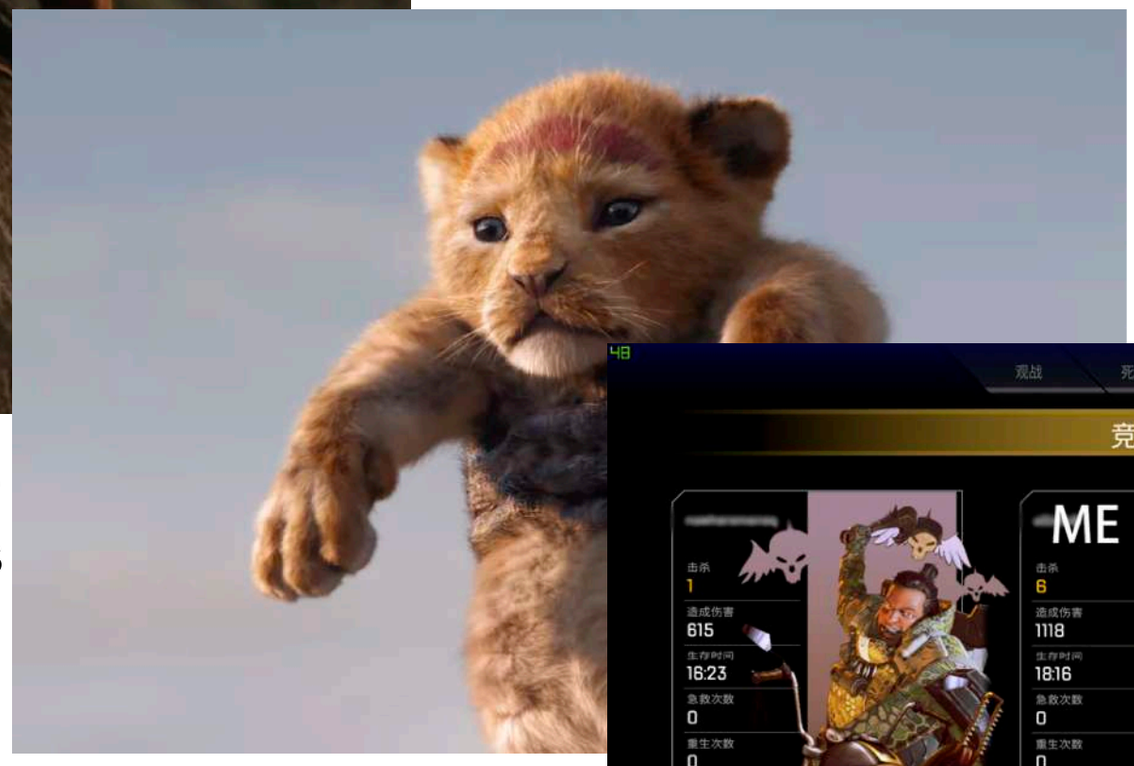
Instructor

- Lingqi Yan (闫令琪)
  - 2018 - now: Assistant Professor @ UCSB
    - 2013 - 2018: Ph.D @ UC Berkeley
      - 2009 - 2013: B.E. @ Tsinghua University
- Website: www.cs.ucsb.edu/~lingqi/
- Research: Rendering in Computer Graphics
- Hobbies: research, video games, piano, traveling, NBA, etc.

Instructor’s Achievements



2018: Oscar Nominee for Best Visual Effects



2019: research 2017 widely adopted in Lion King HD

2019: six APEX Champions in one evening (collaborated with Adobe)

Course Staff

- Teaching Assistants
  - 刘光哲（清华，lgz17@mails.tsinghua.edu.cn）
  - 史雨宸（中科大，syc0412@mail.ustc.edu.cn）
  - 邓俊辰（哈工大，1050106988@qq.com）

- More will be recruited soon after this lecture (based on need)

Today's Topics

- What is Computer Graphics?
- Why study Computer Graphics?
- Course Topics
- Course Logistics
- Linear Algebra Review

What is Computer Graphics?

com•put•er graph•ics /kəmˈpyo͞odər ˈgrafiks/ n.

The use of computers to synthesize and manipulate visual information.

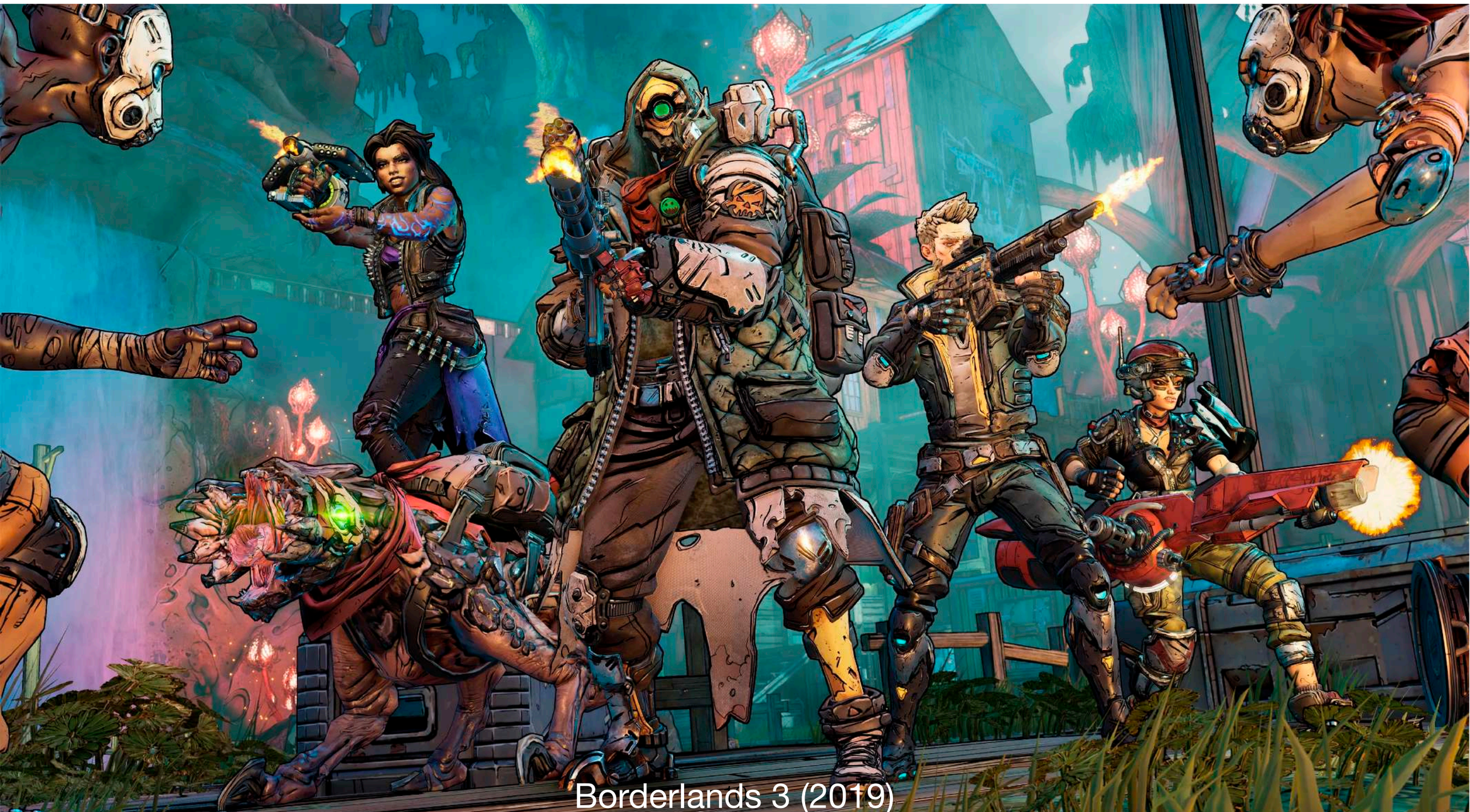
Today's Topics

- What is Computer Graphics?
- Why study Computer Graphics?
  - Applications
  - Fundamental Intellectual Challenges
  - Technical Challenges
- Course Topics
- Course Logistics

Video Games

Sekiro: Shadows Die twice (2019 Game of the Year)

Video Games



Borderlands 3 (2019)

Movies

The Matrix (1999)

Movies

Avatar (2009)

Animations

Zootopia (2016)

Animations

Frozen 2 (2019)

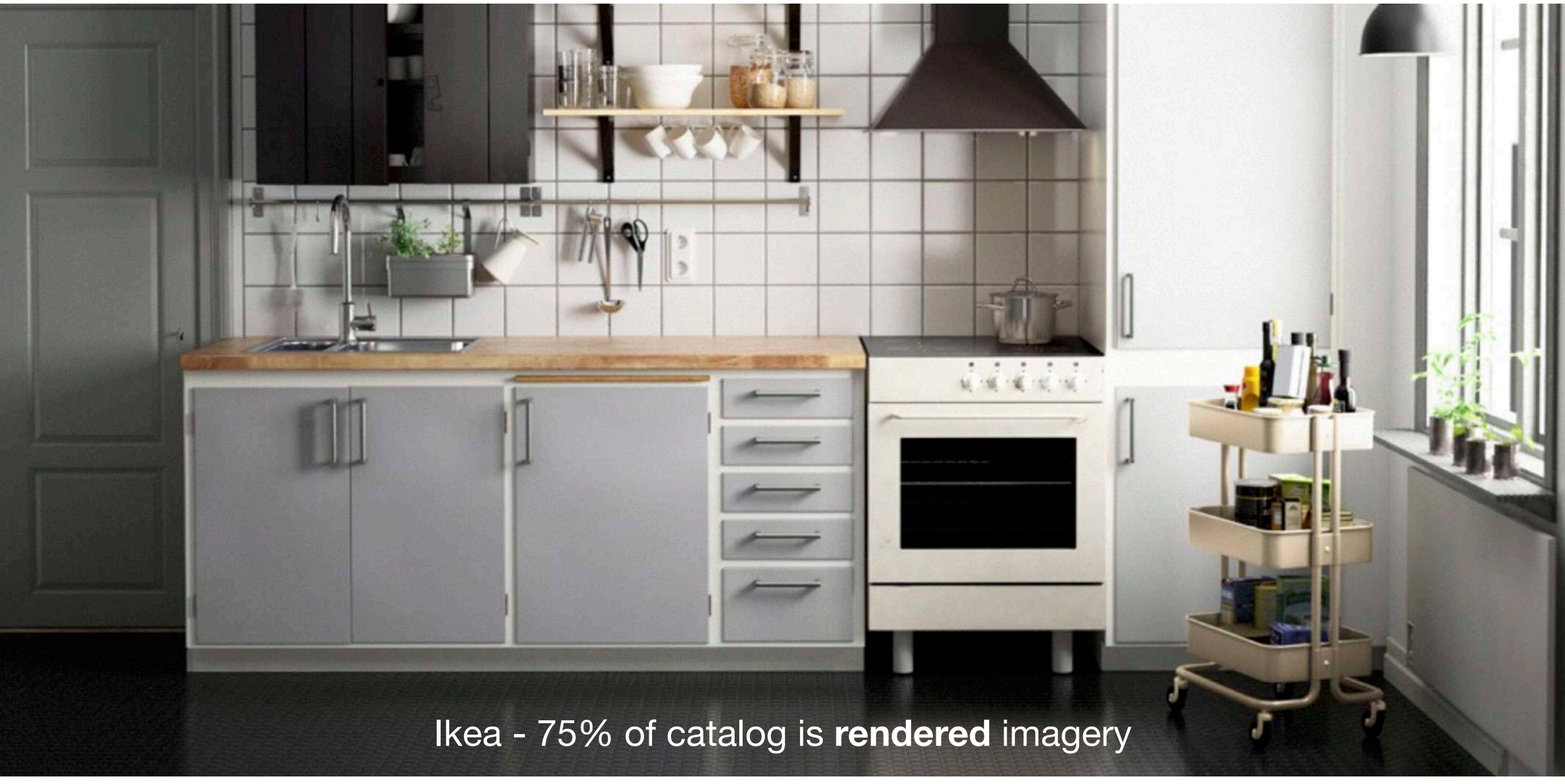
Design

CG

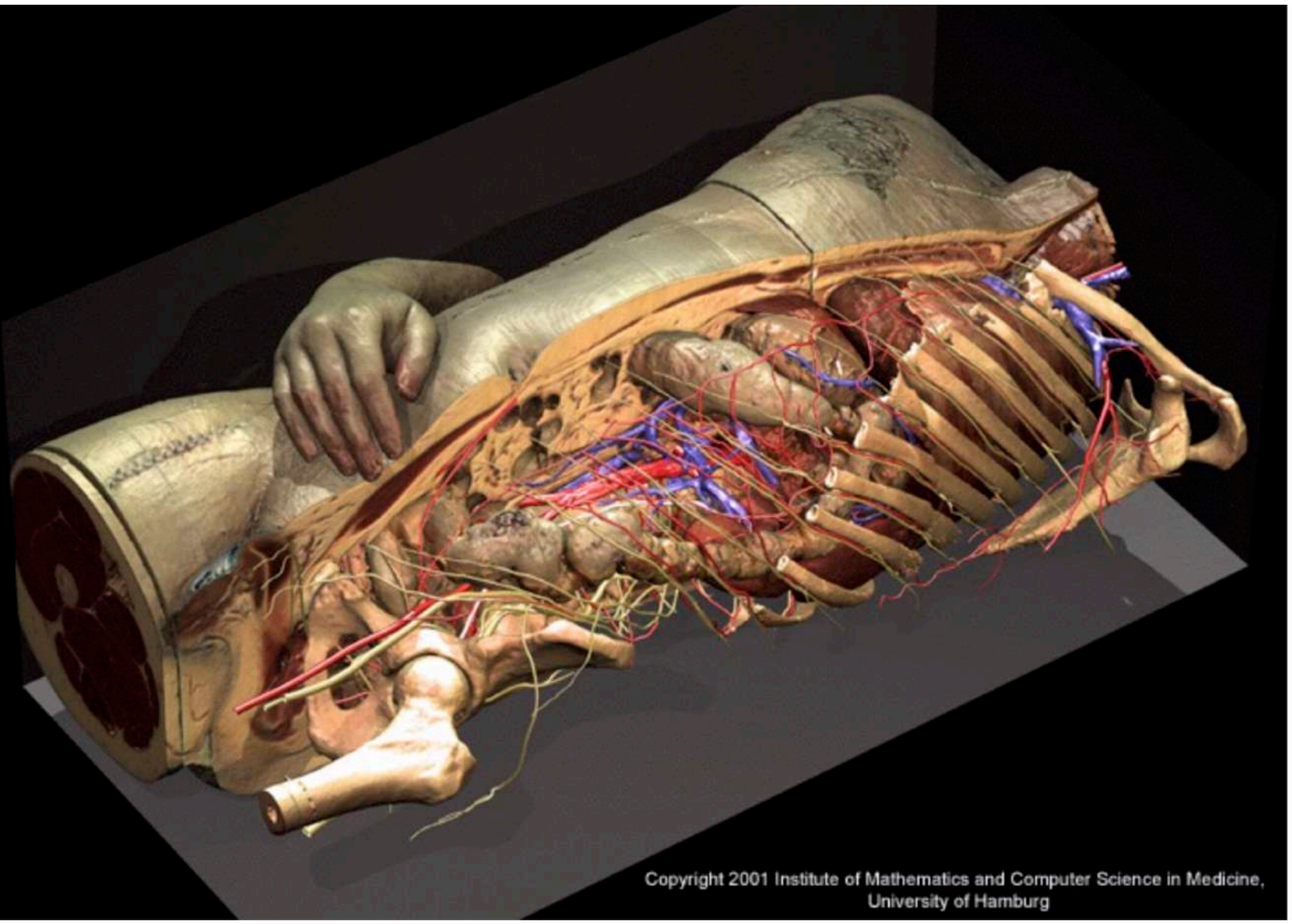
Photo

Autodesk Gallary

Design



Visualization

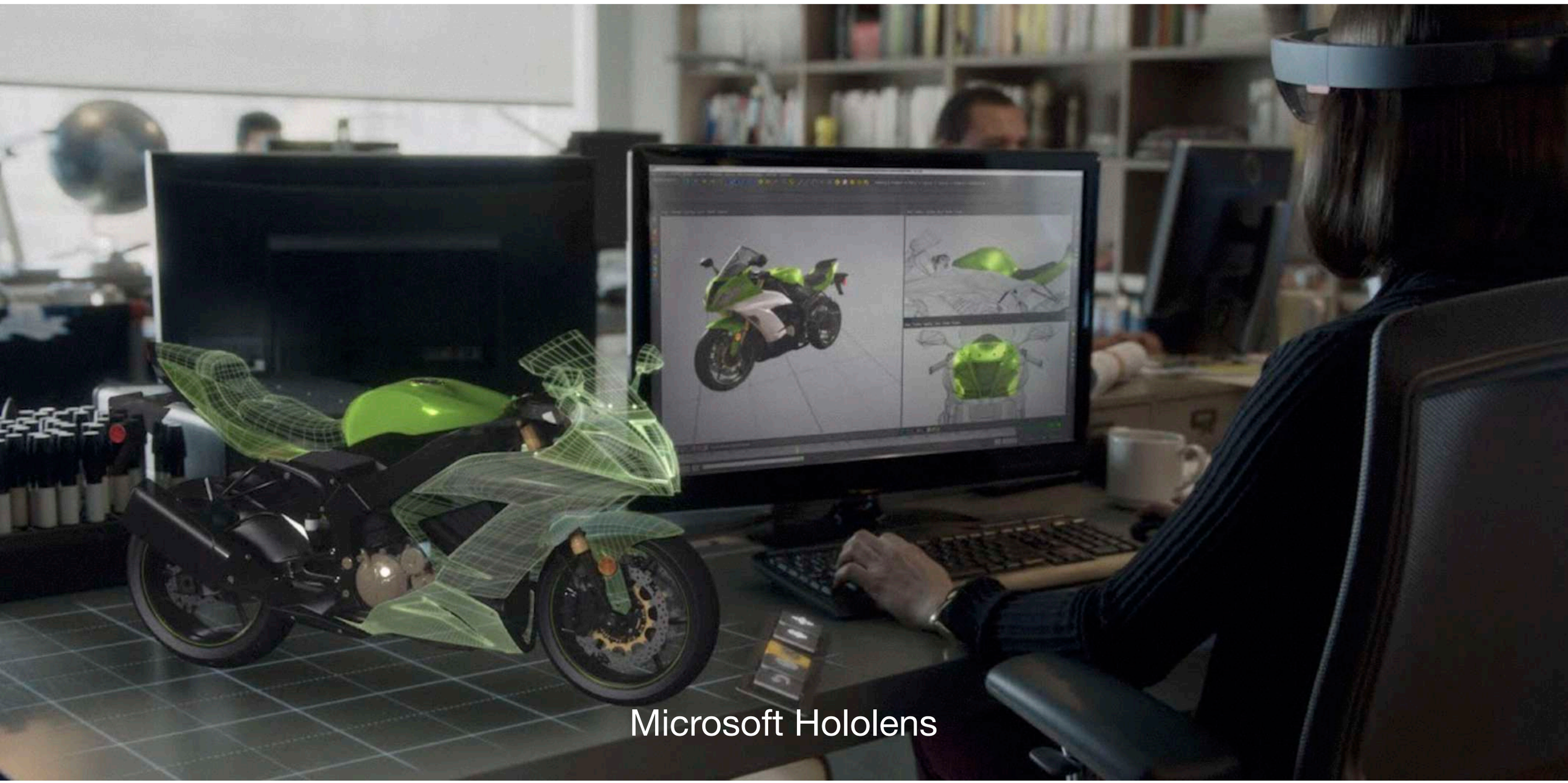


Science, engineering, medicine, journalism, etc.

Virtual Reality

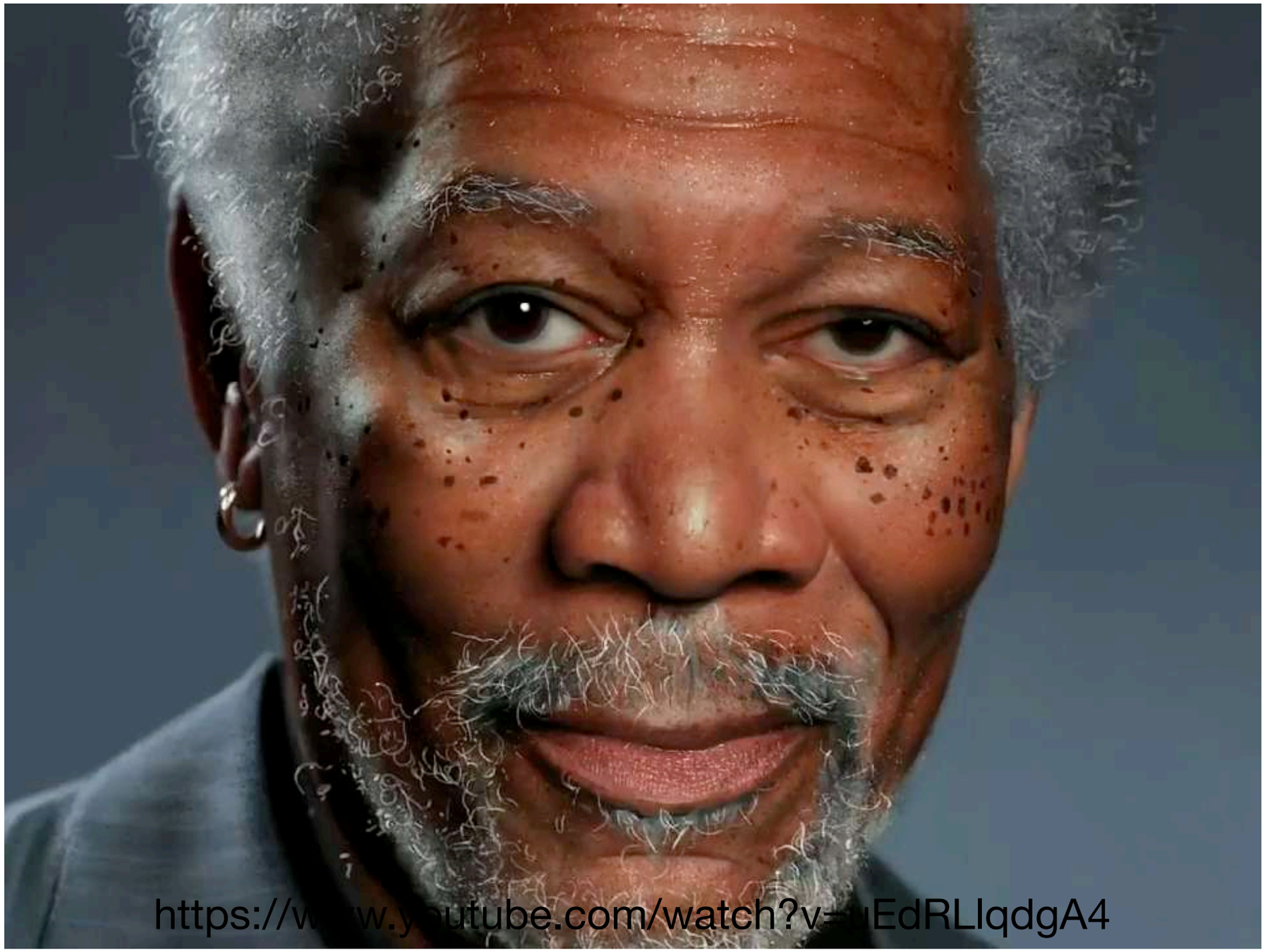
Oculus VR

Augmented Reality



Microsoft Hololens

Digital Illustration



Simulation

The Dust Bowl phenomena

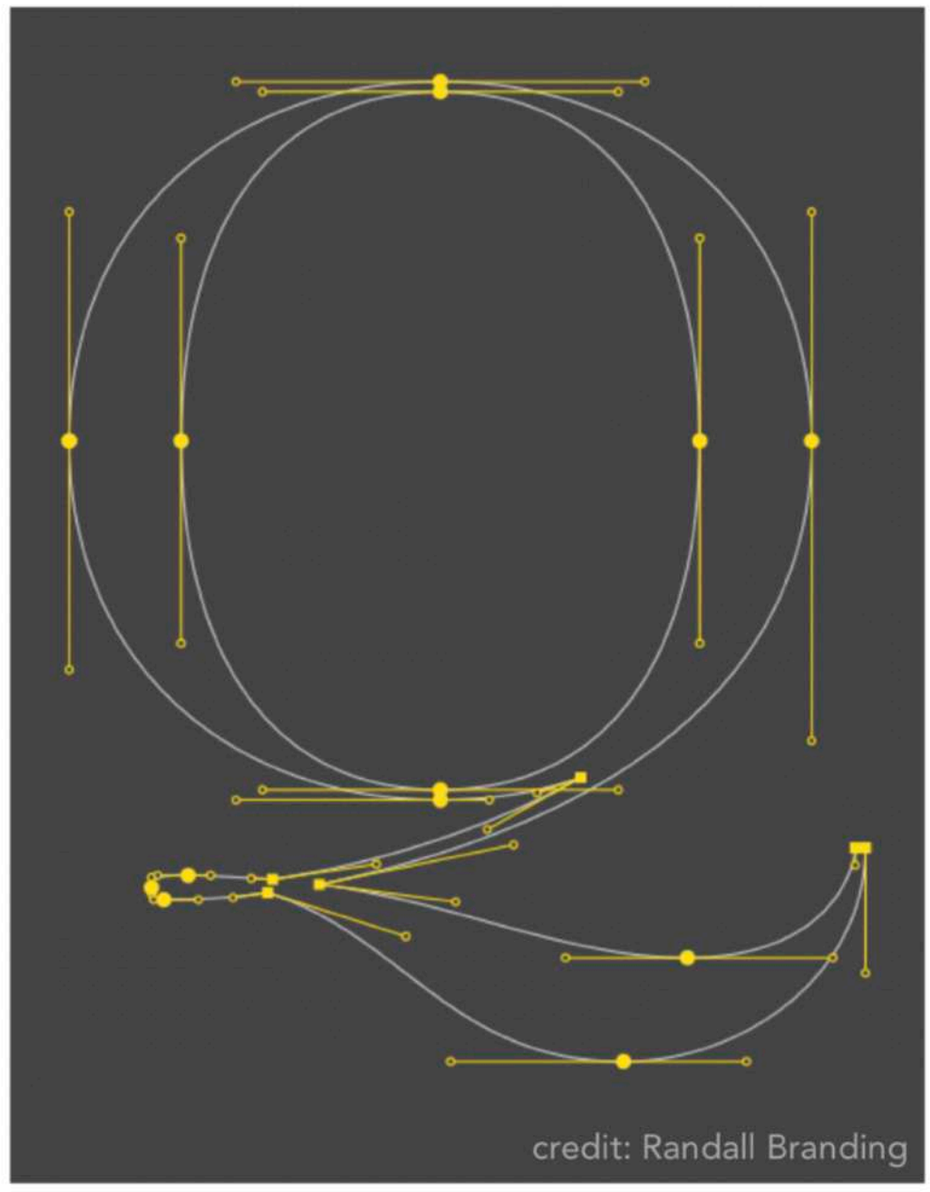
Black hole from Interstellar

Graphical User Interfaces

Typography

The Quick Brown Fox Jumps Over The Lazy Dog

ABCDEFGHIJKLMNOPQRSDTUVWXYZ
abcdefghijklmnopqrstuvwxyz 01234567890



The font Baskerville

Why Study Computer Graphics?

- Fundamental Intellectual Challenges
  - Creates and interacts with realistic virtual world
  - Requires understanding of all aspects of physical world
  - New computing methods, displays, technologies

Why Study Computer Graphics?

- Technical Challenges
  - Math of (perspective) projections, curves, surfaces
  - Physics of lighting and shading
  - Representing / operating shapes in 3D
  - Animation / simulation
  - ~~3D graphics software programming and hardware~~

Why Study Computer Graphics?

- Forget about the previous reasons

Computer Graphics

is

AWESOME!

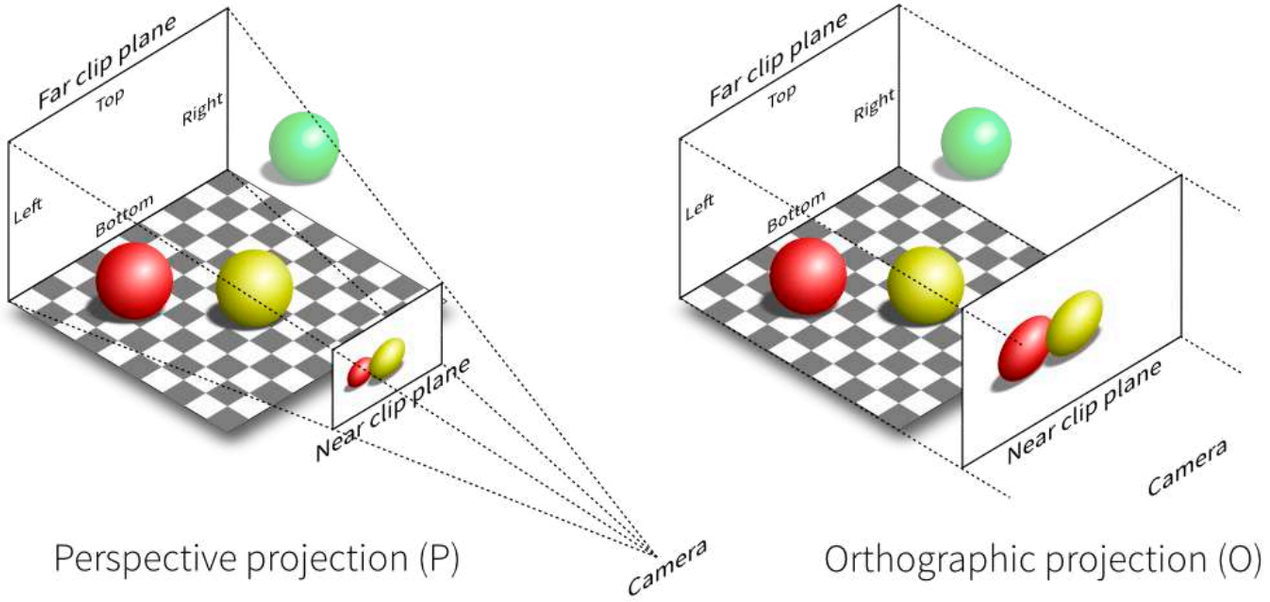
Questions?

Today's Topics

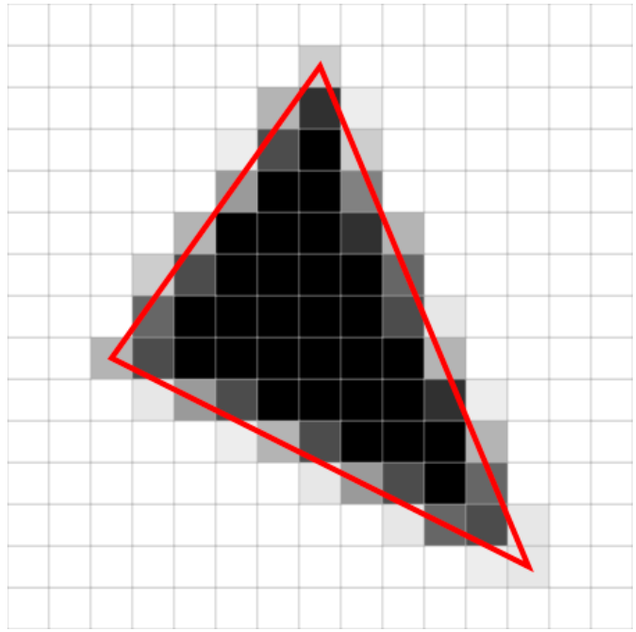
- What is Computer Graphics?
- Why study Computer Graphics?
- Course Topics (mainly 4 parts)
  - Rasterization
  - Curves and Meshes
  - Ray Tracing
  - Animation / Simulation
- Course Logistics

Rasterization

- Project geometry primitives (3D triangles / polygons) onto the screen
- Break projected primitives into fragments (pixels)
- Gold standard in Video Games (Real-time Applications)



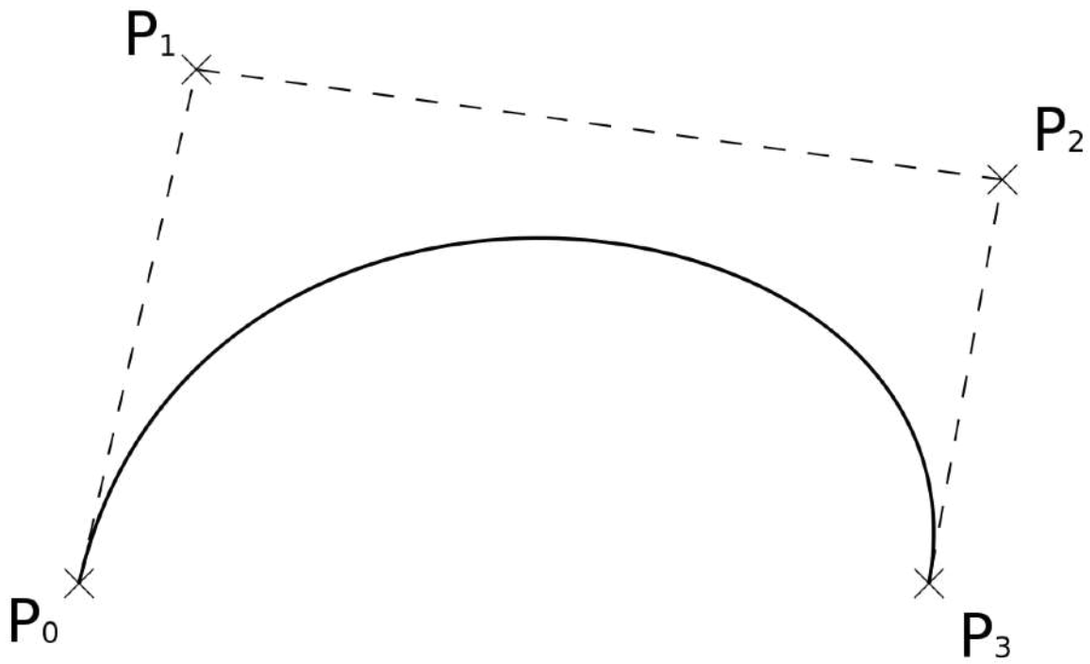
http://vispy.org/modern-gl.html



https://commons.wikimedia.org/wiki/File:Rasterisation-triangle_example.svg

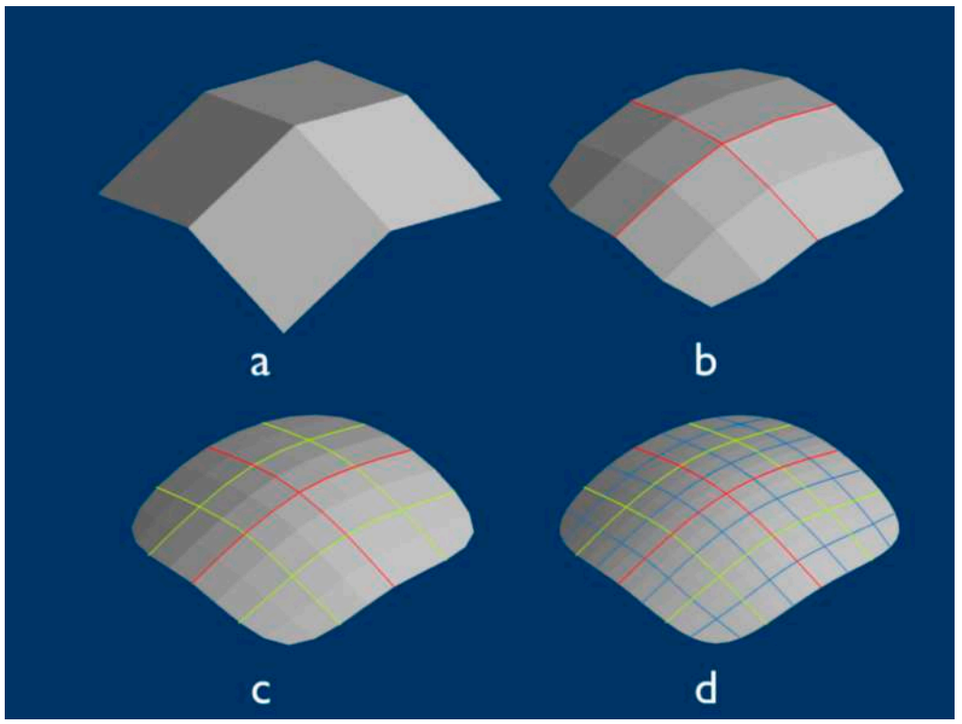
Curves and Meshes

- How to represent geometry in Computer Graphics



Bezier Curve

https://en.wikipedia.org/wiki/B%C3%A9zier_curve

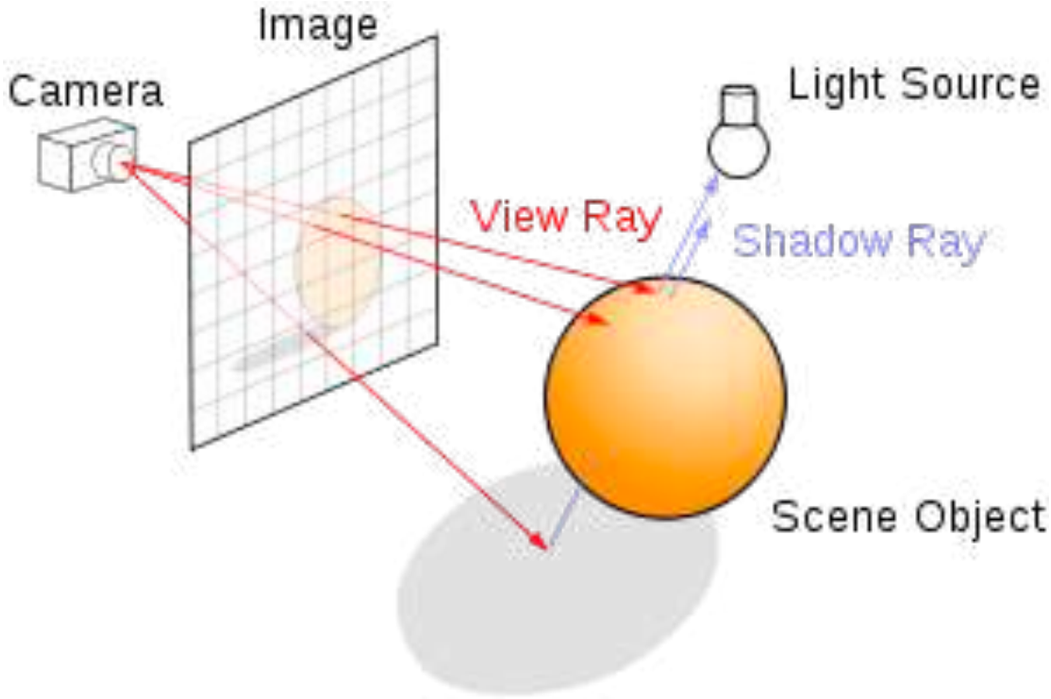


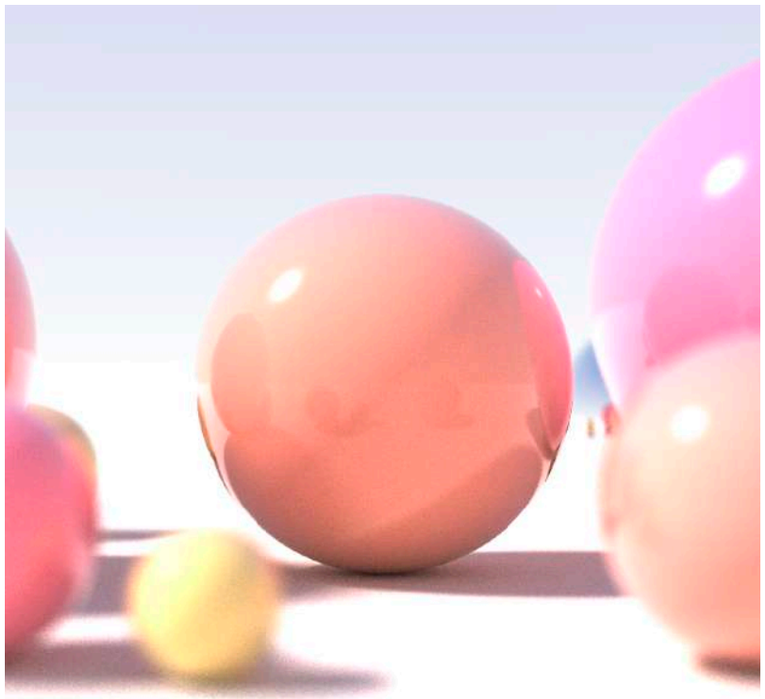
Catmull-Clark subdivision

https://commons.wikimedia.org/wiki/File:Catmull-Clark_subdivision_of_4_planes.png

Ray Tracing

- Shoot rays from the camera though each pixel
  - Calculate intersection and shading
  - Continue to bounce the rays till they hit light sources
- Gold standard in Animations / Movies (Offline Applications)

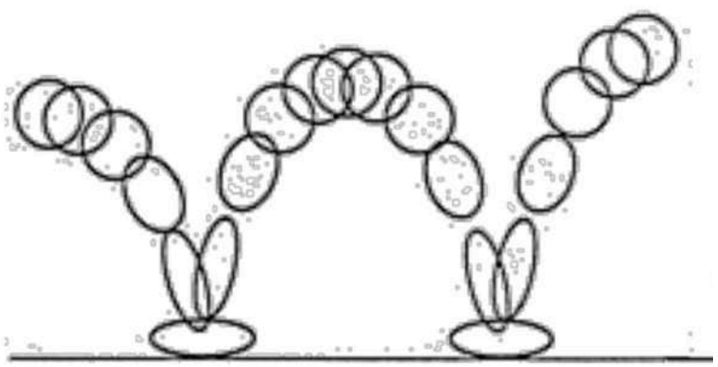


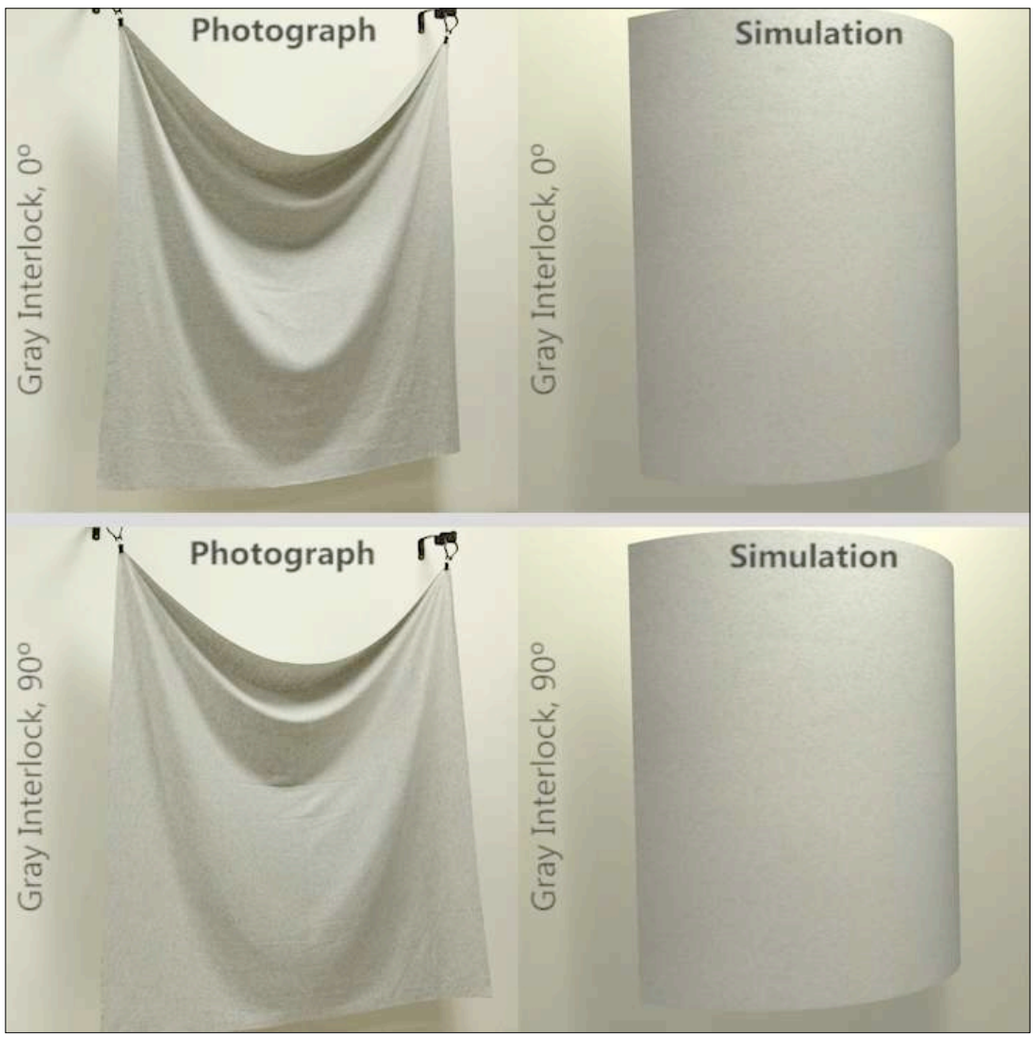


https://en.wikipedia.org/wiki/Ray_tracing_(graphics)

Animation / Simulation

- Key frame Animation
- Mass-spring System



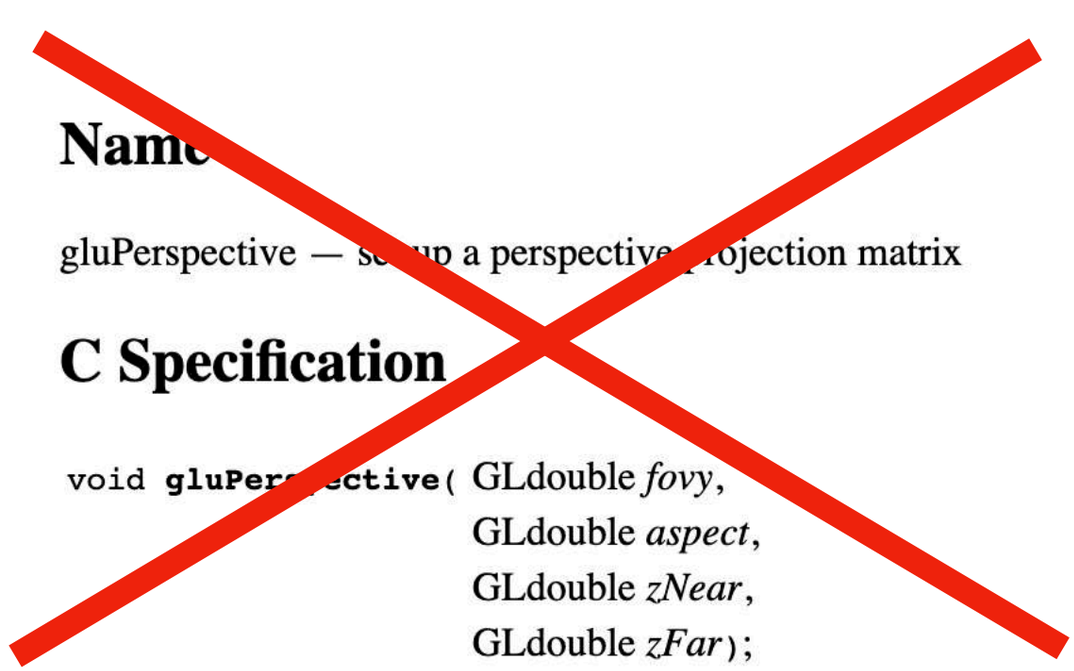


https://cs184.eecs.berkeley.edu/sp18/lecture/simulation/slide_010

GAMES101 is NOT about

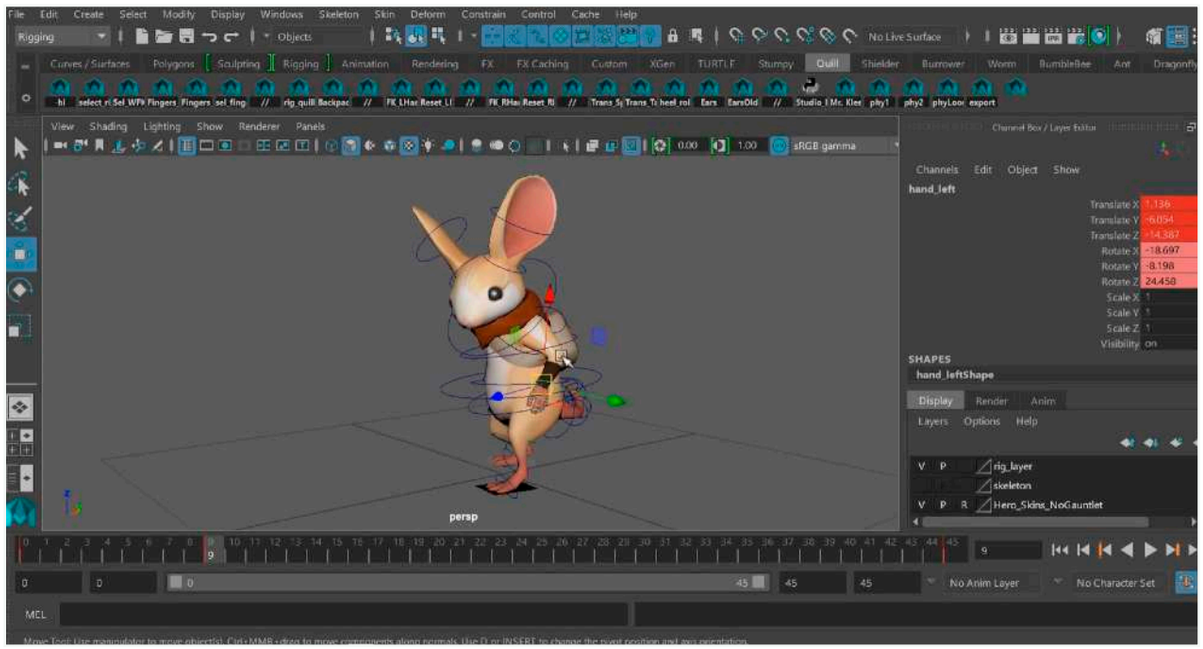
- Using OpenGL / DirectX / Vulkan
- The syntax of Shaders

- We learn Graphics, not Graphics APIs!
- After this course, you'll be able to learn these by yourself (**I promise**)



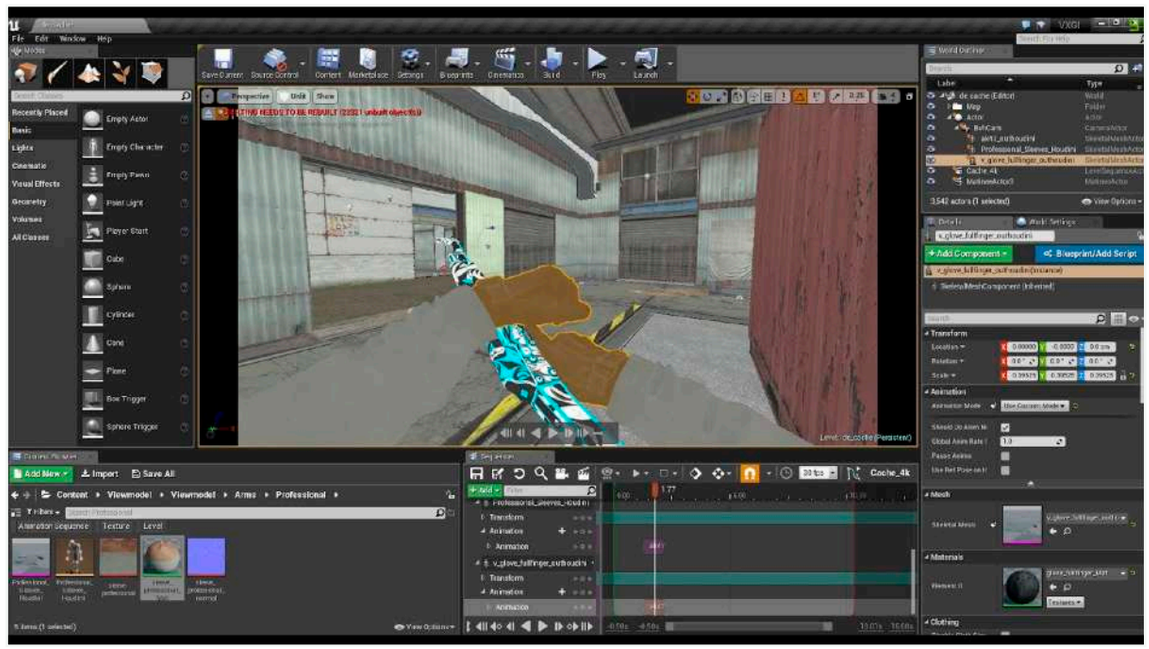
GAMES101 is NOT about

- 3D modeling using Maya / 3DS MAX / Blender, or VR / game development using Unity / Unreal Engine (where can I learn them?)



Modeling character animation in Maya

[http://tutorials.cgrecord.net/2017/08/17-minute-animation-process-in-autodesk.html]



CSGO PoV Cam set up in Unreal Engine

[https://www.youtube.com/watch?v=3TQ18SmQSw0]

GAMES101 is NOT about

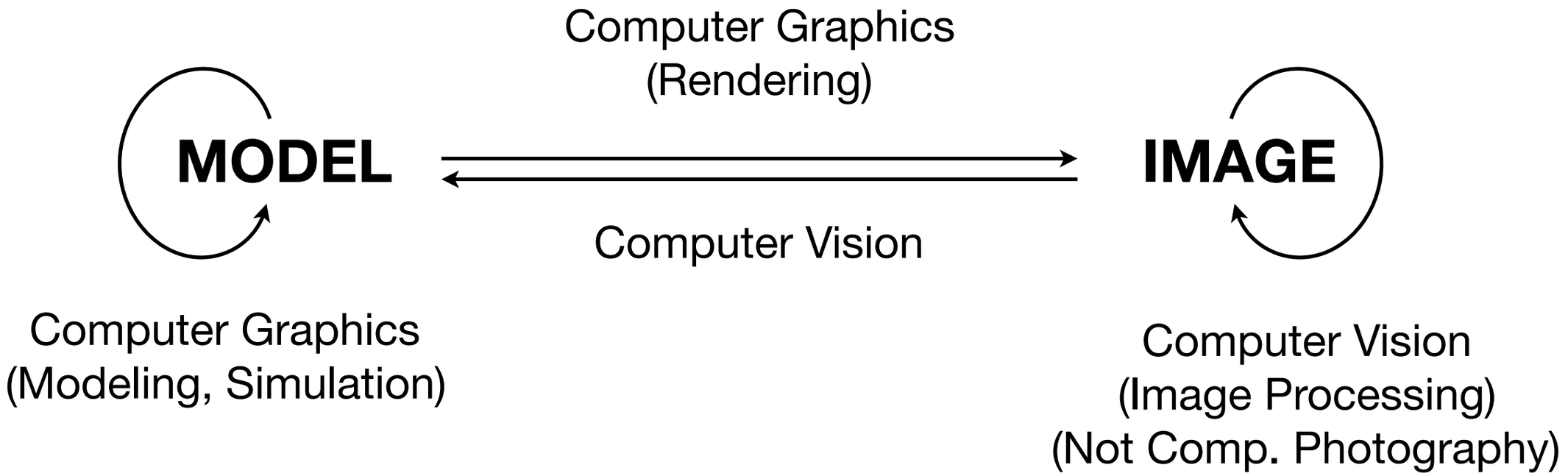
- Computer Vision / Deep Learning topics, e.g. XYZ-GAN (where can I learn them?)

Semantic Segmentation
https://modeldepot.io/oandrienko/icnet-for-fast-segmentation

GAN 2.0: NVIDIA's
face generator (both are fake)

Differences?

- Personal Understanding



- No clear boundaries

- And I can’t define Computer Graphics

Questions?

Today’s Topics

- What is Computer Graphics?
- Why study Computer Graphics?
- Course Topics
- Course Logistics

General Information

- Modern Course
  - Comprehensive but without hardware programming!
  - Pace / contents subject to change

- Course Website
  - http://www.cs.ucsb.edu/~lingqi/teaching/games101.html
  - Has all the needed information
  - Syllabus, slides, reading materials, etc.

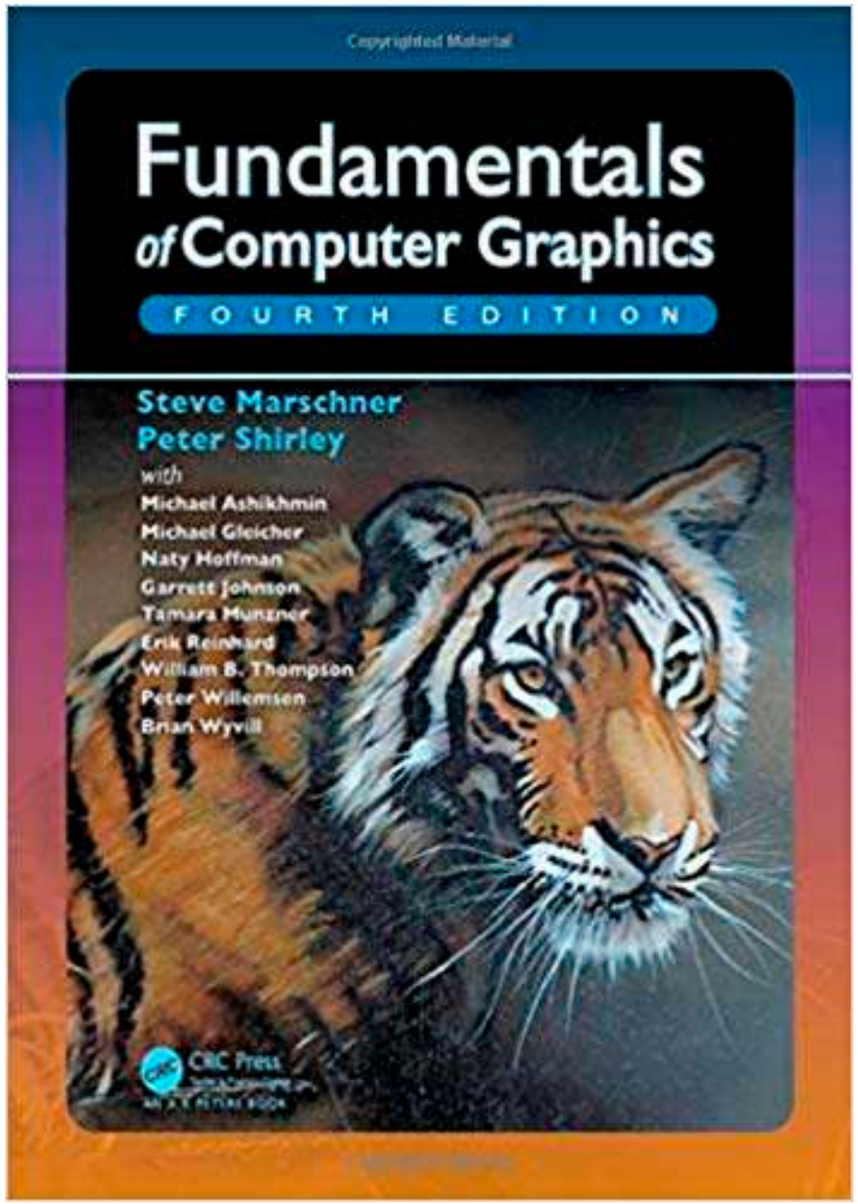
Course Website

- Course slides and (pre)-reading materials

Week	Date	Topics
1	Jan 7	**Overview of Computer Graphics** [PDF]
	Jan 9	**Vectors and Linear Algebra** Reading: Chapter 2 (Miscellaneous Math) and Chapter 5 (Linear Algebra)

References

- No Required Textbooks
  - Reading materials (if any) will available online before lectures
  - Lecture slides will be available after class
- Most recommended reference
  - Steve Marschner and Peter Shirley, "Fundamentals of Computer Graphics", 3rd or later edition.



Q & A

- Sign up on our BBS for discussion (http://games-cn.org/forums/forum/games-online-course-forum/)

Assignments

- Assignments
  - Mostly programming tasks with provided code skeletons and virtual machine image
  - Weekly (usually no more than 20 lines of code per week)
  - Language: C++
- Submission
  - Submit your project by 11:59PM on/before the due dates (strictly enforced)
  - Feedback will be provided in a week

Assignments

- Assignment Submission Website (http://www.smartchair.org/GAMES2020Course-YLQ/)

- No Exams

- Course Project / Final Project
  - Starting midway of this course
  - References will be provided, but you decide the topic
  - Best work will be posted online for showing off

Use An IDE!

- IDE: Integrated Development Environment
- Helps you parse a entire project
  - And gives hints on syntax / usages of member functions, etc.
- Recommended IDEs
  - Visual Studio (Windows only) / Visual Studio Code (cross platform)
  - Qt Creator (personal)
- Not Recommended IDEs (for C++ programming)
  - CLion, Eclipse
  - Sublime Text, Vi / Vim, Emacs (not even IDEs)

Academic integrity

- Work alone for regular assignments
  - no copy-pasting from any other sources
- Do not publish your code (on Github, etc.) for assignments using our skeleton code
- Do not post your solution online
  - Discussion / explanation is welcomed

Questions?

Thank you!