Lecture 1:

Introduction

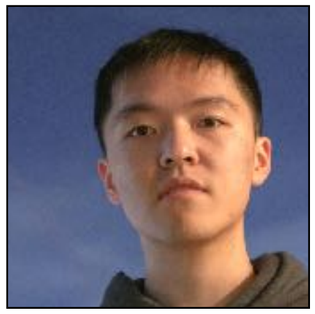
Computer Graphics and Imaging
UC Berkeley CS184/284A

Welcome to CS184 / 284A!

Prof. Ren Ng

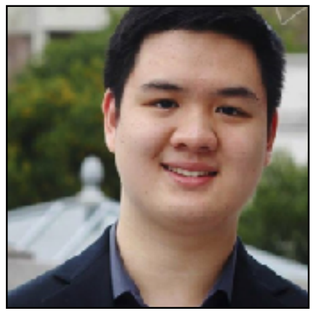
- Ph.D. 2006 on Digital Light Field Photography (evolving camera design using graphics technology)
- Founder of Lytro, a light field camera company
- Research interests: computational imaging systems, computer graphics, computer vision, human vision
- Fun fact: born Malaysian, became Australian, naturalized American

Welcome to CS184 / 284A!



Cheng Cao

Gabby Delforge

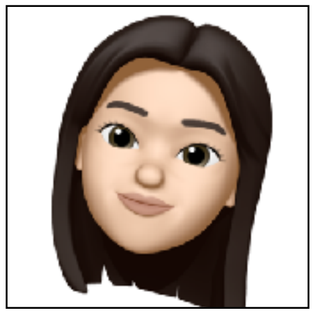


Randy Fan

GSR

Karthik Gopalan

Anup Hiremath



Iris Li

Jessica Lee

Seth Lu

20 HOUR

Vivien Nguyen

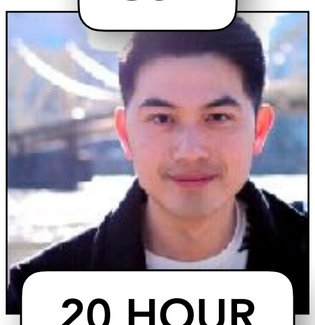
20 HOUR

Varsha Ramakrishnan

Henry Sun

Rishi Upadhyay

GSR



20 HOUR

Eric Yao

https://cs184.eecs.berkeley.edu/sp20/staff

Your Names: An Important Request

We want to get to know you

It starts with your names

We want to remember, but there are many of us

Please help us with this rule:

- Every time you participate in class, section, office hours, please remind us your name.

Example: “Hi, this is Susan. My question is about…”

Thank you very much!

CS184/284A: Computer Graphics & Imaging

Why Study Computer Graphics?

Course Overview

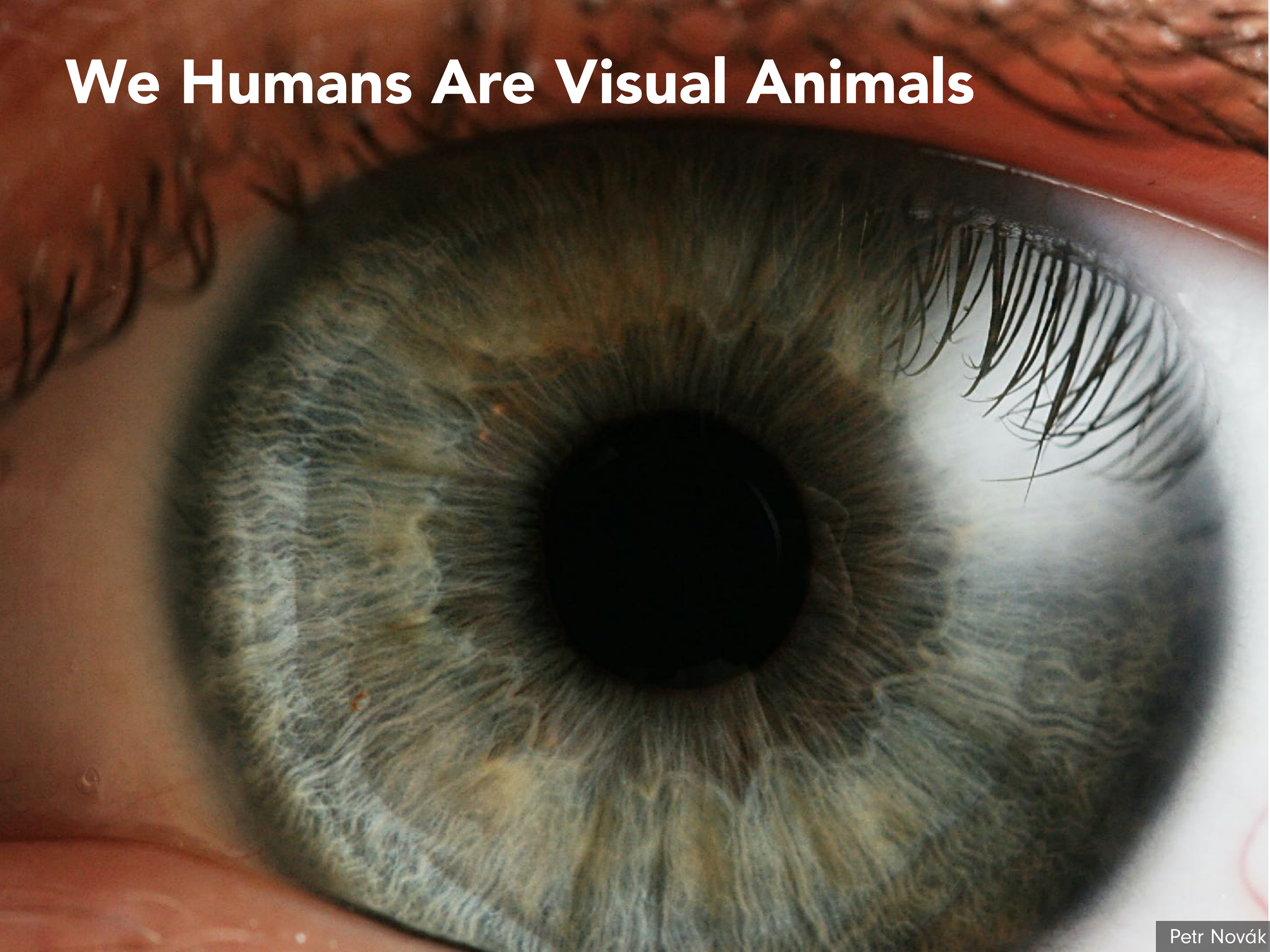
Logistics

What is Computer Graphics?

com•put•er graph•ics /kəmˈpyo͞odər ˈgrafiks/ n.
The use of computers to synthesize and manipulate visual information.

Why Visual Information?

We Humans Are Visual Animals



Petr Novák

Discussion

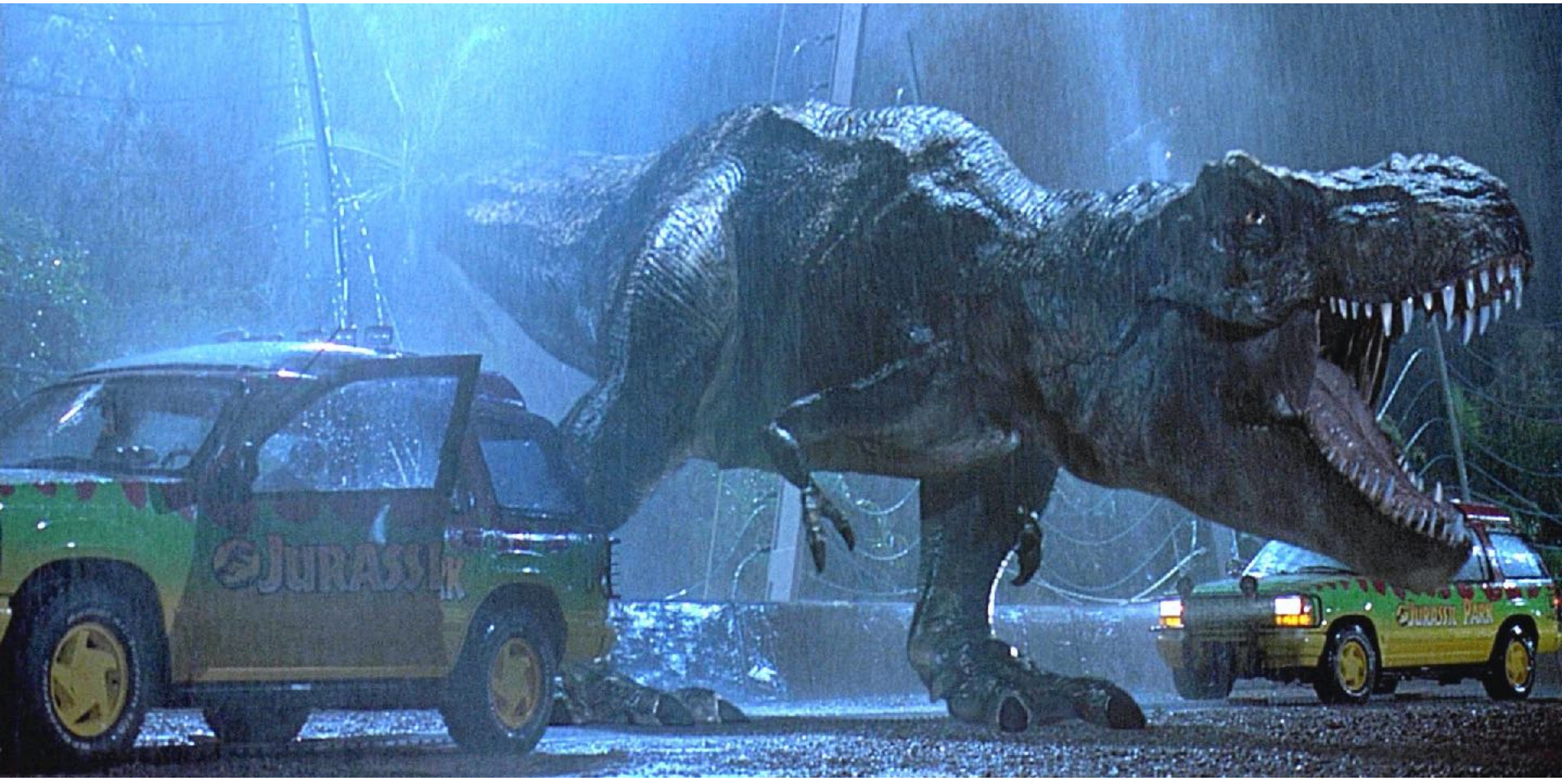
Why are you interested in this course?

What do you want to learn about graphics & imaging?

- Computer games
- Courses that are creativity driven
- Like pretty things
- Would like to articulate things I've seen to others
- Work in VR/AR, want to learn more about lower-level technology
- Arts-science bridge: technology for helping narrative storytelling
- Learn C++ and leverage power of GPUs
- Wants hand-on work to practice to build things
- Animation, image segmentation, advanced techniques
- Visualization -- ways to convey info others
- What do graphics programs use hardware wise?

Why Study Computer Graphics and Imaging?

Movies



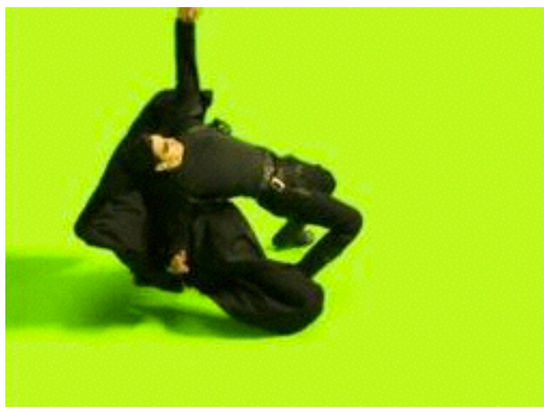
Jurassic Park (1993)

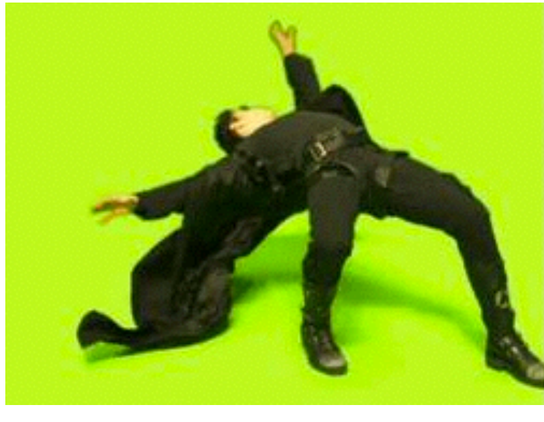
Moments That Changed The Movies: Jurassic Park
https://www.youtube.com/watch?v=KWsbcBvYqN8

Movies

The Matrix (1999)

Movies





The Matrix (1999)

Games

Crysis 3 (2013)

Games

"Adam" Realtime Rendering Demo (Unity 2016)

Product Design and Visualization

Ikea - 75% of catalog is rendered imagery

Product Design and Visualization

Tesla Model X concept (2012)

Product Design and Visualization

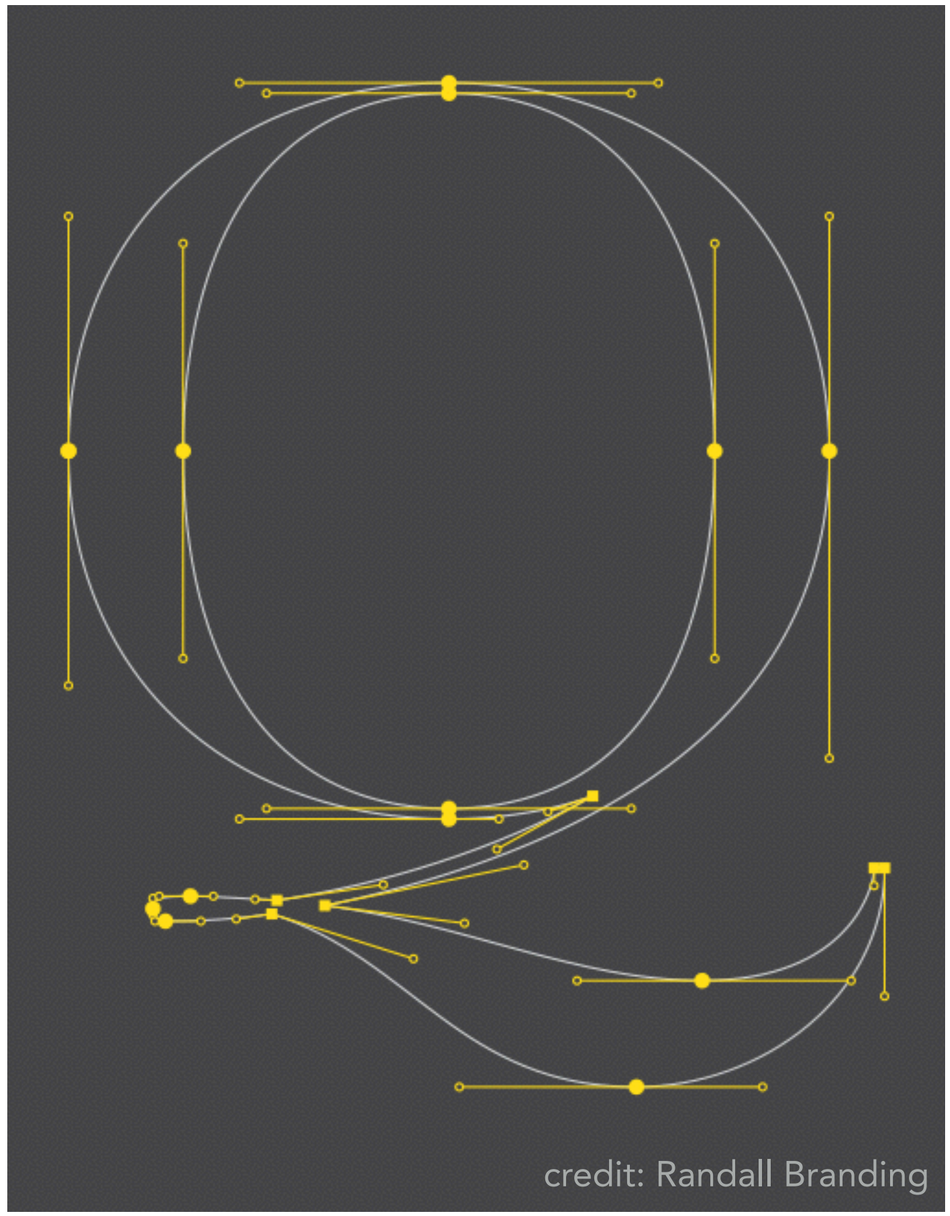
Credit: EV obsession.com, James Ayre

Tesla Model X review

Typography

The Quick Brown Fox Jumps Over The Lazy Dog

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz 0123456789



credit: Randall Branding

Baskerville

Illustration

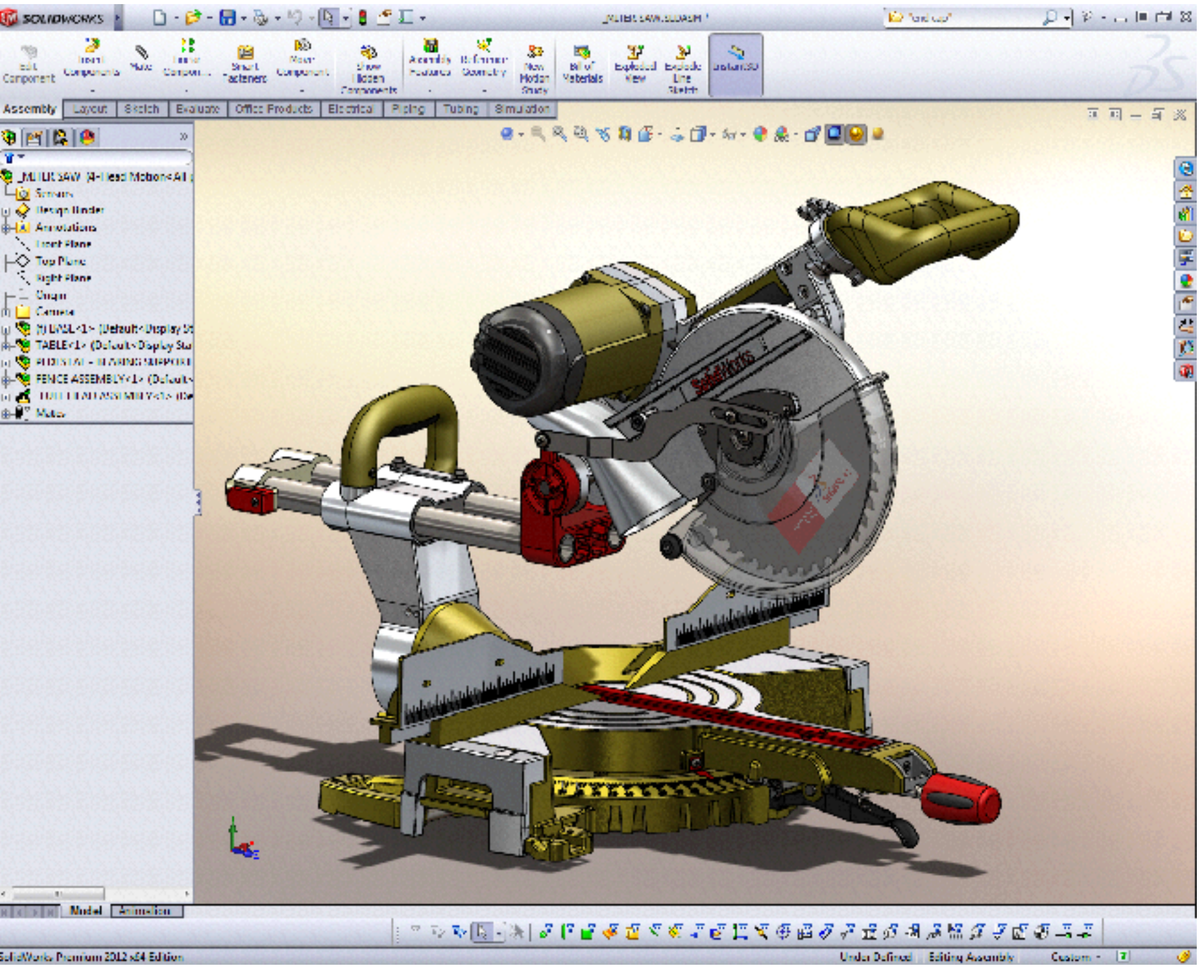
Cave painting c. 36,000 B.C.

Digital Illustration

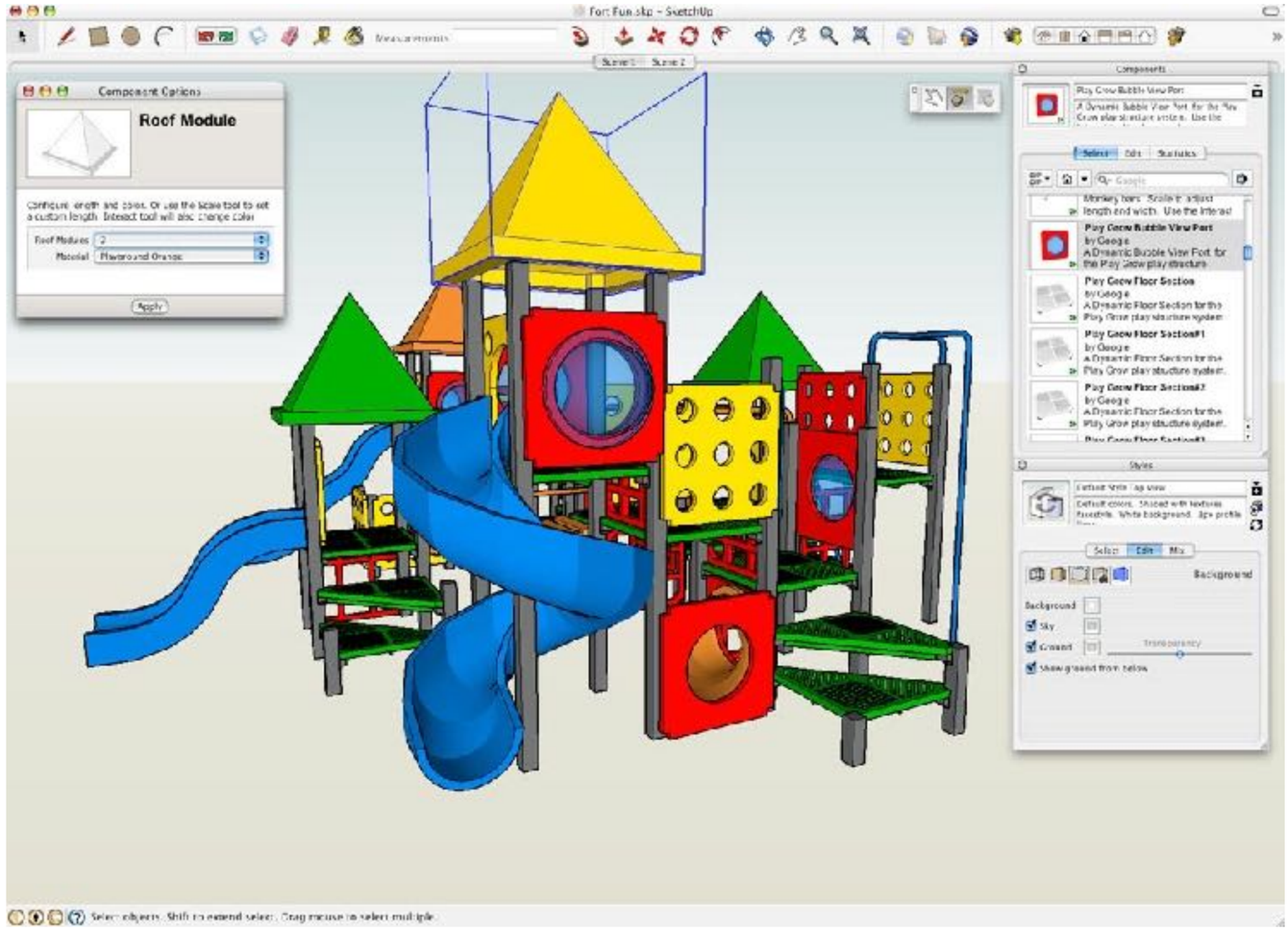
Meike Hakkart

http://maquenda.deviantart.com/art/Lion-done-in-illustrator-327715059

Computer-Aided Design



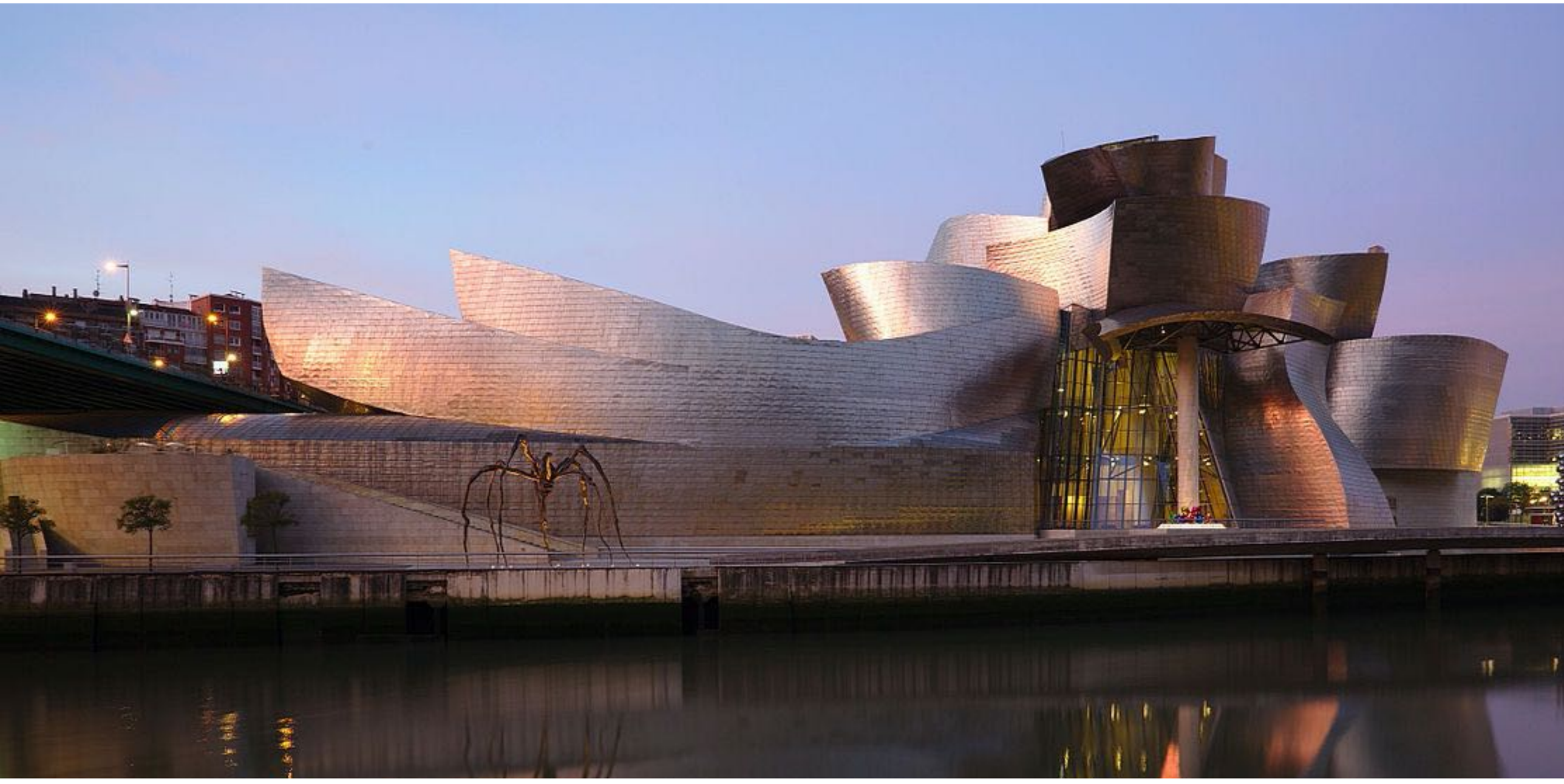
SolidWorks



SketchUp

For mechanical, architectural, electronic, optical, …

Architectural Design

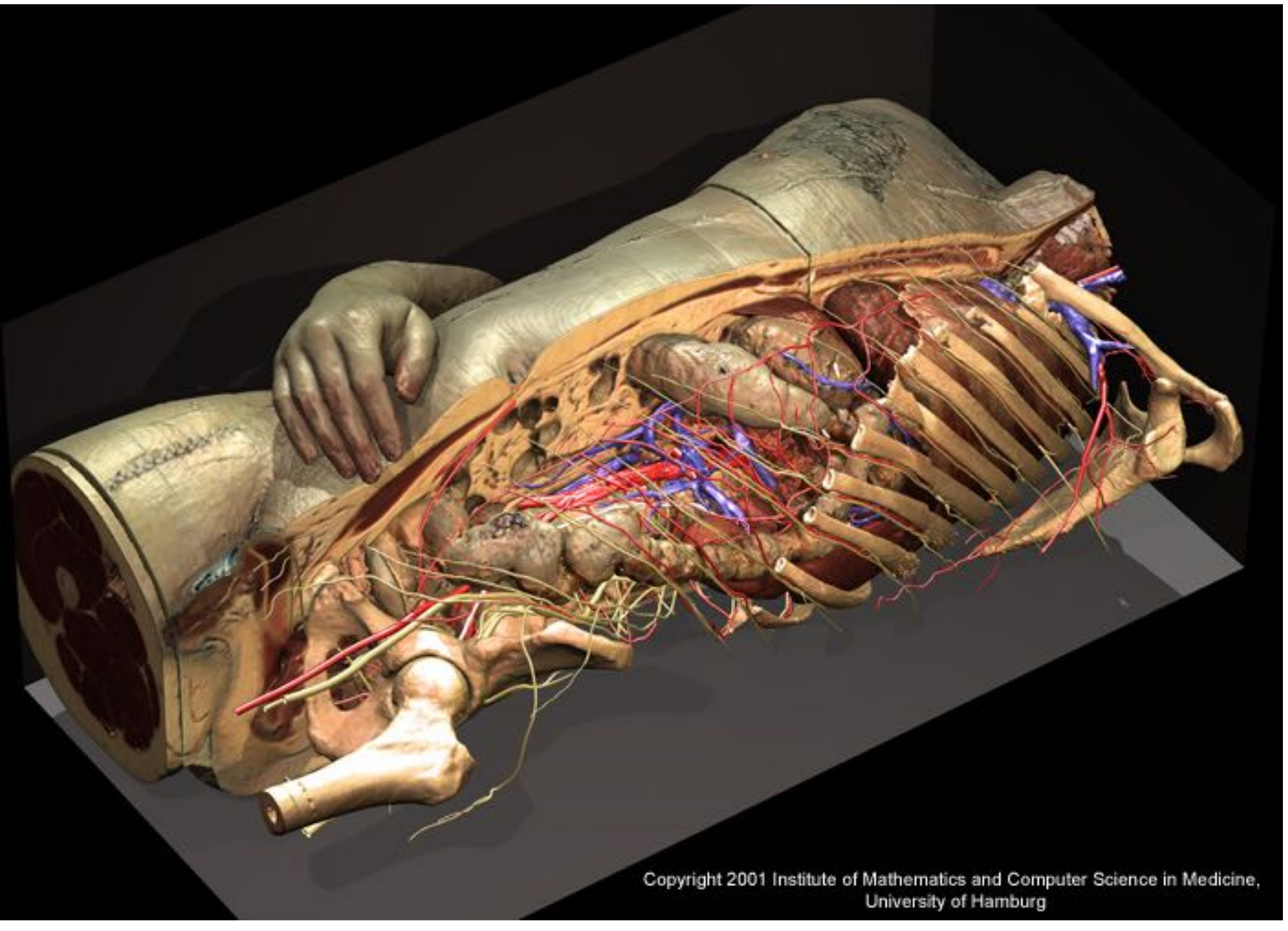


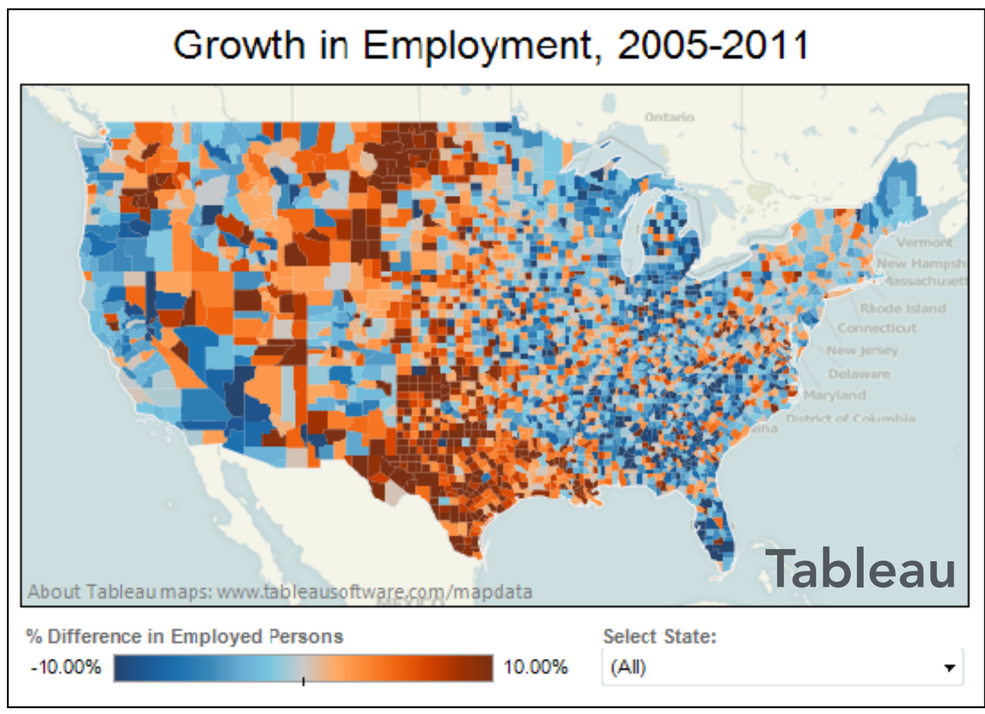
Bilbao Guggenheim, Frank Gehry

Architectural Design

Heydar Aliyev Center, Zaha Hadid Architects

Visualization





Science, engineering, medicine, journalism, ...

Visual Simulation

Driving simulator
Toyota Higashifuji Technical Center

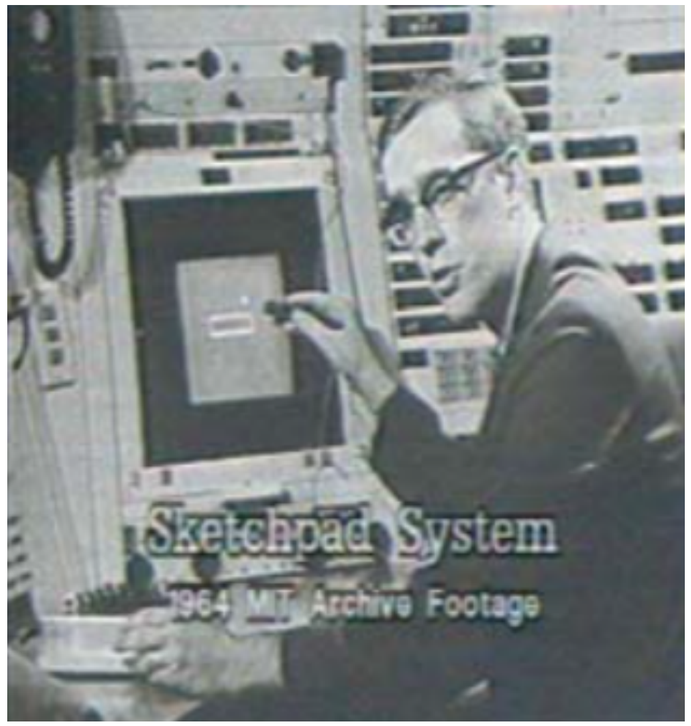
da Vinci surgical robot
Intuitive Surgical

Flight simulator, driving simulator, surgical simulator, …

Graphical User Interfaces

Desktop metaphor

- Input: Keyboard, mouse
- Ouput: Cathode-ray tube



Ivan Sutherland, Sketchpad
Light pen, vector display

Doug Engelbart
Mouse

Graphical User Interfaces

2D drawing and animation are ubiquitous in computing.
Typography, icons, images, transitions, transparency, ...

Graphical User Interfaces

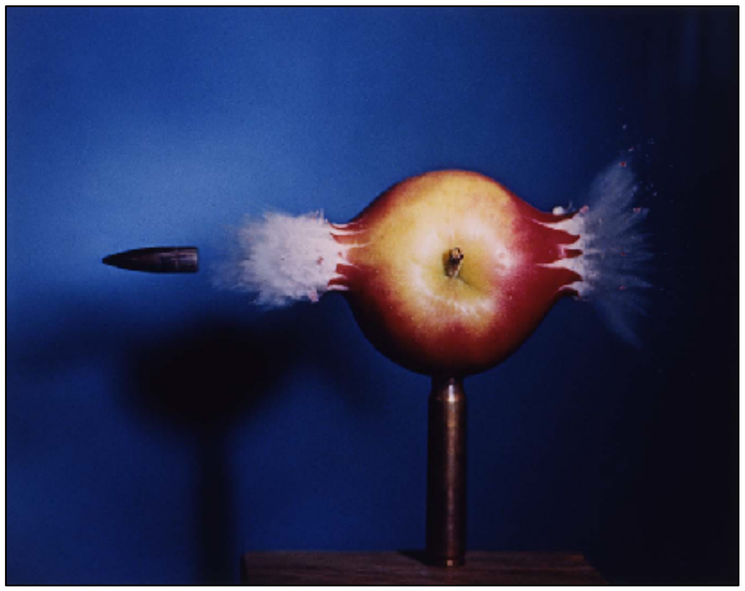
2D drawing and animation are ubiquitous in computing.

Typography, icons, images, transitions, transparency, ...

Graphical User Interfaces

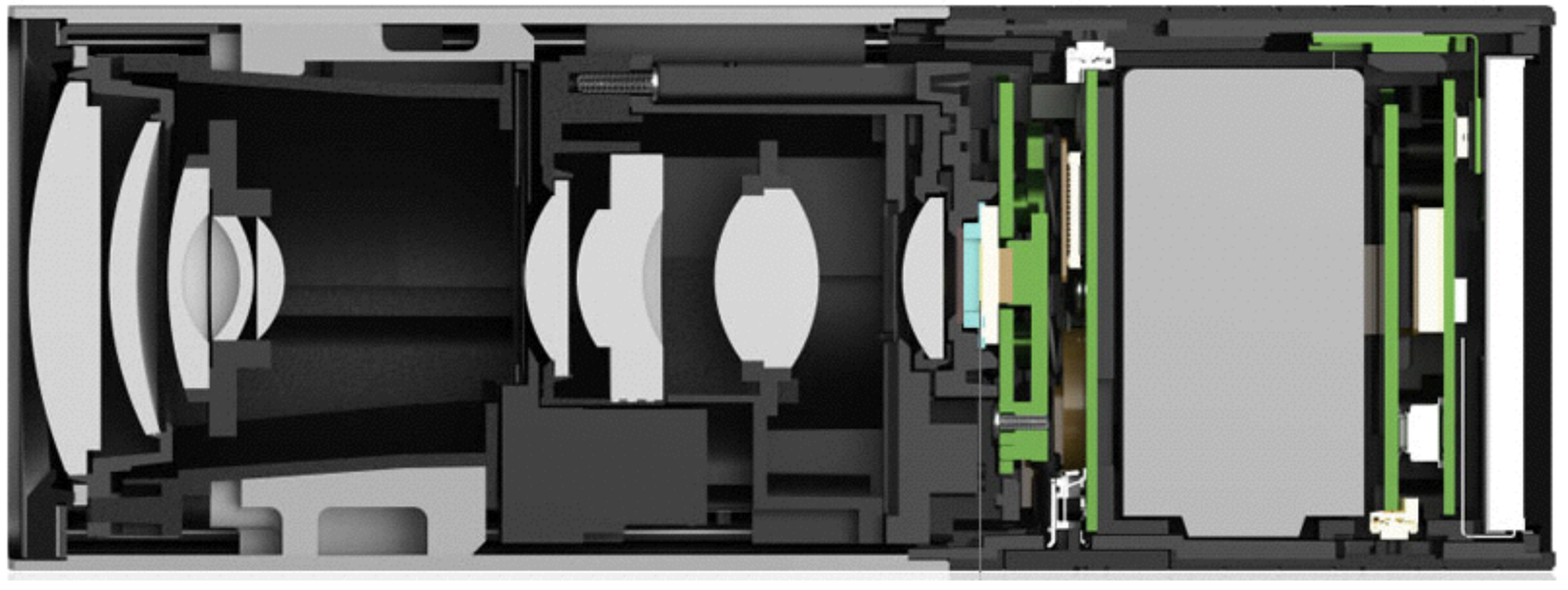
https://www.youtube.com/watch?v=YndL315tQq8

Photography



NASA | Walter Iooss | Steve McCurry
Harold Edgerton | NASA | National Geographic

Digital and Computational Cameras

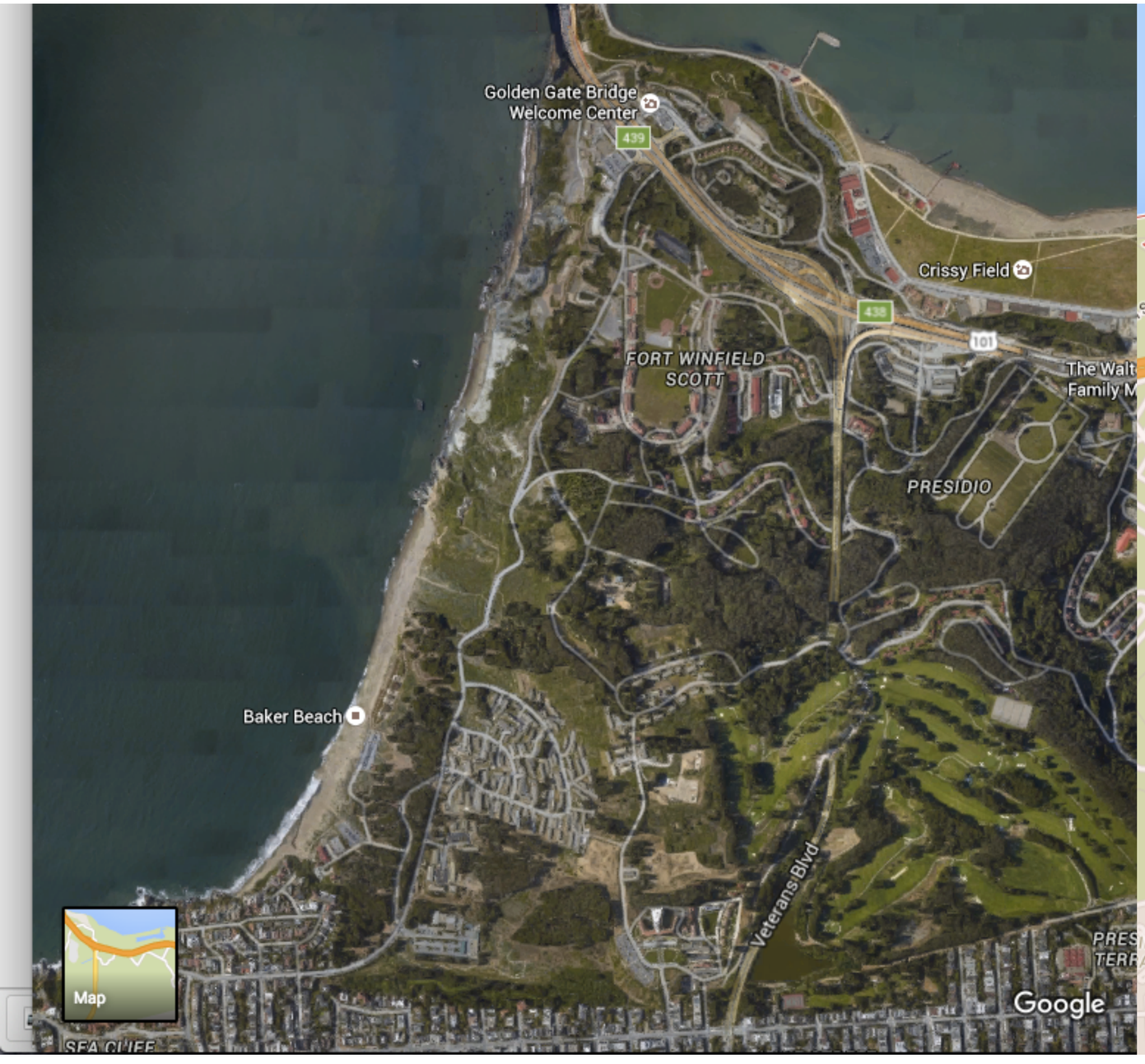


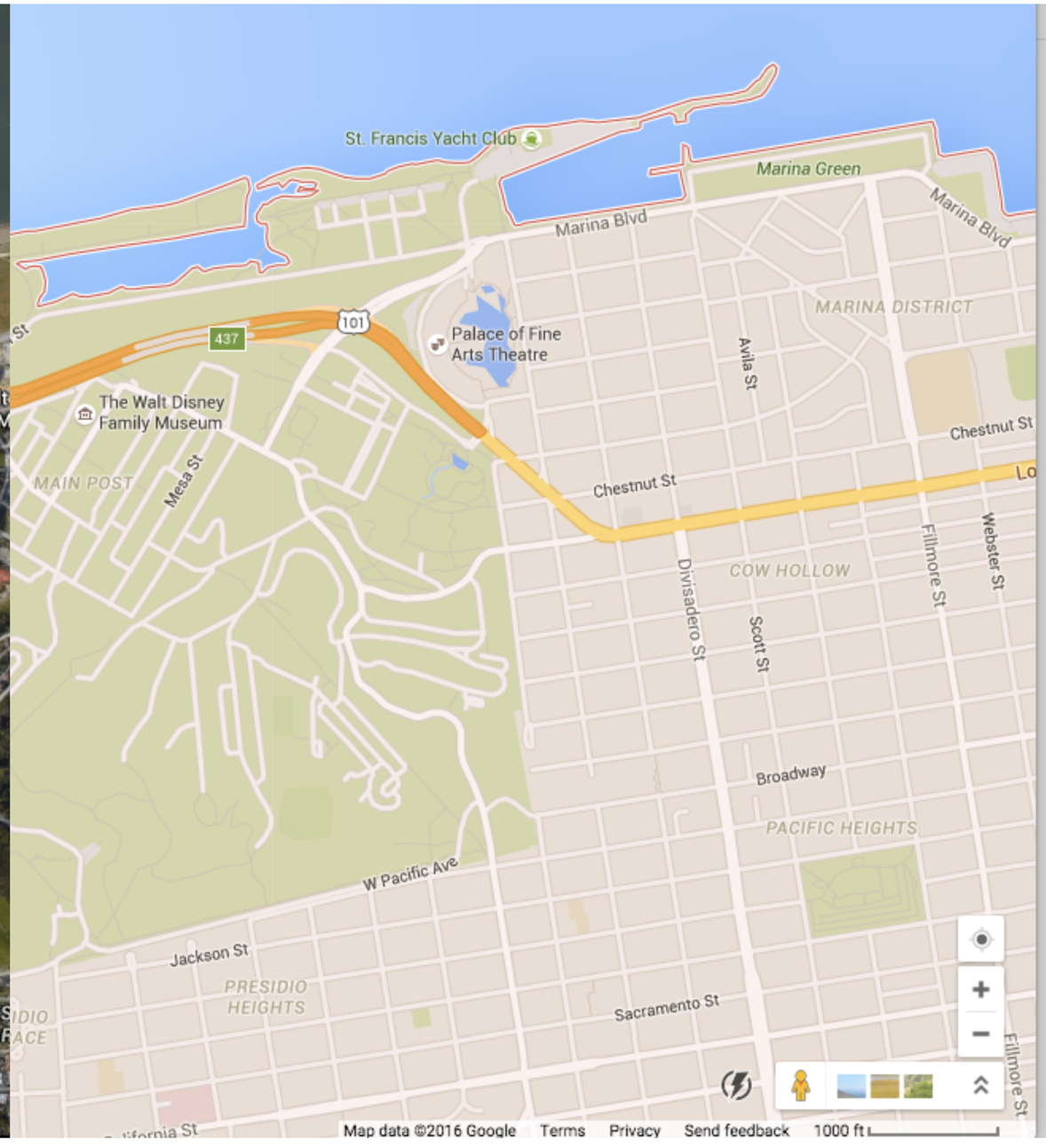
Panaromic stitching, HDR photos, light field cameras, …

Ubiquitous Imaging

Cameras everywhere

Imaging in Mapping





Maps, satellite imagery, street-level imaging,...

Imaging in Mapping

Maps, satellite imagery, street-level imaging,...

Imaging for Computer Vision

ImageNet: 15M images, 22K categories

http://image-net.org

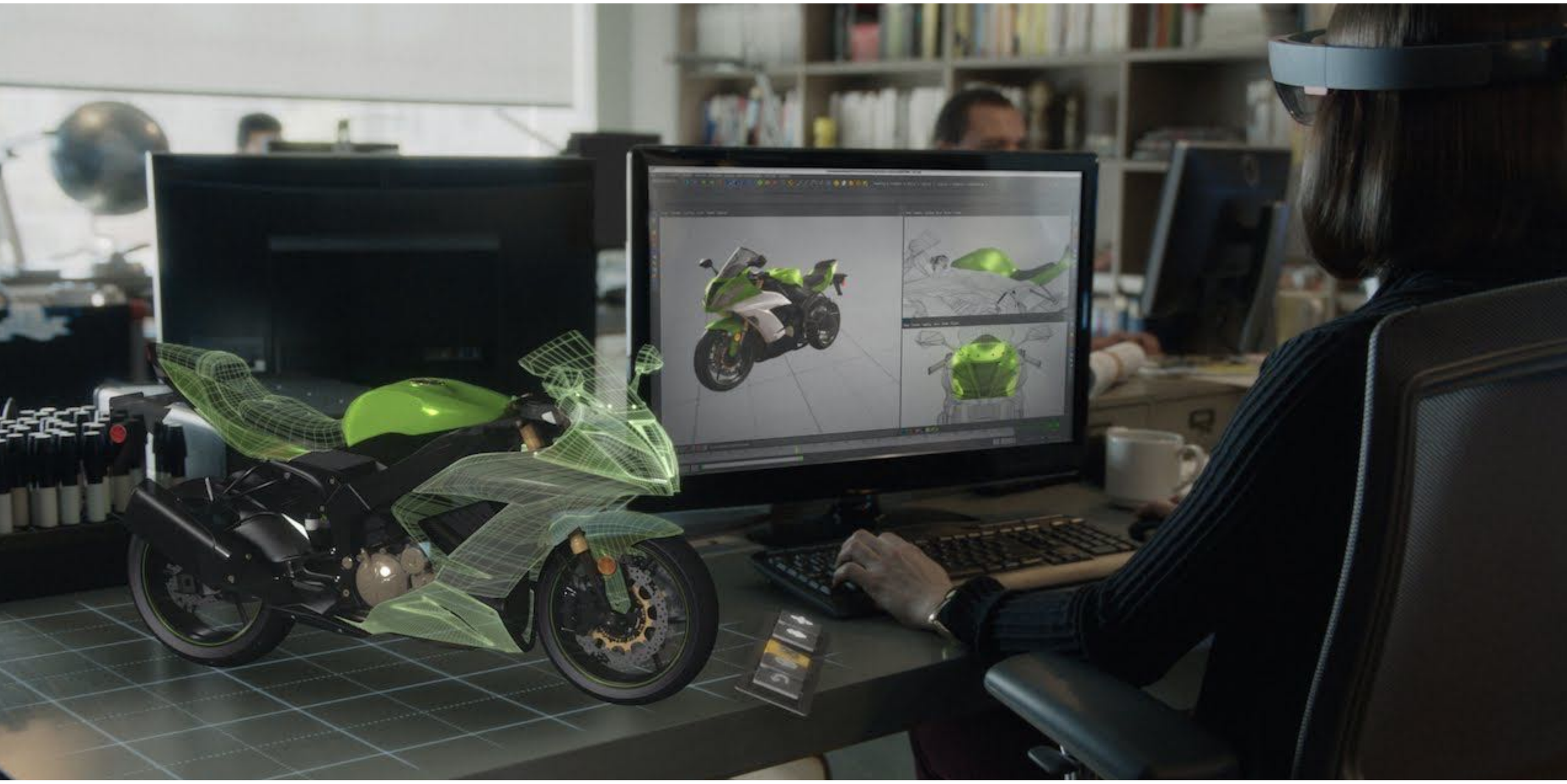
Imaging for Robotics

Google's "Arm Farm"

Virtual Reality

HTC Vive headset and controllers

Augmented Reality



Microsoft Hololens augmented reality headset concept

Foundations of Graphics and Imaging

These applications require sophisticated theory and systems

Science and Mathematics

- Physics of light, color, optics, …
- Math of curves, surfaces, geometry, perspective, …

Technology and Systems

- Input devices, GPUs, displays, …
- Cameras, lenses, sensors, …

Art and Psychology

- Perception: color, stereo, motion, image quality, …
- Art and design: composition, form, lighting, …

Course Goals

Overview of core ideas in graphics and imaging

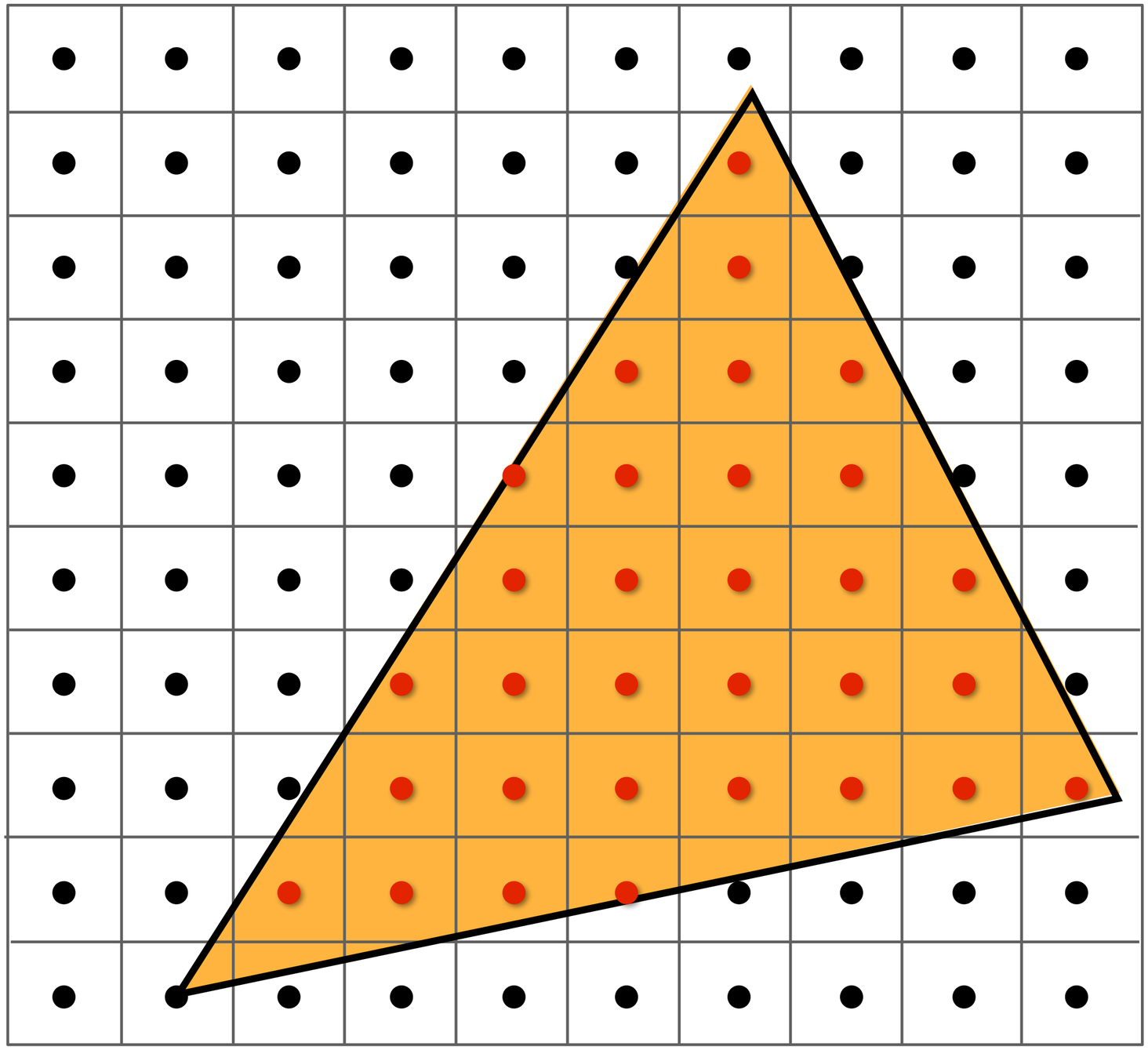
- Modeling the world, image synthesis
- 3D graphics: geometry, rendering, animation
- Image capture, manipulation and display

Acquire core concepts and skills

- Representations (geometry, images, transforms, …)
- Algorithms (sampling, subdivision, ray-tracing, …)
- Technology (GPUs, displays, cameras, …)

Course Topics

Drawing Digital Images (Rasterization)

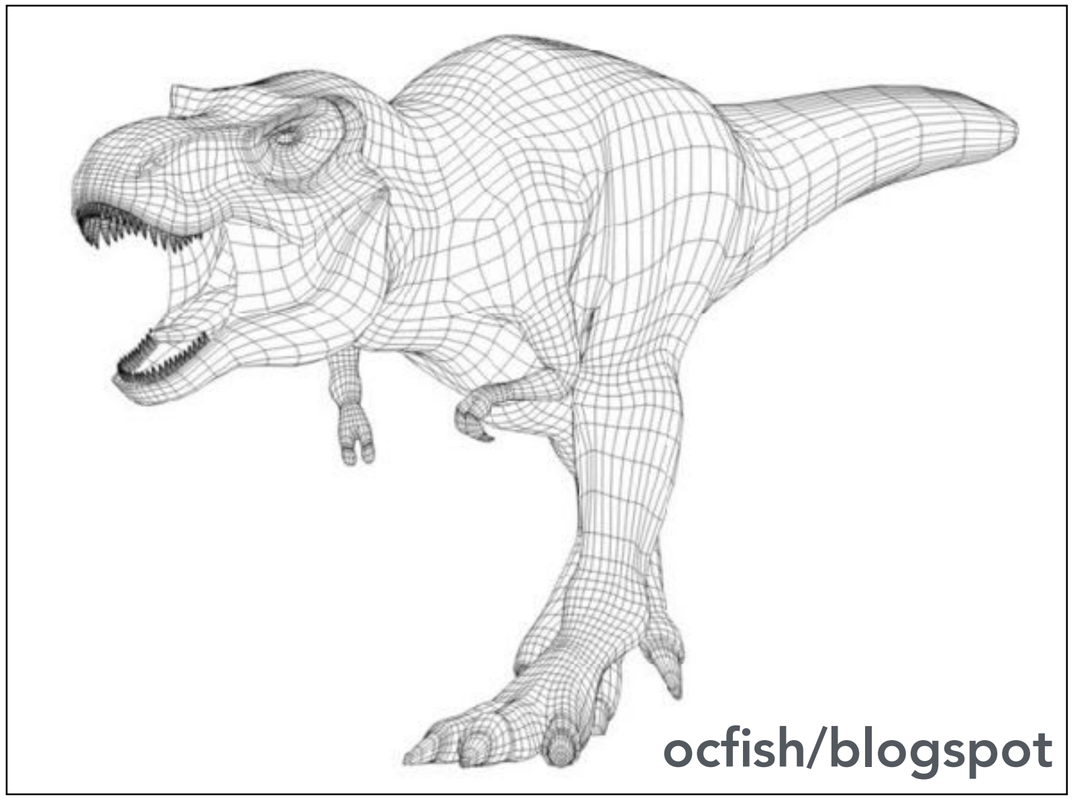


Filtering and Sampling

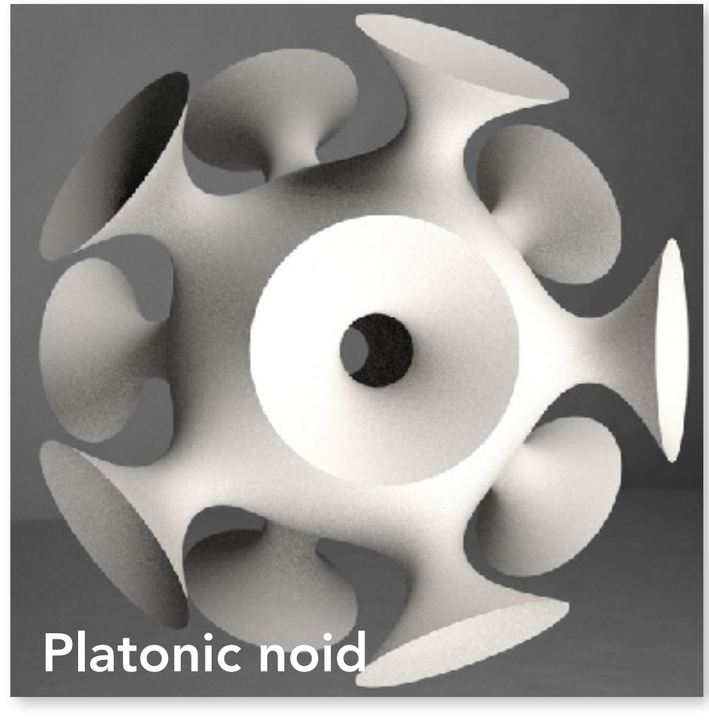
No Jaggies

Modeling Geometry

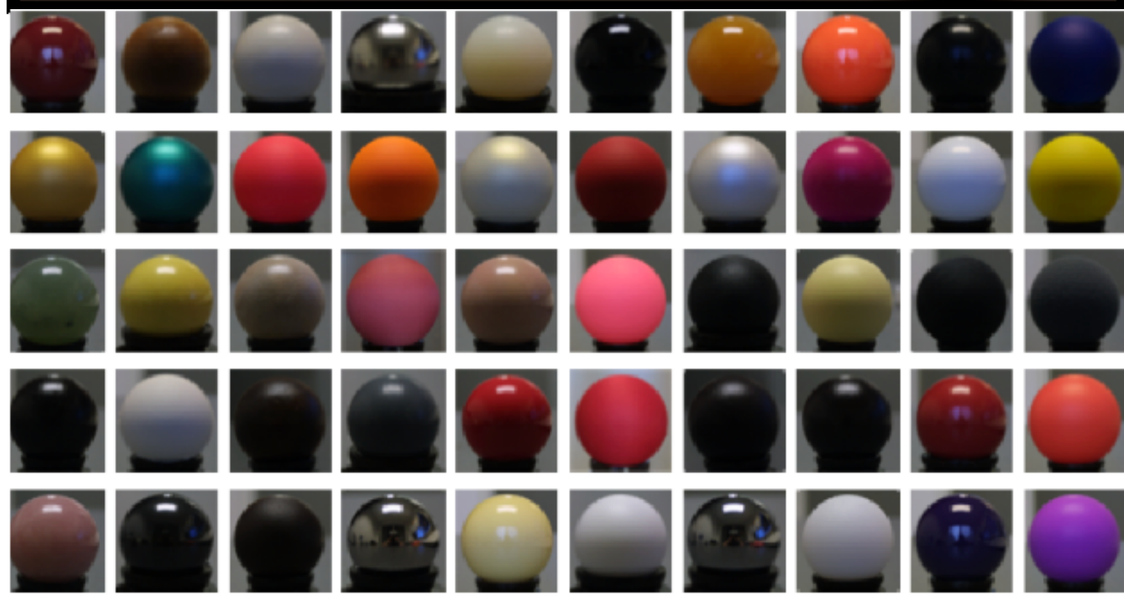

(Stanislav Orekhov)


ocfish/blogspot


[Kaldor 2008]


Platonic noid

Modeling Material Properties



Modeling Lighting

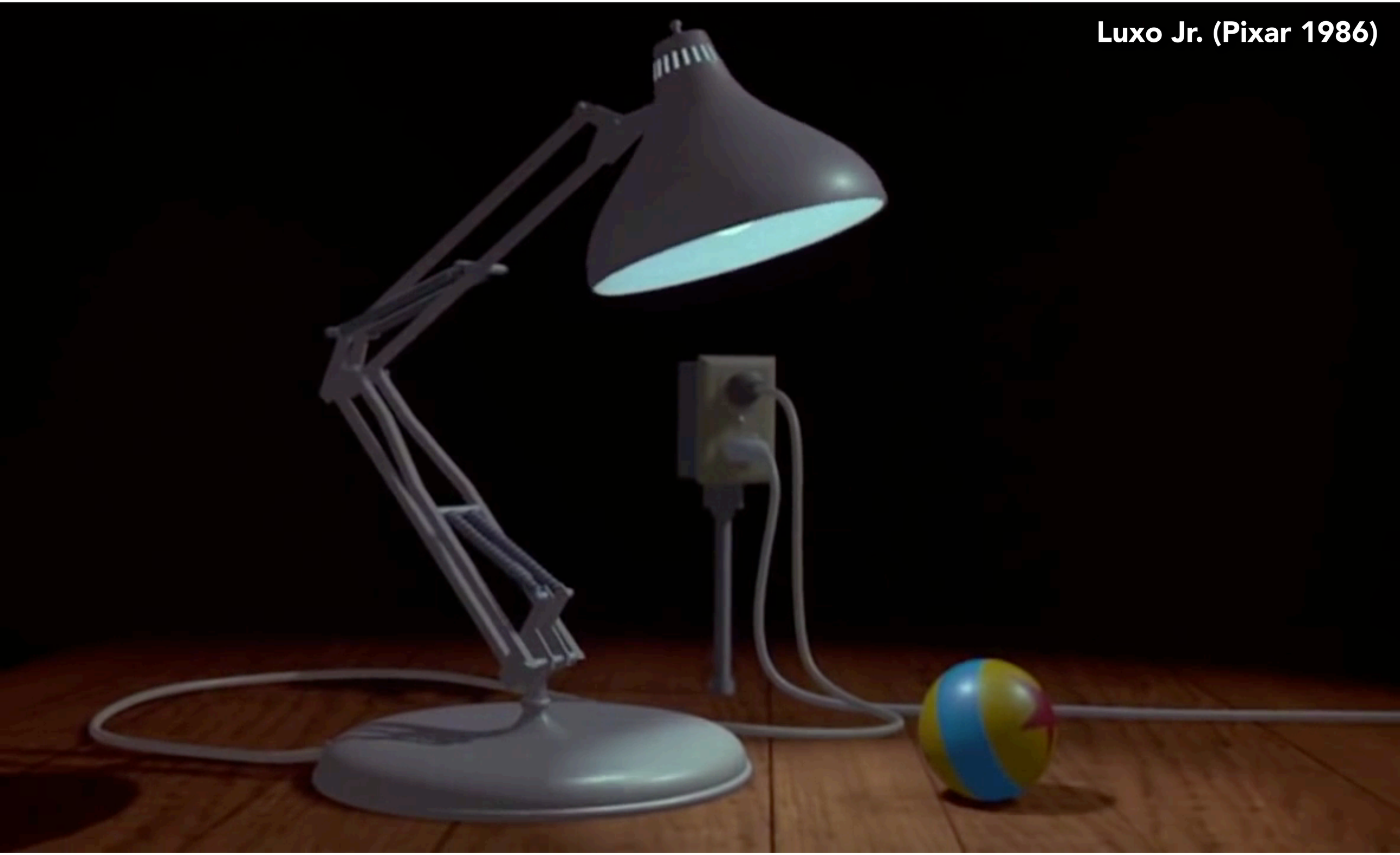
Light Transport and Image Synthesis

Photograph (CCD) vs. computer rendering

How Do Cameras Work?

Glenn Derene, Popular Mechanics

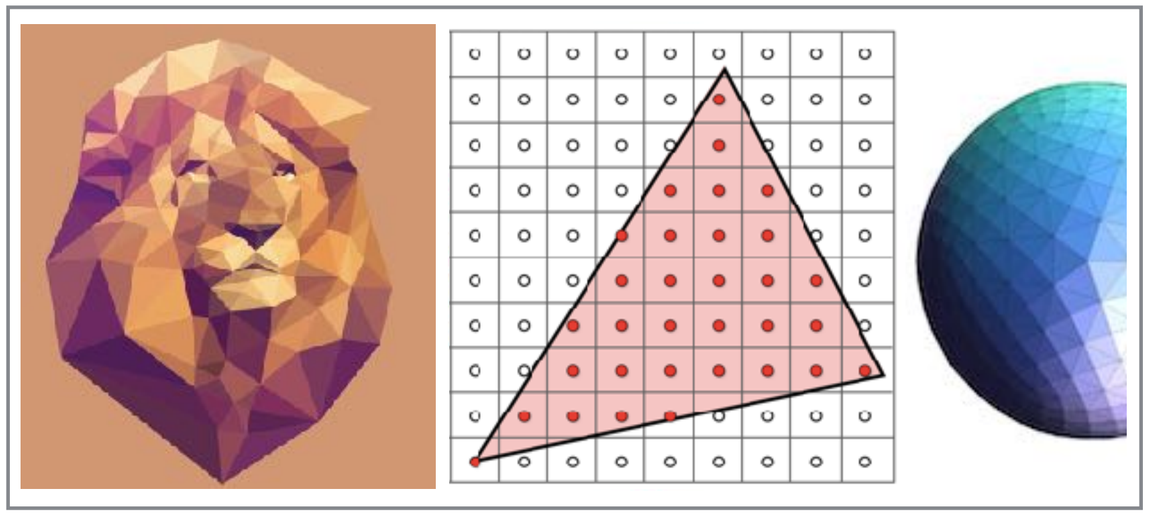
Animation and Physical Simulation



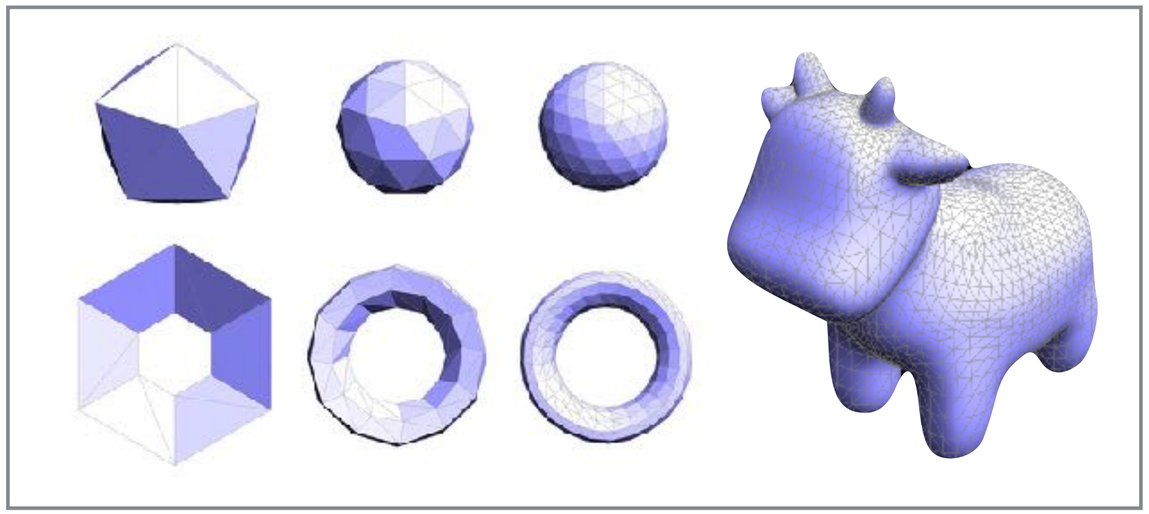
Virtual Reality

Hands-On Learning

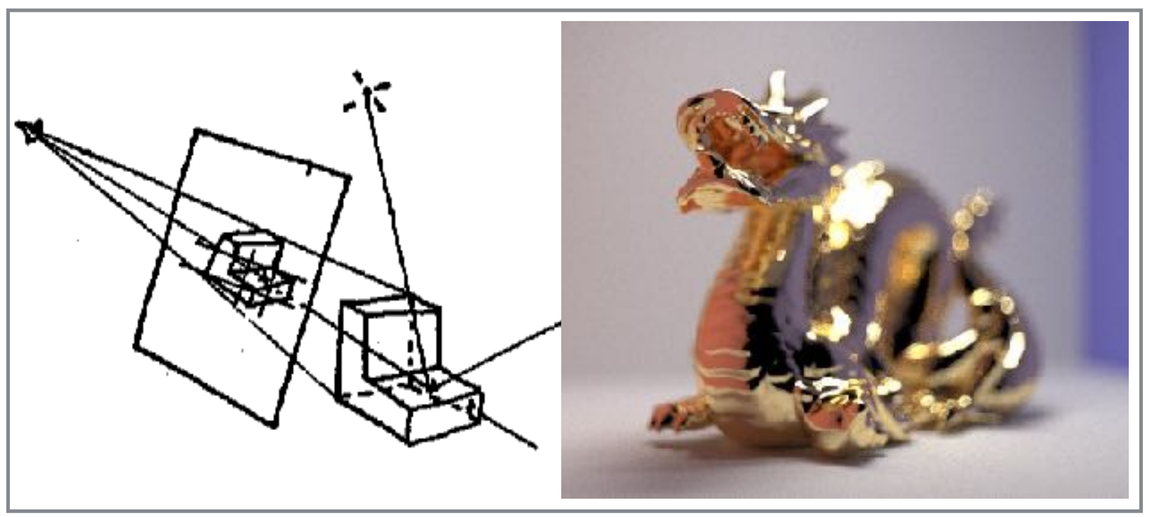
Course Assignments



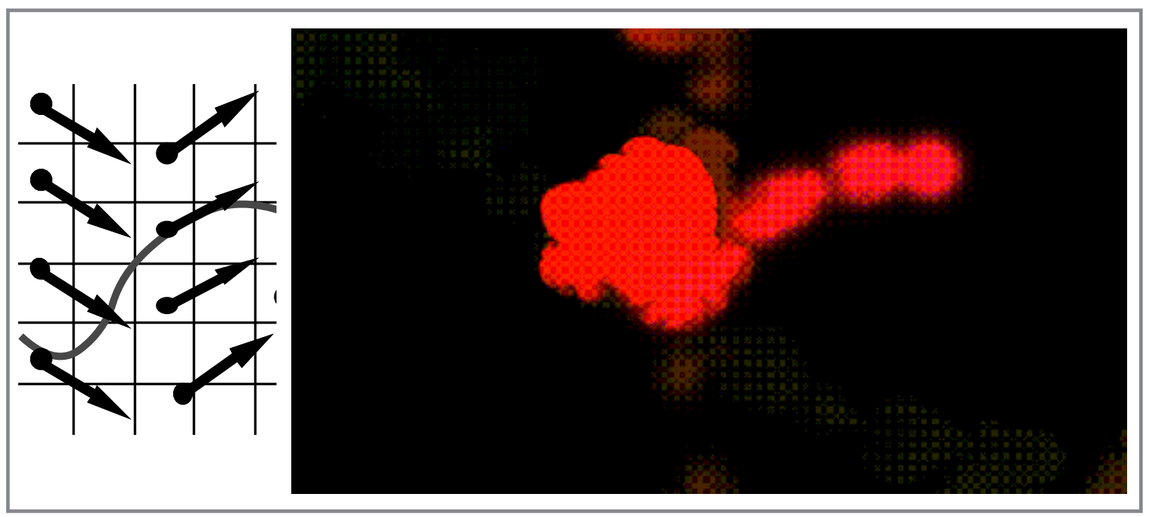
1. Digital Drawing (2 weeks)



2. Geometry (2 weeks)



3. Ray-Tracing (4 weeks)



4. Animation (2 weeks)

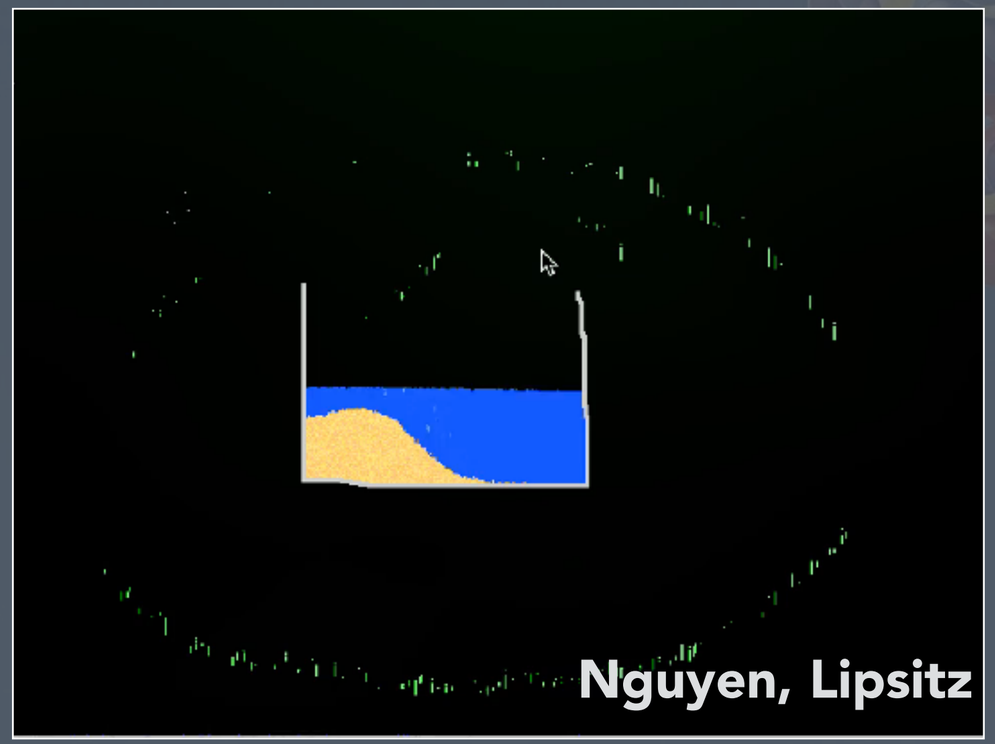
Final Project

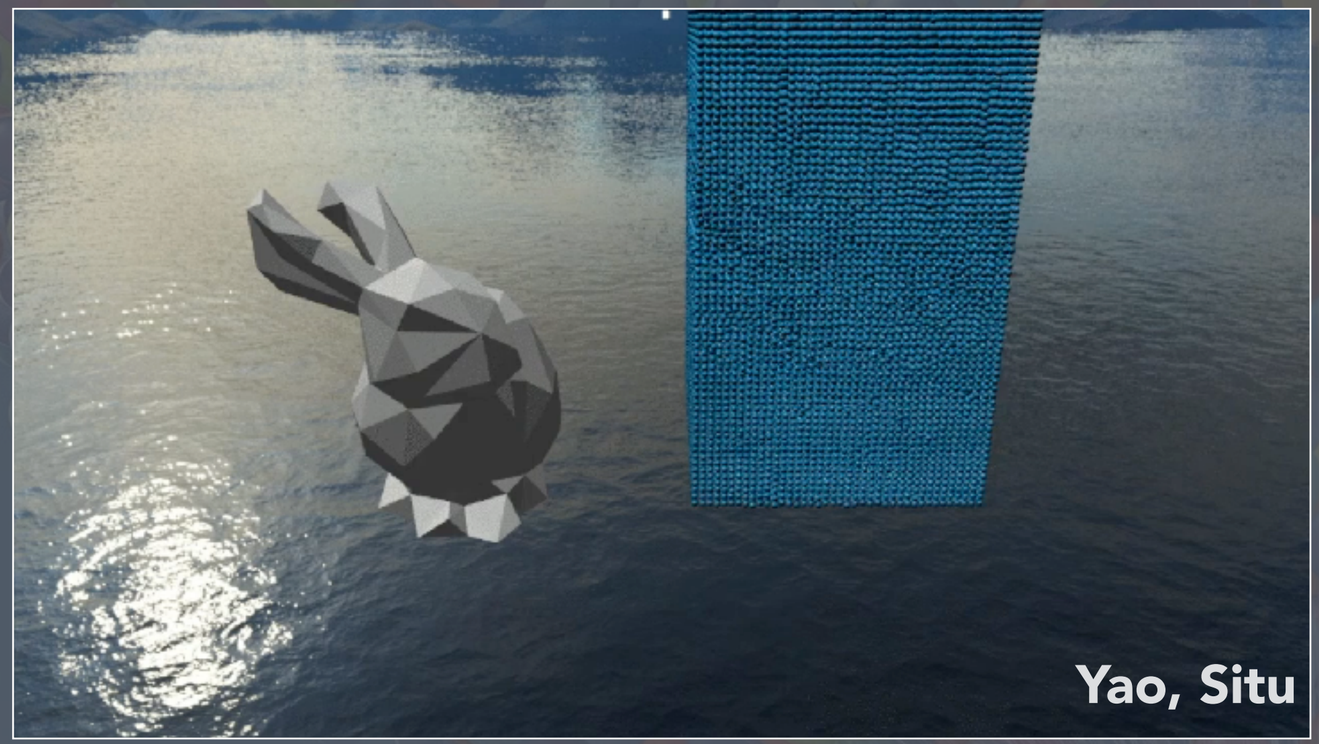
Project Competition

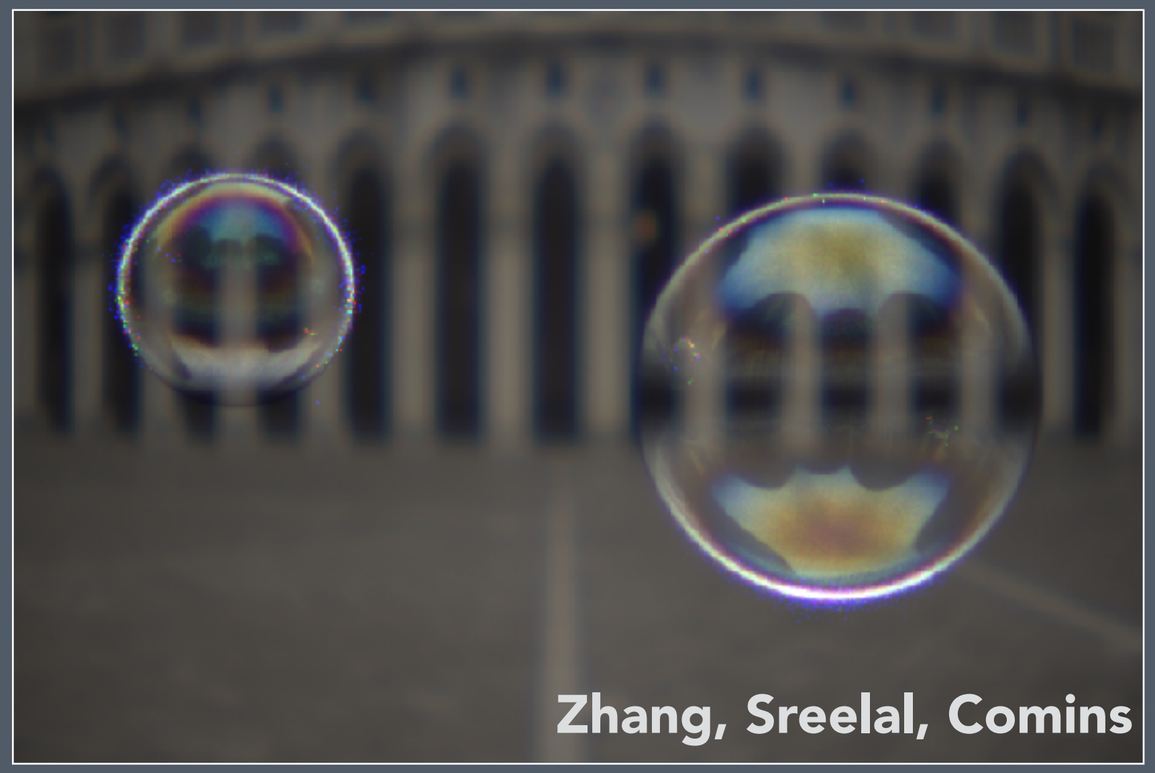
- 4 weeks, let your creativity take flight!
  (we will have suggested projects)
- Proposal; checkpoint; presentation, video, report

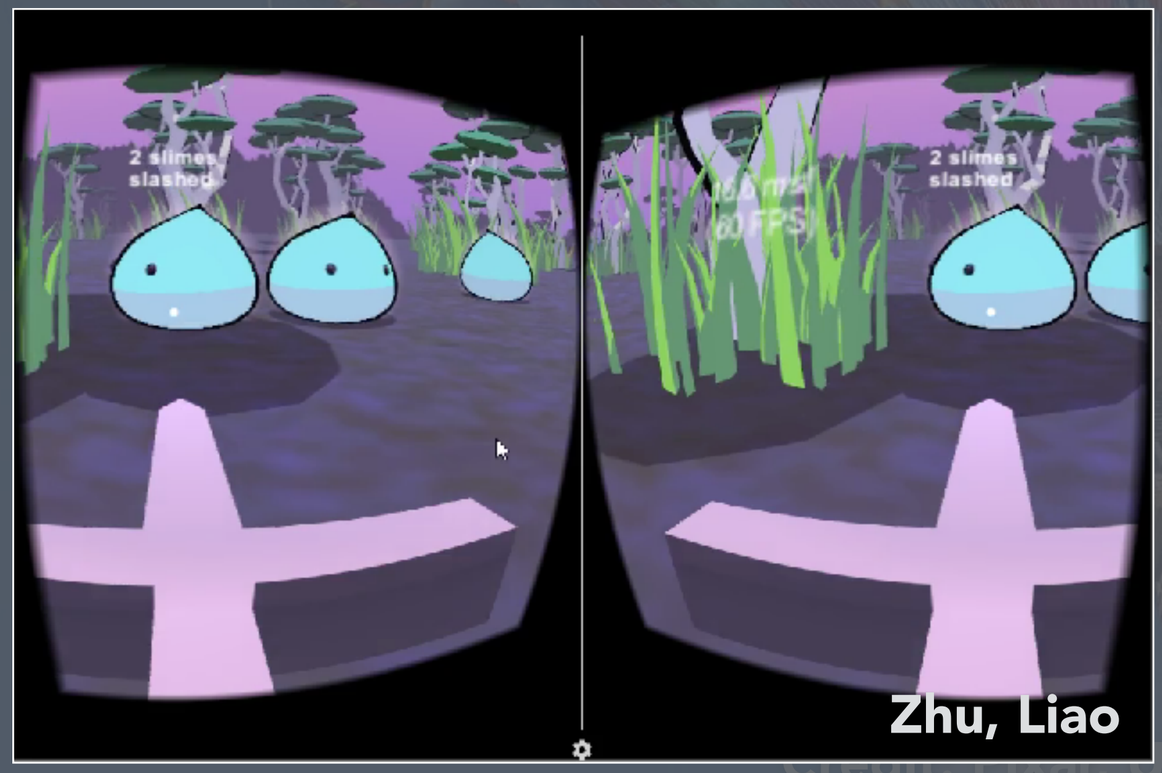
Credit: Pixar, Up

Final Project - Examples

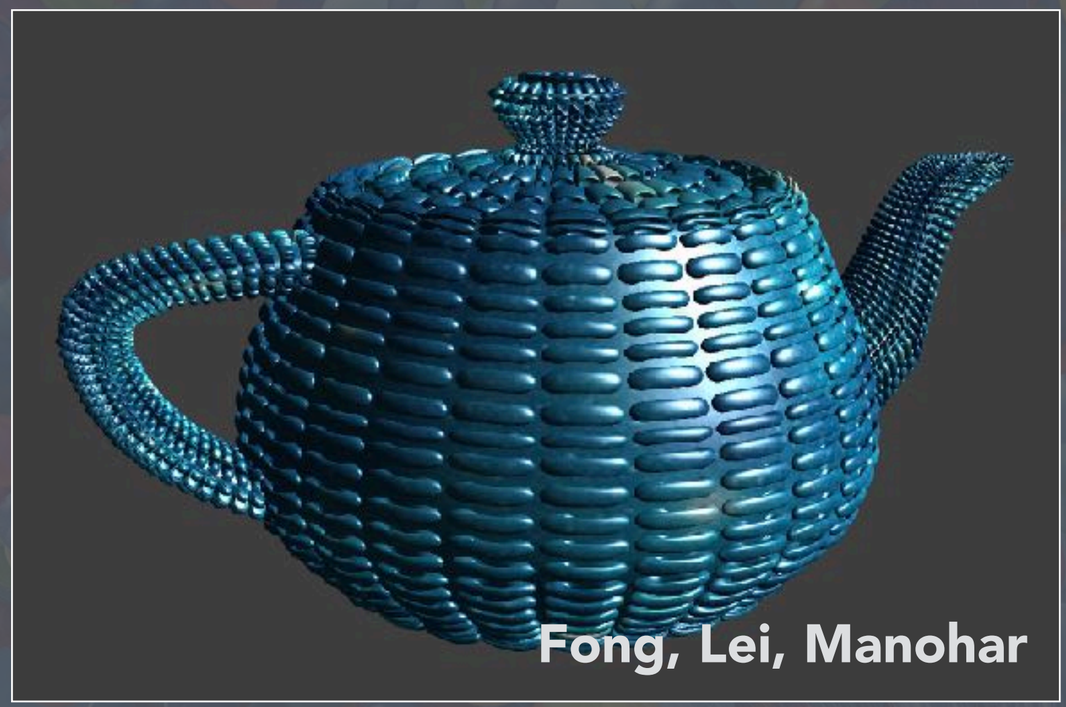


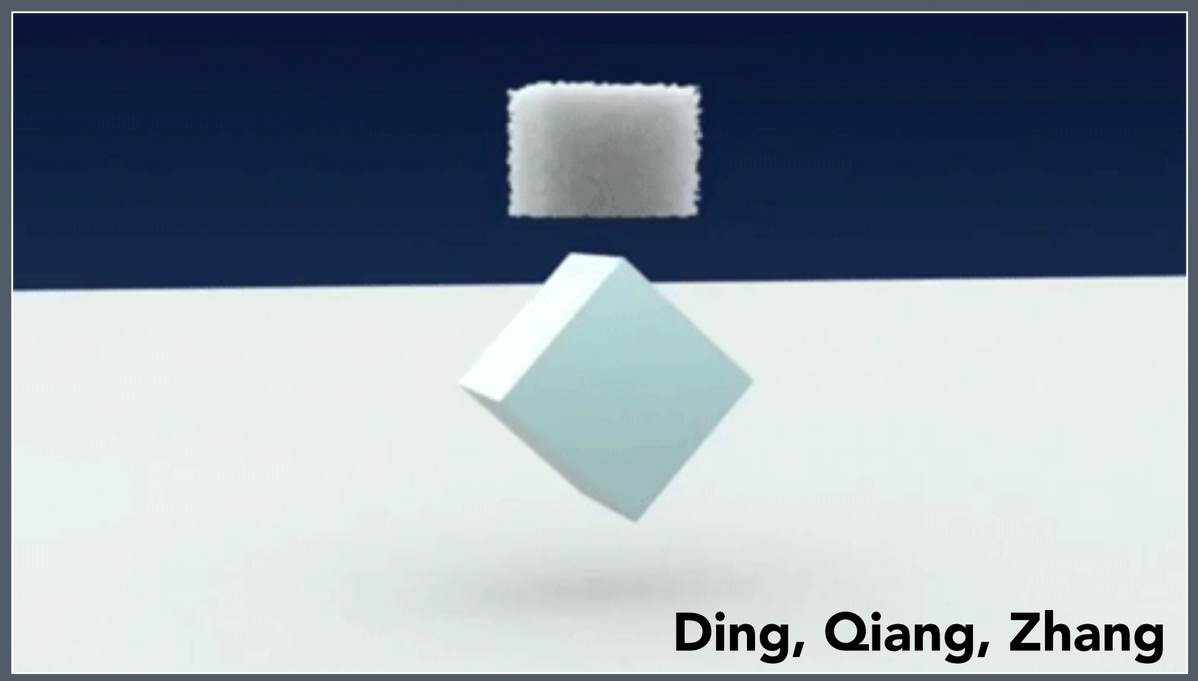


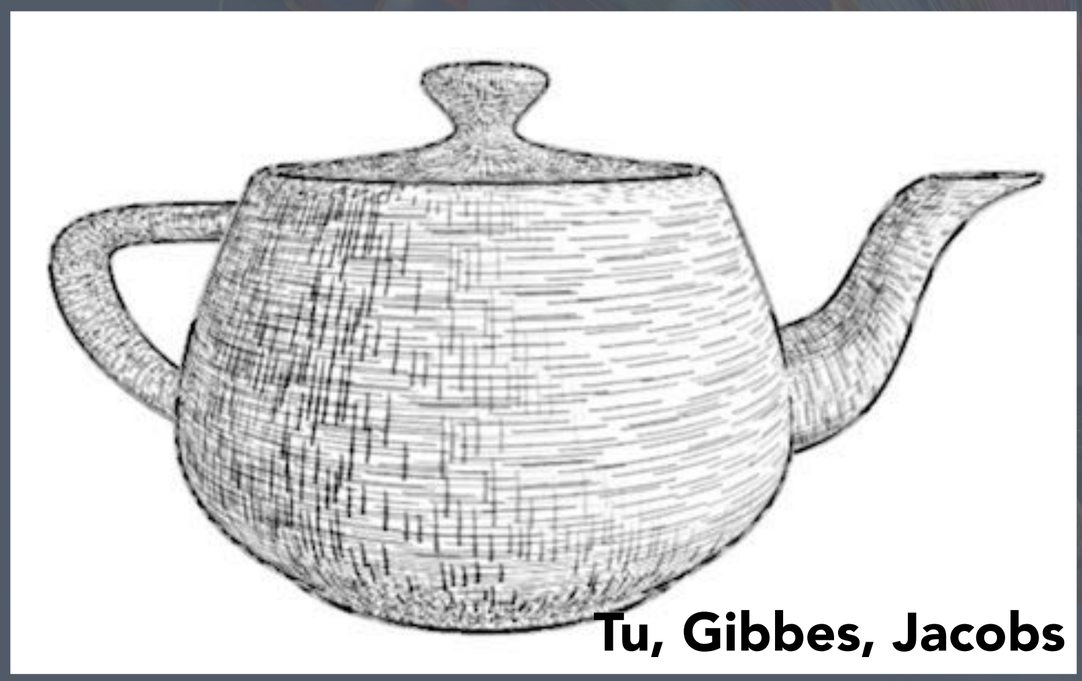




Final Project - Examples







Credit: Pixar, Up

Course Logistics

Prerequisites

Math

- Vectors, matrices, basic linear algebra
- Helpful: exposure to statistics, signal processing, Fourier transform

Programming

- Data structures (CS61B)
- Fluent with C and C++
- Fluent with development environment, debugging, etc.

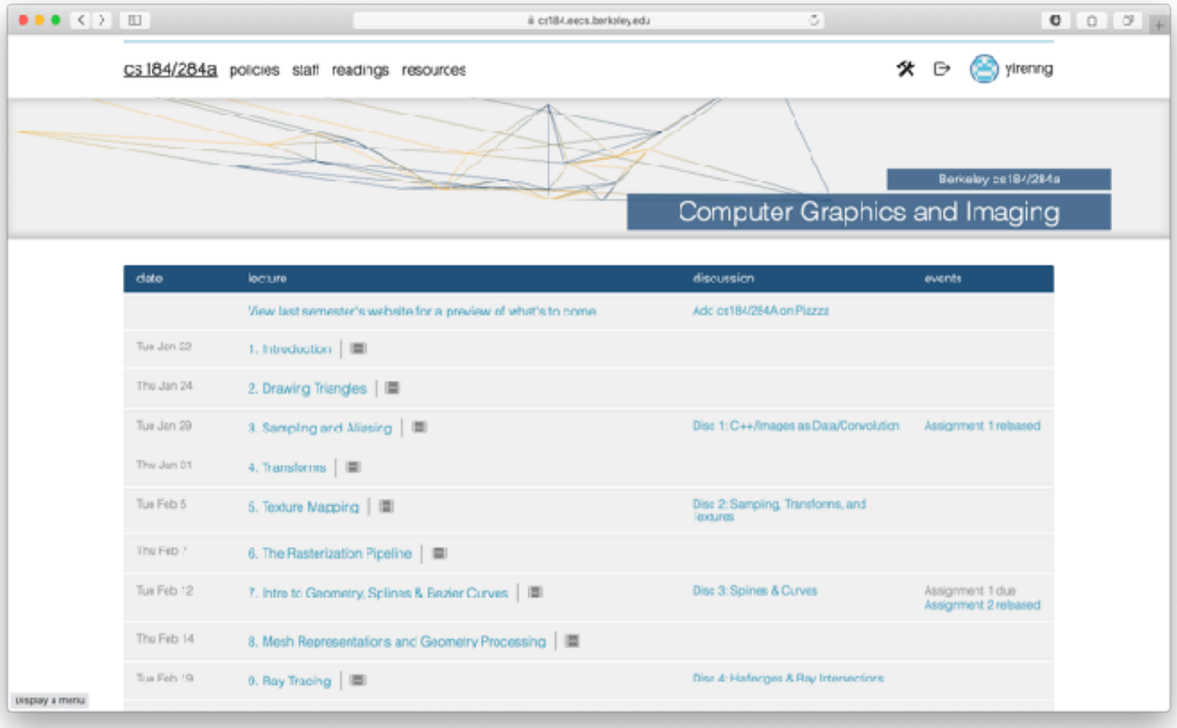
Enrollment

- Last year, high turnover from wait list
- Class was basically full after dust settled
- Questions about enrollment:
  - CS184: ask scheduler Cindy Conners, csconners@cs
  - CS284A: contact instructors on Piazza
  - Concurrent enrollment: send note to instructors on Piazza about your prerequisites for the class

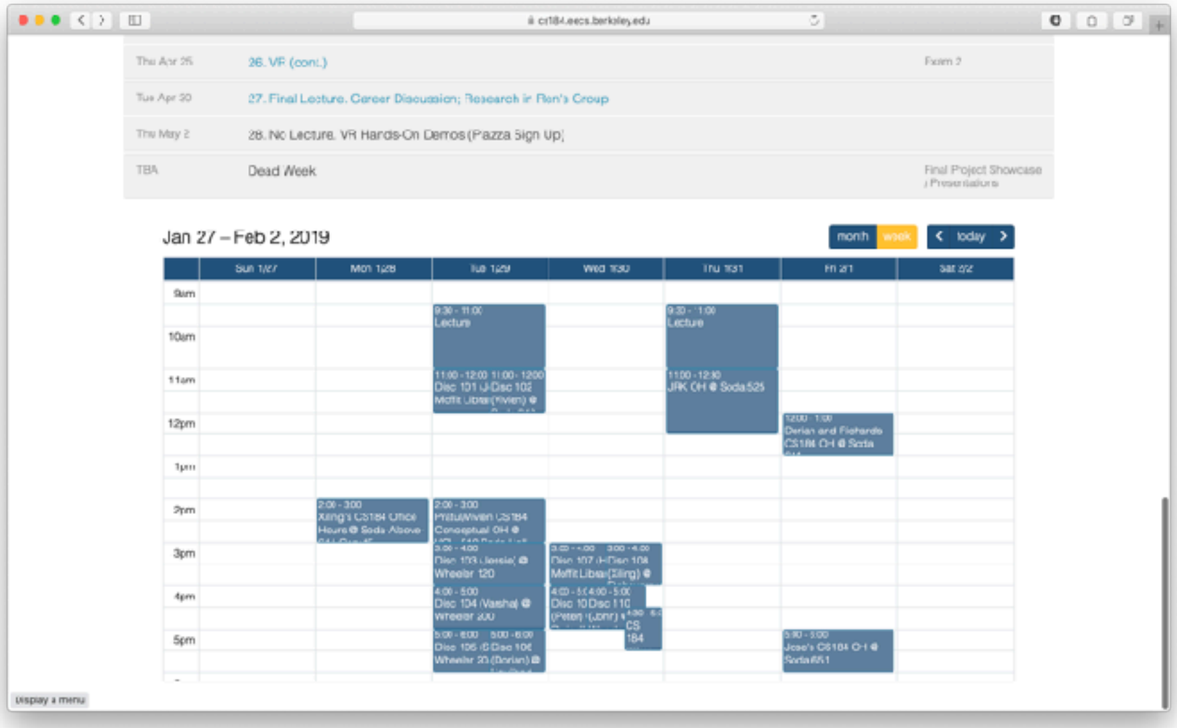
Course Schedule

cs184.org or
cs184.eecs.berkeley.edu

Full schedule for class will be on website soon



Note class calendar at bottom for OH, homework, parties, etc.



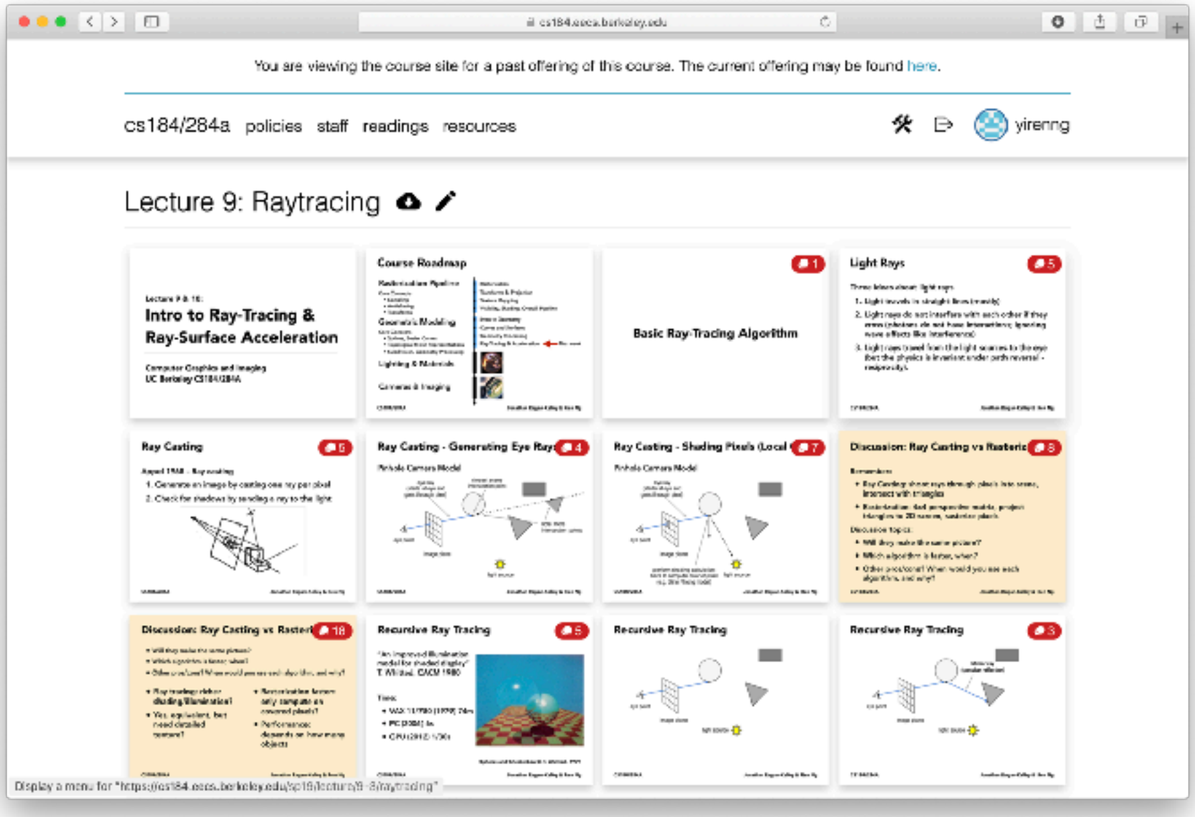
CS184/284A

Ren Ng

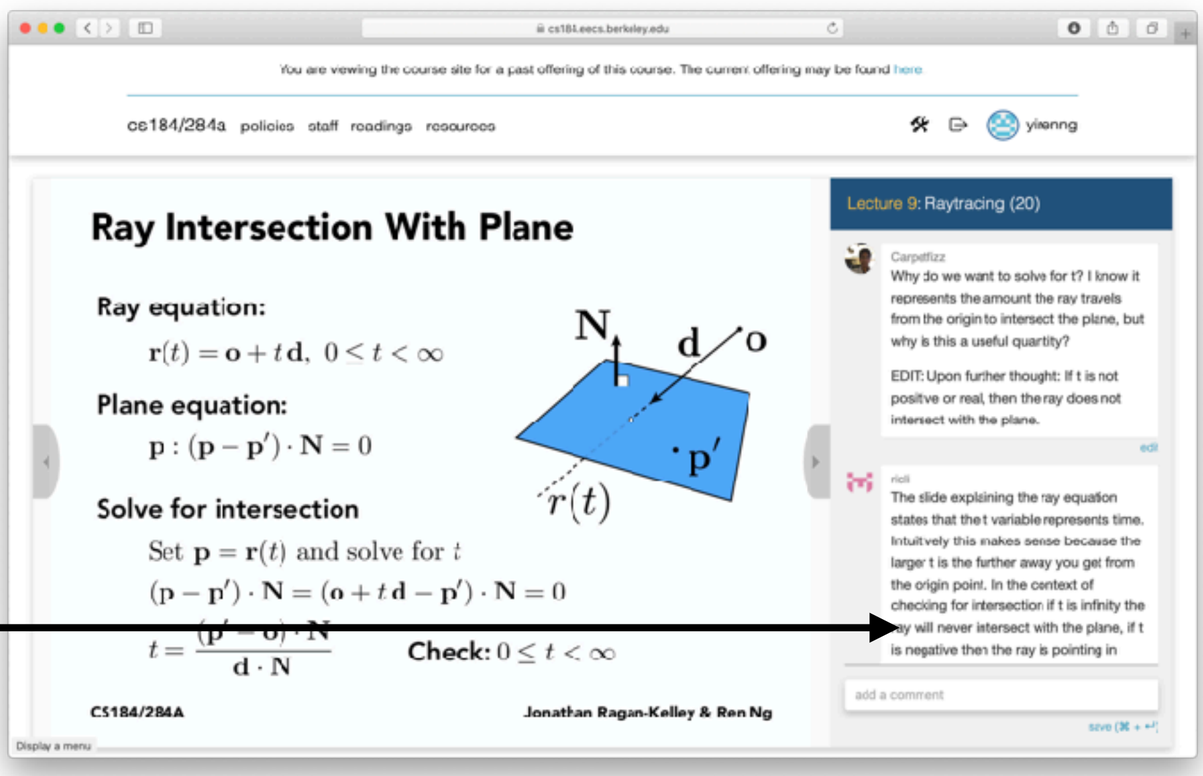
Lecture Slides

cs184.org or
cs184.eecs.berkeley.edu

Lecture slides and instructor/TA/ student discussions on the web are the primary course reference materials



Slide comments and discussion



CS184/284A

Ren Ng

Piazza

piazza.com/berkeley/spring2020/cs184

Please sign up!

For logistics and general communication / discussion

- Use Piazza instead of email
- But intellectual discussions about content should primarily go on website as slide comments

Webcasting

Lecture will be recorded this semester

- Screen capture and audio only.
- Videos available in CalCentral, bCourses

Section

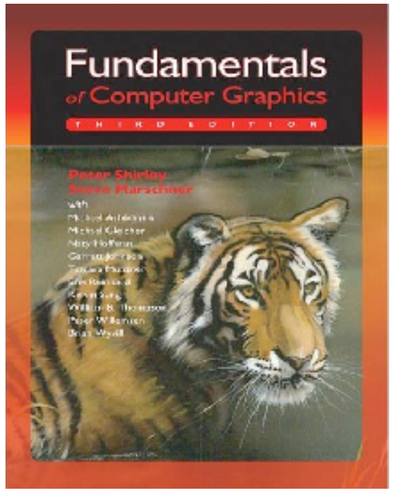
Sections start next week, and TAs will give a primer on C++ and building class projects

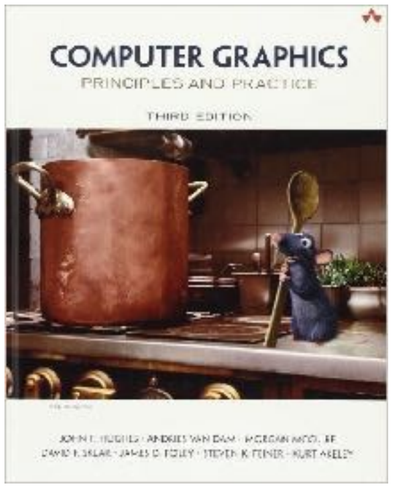
Resources

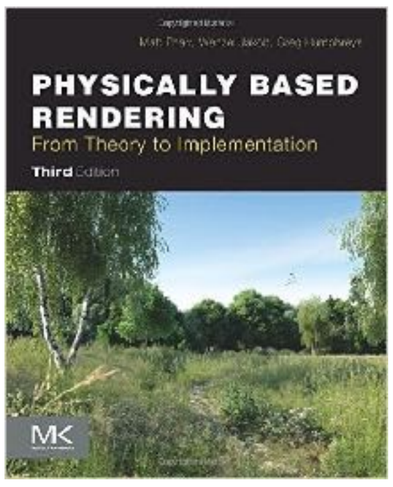
Lectures will be primary source

Textbook reference material:

- Fundamentals of Computer Graphics by P. Shirley, S. Marschner, et al.
- Computer Graphics: Principles and Practice (3rd Edition) by Hughes, van Dam, et al.
- Physically Based Rendering, Third Edition: From Theory to Implementation by Pharr, Jakob and Humphreys







Other resources on class website

Assignments and Evaluation

(40%) Assignments (5)

(20%) Final Project (in groups of three, presentations, report)

(35%) Exams

- Exam 1 on (see website)
- Exam 2 on (see website)
- No Final Exam

(5%) Participation

- Lecture attendance, website comments
- Piazza (give / get help), come to office hours and homework parties

284A students: Project is 40% of grade, remainder normalized

Late Days Policy

Assignments are late after 11:59pm on due date.

You have 5 late days for assignments (not final project)

- Extend a programming assignment deadline by 24 hours using one late day.
- If you do not have remaining late days, 10% penalty per day.
- Use this flexibility to manage your own exceptional circumstances. No exceptions beyond this!

Course Participation Grading Policy [updated from video]

The basic idea is that doing any of the following each week will get you full participation points:

- Attending both lectures
- Attending one lecture and making one well-thought-out web comment
- Making 3 well-thought-out web comments
- Details (a bit more complicated, in your favor) are on the class website if you wish to know.

What We Are Looking For In Slide Comments

Try to explain the slide (as if teaching your classmate to study for an exam)

- "Ren said this, but if you think about it this way it is much clearer"

Explain what is confusing you

- "What I was totally confused about here was…"

Challenge classmates with a question

- For example, make up a question you think might be on an exam

Provide a link to an alternative explanation

- "This site has a really good animation of pre-filtering to avoid aliasing"

Mention real-world examples

- For example, describe what default interpolation functions are used in iOS.

Constructively respond to another student's question

- "@nojaggies, are you sure that is correct? I thought that Ren said…"

It is OK, and even encouraged, to address the same topic (or repeat someone else's summary, explanation or idea) in your own words

- "@cornellbox's point is that subdivision is also used to…"

Website Comments in Markdown

You are encouraged to write your comments in Markdown, which enables working hyperlinks, typeset equations, and more. There is an article on Markdown linked on the website.

Class Philosophy

We want a very active class.

Come to class, participate in lecture, discussion, office hours, homeworks parties.

Contribute on the website.

Uphold academic honor individually and collectively.

Questions?

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