Lecture 1:

Introduction

Computer Graphics and Imaging
UC Berkeley CS184/284A
Welcome to CS184 / 284A!

Prof. Ren Ng

Vivien Nguyen

Pratul Srinivasan

Ling Qi Yan

Dillon Yao

Cecilia Zhang

Megan Zhu
Welcome to CS184 / 284A!

Prof. Ren Ng

- Ph.D. 2006 on Digital Light Field Photography (evolving camera design using graphics know-how)
- Founder of Lytro, a light field camera company
- Research interests: computational imaging systems, computer graphics and computer vision
- Fun fact: born Malaysian, became Australian, lived in California for most of my life
Welcome to CS184 / 284A!

Course assistants

- Vivien Nguyen, 184 ‘17: powder game, first time Japan 2017
- Pratul Srinivasan, PhD in computer vision, scuba diver
- Ling Qi Yan, PhD in graphics, piano, PUB hard PUBG harder!
- Dillon Yao, 184 ‘17: water simulation, learning calligraphy
- Cecilia Zhang, PhD in comp. photography, cats make her cry
- Megan Zhu, 184 ‘17: VR game, top 0.2% League of Legends
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!
Why Study Computer Graphics?

Course Overview

Logistics
What is Computer Graphics?

**computer graphics** /kəmˈpyʊdər ˈɡrafɪks/ 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?

- CV, deep learning, connection to graphics
- CGI, visual learning
- Creating VR experiences
- Light field camera - how to model?
- UC BUGG, continue learning

- Synthesizing images
- How optics relates to computer science
- Rendering
- Digital arts
- Games
Why Study Computer Graphics and Imaging?
Movies

Jurassic Park (1993)
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

Tesla Model X review

Credit: EVobsession.com, James Ayre
Typography

The Quick Brown Fox Jumps Over The Lazy Dog

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz 0123456789

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

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
• Output: 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

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Graphical User Interfaces

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

NASA | Walter Iooss | Steve McCurry
Harold Edgerton | NASA | National Geographic
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”
How Do Camera's Work?

Glenn Derene, Popular Mechanics
Digital and Computational Cameras

Panaromic stitching, HDR photos, light field cameras, ...
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

(Kaldor 2008)

Platonic noid

ocfish/blogspot
Modeling Material Properties
Modeling Lighting

WALL-E, (Pixar 2008)
Photograph (CCD) vs. computer rendering
Digital and Computational Cameras

Glenn Derene, Popular Mechanics
Animation and Physical Simulation

Luxo Jr. (Pixar 1986)
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

• Win a visit to Pixar Studios
• 4 weeks, let your creativity take flight! (we will have suggested projects)
• Proposal; checkpoint; presentation, video, report
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
- This year, ~50% larger enrollment
- 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 Website

cs184.org or cs184.eecs.berkeley.edu

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

“Add private note” button:
You can add notes to yourself about this slide here.

Slide comments and discussion

Projective Transforms

Standard perspective projection
- Center of projection: \((0, 0, 0)^T\)
- Image plane at \(z = d\)

\[
\begin{pmatrix}
x \\
y \\
z
\end{pmatrix} \rightarrow \begin{pmatrix}
x \cdot d/z \\
y \cdot d/z \\
d 
\end{pmatrix} \in \mathbb{R}
\]

CS184/284A, Lecture 1
Ren Ng, Spring 2016
Piazza

piazza.com/berkeley/spring2018/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 and bCourses
Section

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

Lectures will be primary source

Textbooks

• Physically Based Rendering, Third Edition: From Theory to Implementation by Pharr, Jakob and Humphreys

Other resources on class website

CS184/284A Ren Ng
Assignments and Evaluation

(40%) Assignments (5)

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

(35%) Exams
  • Exam 1 on (tentative) Tuesday March 13, 7–9pm
  • Exam 2 on (tentative) Tuesday April 24, 7–9pm
  • 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

Lecture attendance

• Attend at least 2 of 3 lectures weekly for 10 weeks
• Will use “DeNero method” for tracking attendance

Or website participation

• Contribute at least 3 well-thought-out comments on lecture slides each week

• 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.
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...”
Class Philosophy

We want a very active class.

Come to class, participate in lecture.

Contribute on the website.
Questions?
Acknowledgments

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