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GSIs: Ruilong Li  
Jack Austin
 Readers: Morgan Lyu  
Preston McCrary  
Max Vogel
UC Berkeley, Fall 2023
Covid Precautions
Today

Introductions
Why this Course?
Administrative stuff
Brief History of Visual Data
Teaching Team: professors

Angjoo Kanazawa

Alexei Efros
Teaching Team: GSIs

Ruilong Li

Jake Austin
Teaching Team: Readers/Tutors

Morgan Lyu

Max Vogel

Preston McCrary
Why This Course?
Visual Computing in the old days…

Image Processing  
EECS 225B

Computer Graphics  
CS 184

Computer Vision  
CS 280
Visual Computing gets interconnected

Image Processing
EECS 225B

Art History
ART 10

Computer Graphics
CS 184

Visual Perception
PSYCH

Computer Vision
CS 280

Computational Photography

Machine Learning
The key objective of this class is to become friends with every pixel!
Course objectives

1. You will appreciate the fundamental difficulty of understanding and computing with visual data
Course objectives

2. You will get a foundation in image processing and computer vision, from the ground up:

- Camera basics, image formation
- Convolutions, filtering
- Image and Video Processing (filtering, anti-aliasing, pyramids)
- Image Manipulation (warping, morphing, mosaicing, matting, compositing)
- Data-driven Generative Models
- Projection, 3D, stereo
- NeRFs
- …
Course objectives

3. You will get a more intuitive understanding of important mathematical and computational concepts

- Gradients
- Change of basis, interpolation, extrapolation, PCA
- FFT
- Dynamic programming, recursion
- Machine learning, Convolutional Neural Networks
- Large-Pixel-Models
- ...
Course objectives

4. You will learn approaches for visual synthesis

Graphic by James Hays

DALL-E + Danielle Baskin
Course objectives

4. You’ll better appreciate human visual perception
Course objectives

4. You’ll better appreciate human visual perception
Different people see different things

https://en.wikipedia.org/wiki/The_dress
People see things that aren’t there

Video by Antonio Torralba (starring Rob Fergus)
But actually…

Video by Antonio Torralba (starring Rob Fergus)
Course objectives

5. You will learn about the **history of ideas** in visual computing

- Did you know Large Generative Models go back to 1940s?
- Or that Deep Learning started with a Nobel Prize in Neuroscience in the 1960s?
- ...


Course objectives

6. You’ll have fun doing cool stuff, coding up a storm, while you **befriend the pixels**
Programming Project #1

Prokudin-Gorskii’s Color Photography (1907)
Programming Project #1
Project 2: Fun with frequencies
Project 2: Fun with frequencies

Prof. Christos Papadimalik
Project 2: Fun with Frequencies
Project 3: Face modeling and morphing
Project 4: Panorama Stitching

Photo Mosaics
Project 5: TBD

(depending on if we could get GPU donation)
Final Project

Something cool!!!

- We will have some pre-canned projects
- Will also have some suggestions, cool datasets, etc
- Or you can do whatever you want!

(can be done in groups of 2 or 3)
Example Pre-canned Project

Tour Into the Picture
Paper Pop-up

Step 1: define planes

Step 2: rectify each plane

Step 3: compute 3D box coords
Sample final project in my class
Everybody Dance Now

https://www.youtube.com/watch?v=PCBTZh41Ris&feature=youtu.be
For each project:

Derive the **math**, implement stuff **from scratch**, and apply it to your **own** photos

Every person does their own project (except final projects)

Reporting via web page (plus submit code)

Afterwards, vote for class favorite(s)!
Class Organization / Administrivia
Prerequisites

- Linear algebra!!! (EE16A, Math 54, or Math 110)
- Good programming skills (at least CS61B)
- Deep Learning experience strongly recommended!

Emphasis on programming projects!

- Building something from scratch

Graduate Version:

- Final project required (not pre-canned), including conference-style report paper
Administrative Stuff

Grading

• Programming Project (60%)
• Exam + possible popup quizzes (20%)
• Final Project (20%)
• Class Participation: priceless

Late Policy

• Five (5) emergency late days for semester. The expectation is you will never use them.
• Max 10% of full credit afterwards

Extra Points

• Most projects will have optional “bells & whistles”
• These extra points could be used to pad scores on other projects (but not exams!)
Rule # 1: No lecture recordings

This is an in-person class. You are to come to the lecture and ask questions! Attendance is required.

Only available by request for truly exceptional circumstances, e.g. severe illness
Rule # 2: Deadline is a deadline

In real life there’s no slip days

This is a FUN but INTENSE class, projects come one after another

Slip days are for emergencies. If nothing dramatic happened to you during the semester, you should have all your slip days left.

Projects are time consuming. Start early!!!
Rule # 3: TA’s don’t debug code

TA’s don’t debug code for you.

Part of the skill is to learn how to ask questions to debug the issue without presenting the code.

Visualize the results and send those to figure out what is wrong.

Use the pixels – become friends with visual debugging.
Getting help outside of class

Course Web Page
  • http://inst.eecs.berkeley.edu/~cs180

Discussion board:
  • Ed

Discussion Section:
  • Ruilong: Tuesdays, Cory 247 1pm - 2pm (Capacity 63)
  • Jake: TBD

Office hours
  • For instructors: after lecture
  • For others, see webpage
Academic Integrity

- Can discuss projects, but **never share code**
- Don’t search for code or copy from a friend
- If you’re not sure if it’s allowed, ask
- Cite any sources and inspirations
Our GPT policy

• GPT is a wonderful tool
  • And so is calculator, Wolfram Alpha, Wikipedia, Stack Overflow, etc.

• but before you use a calculator, it’s important to learn how to do long division by hand.

• In this course, we want you to do things from scratch.
  • So, no Stack Overflow, no searching for code, no fancy libraries, and no GPT

• You can use GPT (sparingly) to debug your code (if nothing else works), but please acknowledge and submit transcript

• Can use whatever for “bells and whistles”
Waitlists

- To keep this course live, we are limited by room size (~300 people)

- However, we expect 50-70 people to drop after the first two projects 😊
  - So, if you are on waitlist, etc, you have good chance to get into class
  - But need to start doing projects!
Warning: historically high GPA of this course

• Survivor bias

• High class GPA != easy course

• This is a FUN but INTENSE class

• You write the code from scratch, that’s the point.

• Rubrics are fuzzy, goals are ill-defined, that’s the point.
Why you should NOT take this class

• Project-based class
  • No canned problem sets
  • Not theory-heavy (but will read a few research papers)
  • No clean rubrics
  • Open-ended by design
  • Will not copy advanced topics, but will try to make sure everyone understands the basics super-well

• Need time to think, not just hack
  • Creativity is a class requirement
  • We already expect you to know Deep Learning!

• Lots of work…There are easier classes if
  • you just need some units
  • you care more about the grade than about learning stuff

• Not worth it if you don’t enjoy it
Now… reasons TO take this class

• It’s your reward after 3 grueling years 😊
• You get to work with pictures, unleash your creative potential
• Interested in grad school? 😊
A Brief History of the Visual Data
Depicting Our World: The Beginning

Prehistoric Painting, Lascaux Cave, France
~ 13,000 -- 15,000 B.C.
Prehistoric Cave Painting, Altamira
~ 20,000 – 15,000 B.C.
The Empress Theodora with her court.
Ravenna, St. Vitale 6th c.
Nuns in Procession. French ms. ca. 1300.
Giotto, *The Mourning of Christ*, c.1305

Beginnings of the Renaissance
Depicting Our World: Renaissance

North Doors (1424)  Lorenzo Ghiberti (1378-1455)  East Doors (1452)
Depicting Our World: Renaissance

Piero della Francesca,
The Flagellation (c.1469)
Depicting Our World: Toward Perfection

Jan van Eyck, *The Arnolfini Marriage* (c.1434)
Depicting Our World: Toward Perfection

Lens Based Camera Obscura, 1568
Depicting Our World: Perfection!

Boulevard du Temple, Louis Daguerre, 1838
Depicting Our World: Realism?
Paris, according to Flickr
Paris, according to Google StreetView

Knopp, Sivic, Pajdla, ECCV 2010
Paris, according to me
After realism...

Monet, 
La rue Montorgueil
Depicting Our World: Ongoing Quest

Pablo Picasso

David Hockney
Better than realism?

David Hockney, Place Furstenberg (1985)
Which one is right?

**Multiple viewpoints**

David Hockney, Place Furstenberg, 1985

**Single viewpoint**

Alyosha Efros, Place Furstenberg, 2009
Depicting Our World: Ongoing Quest

Enter Computer Graphics...
Traditional Computer Graphics

3D geometry

physics

Simulation

GRAPHICS

projection
Modern Computer Graphics

• Amazingly real
• But so sterile, lifeless, *futuristic* (why?)
The richness of our everyday world

Photo by Svetlana Lazebnik
Beauty in complexity

University Parks, Oxford
Which parts are hard to model?

Photo by Svetlana Lazebnik
Creating Realistic Imagery

**Computer Graphics**
- + great creative possibilities
- + easy to manipulate objects/viewpoint
- - Tremendous expertise and effort to obtain realism

**Computational Photography**
- Realism
- Manipulation
- Ease of capture

**Photography**
- + instantly realistic
- + easy to acquire
- - very hard to manipulate objects/viewpoint