# CS 194-26/294-26

## Intro to Computer Vision and Computational Photography

## Syllabus

| | | |
|---|---|---|
| Instructors: | Alexei Efros | Fall 2021 |
| | Angjoo Kanazawa | M W 5:00 - 6:30 PM |
| GSIs: | Tim Brooks | Hearst Field Annex A1 |
| | Vickie Ye | Course Website |
| Tutors: | Kamyar Salahi | Piazza |
| | Lily Yang | bCourses |
| | Violet Yao | |

The aim of this advanced undergraduate course is to introduce students to computing with visual data (images and video). We will cover acquisition, representation, and manipulation of visual information from digital photographs (image processing), image analysis and visual understanding (computer vision), and image synthesis (computational photography). Key algorithms will be presented, ranging from classical (e.g. Gaussian and Laplacian Pyramids) to contemporary (e.g. ConvNets), with an emphasis on using these techniques to build practical systems. This hands-on emphasis will be reflected in the programming assignments, in which students will have the opportunity to acquire their own images and develop, largely from scratch, the image analysis and synthesis tools for solving applications.

The course objective is to get a foundation in image processing and computer vision as well as build a more intuitive understanding of mathematical and computational concepts. Topics discussed include:
1. Camera basics, image formation
2. Convolutions, filtering
3. Image and Video Processing (filtering, anti-aliasing, pyramids)
4. Image Manipulation (warping, morphing, mosaicing, matting, compositing)
5. Projection, 3D, stereo
6. Basics of recognition
7. Gradients, change of basis, interpolation, extrapolation, PCA, FFT

## Disclaimer

Assignments in this course will require Python coding without starter code. This course will not teach you how to code, and you are expected to already know how to program in Python.

## Prerequisites

This is a **heavily** project-oriented class, therefore good programming proficiency (at least **CS61B**) is absolutely essential. Moreover, familiarity with linear algebra (**MATH 54** or **EE16A/B** or Gilbert Strang's online class) and calculus are vital. Experience with neural networks (**CS 182** or equivalent) is strongly recommended. Due to the open-endedness of this course, **creativity** is a class requirement.

## Textbooks

We will be using the new 2nd edition of Rick Szeliski's [Computer Vision textbook](#).

The following books may also be useful as a reference:
Forsyth and Ponce: [Computer Vision: A Modern Approach](#)
Stephen Palmer: Vision Science: Photons to Phenomenology
Gonzalez and Woods: Digital Image Processing, 2nd edition
Gilbert Strang : Linear Algebra and its Applications

## Grading

60% Programming and Written Assignments
20% Midterm (**11/17 Wednesday**) and potentially some Pop Quizzes
20% Final Project (**12/10 Friday**)

Students will be allotted a total of **5 (five)** late days per semester with each additional late day incurring a 10% penalty.

Students taking CS294-26 will also be required to submit a conference-style paper describing their final project.

## Projects

There are 5-6 projects plus a final project. **All projects are to be done solo** (with the possible exception of the final project). We expect you to derive the math, implement algorithms from scratch, apply your code to your own photos, and create a portfolio website.

## Lecture & Office Hours

This is an **in-person** course, so, unless the campus policy changes, <u>lectures will be live and physical attendance is required</u>.  We plan to record lectures but will only make them available for emergency circumstances (e.g. covid).

Office hours will be divided into recitation sections and conceptual/programming sections. Consult the [CS 194-26 Calendar](#) for office hour times and locations.

## Computational Resources

Students will be encouraged to use Python (with either scikit-image or opencv) as their primary computing platform (although MATLAB with the Image Processing Toolkit is also good). Although it is not required, students are highly encouraged to obtain a digital camera for use in the course.

## Piazza Etiquette

1.  Search for the answer on Piazza to see if it has already been answered before making a post.
2.  Please post project questions only in the designated project posts.
3.  Link/screenshot any external resources you are referencing.
4.  Do not post answers/code in public Piazza threads.

## Academic Integrity

You can discuss projects, but are not permitted to share code. You may not look up code or copy code from any other source. If you have any questions regarding what is permitted, ask on Piazza.

## Inclusion

We are committed to creating a learning environment welcoming of all students. If you anticipate or experience any barriers to learning in this course, please feel welcome to discuss your concerns with me. We intend to support a diversity of perspectives and experiences and respect each other as an individual regardless of their identities and backgrounds. To help accomplish this:

- If you feel like your performance in the class is being impacted by a lack of inclusion, please contact the instructors, your ESS advisor, or the departmental Faculty Equity Advisor (list and information at: https://diversity.berkeley.edu/faculty-equity-advisors. An anonymous feedback form is also available at https://engineering.berkeley.edu/about/equity-and-inclusion/feedback/.
- If you have a name and/or set of pronouns that differ from your legal name, designate a preferred name for use in the classroom at: https://registrar.berkeley.edu/academic-records/your-name-records-rosters.
- If you feel like your performance in the class is being impacted by your experiences outside of class (e.g., family matters, current events), please don't hesitate to come and talk with the instructor(s). We want to be resources for you.
- We are all in the process of learning how to respect and include diverse perspectives and identities. Please take care of yourself and those around you as we work through the challenging but important learning process.
- As a participant in this class, recognize that you can be proactive about making other students feel included and respected.

If you have a disability, or think you may have a disability, you can work with the Disabled Students' Program (DSP) to request an official accommodation. The Disabled Students' Program (DSP) is the campus office responsible for authorizing disability-related academic accommodations, in cooperation with the students themselves and their instructors. You can find more information about DSP, including contact information and the application process here: dsp.berkeley.edu. If you have already been approved for accommodations through DSP, please meet with me so we can develop an implementation plan together.

*Students who need academic accommodations or have questions about their accommodations should contact DSP, located at 260 César Chávez Student Center. Students may call 510-642-0518 (voice), 510-642-6376 (TTY), or email dsp@berkelely.edu.*

## Other Student Resources

**Center for Access to Engineering Excellence (CAEE)**

The Center for Access to Engineering Excellence (227 Bechtel Engineering Center; https://engineering.berkeley.edu/student-services/academic-support is an inclusive center that offers study spaces, nutritious snacks, and tutoring in >50 courses for Berkeley engineers and other majors across campus. The Center also offers a wide range of professional development, leadership, and wellness programs, and loans iclickers, laptops, and professional attire for interviews.

**Counseling and Psychological Services**

University Health Services Counseling and Psychological Services staff are available to you at the Tang Center (http://uhs.berkeley.edu; 2222 Bancroft Way; 510-642-9494) and in the College of Engineering (https://engineering.berkeley.edu/students/advising-counseling/counseling/; 241 Bechtel Engineering Center), and provide confidential assistance to students managing problems that can emerge from illness such as financial, academic, legal, family concerns, and more. Long wait times at the Tang Center in the past led to a significant expansion to include a 24/7 counseling line at (855) 817-5667. This line will connect you with help in a very short time-frame. Short-term help is also available from the Alameda County Crisis hotline: 800-309-2131. If you or someone you know is experiencing an emergency that puts their health at risk, please call 911.

**The Care Line (PATH to Care Center)**

The Care Line (510-643-2005; https://care.berkeley.edu/care-line/) is a 24/7, confidential, free, campus-based resource for urgent support around sexual assault, sexual harassment, interpersonal violence, stalking, and invasion of sexual privacy. The Care Line will connect you with a confidential advocate for trauma-informed crisis support including time-sensitive information, securing urgent safety resources, and accompaniment to medical care or reporting.

**Ombudsperson for Students**

The Ombudsperson for Students (102 Sproul Hall; 642-5754; http://students.berkeley.edu/Ombuds) provides a confidential service for students involved in a University-related problem (academic or administrative), acting as a neutral complaint resolver and not as an advocate for any of the parties involved in a dispute. The Ombudsman can provide information on policies and procedures affecting students, facilitate students' contact with services able to assist in resolving the problem, and assist students in complaints concerning improper application of University policies or procedures. All matters referred to this office are held in strict confidence. The only exceptions, at the sole discretion of the Ombudsman, are cases where there appears to be imminent threat of serious harm.

**UC Berkeley Food Pantry**
The UC Berkeley Food Pantry (#68 Martin Luther King Student Union; https://pantry.berkeley.edu) aims to reduce food insecurity among students and staff at UC Berkeley, especially the lack of nutritious food. Students and staff can visit the pantry as many times as they need and take as much as they need while being mindful that it is a shared resource. The pantry operates on a self-assessed need basis; there are no eligibility requirements. The pantry is not for students and staff who need supplemental snacking food, but rather, core food support.