Deep Learning for Computer Vision
CS188 Special Topic, Winter 2022

Course Logistics

Instructors: Professor - Bolei Zhou <bolei@ucla.edu>

TA: Yining Hong <yininghong@cs.ucla.edu>

Lecture Time: Tuesday/Thursday 10:00 am - 11:50 am

Lecture Location

- **(First four weeks online): https://ucla.zoom.us/j/93160853647**
- (Hopefully after the first two weeks): Boelter 5249

Prof. Zhou's Office Hours: Friday 4:30 pm - 5:30 pm
https://ucla.zoom.us/j/93160853647 (please join before 5:00 pm)

Discussion: Friday 2:00pm-3:50pm https://ucla.zoom.us/j/2125631157

TA's Office Hours: Monday 9:00am - 11:00am
https://ucla.zoom.us/j/2125631157

Piazza Link: https://piazza.com/ucla/winter2022/cs188dlcv

Bruinlearn course site: https://bruinlearn.ucla.edu/courses/111828

Prerequisites: Familiarity with **Python programming**, and **Linear Algebra**, **Calculus**, and **Probability**. Students should have taken **at least one course relevant** to machine learning or image processing or computer vision or data mining.

Grade Structure: Letter grades assigned based on:

Assignments	40%
Final exam	30%
Course project	30%

Course Material: There is no required textbook, although the following two textbooks can be seen as helpful resources and practices. Both are freely available online.

- Dive into Deep Learning by Zhang, Lipton, Li, Smola
- Deep Learning by Goodfellow, Bengio, and Courville

Details on Homework Assignments: There will be four assignments, released on the following schedule. Each problem set is allotted 2 weeks for completion. Note that the problem set schedule is cyclical and therefore is not impacted by exams. However, you will be allotted 3 late days to use for assignments as you choose. Beyond this 3 day grace, late assignments will not be accepted without a valid explanation.
Assignments will be released at: https://github.com/UCLAdeepvision

Assignment 1	OUT: Sunday, Jan 9	DUE: Sunday, Jan 23
Assignment 2	OUT: Sunday, Jan 23	DUE: Sunday, Feb 6
Assignment 3	OUT: Sunday, Feb 6	DUE: Sunday, Feb 20
Assignment 4	OUT: Sunday, Feb 20	DUE: Sunday, Mar 7

Exam Details: TBD

Course Description

Computer Vision has been a core field of Artificial Intelligence, facilitating a wide range of applications from image search to self-driving. The recent development of deep learning has greatly advanced the performance of visual tasks like visual recognition and image generation. This course covers the details of deep learning approaches for computer vision. Through this course, students will learn to implement the deep neural networks used in various computer vision such as visual recognition and image generation. We will go through the learning algorithms, neural architecture design, and practical skills of training and debugging neural networks.

The course is directed primarily at senior undergraduates and fresh graduate students who are interested in deep learning applications, but it can also be taken by juniors who satisfy the prerequisites. Students should have taken linear algebra, programming, and data structure; having taken at least one machine learning relevant course will be also very helpful. **Please note** this is the first time the

lecturer runs this course. Thus the syllabus and the assignments might not be well structured. If possible, students could wait for the next run of this course with better content and course structure.

Learning Objectives

- Students should be able to understand the deep learning foundations such as back-propagation and convolutional neural networks.
- Students should be able to train and debug deep neural networks for various computer vision tasks, including but not limited to image recognition, semantic segmentation, object detection, image generation.

Course Project

- The objective of the course project is to provide students an opportunity of exploring a topic in computer vision in detail.
- Each group has 2 students by default. If you have found your teammate, please sign up in this Google Sheet.
- Understanding + Reproduction + Innovation (bonus)
- A list of potential project topics is provided. Students are welcome to propose their own topics.
- Project schedule:
    - By Week 3, each group should determine the topic and list the 3 most relevant papers and their code repo. The template will be provided.
    - By Week 7, each group should include technical details and algorithms/code
    - By Week 10, finalize blog article, Colab demo, and recorded video
- Project final deliverables:
    - **A technical blog article on the topic**: **Your peer students or general public can read it and learn from it.** This article should include the dummy-proof introduction of the topic, the core code/algorithms, cool qualitative and quantitative results, your analysis, your improvement. Some good technical blog articles are below)
        - https://lilianweng.github.io/lil-log/2021/07/11/diffusion-models.html and https://lilianweng.github.io/lil-log/2018/12/27/object-detection-part-4.html (md source: https://github.com/lilianweng/lil-log/blob/master/_posts/2018-1

        2-27-object-detection-part-4.md)) and many other blogs by Lilian.
        - https://yang-song.github.io/blog/2021/score/
        - http://karpathy.github.io/2016/05/31/rl/
        - https://gtsam.org/2020/08/30/Laplacian.html
    - **A Google Colab demo of the topic you study: Your peer students or general public can play with it**
    - **A 5~10 min recorded spotlight presentation** to help achieve the above two goals
    - The above things will be peer-reviewed by other students, as well as by Lecturer and TA,

Schedule (to be updated)

PDFs are available on the Bruinlearn course site

Week 1: Overview

Lecture 1: Course introduction [recording](Password: !9qgw^O=) [slides]

Lecture 2: Image classification and machine learning basics [recording] (Passcode: 2bJi*o66) [slides]

Discussion: TA Tutorial on Colab & PyTorch Basics [Tutorial] [Recording](Passcode: J&9HRSnj) [slides]

Assignment 1 out

Week 2: Image classification and linear neural networks

Lecture 3: Linear classifier for image classification [Recording](Passcode: w8n&ks.n) [slides]

Lecture 4: Regularization + optimization

Discussion: TA Tutorial on PyTorch Advanced

Week 3: Foundation on neural networks

Lecture 5: Neural Networks

Lecture 6: Backpropagation

Assignment 2 out

Assignment 1 due

Week 4: Convolutional neural networks

Lecture 7: Convolutional Neural Networks

Lecture 8: CNN architectures

TA Tutorial 2 on Assignment 1

Week 5: Practices of training neural networks

Lecture 9: Hardware and software for deep learning and Training NN part 1

Lecture 10: Training NN part 2
Assignment 3 out
Assignment 2 due

Week6: Understanding neural networks
Lecture 12: Visualizing and understanding
Lecture 13: Few-shot learning, adversarial samples, and self-supervised learning
TA Tutorial 3 on Assignment 2

Week 7: Object detection and dense prediction
Lecture 13: Object detection
Lecture 14: Dense prediction (semantic segmentation, pose estimation)

Week 8: Generative models
Lecture 15: Generative model part 1
Lecture 16: Generative model part 2
Assignment 4 out
Assignment 3 due

Week 9: Applications
Lecture 17: Videos
Lecture 18: 3D vision and computational photography
TA Tutorial 4 on Assignment 3

Week 10: Applications
Lecture 19: Embodied AI and visual navigation and self-driving
Lecture 20: Course recap and trendy topics
Assignment 4 due
TA Tutorial 5 (recorded)/Week 11.