Recent Advances in Computer Vision (CSCI 7000 and CSCI 4831)
University of Colorado Boulder, Computer Science Department

Course Lectures: Mondays and Wednesdays, 1:25-2:40pm MT
Course Mode: We will meet in-person in AERO 114. Class meetings will also be recorded and shared afterwards (in Canvas) so students can review the material and/or watch it for the first time if they miss a class.
Course Website: https://dannagurari.colorado.edu/course/recent-advances-in-computer-vision-fall-2024/about-course/

Instructor: Danna Gurari
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Pronouns: she/her
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Course Manager: Josh Myers-Dean
Pronouns: he/him
Email: josh.myers-dean@colorado.edu

Ways to Contact Us:

- **Questions for Instructor:** Instructor will stay after each lecture to answer questions.
- **Office Hours:** The course manager will host office hours weekly at times posted on the course website.
- **Appointments:** For any other matters, email the instructor or course manager to make an appointment or solicit an answer. Please note that at least 24 hours notice will typically be needed before we will be able to meet/respond.
- **Regrade requests:** All requests must be emailed to the instructor within 2 weeks of receiving the grade to be considered.

Food and Drinks: No food (including chewing gum) or drinks (aside from water) are allowed in the classroom.

Personal Devices: Use your devices (e.g., laptop, phones) only for our in-class activities. It is unprofessional and can distract others when you use your device for other activities.

Course Overview

Summary
Computer vision is the subdiscipline of artificial intelligence focused on creating computers that can 'see'. In this course, students will learn about core and new problems in this field through examination of the types of *algorithms* commonly used as well as the *data* employed

to train and evaluate those algorithms. The course is taught in a seminar style, with students expected to regularly read and critique research papers from premiere computer vision conferences (such as CVPR, ICCV, and ECCV). As a result, students will also learn how to engage with the latest research in computer vision.

Objectives
By the end of the course, the goals are for students to:

1. Understand core computer vision problems and typical solutions, a critical precursor to effective collaborations in industry and academia. Towards this aim, students will:
    - Recognize and define core computer vision problems
    - Identify types of algorithms commonly used to solve each problem alongside their general properties that make them well-suited for the problem
    - Characterize strengths and weaknesses of benchmarks used to track progress on each problem (i.e., data source, data annotation process, evaluation metrics)
    - Critique modern datasets used to train algorithms
    - Experiment with modern computer vision libraries and computing resources to solve computer vision problems
2. Analyze and present cutting-edge research. Towards this aim, students will:
    - Identify in research papers the novelty claims, why they matter to society, and mechanisms used to validate those claims (e.g., theories and experiments)
    - Discuss the merits and limitations of research papers
    - Deliver oral presentations that explain research papers (for graduate students only)
3. Conduct and communicate about a novel project. Towards this aim, students will:
    - Design and execute a project involving computer vision, such as comparing and contrasting existing works, evaluating existing work in novel settings, or creating novel methods
    - Create and deliver an oral presentation about the project
    - Describe the project through a final report
    - Review fellow students' presented projects and provide constructive feedback

Prerequisites
Machine learning experience (e.g., CSCI 4622, 5622, or 5922).

Class Participation
Students are expected to attend every class and demonstrate ongoing engagement in class discussions. More than two unexcused absences will lower your final grade.

Tentative Schedule

Week	Topic(s)	Assignments Due
1	Introduction	
2	Rise of Neural Networks	Reading Assignments
3	Object Recognition	Reading Assignments, Lecture Topic Selection
4	Image Classification, Semantic Segmentation	Reading Assignment
5	Object Detection, Instance Segmentation	Reading Assignments, Project Proposal
6	Object Tracking, Vision-Language Tasks	Reading Assignments
7	Foundation Models, Image-to-Image Translation	Reading Assignments, Project Outline
8	Student-led Lectures	Reading Assignments
9	Student-led Lectures	Reading Assignments
10	Student-led Lectures	Reading Assignments
11	Student-led Lectures	Reading Assignments
12	Student-led Lectures	Reading Assignments
13	Student-led Lectures	Reading Assignments
14	Efficient and Responsible Computer Vision	
15	Responsible Computer Vision	Project Presentation, Peer Evaluation
16	*No Class*	Project Report

Readings with Assignments
For the majority of the course, students will be expected each week to read two research papers and complete assignments about those readings. Assigned readings will be posted

on the course website and assignments will be posted on Canvas. The assignments will offer training in understanding and thinking critically about computer vision research papers and concepts. The assignments will require a brief summary of select aspects of the papers and "discussion points" to explore during class. Discussion points can be in the form of questions, critiques, connections to other readings, or plausible future work that students think are interesting to investigate in greater detail.

Student-Led Lectures (only for graduate students)
In the middle portion of the course, students will also be expected to present research papers on a select topic. Each student/team will lead one lecture on one computer vision topic. For the first seven weeks, the course instructor will lead all lectures.

Topics will be selected and assigned by the fourth week of the semester based on students' preferences (the number of topics and number of students leading each lecture may slightly change depending on the number of students in the course). Students are expected to begin preparing their lecture as soon as they receive the topic.

Each lecture should take about 50 minutes and consist of two parts. The first portion should: (i) define the problem, (ii) motivate the practical importance of solving this problem with a computer vision solution (i.e., applications that can/do benefit society), (iii) describe 1-2 datasets used to track progress on this problem, and (iv) describes metric(s) used to evaluate the performance of computer vision models. The second portion should introduce at least one computer vision model, covering: (i) its claimed novelty, (ii) mechanisms used to validate the claims, and (iii) open technical questions/problems. Then, the lecture will conclude with a facilitated class discussion about the merits and limitations of existing community-shared datasets, evaluation metrics, computer vision models, organized by the instructor around the questions and discussion points submitted by all students. Students can incorporate materials from outside sources in their presentations (for example, content from the paper's authors or slides), but proper credit MUST be given.

The student/team leading the lecture is expected to select research papers to cover that were recently published at a premiere computer vision conference (e.g., CVPR, ICCV, ECCV). The student/team must meet with the instructor at least two weeks prior to the first lecture to share 4-6 candidate papers to cover (including one about a specific dataset challenge that will be assigned to the class) and resolve any open questions; the candidate papers must be sent to the instructor at least 48 hours prior to this meeting. The student/team must meet with the instructor again at least one week prior to the first lecture to review a draft of the slide decks for both lectures and resolve any open questions; the draft must be sent to the instructor at least 24 hours prior to the meeting. It is the responsibility of the student/team to schedule these meetings; they must reach out to the instructor with options for suitable days and times for both of these meetings. The instructor's goal for the meetings is to help make the presentations as awesome as possible and build students' knowledge and confidence in presenting the material.

Course Project
The final component of the course will be a final project. The goal is for students to develop their skills in conducting and communicating original work on a topic of their choice. If proposing a new model or evaluating existing models, experiments must be conducted to

demonstrate the models' strengths and weaknesses. If choosing to conduct a survey paper, it is expected to be comprehensive and critical of the literature. This project will consist of four milestones to help students define/refine the scope so that ultimate success is possible: a proposal, outline, 1-2 minute poster presentation, and final report. An additional part of this effort will be to review peers' final presentations and provide constructive feedback, which in turn can then be used to strengthen the final report.

Resources
Links to required readings will be posted on the course website for each class meeting. Readings will draw heavily from conference proceedings at top computer vision publication venues such as CVPR, ECCV, and ICCV.

Grading

Final grades will be determined differently for undergraduate and graduate students. Final course scores for *undergraduate* students will be calculated as follows:

	% of Final Class Grade
Class Participation	10%
Reading Assignments	45%
Final Project	45%

Final course scores for *graduate* students will be calculated as follows:

	% of Final Class Grade
Class Participation	10%
Reading Assignments	30%
Student-Led Lecture	30%
Final Project	30%

Final course scores represent the following grades (scores are rounded to the nearest integer):

Grade	**% of Final Class Grade**
A	94-100%
A-	90-93%
B+	87-89%
B	84-86%
B-	80-83%
C+	77-79%
C	74-76%

Late Policy
Late submissions will be penalized 1% of the grade per hour up to 2 hours. After 2 hours,

no credit will be given.

Extra Credit Policy
There will be no extra credit opportunities.

Regrade Requests
Students may submit a regrade request within two weeks of receiving an assignment grade, when it is believed a mistake was made. After the allotted time frame, regrade requests will not be considered.

Policies

Statement on Learning Success
Your success in this course is important to me. We will all need accommodations because we all learn differently. If there are aspects of this course that prevent you from learning or exclude you, please let me know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course.

Classroom Behavior
Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Conduct & Conflict Resolution policies.

Honor Code
All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

Requirements for Infectious Diseases
Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all public health orders to reduce the risk of spreading infectious diseases.

The CU Boulder campus is currently mask optional. However, if masks are again required

in classrooms, students who fail to adhere to masking requirements will be asked to leave class. Students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct & Conflict Resolution. Students who require accommodation because a disability prevents them from fulfilling safety measures related to infectious disease will be asked to follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

For those who feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the further guidance of the Public Health Office. For those who have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home.

Excused Absences
A student will be given an opportunity to complete any work missed due to absences in observance of a religious holy day or military service. Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. The student must notify me at least two weeks in advance of the absence. The student will not be penalized for excused absences, but must complete the missed material within a reasonable time after the excused absence. Please see the campus policy regarding religious observances for full details.

University Resources for Students
There are a range of resources available on campus to support you and your academic success:

- *Mental Health and Wellness*
  If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277 24/7. Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.

- *Accommodations for Disability*
  Disability Services determines accommodations based on documented disabilities in the academic environment. If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or required medical isolation for which you require accommodation, see Temporary Medical Conditions on the Disability Services website.

- *Writing Center*
  All students are encouraged to consult the University Writing Center for support.

Personal Pronouns
CU Boulder recognizes that students' legal information doesn't always align with how they

identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation
The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about OIEC, university policies, reporting options, and the campus resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit Dont Ignore It.

Sharing of Course Materials is Prohibited
Class recordings are reserved only for students in this class for educational purposes. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.