

Neural Networks and Deep Learning (CSCI 5922)

University of Colorado Boulder, Computer Science Department

Course Lectures: Mondays and Wednesdays, 3:05-4:20pm MT

Course Mode: Synchronously remote, which means classes will be held virtually during the listed days and times. Classes will also be recorded for students who can only join asynchronously.

Instructor: Danna (pronounced similar to “Donna”) Gurari (rhymes with Ferrari)

Instructor Nickname: for simplicity, you can call me Dr. G.

Pronouns: she/her

Email: danna.gurari@colorado.edu

Teaching Assistant: Samreen Anjum

Pronouns: she/her

Email: samreen.anjum@colorado.edu

Teaching Assistant: Lucas Hayne

Pronouns: he/him

Email: lucas.hayne@colorado.edu

Ways to Contact Us:

- **Questions for Instructor:** She will stay after each class meeting to answer questions.
- **Piazza:** We encourage you to post questions to Piazza. This can benefit other students, who may have similar questions to see the answers posted on Piazza, and it also allows peers to answer your questions. You can post questions to Piazza from Canvas.
- **Office Hours:** The TAs will host office hours every day of the week for 1 hour. Office hours will be held on Mondays at 11am MT, Tuesdays at 2pm MT, Wednesdays at 11am MT, Thursdays at 5pm MT, and Fridays at 2:30pm MT. To attend, please enter your name on the office hours spreadsheet shared on Canvas and then join the video meeting link shared on Canvas.
- **Regrade requests:** All requests must be emailed to the TA, Samreen Anjum, within 2 weeks of receiving the grade to be considered.
- **Appointments:** For any other matters, email the TA, Samreen Anjum, to make an appointment or solicit an answer. Please note that at least 24 hours notice will typically be needed before a TA will be able to meet. The TAs will involve the instructor for any items they are unable to address.

Course Overview

Summary

This course will cover machine learning approaches that are based on neural networks, also referred to as ‘deep learning’, and how these approaches are applied to solve artificial intelligence problems. We will begin with the history of deep learning, examine the theory behind a range of deep learning algorithms, and practice applying deep learning algorithms to, for example, visual data (computer vision), textual data (natural language processing), and their combination. The course homework will consist of problem sets and lab assignments for the first part of the semester followed by a research project the second part of the semester. Readings will come both from textbooks and research articles.

Objectives

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

1. Understand the key concepts for designing deep learning models, a critical precursor to effective collaborations in industry or academia. Towards this aim, students will:
 - Characterize the fundamental architectures used in designing neural networks
 - Identify techniques used to train and evaluate deep learning algorithms
 - Recognize strengths and weaknesses of different neural network architectures and training approaches
2. Apply deep learning models to perform various artificial intelligence tasks. Towards this aim, students will:
 - Experiment with deep learning libraries, including scikit-learn and Keras
 - Evaluate deep learning algorithms for tasks in various application domains, including for analyzing images and text
3. Conduct and communicate a novel project. Towards this aim, students will:
 - Propose a novel project idea (this will be an iterative process)
 - Design and execute experiments to support the proposed idea
 - Create a presentation about the project
 - Write a report about the project

Prerequisites

Programming competency as well as experience with probability/statistics and linear algebra.

Website

<https://www.cs.colorado.edu/~DrG/Courses/NeuralNetworksAndDeepLearning/>

Readings

Readings will be assigned in the first part of the course. This will supplement the lectures

by providing a more detailed and formal coverage of many of the topics.

Problem Sets

Three problem sets will be assigned in the first part of the course. Each assignment description will be posted in Canvas before the due date. These assignments will offer deeper examination of the foundational concepts in deep learning. You will be given one week to complete each assignment. Due to the large number of students in the course, we expect graded assignments will be returned 1 week after submission.

Lab Assignments

Four lab assignments will be assigned in the first part of the course. Each assignment description will be posted in Canvas before the due date. These lab assignments will give students hands-on practice in developing deep learning models. You will be given one and a half weeks to complete each assignment. Due to the large number of students in the course, we expect graded assignments will be returned 1 week after submission.

Final Project

The second part of the course will center on strengthening students' skills in conducting and communicating original work by applying their deep learning knowledge in a novel way. It will consist of four milestones to help students define/refine the scope so that ultimate success is possible: a proposal, outline, presentation, and final report. Details about each project milestone will be posted on the course website prior to each milestone's deadline.

Resources

Assigned readings will be posted on the course website for each class meeting. The primary texts will be "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville and "Deep Learning for NLP and Speech Recognition" by Uday Kamath, John Liu, and James Whitaker. Both texts are available online for free. Finally, we will also read publications from conference proceedings, all of which are available online for free.

Tentative Schedule

Week	Topic(s)
1	Introduction, Artificial neurons
2	Feedforward neural networks (NN), NN training
3	NN training
4	Convolutional neural networks (CNN), Introduction to CV
5	Training CNN algorithms
6	Regularization, Pretrained CNN features, Fine-tuning
7	Object detection, Semantic segmentation, Recurrent neural networks
8	Introduction to natural language processing, Neural word embeddings, Attention
9	Transformers
10	Multimodal NN (vision + language)
11	Multimodal NN, Self-supervised learning, GANs
12	Few/zero-shot learning, Responsible/ethical learning
13	Deep learning in industry (guest speakers)
14	Model compression, Efficient learning
15	NNs for speech processing & reinforcement learning
16	NN for information retrieval & course summary

Grading

Final course scores will be calculated as follows:

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% of Final Class Grade	
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Problem Sets	25%
Lab Assignments	35%
Final Project	40%

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

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Grade	% of Final Class Grade
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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.

Regrade Requests

Students may submit a regrade request within 2 weeks of receiving an assignment grade, when it is believed a mistake was made. These requests should be submitted to the TA. 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

Both 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](#).

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:

- *Coping with Stress and Personal Hardships*

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the University experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, please consider taking advantage of the support available to you from the [Counseling and Psychiatric Services \(CAPS\)](#).

- *Accommodations for Disability*

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. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, 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.

Requirements for COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the Accommodation for Disabilities statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulders COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see

the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the Accommodation for Disabilities statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.