



USC University of
Southern California

CSCI 566: Deep Learning and its Applications

Fall 2024

Course Description

This course offers a comprehensive introduction to the mathematical foundations of machine learning (ML) as well as a variety of deep learning (DL) models and their applications. The course emphasizes both mathematical foundation and practical applications. You will gain insights into basic ML techniques, learn knowledge of advanced DL applications in fields like computer vision and natural language processing, and understand their transformative impact on areas such as image recognition and autonomous systems. The course includes hands-on assignments and a customizable final project, providing you with practical experience in implementing ML and DL solutions.

Course Piazza: <https://piazza.com/usc/fall2024/csci566>

All materials will be distributed through Piazza.

Guest Lectures: Industry and academic professionals will join our lectures regularly, sharing their experiences in ML and data science, and providing career insights.

Prerequisite(s):

1. Proficiency in Python
2. College Calculus, Linear Algebra
3. Probability and Statistics

Recommended Preparation: sufficient mathematical background; good programming skills; familiarity with concepts and methods in machine learning and AI.

Instructor: Yan Liu

Office: TBD

Office Hours: Wed 10am

Office Hours Sign-Up Link:

https://docs.google.com/spreadsheets/d/1GwNLTGGbPZABYjI8_b6-IHQXt48PhHLsfc1QBMMBko4/edit?usp=sharing

Purpose: Office hours are intended for non-homework and non-project related inquiries. We will focus on addressing personal challenges and logistics.

Teaching Assistants: Office hours and details are available shortly after the first class on Piazza

Purpose: TA sessions focus on homework, project guidance, and administrative support

Contact: All course communications should be directed through Piazza for efficiency and inclusivity. We prioritize this platform over email due to the course's large size.

Required Readings and Supplementary Materials

- Deep Learning (MIT Press) by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
 - A free online version is available at <http://www.deeplearningbook.org/>
- Mathematics for Machine Learning (Cambridge University Press) by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong.
 - A free online version is available at <https://mml-book.github.io/>

Description and Assessment of Assignments

3 in-class quizzes, 1 midterm exam, and 1-course project (a proposal, reports, presentations, etc.)

Grading Breakdown

Deliverable	Points of the total grade
In-class Quizzes	30 (10 each)
Midterm	20
Course Project	50
TOTAL	100

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In-class Quizzes

Quizzes will be conducted during the class, and the results will be reviewed together during the same class session or the following session to facilitate a collective discussion of the answers. Please note that quizzes must be completed within the designated class period. **No remote quizzes or makeup quizzes.**

Exercise questions

Exercise questions and solutions will be distributed on Piazza in preparation for quiz and midterm exam. There is no need to submit your solutions and no grade will be given for the solutions.

Midterm Exam

- Format: Closed book (no electronic devices allowed) with mostly multiple-choice questions and some computation-based questions (with unambiguous, single-number answers).
- Makeup exams will not be provided.

Project (more information to come)

The project should be in groups of 2-4 students; the topic is open. This can be from applied ML projects to some rigorous ML research projects (which lead to publications).

Each group will have a dedicated TA, who will meet with you for two times to make sure the project is flowing smoothly.

- *Project matching.* This form is designed to assist with the team-matching process for the course research project. Students will indicate their project preferences and potential teammates. We will use Piazza to help this process
- *Pre-proposal (10%).* The pre-proposal is a short, 1-page document confirming your team and providing initial thoughts on your research project. This includes the dataset you plan to use.
- *Midterm Report (30%).* The midterm report should summarize the current research progress, literature review, and initial results. It should also present an updated list of research ideas that the team plans to explore.
- *Presentation (30%).* Presentation include 3-minute oral presentation and poster presentations.
- *Final Report (30%).* The final report should resemble a research paper, motivating the problem, presenting novel approaches, describing the experiment, and discussing results.

Assignment Submission Policy

All project reports need to be submitted in an electronic form by **11:59 pm PST** of the due date. There are NO late days for these.

	Topics/Daily Activities	Quiz dates	Deliverable/ Due Dates
Week 1 Aug 27	1. Course Introduction 2. Framing ML Problems 3. Start the contents in Week 2 if time permits		
Module 1: Mathematical Foundations			
Week 2 Sep 3	Basic math concepts in deep learning 1. Linear Algebra 2. Matrix decomposition 3. Vector Calculus 4. Probability and Distribution 5. Continuous optimization		
Week 3 Sep 10	Basic concept in ML a. Supervised learning: linear regression, non-linear regression regularization b. Unsupervised learning: density estimation c. Bias-variance trade-off		
Week 4 Sep 17	Neural Network Basics <ul style="list-style-type: none"> Perceptron Revisited Gradient Descent Forward Propagation 	Quiz 1	Course Project Teams Formed; Pre-prosal DUE
Week 5 Sep 24	1. Neural Network Continued: <ul style="list-style-type: none"> Backpropagations 2. Cloud computing service tutorial 3. Deep Learning Software Tutorial		
Week 6 Oct 1	Different Types of Neural Networks: 1. Convolutional Neural Networks 2. Recurrent Neural Networks 3. Graph Neural Networks (tbd)		

Week 7 Oct 8	1. Transformers and AutoDiff 2. Deep Generative Models	Quiz 2	
Module 2 Deep Learning Applications			
Week 8 Oct 15	Deep Learning for Natural Language Processing, Large language models		
Week 9 Oct 22	Deep Learning for Computer Vision		
Week 10 Oct 29	Mid-term exam		Course Project Mid-report DUE
Module 3: Advanced Topics in Machine Learning and Deep Learning			
Week 11 Nov 5	1. Graph Neural Networks 2. ML Scalability and Systems		
Week 12 Nov 12	1. Automated ML and Model Selection 2. Foundational Models, Pretraining, and In-context Learning 3. Self-supervised Learning		
Week 13 Nov 19	Team Project Presentations (poster + video)	Quiz 3	
Week 14 Nov 26	Team Project Presentations (poster + video)		
FINAL	Final Report Due on University Final Exam Day, Wed Dec 4		Final Project Report due

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions>. Other forms of academic dishonesty are equally unacceptable. See additional information in *Campus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu> or to the *Department of Public Safety* <http://capsnet.usc.edu/departments/departments-public-safety/online-forms/contact-us>. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage <http://sarc.usc.edu> describes reporting options and other resources.

Support Systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.