CSCI 566: Deep Learning and its Applications

The most up-to-date course schedule is https://usc-fortis.github.io/CSCI566-S25/

Spring 2025—Fridays—1:00pm-4:20pm (4)

Location: THH 201

Course Description
This course offers a comprehensive introduction to the principles of machine learning (ML) and deep learning (DL), emphasizing both mathematical foundations 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 website: https://usc-fortis.github.io/CSCI566-S25/ (see up-to-date course schedule and TA office hours)
Course Piazza: https://piazza.com/usc/spring2025/csci566

Course Google Drive (primarily for slides):
https://drive.google.com/drive/folders/1aoTGGtRVO_PGnbvoc0Si8MpDpJdPU_al?usp=sharing
(use your USC login – do not request access from personal Gmail)

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
4. (Recommended) CSCI 567 (Machine Learning) or equivalent

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

Instructor: Yue Zhao
Office Hours: Friday lecture time (as well as after the class)
Purpose: Office hours are intended for non-homework and project-related inquiries. Questions about course content and logistics are encouraged. More technical questions can be directed to TAs

Teaching Assistants: Office hours and details are available on the course website:
https://usc-fortis.github.io/CSCI566-S25/
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, 2 coding assignments, 1 midterm exam, and 1-course project (a proposal, reports, presentations, etc.)

Grading Breakdown

Deliverable	Points of the total grade
In-class Quizzes	10 (5 each)
Assignments	30 (15 each)
Midterm	30
Course Project	30
TOTAL	**100**

In-class Quizzes

Quizzes will typically be graded on a completion basis, and the results will be reviewed together during the same class session to facilitate a collective discussion of the answers. Please note that quizzes must be completed within the designated class period, and they also function as a means of taking attendance. **No remote quizzes or makeup quizzes**.

Assignments

These assignments will be individual coding tasks. Your submissions should include both the written code and accompanying documentation. Typically, you will be given a starter code and a detailed description of the required implementation, along with some unit tests to check the compatibility of your code with the grading scripts.

Midterm Exam
- Format: Open book (no electronic devices allowed) with mostly multiple-choice questions and some computation-based questions (with unambiguous, single-number answers).
- Content: Covers material from Module 1.
- Makeup exams will **NOT** be provided unless Viterbi approves documents.

Project (more information to come)

The project should be in groups of 4-6 students; the topic is open. This can be from applied ML projects to some rigorous ML research projects (which lead to publications; note this is an applied course which means this is rare).

Each group will have a dedicated TA, who will meet with you 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.
- *Final Report and Presentation (60%).* The final report should resemble a research paper, motivating the problem, presenting novel approaches, describing the experiment, and discussing results.

Assignment Submission Policy
All assignments and 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.

Grading Scale
A   93-100
A-   90-92
B+   87-89
B   83-86
B-   80-82
C+   77-79
C   73-76
C-   70-72
D+   67-69
D   63-66
D-   60-62
F   59 and below
Letter grades are decided by rounding floating point grades up to the nearest whole number (e.g., 92.2 -> A; 59.8 -> D-).

Date	Lecture	Homework / Readings	Logistics
	Module 1: ML and DL Foundations		
Week 1 Jan 17	1. Course Introduction 2. My Research Overview: AI Robustness and Trustworthiness 3. My Research Overview: AI4Science and ML Systems 4. Framing ML Problems 5. ML as Function Approximation 6. Linear Models 7. Job or Ph.D.? Is it a Question.		
Week 2 Jan 24	1. Project idea discussion 2. Classical ML - Decision Trees and Ensembles - k-Nearest Neighbors - Clustering - Anomaly Detection 3. Cloud computing service tutorial		
Week 3 Jan 31	1. Classical ML (continued) Neural Network Basics - Perceptron Revisited - Gradient Descent - Forward Propagation 2. Project idea discussion		
Week 4 Feb 7	1. Neural Network Basics - Backpropagation - Vanishing Gradient 2. Different types of Neural Networks: - Convolutional Neural Networks	Quiz 1	Course Project Teams Formed; Pre-proposal DUE
Week 5 Feb 14	1. Different types of Neural Networks: - Convolutional Neural Networks 2. Deep Learning Software Tutorial (maybe)	Assignment 1 OUT	
Week 6 Feb 21	Different types of Neural Networks: 1. Recurrent Neural Networks (RNN) & LSTM 2. Graph Neural Networks (GNN)		
Week 7 Feb 28	**Automated ML and Transfer Learning** *Guest Discussion (TBD)*		
Week 8 Mar 7	**Training dynamics** *Guest Discussion (TBD)*		Assignment 1 DUE
Week 9 Mar 14	MIDTERM EXAM	Assignment 2 OUT	
Week 10 Mar 21	NO CLASS; Spring Recess		

Module 2: Deep Learning Applications & Advanced Topics			
Week 11 Mar 28	**Generative AI** 1. Generative adversarial networks (GAN) 2. Variational AutoEncoder (VAE) 3. Case Study on Controllable Text Generation *Guest Discussion (TBD)*	Quiz 2	Course Project Mid-report DUE
Week 12 Apr 4	**Attention, Relation, and Memory Networks** *Guest Discussion (TBD)*		Assignment 2 DUE
Week 13 Apr 11	**Contrastive Learning and Self-supervised Learning** *Guest Discussion (TBD)*		
Week 14 Apr 18	**Reinforcement Learning** *Guest Discussion (TBD)*		
Week 15 Apr 25	Team Project Presentations (zoom; TBA)		
Week 16 May 2	Team Project Presentations (in person)		
Final Report	Final Report Due on University Final Exam Day	(No in-class Exam)	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/department/department-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.