ECBM E4040: Neural Networks & Deep Learning

Columbia University, Fall 2023

Instructor:	Mehmet Kerem Turkcan	**Time:**	F 10:10AM - 12:40PM
Email:	mkt2126@columbia.edu	**Location:**	501 Northwest Corner Building

Course Pages:

1. Courseworks: https://courseworks2.columbia.edu/courses/180017
2. EdStem Forum: https://edstem.org/us/courses/46398/discussion/
3. Columbia Course Directory: https://doc.sis.columbia.edu/#subj/ECBM/E4040-20233-001/

Office Hours: After class, or by appointment, or post your questions in the EdStem forum.

TA/CA Office Hours: Announced on Courseworks.

TAs and CAs: Chengbo Zang, Aishwarya Patange, Sanjeev Narasimhan, William Ho.

Description: The course covers theoretical underpinnings and practical aspects of Neural Networks and Deep Learning. Students will learn about and implement a range of different deep learning architectures, including convolutional and recurrent neural networks. The focus of the course is on applications and projects.

Main References: The main resource for the course is the book entitled "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, `https://www.deeplearningbook.org`, 2016.

Prerequisites:

1. Machine Learning (taken previously, or in parallel with this course).
2. The course requires background in probability and statistics, and in linear algebra.

Grading Policy:

- Assignments (40%): The course has 4 assignments (homeworks). All assignments are graded. Each student has to complete their own coding tasks and questions, using Python, TensorFlow, Jupyter notebooks, and code management tools.
- Exam (at Week 11, 25%): Students will take an in-class exam covering the deep learning theory, architecture and design, as well as mastery of prerequisite topics in linear algebra, probability and statistics, calculus, and basic machine learning.
- Final Projects (35%): Students will work on one project, based on contemporary papers or original ideas, in groups of no more than 3. Projects will have to be documented in code and a report.

Late homeworks (Assignments) - Slip Days: A student is entitled to 4 late days without penalty. For all homeworks together, a student can divide those four days in any fashion needed. Examples: (i) Homework 2 is late 4 days, in which case no other homework can be late for any amount of time; (ii) Homework 1 is late 1 day, homework 2 is late 2 days, in which case the student still has one more late-day

for future assignments. The unit of delay can not be divided into less than a full day (like hours). Requests for additional extensions will not be granted: if the budget of 4 days is blown, the student will be given 0 credit for homework(s) for which their submission is late. Late policy does not apply to project submissions.

Course Outline:

- **Week 1:** Introduction to the Course, Introduction to Deep Learning, Introduction to Computing Resources for Deep Learning
- **Week 2:** Introduction to the Course (Continued), Review of Machine Learning
- **Week 3:** Deep Feedforward Networks, Introduction to Backpropagation
- **Week 4:** Backpropagation, t-SNE, Universal Approximation Theorem
- **Week 5:** Optimization for Deep Learning
- **Week 6:** Convolutional Neural Networks
- **Week 7:** Regularization
- **Week 8:** Deep Learning in Practice
- **Week 9:** Modern CNN Architectures
- **Week 10:** RNNs and Midterm Preparation
- **Week 11:** Midterm
- **Week 12:** Autoencoders
- **Week 13:** GANs, Variational Autoencoders, Trends in Deep Learning
- **Week 14:** GANs, Variational Autoencoders, Trends in Deep Learning

Important Dates:

Assignment #0	September 22, 2023
Assignment #1	October 17, 2023
Assignment #2	November 7, 2023
Midterm	November 17, 2023
Assignment #3	November 28, 2023
Final Project	December 17, 2023