# ECBM E4040: Neural Networks & Deep Learning

Columbia University, Fall 2023

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| **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/4103727
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:**

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