

# 10-707 Spring 2020 Course Syllabus

## Course Outline

Building intelligent machines that are capable of extracting meaningful representations from high-dimensional data lies at the core of solving many AI related tasks. In the past few years, researchers across many different communities, from applied statistics to engineering, computer science and neuroscience, have developed deep (hierarchical) models -- models that are composed of several layers of nonlinear processing. An important property of these models is that they can learn useful representations by re-using and combining intermediate concepts, allowing these models to be successfully applied in a wide variety of domains, including visual object recognition, information retrieval, natural language processing, and speech perception. This is an advanced graduate course, designed for Masters and Ph.D. level students, and will assume a reasonable degree of mathematical maturity. The goal of this course is to introduce students to the recent and exciting developments of various deep learning methods.

This course covers some of the theory and methodology of deep learning. The preliminary set of topics to be covered include:

- Introduction
  - Background: Linear Algebra, Distributions, Rules of probability.
  - Regression, Classification.
  - Feedforward neural nets, backpropagation algorithm. Introduction to popular optimization and regularization techniques.
  - Convolutional models with applications to computer vision.
- Deep Learning Essentials
  - Graphical Models: Directed and Undirected.
  - Linear Factor Models, PPCA, FA, ICA, Sparse Coding and its extensions.
  - Autoencoders and its extensions. Energy-based models, RBMs.
  - Monte Carlo Methods.
  - Learning and Inference: Contrastive Divergence (CD), Stochastic Maximum Likelihood Estimation, Score Matching, Ratio Matching, Pseud-likelihood Estimation, Noise-Contrastive Estimation.
  - Annealed Importance Sampling, Partition Function Estimation.
  - Deep Generative Models: Deep Belief Networks, Deep Boltzmann Machines, Helmholtz Machines, Variational Autoencoders, Importance-weighted Autoencoders, Wake-Sleep Algorithm.

- Generative Adversarial Networks (GANs), Generative Moment Matching Nets, Neural Autoregressive Density Estimator (NADE).
- Additional Topics
  - More on Regularization and Optimization in Deep Nets.
  - Sequence Modeling: Recurrent Neural Networks. Sequence-to-Sequence Architectures, Attention models.
  - Deep Reinforcement Learning.

## Time and Location

Monday, Wednesday 1:30 - 2:50pm GHC 4401 Rashid Auditorium

## Contact Information

If you have a question, to get a response from the teaching staff quickly we strongly encourage you to post it to the class [Piazza forum](#). For private matters, please make a private note visible only to the course instructors or contact the course Education Associate Daniel Bird ([dpbird@andrew.cmu.edu](mailto:dpbird@andrew.cmu.edu)). For longer discussions with TAs and to get help in person, we strongly encourage you to come to office hours.

## Prerequisites

Students are expected to have mathematical maturity, as well as a strong background in linear algebra, machine learning, and statistics/probability theory.

- 10315, 10401, 10715, 10701 or 10601 must be satisfied to take the course.
- Have a basic understanding of coding (Python preferred) as this will be a coding intensive course.

## Course Materials

Homework assignments will be announced on Piazza when released. Slides will be posted periodically on the class syllabus. Instructor will try to upload slides before class, and additional readings will be posted whenever possible.

## Assignments and Grading

Assignments: There will be two types of assignments -- problem sets (written, mathematical in nature) and coding assignments. The tentative schedule of release and due dates can be seen in the Syllabus. Latex templates will be released with the homework for students to complete with their solutions.

Exams: The course will have two midterm exams which are scheduled to be hosted on February 12th and April 1st. There will be a final exam scheduled during finals week, the official date of which will be announced as soon as it is confirmed.

Course grades: will be made up of assignments (45% in total), 2 midterms (15% each), and one final exam (25%).

## Homework Assignments

The assignments are to be done by each student individually. You may discuss the general idea of the questions with anyone you like, but your discussion may not include the specific answers to any of the problems and when writing your solutions you must close all notes and write the answer entirely yourself.

## Submitting Assignments

Assignments will be submitted through Gradescope. Additionally, you should upload your code to Autolab.

Writeups should be typeset in Latex and should be submitted in PDF form.

All code should be submitted with a README file with instructions on how to execute your code.

You will receive an invite to Gradescope for 10707 Deep Learning Spring 2019 by 01/08/2019.

Login via the invite. If you have not received an invite, please email Daniel Bird

([dpbird@andrew.cmu.edu](mailto:dpbird@andrew.cmu.edu)) with details of your Andrew email address and your full name.

## Marking

As a general rule, matters of marking on assignments and exams (apparent errors, questions about evaluation criteria, etc.) should be taken to the marker (via Gradescope Regrade Request).

## General Policies

### Grace Day/Late Homework Policy

Homeworks: Each student will have a total of 5 grace days that a student may choose to apply to the homework assignments. No more than 3 grace days can be used on any single assignment.

Homeworks submitted late when the student has no Grace days remaining or 3 days past the deadline will be given a score of 0.

## Extensions

In general, we do not grant extensions on assignments. There are several exceptions:

- Medical Emergencies: If you are sick and unable to complete an assignment or attend class, please go to University Health Services. For minor illnesses, we expect grace days or our late penalties to provide sufficient accommodation. For medical emergencies (e.g. prolonged hospitalization), students may request an extension afterwards and should include a note from University Health Services.
- Certificate or a written (not email) request submitted at least one week before the due date and approved by the instructor. Please plan ahead.
- Family/Personal Emergencies: If you have a family emergency (e.g. death in the family) or a personal emergency (e.g. mental health crisis), please contact your academic adviser or Counseling and Psychological Services (CaPS). In addition to offering support, they will reach out to the instructors for all your courses on your behalf to request an extension.
- University-Approved Absences: If you are attending an out-of-town university approved event (e.g. multi-day athletic/academic trip organized by the university), you may request an extension for the duration of the trip. You must provide confirmation of your attendance, usually from a faculty or staff organizer of the event.

For any of the above situations, you may request an extension by emailing the Educational Associate Daniel Bird at [dpbird@andrew.cmu.edu](mailto:dpbird@andrew.cmu.edu) – do not email the instructor or TAs. The email should be sent as soon as you are aware of the conflict and at least 5 days prior to the deadline. In the case of an emergency, no notice is needed.

## Audit Policy

Official auditing of the course (i.e. taking the course for an “Audit” grade) is not permitted this semester.

Unofficial auditing of the course (i.e. watching the lectures online or attending them in person) is welcome and permitted without prior approval. We give priority to students taking the course for a letter grade, so auditors may only take a seat in the classroom if there is one available 10 minutes after the start of class. Unofficial auditors will not be given access to course materials such as homework assignments and exams.

## Pass/Fail Policy

We allow you to take the course as Pass/Fail. Instructor permission is not required. What grade is the cutoff for Pass will depend on your program. Be sure to check with your program / department as to whether you can count a Pass/Fail course towards your degree requirements.

## Accommodations for Students with Disabilities:

If you have a disability and have an accommodation letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with Daniel Bird ([dpbird@andrew.cmu.edu](mailto:dpbird@andrew.cmu.edu)) as early in the semester as possible. We will work with you to ensure

that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

## Academic Integrity Policies

**Read this carefully!**

(Adapted from Roni Rosenfeld's 10-601 Spring 2016 Course Policies.)

### Collaboration among Students

The purpose of student collaboration is to facilitate learning, not to circumvent it. Studying the material in groups is strongly encouraged. It is also allowed to seek help from other students in understanding the material needed to solve a particular homework problem, provided no written notes (including code) are shared, or are taken at that time, and provided learning is facilitated, not circumvented. **The actual solution must be done by each student alone.**

The presence or absence of any form of help or collaboration, whether given or received, must be explicitly stated and disclosed in full by all involved. Specifically, each assignment solution must include answering the following questions:

- Did you receive any help whatsoever from anyone in solving this assignment? Yes / No.
- If you answered 'yes', give full details: \_\_\_\_\_ (e.g. "Jane Doe explained to me what is asked in Question 3.4")
- Did you give any help whatsoever to anyone in solving this assignment? Yes / No.
- If you answered 'yes', give full details: \_\_\_\_\_ (e.g. "I pointed Joe Smith to section 2.3 since he didn't know how to proceed with Question 2")
- Did you find or come across code that implements any part of this assignment ? Yes / No. (See below policy on "found code")
- If you answered 'yes', give full details: \_\_\_\_\_ (book & page, URL & location within the page, etc.).

If you gave help after turning in your own assignment and/or after answering the questions above, you must update your answers before the assignment's deadline, if necessary by emailing the course staff. Collaboration without full disclosure will be handled severely, in compliance with CMU's Policy on Academic Integrity.

### Previously Used Assignments

Some of the homework assignments used in this class may have been used in prior versions of this class, or in classes at other institutions, or elsewhere. Solutions to them may be, or may have been, available online, or from other people or sources. It is explicitly forbidden to use any such sources, or to consult people who have solved these problems before. It is explicitly forbidden to search for these problems or their solutions on the internet. You must solve the homework assignments completely on your own. We will be actively monitoring your

compliance. Collaboration with other students who are currently taking the class is allowed, but only under the conditions stated above.

### Policy Regarding “Found Code”:

You are encouraged to read books and other instructional materials, both online and offline, to help you understand the concepts and algorithms taught in class. These materials may contain example code or pseudo code, which may help you better understand an algorithm or an implementation detail. However, when you implement your own solution to an assignment, you must put all materials aside, and write your code completely on your own, starting “from scratch”. Specifically, you may not use any code you found or came across. If you find or come across code that implements any part of your assignment, you must disclose this fact in your collaboration statement.

### Duty to Protect One’s Work

Students are responsible for pro-actively protecting their work from copying and misuse by other students. If a student’s work is copied by another student, the original author is also considered to be at fault and in gross violation of the course policies. It does not matter whether the author allowed the work to be copied or was merely negligent in preventing it from being copied. When overlapping work is submitted by different students, both students will be punished.

**To protect future students, do not post your solutions publicly, neither during the course nor afterwards.**

### Penalties for Violations of Course Policies

All violations (even first one) of course policies will always be reported to the university authorities (your Department Head, Associate Dean, Dean of Student Affairs, etc.) as an official Academic Integrity Violation and will carry severe penalties.

The penalty for the first violation is a one-and-a-half letter grade reduction. For example, if your final letter grade for the course was to be an A-, it would become a C+.

The penalty for the second violation is failure in the course, and can even lead to dismissal from the university.

### Support

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

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 college 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, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:

CaPS: 412-268-2922

Re:solve Crisis Network: 888-796-8226

If the situation is life threatening, call the police:

On campus: CMU Police: 412-268-2323

Off campus: 911.

If you have questions about this or your coursework, please let the instructors know.