

10-707 Spring 2021 Course Syllabus

Course Information

- **Instructor:** Andrej Risteski
- **Education Associate:** Fatima Kizilkaya
- **Meetings:**
 - **10-707:** MWF, 12:20 PM - 1:40 PM (via Zoom)
 - For all sections, lectures are on Mondays and Wednesdays.
 - Occasional recitations are on Fridays and will be announced ahead of time.
- **Piazza:** <https://piazza.com/class/kjx23s99vle5kc>
- **Gradescope:** <https://www.gradescope.com/courses/228850>
- **Course Calendar:**

<https://calendar.google.com/calendar/u/0?cid=Y184OTJlbnJlMmVhdTJlcmptZWYyZDgzczxyc0Bncm91cC5jYWxlbmRhci5nb29nbGUuY29t>

Course Description

Models that are capable of extracting complex, hierarchical representations from high-dimensional data lie at the core of solving many ML and AI domains, such as visual object recognition, information retrieval, natural language processing, and speech perception. While the usefulness of such deep learning techniques is undisputed, our understanding of them is still in many ways nascent. The goal of this course is to introduce students to recent and exciting developments (both theoretical and practical) in these methods.

This is an advanced graduate course, designed for Masters and Ph.D. level students, and will assume a substantial degree of mathematical maturity.

The preliminary set of topics to be covered include:

- **Supervised Learning**
 - Representational power of neural networks: universal approximation, depth separation. Modern architectures (ResNet, DenseNet).
 - Generalization in neural networks: classical bounds (VC dimension, Rademacher complexity), modern phenomena (flat vs sharp minima, double descent)
 - Optimization for deep learning: backpropagation, momentum and second-order methods, RMSProp, Adam.

- Unsupervised learning
 - Classical topics: graphical models, latent-variable models, variational inference, MCMC.
 - Semi-classical topics: (variational) autoencoders, sparse coding, RBMs
 - Modern topics: generative adversarial networks, normalizing flows
 - Self-supervised/predictive learning in vision and language
- Deep learning for language
 - Word embeddings, Recurrent Neural Networks, Sequence-to-Sequence Architectures, Attention models, Transformers, ELMO, BERT

Prerequisites

This is an advanced course and will assume substantial 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.

You must strictly adhere to these prerequisites! Even if CMU's registration system does not prevent you from registering for this course, it is still your responsibility to make sure you have all of these prerequisites before you register.

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

Course Materials

Homework assignments will be announced on Piazza when released. Slides will be posted periodically on the course website. The instructor will try to upload slides before class, and additional readings will be posted whenever possible and helpful.

The core content of this course does not exactly follow any one textbook.

Assignments and Grading

The grading breakdown is the following:

- 70% Homework Assignments
- 30 % Project

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.

Project: The course will have one project, to be completed by the end of the semester. It will give you an opportunity to explore a deep learning area of particular interest. You will work in groups of 2 (exceptions may be granted on a case-by-case basis). You can explore an applied project (pick an interesting dataset/task, apply an existing approach for a baseline, and improve it) or a foundational/theoretical project (design controlled experiments to explore some phenomenon, or prove a theoretical result to elucidate some aspect of deep learning).

Homework

The homeworks will be of two types: programming and written. The programming assignments will ask you to implement deep learning methods covered in class -- we will ask you to complete them in Python from scratch without using deep learning packages like PyTorch. The written assignments will be mathematical in nature to enhance your understanding of the theory behind the material covered in class.

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 you are writing your solutions you must close all notes and write the answer entirely yourself.

All assignments will be submitted through Gradescope. You will receive an invite to Gradescope for 10707 Advanced Deep Learning Spring 2021 by 02/03/2021. Login via the invite. If you have not received an invite, please email Fatima Jeffrey (fjeffrey@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).

Recitations

Attendance at recitations (Friday sessions) is not required, but strongly encouraged. These sessions will cover in more detail topics that were glossed over in lectures, or provide guidance on the programming assignments. If you are unable to attend one or you missed an important detail, feel free to stop by office hours to ask the TAs about the content that was covered. Of course, we also encourage you to exchange notes with your peers.

Technologies

We use a variety of technologies:

Piazza

We will use Piazza for all **course discussion**. Questions about homeworks, course content, logistics, etc. should all be directed to Piazza. If you have a question, chances are several others had the same question. By posting your question publicly on Piazza, the course staff can answer once and everyone benefits. If you have a private question, you should also use Piazza as it will likely receive a faster response.

Gradescope

We use Gradescope to collect PDF submissions of **open-ended questions** on the homework (e.g. mathematical derivations, plots, short answers). The course staff will manually grade your submission, and you'll receive personalized feedback explaining your final marks.

You will also submit your code for **programming questions** on the homework to Gradescope. After uploading your code, our grading scripts will autograde your assignment by running your program on a VM. This provides you with immediate feedback on the performance of your submission.

Regrade Requests: If you believe an error was made during manual grading, you'll be able to submit a regrade request on Gradescope. For each homework, regrade requests will be open for only 1 week after the grades have been published. This is to encourage you to check the feedback you've received early!

General Policies

Grace Day/Late homework policy

Each student will have a total of 7 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. There will be no late days allowed for the projects (either for the proposal or final project.)

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

All homework submissions are electronic (see Technologies section below). As such, lateness will be determined by the latest timestamp of any part of your submission.

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.
- **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 Education Associate Fatima Jeffrey at fjeffrey@andrew.cmu.edu. 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 allowed with permission of the instructor.

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 accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I 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.

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:
 1. 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")
 2. 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")
 3. 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.

1. 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+.
2. 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.

Note to people outside CMU

Please feel free to reuse any of these course materials that you find of use in your own courses. We ask that you retain any copyright notices, and include written notice indicating the source of any materials you use.