Syllabus

Course Info

- **Instructor**: Andrej Risteski, Hoda Heidari
- **Meetings**:
    - **10-708:** MWF, 1:25 PM - 2:45 PM (WEH 7500)
    - For all sections, lectures are on Mondays and Wednesdays.
    - Occasional recitations are on Fridays and will be announced ahead of time.
- **Piazza:** piazza.com/cmu/spring2022/10708/home
- **Gradescope:** https://www.gradescope.com/courses/349316
- **Video:** https://canvas.cmu.edu/courses/27411 (Under the Panopto Tab)
- **Course Website:** https://andrejristeski.github.io/10708-21
- **Schedule:** https://andrejristeski.github.io/10708-22/schedule.html
- **Office Hours Queue:** https://cmu.ohqueue.com

1. Course Description

Many of the problems in artificial intelligence, statistics, computer systems, computer vision, natural language processing, and computational biology, among many other fields, can be viewed as the search for a coherent global conclusion from local information. The probabilistic graphical models' framework provides a unified view for this wide range of problems, enabling efficient inference, decision-making, and learning in problems with a very large number of attributes and huge datasets. This graduate-level course will provide you with a strong foundation for both applying graphical models to complex problems and for addressing core research topics in graphical models. The class will cover classical families of undirected and directed graphical models (i.e. Markov Random Fields and Bayesian Networks), modern deep generative models, as well as topics in causal inference. It will also cover the necessary algorithmic toolkit, including variational inference and Markov Chain Monte Carlo methods.

Students entering the class should have a pre-existing working knowledge of probability, statistics, and algorithms, though the class has been designed to allow students with a strong mathematical background to catch up and fully participate. Students are required to have successfully completed an introductory course to ML (for example 10715, 10701, or 10601) or an equivalent class.

Key Topics (What are the key subject topics that this course will cover?):

- Undirected graphical models (Markov Random Fields)
- Directed graphical models (Bayesian networks)
- Learning and inference using variational methods
- Sampling using Markov Chain Monte Carlo techniques
- Deep Generative Models (RBMs, VAEs, GANs)
- Topics in causality

Probabilistic graphical models provide a unified view for a wide range of problems in artificial intelligence, statistics, causal reasoning, computer vision, natural language processing, and computational biology, among many other fields.

Students should obtain sufficient working knowledge of multivariate probabilistic modeling and inference for practical applications, should be able to formulate and solve a wide range of problems in their own domain using GM, and should be able to advance into more specialized technical literature by themselves.

2. Prerequisites

Students entering the class are expected to have a pre-existing working knowledge of the following:

- Introductory machine learning.
- Significant experience programming in a general programming language. Some homeworks may require you to use Python, so you will need to at least be proficient in the basics of Python.
- Mathematical maturity, including college-level probability, calculus, linear algebra, and discrete mathematics.

3. Course Components

Grading

The requirements of this course consist of participating in lectures, midterm and final exams, homework assignments, and readings. The grading breakdown is the following:

- Assignments - 40%
- Quizzes - 30%
- Project - 30%

In-Class Quizzes

Throughout the semester we will have 3 in class quizzes. These will test your understanding of the materials covered up to the Quiz. Please check the course schedule and make sure that you make a note of when these quizzes will be hosted. You are required to attend all of the in-class quizzes. If you have an unavoidable conflict with a Quiz, notify us **by filling out "Quiz Conflict" form which will be released a few weeks before the quiz. Only university approved conflicts will be considered, students should identify when these quizzes are ahead of time and manage their schedules around them.**

Homework

There are 5 planned assignments scheduled this semester. These will typically include both a written component and a programming component. The tentative schedule of release and due dates can be seen in the schedule. Written solutions can be completed using either the latex templates, which will be released with the assignments, or handwritten onto the PDF handout. 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.

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 probabilistic graphical model area of particular interest. You will work in groups of 2-3 (exceptions may be granted on a case-by-case basis). More details will be released later in the semester on Piazza.

Recitations

Attendance at recitations (Friday sessions) is not required, but strongly encouraged. These sessions will be interactive and focus on problem solving. Recitations will not necessarily happen every week and as such you should wait for a confirmation from the instructors on whether a recitation session will be occurring.

5. 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!

6. General Policies

Late homework policy

You receive 4 total grace days **for use on any homework assignment**. We will automatically keep a tally of these grace days for you; they will be applied greedily. No assignment will be accepted more than 2 days after the deadline. This has an important implication: **You may not use more than 2 grace days on any single assignment.**

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. For example, suppose the homework requires submissions to both written and programming – if you submit your written on time but to programming 1 minute late, your entire homework will be penalized for the full 24-hour period.

Any homework submitted outside these 2 grace days or by a student with no grace days remaining will be given a score of zero.

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 by contacting their Student Liaison or Academic Advisor and having them reach out to the education associate Daniel Bird on their behalf. Please plan ahead if possible.

- **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 your instructor**. 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 permitted this semester with permission from 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 accommodation letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with Daniel Bird (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.

7. 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.

8. 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.
