COMP 545: Advanced topics in optimization - From simple to complex ML systems

Anastasios Kyrillidis

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E-mail (instructor): anastasios@rice.edu

Web: http://akyrillidis.github.io/comp545/
E-mail (course): RiceCOMP545@gmail.com

Office Hours: By appointment
Office: Zoom link

Class Hours: TR 2:30pm - 3:45pm
Class Room: Zoom link

Course Description

This course is a continuation of COMP 414/514: Optimization - Algorithms, Complexity, and Approximations. The course includes (assuming time permits) a list of more advanced topics in optimization, including variants of gradient descent, such as AdaGrad, Adam and RMSProp; duality theory, and Lagrange multiplier methods and variants; Interior point methods; Mirror descent and the Multiplicative Weight Updates algorithm; Adversarial robustness; Generative Adversarial Networks, min-max optimization; Discrete optimization, convex relaxations and Introduction to Quantum Algorithms; Gaussian Processes for inference.

The main objective of the course is to highlight optimization as a vital part of contemporary research in ML/AI/SP, and draw the attention of students to open-questions in related advanced topics. In particular, the aim for students is to (i) learn how to distinguish differences in research papers of related fields, (ii) understand the connection between them and how researchers advance each area, and (iii) be able to consider possible extensions of these works, as part of the final (open-ended) project of the course.

Textbook

There is no textbook for the class. The class will be a collection of lectures, prepared by the instructor, as well as presentations of research papers. Links to resources will be provided during the course.

Prerequisites

Basics of calculus, linear algebra and basic knowledge of machine learning topics or COMP 414/514.

Course outcomes

After successful attendance, students are expected to:

(*i*) have a good understanding of more involved problem cases where optimization is used.
(*ii*) have a good comprehension how optimization plays a key role in different areas of research.
(*iii*) be able to read and review advanced papers on similar subjects, as well as present the papers in front of an audience.

Registration / Communication / Attendance

The instructor will be available for discussion after an appointment is set up; email communication is sufficient also, if preferable by the student. You are highly encouraged to attend and participate in class (see Grading and Evaluation), even if you are just auditing.

Course Format and Structure

There will be a traditionally formatted series of lectures via Zoom. The link for the course is this: Zoom link. Students are supposed to present papers after the end of "chapters", presenting recent advances on the topics discussed. During lectures or presentations, participation with questions / comments is encouraged.

The papers to be presented will be selected from a pile of papers that are related to the topics of the course and will be provided by the instructor.

Communication

The official email for the course is `RiceCOMP545@gmail.com`; please use this email for communication, instead of instructor's email. The official webpage for the course is **http://akyrillidis.github.io/comp545/**; this will be updated regularly.

Grading Policy

The grade is based on the following factors:

- **5%** participation and attendance.
- **70%** final project.
- **25%** paper presentations.

The instructor reserves the right to curve the scale dependent on overall class scores at the end of the semester. Any curve will only ever make it easier to obtain a certain letter grade.

Scribing notes (bonus)

Every week, a different student (or group of students) can volunteer (otherwise, will be randomly selected) to take notes and prepare a short –but consistent– note on the material presented each week. A latex template will be shared by the instructor.

Final project logistics

Students can team up (up to 3 members per group). *The goal of the project is to engage students to research related topics, even beyond the timeframe of the course*. I.e., there can be topics for a project that focus on simpler scenaria (say convex optimization), and topics that consider some harder non-convex questions. While the former could be potentially finished during the timeframe of the course, the latter could continue after the end of the course (this is the meaning of a *open-ended* project), and the instructor "bets" (and believes) on the self-motivation of the students to continue working on it, after the end of the course.

A project must include:

- The study of at least 3 research papers, on which the project is based on.
- The proposal of at least one “open" question: this includes the theoretical analysis of a specific scenario, or the implementation of a ML/AI system for some task in an interesting scenario, or a survey comparison of several algorithms on an interesting task.

The topic can be outside of the topics considered in the course, as long as it is optimization-based.

The instructor will provide feedback to the students (by appointments + electronic communication). There will be a “midterm“ 1-page report from each group. After the discussion with the instructor, each group should prepare description of the project with:

- Abstract and Introduction.
- Description of the papers considered.
- Any preliminary results you have, and what is the plan from now on.

The project will culminate in a final project report of at least six pages, not including references, in NeurIPS/ICML format. At the end of the course, the group will prepare a 10-15 minute presentation, describing the background and the results they obtained. Final report dates will be available towards the end of the semester.

Course Policies

During Class

The electronic recording of notes will be important for class and so computers will be allowed in class. Please refrain from using computers for anything but activities related to the class. Drinking (coffee, tea, water) is allowed in class. Try not to eat your lunch in class as the classes are typically active.

Policies on Late Assignments

Assignments (scribing, reviews, project) should be turned on time. I don’t like penalties but you will receive a 10% penalty for each day of delay. No submissions after a 2 day grace period. Exceptions will be given to special circumstances, with proper documentations.

Academic Integrity and Honesty

Students are required to comply with the university policy on academic integrity found in the Honor System Handbook http://honor.rice.edu/honor-system-handbook/.

Accommodations for Disabilities

If you have a documented disability that may affect academic performance, you should: 1) make sure this documentation is on file with Disability Resource Center (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) meet with me to discuss your accommodation needs.