CAS CS 630 - Fall 2022 - Advanced Algorithms
Syllabus

Official Course Description

Examines advanced algorithmic topics and methods for CS graduate students, including matrix decomposition techniques and applications, linear programming, fundamental discrete and continuous optimization methods, probabilistic algorithms, NP-hard problems and approximation techniques, and algorithms for very large data sets.

Informal Description

This semester we are going to build your skills further in developing and evaluating efficient algorithms. We do this through exploring exciting topics on algorithmic techniques that are often used in practical applications. This course builds on your prior knowledge of various algorithms design paradigms as well as proving their correctness and estimate their running time. Some topics we will cover are network flow, NP, approximation and randomized algorithms, local methods.

Note that this course is intended for **MS** and advanced **BA** students. PhD students should take CS530 instead.

Prerequisites

Undergraduate prerequisite: CS330 Introduction to Analysis of Algorithms
Graduate prerequisite: an algorithms course at the level of CS330. If you're not sure whether you have the background, please talk to the instructor.

Topics that you should be familiar with from your previous studies:

- Proof techniques (e.g. direct proof, proof by contradiction, induction)
- Data structures (e.g. lists, queues, heaps, hash tables, trees, graph adjacency list)
- Asymptotic analysis of running time (i.e. big-Oh)
- Algorithm design paradigms, such as greedy, divide and conquer, dynamic programming, various graph algorithms

TODO asap:
Sign up to the course Piazza and Gradescope pages. We'll use these for communication and homework. Details can be found later in this syllabus.

Piazza (Q&A, discussion, as well as distribution of lecture notes, homework, all links):
piazza.com/bu/fall2022/grscs630

Gradescope (Homework submission) :
https://www.gradescope.com/courses/436797 (Entry Code:K3DKRE)

Instructors and Teaching Fellows

Name	**Office Hours (updated on Piazza)**
Prof. Dora Erdos	Wed 1 - 2 pm, Fri 8:30-10 am
TF Ryan Yu	Tue 4 - 6 pm, Wed 9 - 11 am
TA	TBD

Piazza is the best way to reach us. You can send a private message (to all instructors, or to just one), if needed.

Textbook

Algorithm Design, by Kleinberg and Tardos. ISBN 0-321-29535-8.

Useful additional resources:

- Cormen, Leiserson, Rivest, and Stein. *Introduction to Algorithms*, 3rd ed. MIT Press.
- J. Erickson. *Algorithms,* 2019. Available from http://algorithms.wtf/
  See also the extensive exercises on the website.
- Mathematics for Computer Science by Eric Lehman, Tom Leighton, and Albert Meyer. (Useful background on discrete mathematics.)

Topics We will mostly follow the order and content in the textbook. Topics are subject to change. (You will find a detailed lecture schedule on our course resources page)

- Network Flow - FF, push-relable, applications
- Complexity - poly time reductions, NP, NP-C
- Approximation algorithms - covering and packing problems, graph problems, greedy, submodular
- Randomized algorithms - graph problems, satisfiability, covering and packing
- Local search - selection and covering problems, Metropolis-Hastings

Course Structure, Communication:

The lectures will be taught by Professor Dora Erdos, the discussion sections will be led by the TFs. Lectures will cover theoretical concepts that are then reinforced through problem solving in labs. Homework assignments will help you consolidate your knowledge. You will need to follow and understand both lecture and discussion material to be able to successfully solve the assignments. All teaching staff will hold office hours and we will utilize Piazza to answer questions.

Lecture:
Tues, Thur 9:30-10:45 am in LAW AUD
Labs:
A2: 1:25 - 2:15 MCS B33
A3: 2:30 - 3:20 CAS 228
A4: 3:35 - 4:25 CAS 225
A5: 5:45 - 6:35 EMA 304
A6: 11:15 - 12:05 MCS B39

Discussion Labs:

Labs will be an invaluable part of the course involving interactive problem-solving sessions, tips on homework questions, and supplemental material not covered in lecture. We will post problemsets on Piazza in advance -- please read before coming to lab. Solutions will be posted after all labs conclude.

Piazza:
We will be using **Piazza for all discussion** pertaining to the class. This is the forum to get all your questions answered, where we will make announcements and post all course resources and assignments.

What to use Piazza for:
You should post your questions about the material, lectures, homework or course logistics here. Piazza is highly preferred over sending the course staff emails. Most often your question and the answer will be just as useful to your fellow students as yourself. We encourage you to respond to questions. The course staff will be monitoring Piazza and chime in as needed. You are encouraged to ask questions about the homework assignments, e.g. clarifications, related material, but **do not post solutions** to the problems. If you think your question is too specific or would reveal too much, then please ask in a private post. See the pinned “Ethics and Etiquette” post on Piazza for further guidance.

Course atmosphere, diversity and inclusion: We intend to provide a positive and inclusive atmosphere in classes and on the associated virtual platforms. Students from a wide range of backgrounds and with a diverse set of perspectives are welcome. We ask that students treat each other with thoughtfulness and respect, and do their part to make all their peers feel welcome. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups.

Grading

The course grade will break down as follows:

3% class participation (based on lab attendance)
35% biweekly homework assignments
27% in-class midterm exam (in-class, planned for Tuesday, October 25th, 2022).
35% comprehensive final (during finals week).

Last day to **drop without a "W": Mon, Oct. 11th 2022**. **With a "W": Mon. Nov. 14th, 2022**. Incompletes for this class will be granted based on CAS Policy (mostly only for last minute emergencies).

Exams: Both exams will consist of problem solving and short questions about the material. The midterm will be during class time and takes 75 minutes. The final is during the University-assigned final exam slot. The content of the final is cumulative.

No collaboration whatsoever is permitted on exams.

Accommodations: All are welcome in the course. If you require particular accommodations for exams or coursework, please contact us (and forward any relevant documentation from Disability and Access Services). If you are facing unusual circumstances during the semester, please reach out to us early on so that we can find a good arrangement.

Attendance: We fully expect you to attend both lectures and discussions (unless you have an excused absence, such as illness or religious observation). Attendance will be taken in lab.

While our textbook will be very helpful, it is an imperfect substitute for in-class learning, which is the fastest (and easiest) way to learn the material. Some material covered in lecture and lab may not be in our textbooks. You are in all cases responsible to be up to date on the material. Class participation and questions are very much encouraged. *Please ask as many questions in class and in labs as you need.* Chances are that your question and answer will be as helpful to your classmates as to you.

Homework:

Homework problems: Homework assignments will be written problems assigned **biweekly**. Assignments will always be posted Saturday morning and due Friday evening two weeks later. They will allow you to practice (a) solving problems using the ideas from class, often in a new way, (b) communicating your ideas using technical language (precise descriptions, pseudocode, formal claims, proofs). Be aware that this latter is just as important as the former.

The lowest grade on your homework assignment will be **dropped**.

Limited collaboration is permitted; see below.

Homework Submission: Assignments will be due **Fridays by 11:59PM ET**, electronically via *Gradescope*. Solutions should be *typed*. We highly recommend - but is not required - to use LaTeX (it's a very useful tool to learn) and are happy to provide you with templates.

Late Policy: You are allowed *two* late submissions; the assignment has to be submitted no later than 24 hours after the deadline. There is no grading penalty. Exceptions are *not* granted.

Regrade Policy: If, after reviewing the solutions and your answer, you still believe a portion of your homework was graded in error, you may request a regrade, **via Gradescope**, *NOT* through email. One of the staff will consider your request and adjust your grade if appropriate. Note that when we regrade a problem, your score may go up or down.

Workload: CS 630 is a substantial amount of work. There are substantial problem sets as well as two exams to study for. As you likely already know, assignments requiring substantial creativity can take more time than you expect, so plan to finish a day early.

Collaboration, Citation, and Academic Honesty

Citation policy: You are allowed and encouraged to further your knowledge by finding related material online or in books. However, if you use any resource other than material distributed in class in your homework solutions, **you have to cite it**. Your citation may be a url, the title and chapter of a book, or a paper reference.

Searching explicitly for answers to problems on the Web or from other outside sources (these include anyone not enrolled in the class) is strictly forbidden.

Collaboration Policy: Collaboration on homework is permitted and even encouraged. If you choose to collaborate on some problems, you are allowed to discuss each problem with **at most**

3 other students currently enrolled in the class. Before working with others on a problem, you should think about it by yourself for at least 45 minutes.

You must write up each problem solution by yourself (using your own words) without assistance, even if you collaborate with others to solve the problem. You must also identify your collaborators clearly on the first page of your assignment. If you did not work with anyone, you should write ``Collaborators: none.'' It is a violation of this policy to submit a problem solution that you cannot orally explain to the instructors. You may get help on Piazza or in office hours from the instructors for the class for specific problems. You don't need to list them as collaborators .

No collaboration whatsoever is permitted on exams!

Collaboration strategies: If you do collaborate, use it as an opportunity to practice group work skills: give everyone a chance to speak, listen carefully, acknowledge good suggestions. If you have a tendency to be shy, speak up! If you have the tendency to dominate conversations, make sure to give others the floor. We strongly encourage you to find a small group of classmates that you regularly discuss and review material with. Feel free to post on Piazza to find a study mate.

Academic Conduct:
Academic standards and the code of academic conduct are taken very seriously by the University, the College of Arts and Sciences, and the Department of Computer Science. Course participants must adhere to the CAS Academic Conduct Code. Please take the time to review this document if you are unfamiliar with its contents.

If in doubt, our department has an extensive compilation of **examples** with regard to Academic Conduct and permissible collaboration.

Violations of this policy will be dealt with according to University regulations.