

CSCI 6114 Computational Complexity Syllabus (Fall 2021)

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1 Logistics

1.1 Instructional Staff

Instructor: Prof. Josh Grochow (jgrochow@colorado.edu). Call me Josh.

1.2 Website & Course Materials

The website is <https://home.cs.colorado.edu/~jgrochow/6114f21/> (linked from instructor's homepage) and there will be a shared Google Drive with course materials.

1.3 Class and Student Hours

Class is online TTh 11:10-12:25pm MT at <https://cuboulder.zoom.us/my/joshuagrochow>.

Student hours are Thursdays 9-10am MT at the same link, or by appointment (email me). In this class, student hours are not just about problems in the class, but are also for your enrichment - come to talk about anything!

If some of you would prefer to meet with one another in person, so that it effectively becomes hybrid, I am open to that and can work to find a room. We're a small group so there are probably rooms that aren't traditionally classrooms (like meeting rooms) that could work.

2 Course Description

2.1 Prerequisites

The listed prerequisite is Graduate Algorithms CSCI 5454 or equivalent. In reality, anyone who has had some exposure to formal algorithms (e.g. an undergrad algorithms class) and is comfortable with writing formal proofs should be fine. If you are not sure, please ask the instructor.

2.2 Learning Objectives

The main learning object is to learn some complexity theory that interests you!

A secondary learning objective is for students to become conversant in the foundations of complexity theory at the research level. If you met a complexity theorist on the street, you should be able to talk to them and understand each other. This includes foundational topics such as

- Time- and space-bounded complexity classes such as P , EXP , L , NL , $PSPACE$ and their relationships $L \subseteq NL \subseteq P \subseteq PSPACE \subseteq EXP$, $L \neq PSPACE$, $P \neq EXP$.
- Circuit complexity. Relation between circuit size and running time, circuit depth and parallel running time. Classes such as $P/poly$, NC , AC .
- Randomized complexity classes. BPP , RP , $coRP$, ZPP and their relationship to non-randomized ones (such as $BPP \subseteq PH$, $BPP \subseteq P/poly$, $NP \subseteq BPP \Rightarrow PH$ collapses).
- Counting complexity $\#P$.
- Interactive proofs, $IP = PSPACE$, $NP \subseteq coAM \Rightarrow PH$ collapses.

These form the “core” topics, but we may spend more or less time on each of them according to student’s existing knowledge and student interests. There are many additional possible topics to covered, to be determined as a group based on students needs & interests.

2.3 Course Text

There is no course text. We will read selections from a variety of different texts, lecture notes, and research articles. These will be posted on the website and/or shared in the Google Drive.

3 Course Structure and Grading

This course will be **ungraded**. There are many forms of ungrading, and the version we’re doing this semester is as follows. Class will consist of mini-lectures and working through exercises in groups or as a big group. Some of those you will write up for feedback. Aside from those, there are three components to the grading structure of the course:

1. Learning log. Throughout the semester, you’ll keep a **learning log**: topics you’ve learned, questions you have, problems you attempted, attempts you made (successful or unsuccessful), and so on. This will be a useful record for you in the future, and also useful for discussions with the instructor on how your learning experience is going and you are progressing in your desired understanding of the material. It will also be useful in your self-reflections for the course (see next point).
2. Self-reflections. At various points during the semester, you’ll be asked to write (prompted) **self-reflections** on your own learning. These self-reflections will be turned in for feedback and discussion with the instructor. In the final self-reflection, you suggest what grade your learning experience over the course of the semester deserves, and this is the starting point for a discussion with the instructor. The instructor reserves the right to assign whatever grade he sees fit. However, in practice, people who do this style of assessment of learning find that, if anything, when assigning themselves grades, students are often harsher on themselves than the instructor would be, and instructors often have to bump student grades *up* from their own self-assessment.

3. Project. There will also be a **project** at the end of the semester, culminating in a presentation to the class. The project can be purely expository—you read about some topic that we didn’t cover in class and then present it to the class—or more research-based, working on an open problem. In the latter case, the presentation should still presumably be mostly exposition of the problem, its context, etc., and then some discussion of things you tried or progress you made. More details will be forthcoming in the first few weeks of class. For students taking the class pass-fail, we still highly recommend the learning log and self-reflections, but the bar for passing will be the presentation from the project.

4 Course Policies

4.1 Student Feedback

Student feedback regarding this course is encouraged and welcome. Those who wish to leave feedback anonymously may do so using this Google form: <https://forms.gle/SR7EevoThezCPJiJ6>. Students are also welcome to reach out to the instructors via email or in student hours to discuss their concerns.

4.2 Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Conduct & Conflict Resolution policies.

4.3 Requirements for COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

As of Aug. 13, 2021, CU Boulder has returned to requiring masks in classrooms and laboratories regardless of vaccination status. This requirement is a temporary precaution during the delta surge to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined: rest, get better, and help keep others safe—we’ll figure out how to help you catch up (if needed) after.

4.4 Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

4.5 Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

4.6 Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

Intellectual dishonesty or plagiarism of any form, at any level, will not be tolerated.

Discussing problems with other students is highly encouraged, but you must list your collaboration on the page where you give the solution. If you discussed it with 20 other people, then all 20 names should appear in your solution. If someone was particularly helpful, say so. Be generous; if you're not sure whether someone should be included in your list of collaborators, include them. There is no penalty for discussing problems with other students.

Copying from any source in any way is strictly forbidden. This includes both the Web and other students (past or present). If you are unsure about whether something is permitted, please ask the instructors before the assignment is due.

Posting to online forums for help (e.g., Chegg, Discord, Reddit, StackExchange, etc.) is an **honor code violation**.

Write everything in your own words and cite all outside resources. You are strongly encouraged to use outside resources, but you must write your solutions yourself. We are not interested in seeing Wikipedia's or anyone else's solution. The only sources you are not required to cite are the textbook and lecture notes, and the prerequisite material.

There will be a zero-tolerance policy to violations of this policy. Violators will be removed from the class, given a grade of F, and reported to the University Honor Council, which may choose to impose additional penalties.

4.7 Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about OIEC, university policies, reporting options, and the campus resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options.

4.8 Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, we will make reasonable efforts to accommodate such needs if you notify the professors of their specific nature by the end of the 3rd week of class (Friday September 10, 2021).

See the campus policy regarding religious observances for full details.