CSCI 7000 Topics in Combinatorics with Applications to Computer Science
Syllabus, Fall 2023

Contents

1 Logistics

1.1 Instructional Staff

Instructor: Prof. Josh Grochow (jgrochow@colorado.edu). You are welcome to call me Dr. Grochow, Prof. Grochow, or Josh.

1.2 Website & Course Materials

The website is https://home.cs.colorado.edu/ jgrochow/7000f23/ (linked from instructor's homepage) and there will be a shared Microsoft OneDrive with course materials.

1.3 Class and Student Hours

Class is online TTh 3:30-4:45pm MT at https://cuboulder.zoom.us/my/joshuagrochow.

Student hours are Thursdays 12:30-1:30pm 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

You should have some familiarity with some basic combinatorics (not necessarily in a class! Many people learn about these things informally or along the way to learning other topics, both in and outside of mathematics and computer science), as well as some familiarity and comfort with formal mathematics and proofs.[1] If you are unsure whether you have the prerequisites to succeed in this class, please contact the instructor to find out!

2.2 Learning Objectives

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

A mix of counting techniques from combinatorics that are useful in computational complexity and beyond, as well as some techniques from computational complexity that are useful in combinatorics. Exact topics will be selected based on student interest, but some likely candidates include: generating functions, analytic combinatorics (using generating functions and techniques from complex analysis to estimate asymptotic growth rates), counting under symmetry (eg "how many graphs on n vertices are there up to isomorphism?"), some bijective combinatorics, complexity of counting, counting using computational models such as finite automata or context-free grammars.

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 MS OneDrive.

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. There will be problem sets roughly weekly (on a schedule to be decided in part by consultation with the class members, and will be clearly communicated once decided), which you turn in for written (not numerical) feedback. The class will consist of a mix of material to learn outside of class via readings or videos, lectures or mini-lectures in class, in-class group exercise, and out-of-class exercises. The proportion of each of these activities will be agreed upon by discussion between the instructor and members of the class.

Aside from the above, 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 or Student Lectures. Within the first two weeks of class, the class will elect to either do final projects, or student lectures. Student lectures consist of each student learning a topic and teaching the class that topic, through a combination of lecture and exercises. Final projects culminate in a shorter (20-30 minute) 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

[1] Here I mean "formal" in the sense of "writing proofs in your native language" e.g. in the context of an advanced undergraduate mathematics course or similar. I *do not* mean "formal" in the sense of "checked formally on a computer in a verification language such as Coq or Lean."

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 student lecture or the presentation from the project.

Doing student lectures turns part of the class into something more like a reading group. Doing final projects enables student to dig deeper into additional material that interests them, that we may not have time to cover in the class, and then to expose the class to the highlights of that material. This has the side effect of everyone in the class getting a sampling of topics beyond the course.

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/KP1bbCV7539ovtCE8`. Students are also welcome to reach out to the instructor via Zulip private message or in student hours to discuss questions and concerns. Students may also reach out to the instructor via email, but Zulip PMs are preferred.

4.2 Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277 24/7. Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.

4.3 Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

Disability Services determines accommodations based on documented disabilities in the academic environment. If you qualify for accommodations because of a disability, submit your accommodation letter from Disability Services to your faculty member in a timely manner so your needs can be addressed. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance.

If you have a temporary medical condition or required medical isolation for which you require accommodation, please let the instructor know **by email**. You are not required to provide details of your condition, but because of the highly interactive nature of the class, it is helpful if students let us know as much ahead of time as possible when they are going to miss class.

Also see Temporary Medical Conditions on the Disability Services website.

In this class, the instructor is also willing and eager to work with you to provide any reasonable accommodations you need to help you best learn and participate. While we cannot guarantee that we will be able to make all such accommodations, if there is an accommodation that would help you learn and participate in this class, please reach out to the instructor to ask about it.

4.4 Requirements for Infectious Diseases

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all public health orders to reduce the risk of spreading infectious diseases.

The CU Boulder campus is currently mask optional. However, if masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class. Students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct & Conflict Resolution. Students who require accommodation because a disability prevents them from fulfilling safety measures related to infectious disease will be asked to follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

For those who feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the further guidance of the Public Health Office. For those who have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home.

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 Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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 classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

4.7 Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), 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 Student Conduct & Conflict Resolution: honor@colorado.edu 303-492-5550. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

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. While you may consult any source in arriving at your solutions, you may not *copy verbatim* from any source. This includes both the Web and other students (past or present). If you are unsure about whether something is permitted, please ask the instructor before the assignment is due.

Posting to online forums for help with course questions (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 assigned readings and the prerequisite material.

You are strongly **discouraged** from using generative AI models such as ChatGPT, Bing AI, Bard, etc. While these products can sometimes be useful for generating ideas, any content they will produce that is of value to this course will necessarily have been scraped from material on the web without the consent of nor attribution to its original authors. The point of this course is for you to learn this material, not for you to learn how to get an AI to produce reasonable-sounding answers to this 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.

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

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment,

exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and support resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive an outreach from OIEC about their options for addressing a concern and the support resources available. To learn more about reporting and support resources for a variety of issues, visit Don't Ignore It.

4.9 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 15, 2023). That said, very little in this class is strictly required, so most absences for religious holidays fall under our usual absence policy: please notify the instructor as much in advance as possible.

See the campus policy regarding religious observances for full details.