CSCI 0500: Data Structures, Algorithms, and Intractability

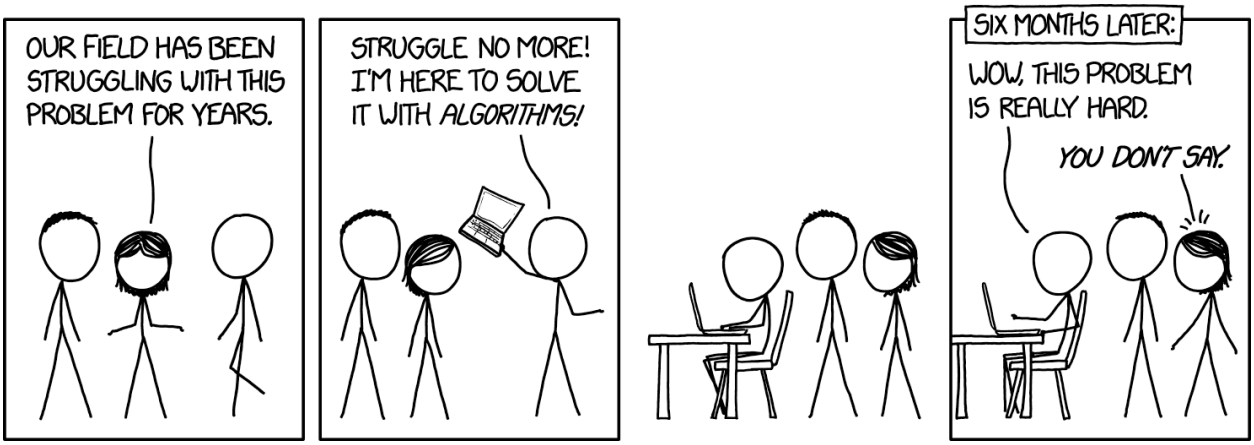

Figure 1: Here to Help (`https://xkcd.com/1831`

Instructor Information

Name: Philip Klein
Office: CIT 503
Email: `klein@brown.edu`
Office Hours: Monday and Wednesday, 4:30 – 5:00p

Prof. Klein would like every student to come to office hours at least once. The professor will try to put together groups of students to meet together with him. If you cannot make the scheduled office hours, please email Prof. Klein to arrange another time.

Class Information

Lecture: Mondays, 3:00–4:30 in CIT 241 (Swig Boardroom)
Lecture: Wednesdays, 3:00–4:30 in CIT 241 (Swig Boardroom)
Workshops will take place on most lecture days.
Lecture notes will be provided.

If you are sick, please do not come to class. Instead, email cs500-extensions@lists.cs.brown.edu to let the professor know you are unable to attend so that missing that day's workshop will not be counted against you.

Optional help session: (most) Fridays, 3:00–4:00.

Prerequisites

A completed introductory program sequence (CSCI0200 or CSCI0190) along with some introduction to proof-writing and probability (CSCI0220, or APMA1650/APMA1655 combined with a proof-writing course such as MATH0540 or MATH1530, or equivalent with permission of the instructor).

Course Description

This course will cover the basics of how to design and analyze data structures and algorithms. We will develop algorithmic intuition through rigorous analysis of algorithmic correctness and performance. We will also study the theory of NP-completeness, which helps us understand which problems are computationally intractable.

The course website can be found via https://cs.brown.edu/courses/csci0500/

Course Objectives

- Develop your ability to think algorithmically.
- Ensure that you understand some well-established techniques, algorithms, and methods of analysis.
- Give you some technical tools to predict for a given computational problem what kind of performance is possible.
- Hone your ability to reason rigorously about computational problems and algorithms and quantities such as running time.

Topics

The course will address the following topics:

- Arithmetic computation
- Sorting and selection
- Data structures (hash tables, binary search trees)
- Graph algorithms (topological sorting, bipartite matching, reachability and strongly connected components, shortest paths, minimum spanning trees)
- Dynamic programming
- Finite automata (briefly) and Turing machines
- NP-completeness and NP-complete problems and the Cook-Levin Theorem

The course will emphasize formal proofs of correctness and methods of analysis, including worst-case and probabilistic analysis.

Course Structure

- Two times a week we will meet for a combination of *lecture* and *workshop*. In workshop, you will work (sometimes alone, sometimes in a small group) to solve a problem arising during the lecture and to produce a short writeup.
- There is a weekly lab in which students will work in pairs to implement and test algorithms for correctness and performance. At each lab session, students will be paired *randomly*.[1]
- There will be weekly homework assignments, due at 6 pm on Tuesdays. Homeworks will be primarily proof-based, and must be typeset in Latex.
- On some Fridays, there will be optional *help sessions* with the professor or a TA. At these sessions, you can learn about solutions to homework problems (after submission) or review lecture material or get direction on going deeper into course concepts.
- There will be a midterm exam and a final exam. The midterm will be on March 19, during regular class time. The final exam will be 2:00 pm - 5:00 pm on May 15.

[1] If there is someone in your lab session that you do not want to be paired with, email the professor.

Estimated time requirements

- Lecture + workshop + midterm: 1.5 hours per for twenty-eight meetings, totaling 42 hours
- Lab: 2 hours per lab for eight labs, totaling 16 hours
- Homework: 5.5 hours a week for ten homeworks, totaling 55 hours
- Studying/review/help sessions: 4 hours a week for thirteen weeks, totaling 52 hours
- Preparation for midterm and final exams: 12 hours
- Final exam: 3 hours

Grading Policy

Your overall score will be the **minimum** of your score in the following categories.

- Homework (equally weighted)
- Workshop (equally weighted)
- Labs (equally weighted)
- Exams (30% midterm, 70% final)

Note that this means that to get an overall score of at least 90%, for example, you must earn at least 90% in each of the four categories. Furthermore, **in order to pass the course, you must get a score of at least 55% in each of the four categories.**

You will not be graded "on a curve." Therefore, you are not competing with your classmates.

The lowest homework grade, lowest lab grade, and lowest three workshop grades will be automatically dropped.

Labs should be completed during the assigned two-hour block. A student can request from their lab TA to make up any missed checkpoints at the beginning of the next lab for half-credit.

Late Days and Extensions

There will be no automatic late days for homework assignments. If there are extenuating circumstances (illness, family emergencies, etc.) that will prevent you from completing an assignment on time or from attending class, please email cs500-extensions@lists.cs.brown.edu to request an extension in advance. This email will go to the professor and to a CS Department administrative staff member.

Collaboration Policy

We allow (and encourage!) discussion of the material presented in class as well as discussion of concepts involved in homework assignments. Written work is another matter. *You must write up your homework solutions by yourself.* This ensures that you understand the material even if you collaborated on finding the problem. *You should not take notes away from collaboration sessions and you should be by yourself when writing the solution.*

Rule of thumb: If you cannot independently reproduce what you hand in, don't hand it in. We might ask you to explain your solution to a problem so we can ensure that the solution was your own work.

For the topics we address in class, there are resources available (from books and from scientific journals, and from the Web) to help you understand. You are welcome to consult such resources to help you learn the material. Similarly, you can consult people (e.g. a tutor) to help you with understanding course material. However, you are forbidden from using resources from outside the class to address topics or problems arising in assignments (homework, workshops, labs, and exams). This includes AI tools such as ChatGPT, Bard, and Github Copilot; you must not consult such tools in the course of preparing solutions to assignments.

In the event that you inadvertently stumble upon information relevant to a solution to a problem, just close the site or book before reading details. If you feel you crossed the line of the policy, contact course staff

and document your source. Depending on the extent, you might not receive credit for your solution, but a citation will protect you from being charged with violating the course collaboration policy.

Helping someone else in the class to violate the collaboration policy is also a violation of the collaboration policy. Do not provide any written resources to another student in the class that the other student could physically/digitally retain and use in writing up solutions.

During exams and workshops, you must not use any resources other than your mind (and pen and blank paper). You are not allowed to consult the Web, for example. For specific exams, the instructor might provide guidance specifying what notes you can bring with you.

Making your solutions available to others, *even after the class ends*, is a violation of course policy. Because we might reuse problems, please do not share your solutions.

Office/TA Hours

In addition to Professor Klein's office hours after class on Monday and Wednesday, TA hours will be held each day from Sunday to Thursday. We welcome and encourage students to collaborate in TA hours, so long as discussion is limited to high-level conceptual concepts and not sharing of specific solutions.

On Sundays and Mondays, we will hold individual office hours where students can discuss solutions in more depth with TAs.

(Optional) Friday Review Sessions

In addition to lectures, labs, and office hours, we will frequently hold supplemental review sessions on Fridays from 3-4:00 pm. These sessions may include specific workshops on LaTeX, review sessions of prerequisite content for particular parts of the course, or exam review sessions around the midterm and final. These sessions are not required for anyone but are meant to provide an opportunity for students who would like additional review of key concepts and techniques.

Diversity and Inclusion

The course intends to provide a welcoming environment for all students. We especially welcome diverse ideas and perspectives during class discussions.

All members of the CS community, including faculty and staff, are expected to treat one another professionally. Toward this goal, TAs have undergone training in diversity and inclusion. However, despite our best efforts, we may accidentally slip up, so please feel free to speak to any member of the course staff with any concerns you have during the semester, and do not hesitate to contact Professor Klein directly. We will take your concerns very seriously.

SAS Accommodations

If you feel you have physical, psychological, or learning disabilities that could affect your performance in the course, we suggest you contact SEAS (https://www.brown.edu/campus-life/support/accessibility-services/). We will try to support accommodations recommended by SEAS.

If you require SEAS accommodations, please let Professor Klein know at the beginning of the semester.