CS 161: Design and Analysis of Algorithms

Karey Shi

Summer 2020

Note: This syllabus is mainly a compact version of the course website.
For all up-to-date information, including lecture slides and assignment handouts, please visit the website.

Course Overview

Instructor: Karey Shi (kareyshi at stanford.edu)

Time: Mondays & Wednesdays, 1:30pm-3:20pm (PST)

Location: Zoom. See information Canvas for more details (meeting links and authentication details).

Course Assistants: Adam Stanford-Moore, Albert Zuo, Arjun Sawhney, Bryce Cai, Luke Miller, Milan Mosse

Course Description: This course will cover the basic approaches and mindsets for analyzing and designing algorithms and data structures. Topics include the following: Worst and average case analysis. Recurrences and asymptotics. Efficient algorithms for sorting, searching, and selection. Data structures: binary search trees, heaps, hash tables. Algorithm design techniques: divide and conquer, dynamic programming, greedy algorithms, amortized analysis, randomization. Algorithms for fundamental graph problems: minimum-cost spanning tree, connected components, topological sort, and shortest paths. Possible additional topics: network flow, string searching.

Prerequisites: CS 103 or CS 103B; CS 109 or STATS 116.

Class requirements: Six homework assignments, Midterm, Final.

Staff support: We will lead weekly sections (practice problem sessions taught with smaller groups), hold office hours throughout the week, and answer questions on Piazza.

Staff Contact: The best way to reach the staff is by making a private post on Piazza, or by sending an email to the staff mailing list (cs161-sum1920-staff@lists.stanford.edu).

Quick Links

- **Official Course Website:** cs161.stanford.edu
- **Canvas**: click here (we will only use Canvas for managing Zoom lectures)
- **Piazza**: click here (class discussion and Q&A forum)
- **Gradescope**: click here (for submitting homework & exams, course entry code: **9DEP27**)
- **Zoom**: Zoom resources & information for students can be found here
- **Queuestatus**: the office hour queue can be found here

Textbooks

You may refer to these texts for supplementing lectures with additional details (technically optional, but highly recommended).

Primary textbook(s): Algorithms Illuminated.

- Tim Roughgarden, Algorithms Illuminated, Volumes I, II, and III. Soundlikeyourself publishing.
- Even though these are three books, they are small, paperback, and relatively cheap!

Supplementary textbook: CLRS.

- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, 3rd Edition, MIT Press.
- This book is available online for free through the Stanford library.
- CLRS has much more detail than Algorithms Illuminated, and is a great resource for additional details, especially if you'd like to dive deeper into any of the topics discussed in class.

Sections

There will be weekly sections, in which you will work on practice problems and reinforce any difficult concepts covered in class. Each section will meet on Zoom. While section attendance will not be incorporated into your final grade, we *highly* recommend that you try to attend section each week. The problems we'll work on will often be past exam or homework problems, and you'll have the opportunity to ask questions in smaller group settings and discuss problems with other students.

Section times will be posted during the first week of the quarter.

Homeworks

There will be six graded homework assignments throughout the quarter, released weekly on Wednesday afternoons (no homework will be assigned the week of the midterm or final) and due 7 days after the release date (on the following Wednesday at 1:00pm PST). Homework will be released on the course website's "Homework" page.

All homework submissions must be typed and submitted to Gradescope. We will not be accepting or grading any handwritten submissions. We highly recommend using LaTeX, and we will be posting the LaTeX version of the homework assignments so you can borrow the LaTex code from the problem statements. Also, see below for some LaTex Resources that might be useful. One of the important skills we want you to develop is to communicate technical material clearly, so we expect your submissions to be clear, and easily human-readable.

Homework LaTeX Resources

- **Guides to using LaTeX**: An introduction to LaTeX can be found here. Other guides can be found at Wikibooks and NYU.
- **Online Environments**: If you don't want to install LaTeX, ShareLaTeX and Overleaf are online environments which compile previews of your LaTeX documents as you type. Stanford students get a free OverLeaf Pro account.
- **LaTeX Editors**: There are many LaTeX editors which allow you to use GUI to edit your LaTeX. LyX is a free one.
- **Finding symbols**: Detexify lets you draw the symbol that you are looking for and get LaTeX code. A static guide is here.

Homework Collaboration Policy

The homework assignments will have two sections: Exercises and Problems. We recommend that you complete the Exercises on your own. (But if you happen to chat about them with a fellow CS161 student that's okay; you must acknowledge your collaborators). The Problems can be completed in small groups of current CS161 students (up to four). In both cases, you must type up your own solutions, and for each problem you must list the students you collaborated with.

- The following is **OK**: You and your friend work through the problems together over a couple of days. You bounce ideas off each other, and eventually come up with a pretty good solution idea. You sit down at your computer and type up that idea in your own words, perhaps lightly consulting notes you took while working with your friend.
- The following is **NOT OK**: You and your friend work through the problems together over a couple of days. You bounce ideas off each other, and eventually come up with a pretty good solution idea. Your friend types up their solutions first; since you helped come up with the answers, you use your friend's write-up as a starting point for your own.
- A good test: if you ever share your typed-up solutions, or if someone shares theirs with you, it is probably NOT OKAY.

Late Homework Policy

You will have a total of 6 late days to use on homework assignments with a maximum of 2 late days on a single assignment. Each late day can be treated as a 24-hr extension; e.g. if the assignment is due Wednesday at 1pm, you may hand it in by Thursday at 1pm and use one late day, or by Friday at 1pm and use two late days. You are responsible for keeping track of your late days, and you can always ask to find out how many you have left. No credit will be given for homework turned after 48 hours past the due date, or for late homework after all late days have been used.

Homework Regrade Policy

You may submit a regrade request for homework on Gradescope. Please include a thorough description of the error that the grader made. You must submit a regrade request within *three days* of receiving your grade, by end of day (i.e. 11:59 PM). Some notes:

- We will *regrade the entire assignment* on a regrade request. This means you may lose more points on other problems if we discover grading errors in the other direction.
- Your regrade request will go to the TA who graded your work originally and the instructor.
- Legitimate regrade requests include:
    - The points were not added correctly.
    - The comments say I'm missing part (c), but it was actually on a different page.
    - The comments say that my algorithm is incorrect with this particular case, but I implemented my algorithm and it does work in that case.
- Illegitimate regrade requests include:
    - I disagree with the rubric; I should have gotten more partial credit for my solution.
    - I understand that my solution wasn't clear, but what I meant to say was correct.

Homework Tips & Resources

Guidelines: One of the big skills you'll be developing in CS161 is communicating technical material clearly. To that end, we expect homework submissions to be clear and easily human-readable. Your homeworks should be *typed* and clearly written with *complete sentences* and *well-organized logic*, and should definitely not be your first draft. When we ask for pseudocode, we are expecting pseudocode that is clear enough that a CS106B student (and certainly the grader) can understand what your algorithm is doing, and could implement it in a language of their choice, without thinking too hard. It is good practice to include an English description of what your pseudocode is doing, to help out the reader. See the example homework before for good and bad examples of pseudocode.

Homework 0: To give you a concrete example of what we are expecting, we will be providing an example of an appropriate homework solution to “Homework 0”. See the course website for relevant files. Note: Note: although this example problem set has code-based exercises, we will not be using iPython notebooks this quarter.

General Homework Tips:

- Be sure to look through the example Homework 0 submission for style advice.
- Try to put yourself in the position of the reader. If you hadn't just been thinking about this problem for two hours, would your answer make sense to you?
- The homework questions will always end with a text block explaining what sort of answer we expect. Read this text block carefully.
- Start the homework early!
- Try to "finish" the homework early, step away from it for a day, and then come back to it and read it over again. Chances are, you'll find some way to write what you've written more clearly.

- If you get stuck, then ask for help from the course staff: come to office hours prepared to explain what you have tried, and why you are stuck.

Office Hours

Karey, as well as the CAs, will hold regular office hours each week. Office hours will take place on Zoom, and the sign-up procedure will be facilitated through QueueStatus. We will be uploading a full office hour calendar during the first week of the quarter (see cs161.stanford.edu), as well as any additional instructions regarding office hour protocols.

Accommodations

Students who may need academic accommodations based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE) and notify us at least 7 days (ONE week) prior to the Midterm and/or Final Exam. Please email OAE-forms to cs161-sum1920-staff@lists.stanford.edu.

Honor Code Policy

Students must adhere to the Stanford Honor Code. The following things are examples of what will be considered a violation of the honor code in this course:

- Violation of the homework collaboration policy (e.g. forgetting to cite student collaborators).
- Using old solution sets for CS161, unless specifically approved by the instructor. (These should not be available; if you learn of any floating around, please immediately alert the course staff).
- Collaborating with others during the exams.

If we have reason to believe that you are in violation of the honor code, we will follow the university policy to report it.

Feedback Form

If you ever have any feedback that you'd like to provide, please feel free to leave a comment here! Your feedback will be completely anonymous. We'd love to have your help with improving this course.

Lecture Schedule

WEEK	LECTURES	OTHER NOTES
1	Lecture 1 (6/22). Logistics, introduction, and multiplication!	HW 1 released
	Lecture 2 (6/24). Sorting, Recurrences, and the Master Theorem	
2	Lecture 3 (6/29). More Recurrences and the Selection Problem	HW 1 due HW 2 released
	Lecture 4 (7/1). Randomized Algorithms and QuickSort	
3	Lecture 5 (7/6). Sorting Lower Bounds	HW 2 due HW 3 released
	Lecture 6 (7/8). Binary Search Trees and Balanced Trees	
4	Lecture 7 (7/13). Hashing	HW 3 due *Midterm*
	Midterm Review Session	
5	Lecture 8 (7/15). Graphs, BFS, DFS	HW 4 released
	Lecture 9 (7/20). Finding SCCs & Dijkstra	
6	Lecture 10 (7/22). Dynamic Programming: Bellman-Ford & Floyd-Warshall	HW 4 due HW 5 released
	Lecture 11 (7/27). More DP: LCS, Knapsack, Independent Set	
7	Lecture 12 (7/29). Greedy Algorithms	HW 5 due HW 6 released
	Lecture 13 (8/3). More Greedy: Minimum Spanning Trees	
8	Lecture 14 (8/5). Min-cuts & Max-flows: Karger & Ford-Fulkerson	HW 6 due *Final*
	Final Review Session	