Preliminary Syllabus: CSE 450 Design and Analysis of Algorithms
Fall 2024

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Teaching Assistants: TBA

Class Schedule

CSE 450, SLN 60463: T Th 10:30-11:45am, HLMK 359

Course Objectives and Expected Learning Outcomes

This is a "second" course in algorithms. The goal of this course is to show you some useful algorithms and explain how they work and why they are considered good, in order to (1) help you recognize situations in which you would be better off looking in the literature or asking someone knowledgeable for a good algorithm to solve your problem instead of just coding the first idea that comes to your mind, and (2) give you enough background so that you are able to understand and navigate the literature on algorithms. In order to achieve this, you will have to work through and understand several algorithmic techniques (e.g., *divide-and-conquer, dynamic programming, greedy algorithms*) and the mathematical background necessary for analyzing the properties of these techniques and the algorithms based on them (e.g., *recurrence relations, graph theory*).

The students are expected to understand the material typically covered in CSE310 (and its prerequisites such as MAT243). In particular, you should know how quicksort and merge sort work (and be able to write and solve recurrence relations for those), you should be able to use the "big-Oh" notation and you should have seen the algorithms of Dijkstra and Prim and have at least an intuitive understanding of how they work. I will also assume you know the definitions and basic properties of heaps and binary search trees. The expected background in recurrence relations (and a little more) is detailed in a separate handout available from the course web page (on myASU). All of this prerequisite material is covered in CSE310 (or an equivalent class, for graduate students), which is required as a prerequisite for this class.

Textbook

J. Kleinberg and E. Tardos. *Algorithm Design*, Addison Wesley, 2006.

Other recommended references:

- Cormen, Leiserson, Rivest, and Stein. *Introduction to Algorithms*, 3rd edition, MIT Press.
- M. Goodrich and R. Tamassia, *Algorithm Design*, Wiley.
- Garey and Johnson. *Computers and Intractability*, Freeman, 1979.

- R.E. Tarjan, *Data Structures and Network Algorithms*, SIAM, 1983.
- Jeff Erickson's classnotes, available at
  http://jeffe.cs.illinois.edu/teaching/algorithms/

Web material

You have to request the TAs to add you to this course on Canvas at `my.asu.edu`, if you are not already subscribed. Students are *required* to check the *Bulletin Board* — which can be reached from the CSE 450 myASU homepage by following the link to Discussion Board on the left-hand side of the screen — *at least every other day. All course announcements* will be posted on the bulletin board (some course announcements may actually be posted on the bulletin board *only*).

Office Hours

The TAs's office hours are: TBA

Email

Since email has proliferated, and now constitutes the bulk of extra-classroom conversation between student and instructor, it must be subject to normal rules of formality. Therefore, all email communication will follow the guidelines enumerated here.

Email communication regarding this class **MUST** include in the *subject line* the prefix `CSE 450:` (for example, the subject line of your email may read `CSE 450: question about hw1`). Every email *must* also cc the TAs (unless there is a specific and clear reason why the TAs should not be cc'ed). Emails will be read once a day, M-F. The TAs will directly answer your email, unless the TAs feel that my direct assistance is needed.

Email should be clear, self-contained, and to the point. Email should not ask questions whose answers are contained in the course syllabus, classnotes/class material, or the Bulletin Board. Students should avoid asking questions in email that should be raised either in class, or in individual consultation with TAs during office hours. These include questions of an excessively conceptual nature, and questions that expect an unreasonable amount from the instructor. A good rule of thumb: if your question cannot be answered in a short paragraph, or if it is a question that you should solve on your own through the course of your reading, then it is not appropriate for email.

Email that does not follow the guidelines above will *not* be returned by the TAs/instructor.

Evaluation & Grading Policy

The grades will be based on

- homework assignments : eight to nine assignments (roughly one assignment every 1 1/2 weeks). Given the reduced grader support for this course, *not all the questions* of the hw assignments will be graded: In each assignment, the instructor may *select a subset, e.g. of 2 or 3, of the questions at random to be graded*; your grade in the assignment will be the *sum the graded questions* plus some fixed number of points that you will receive for each other answer submitted but not graded. Some assignments may be in *groups of two* students.
- two midterms and one final exam: All students are expected to be present on all exams; if for some unforeseen reason you may not be able to make it to one of the exams, I will need a doctor's

or hospital note, or some other form of documentation supporting your absence: No makeup exams will be given without proper documentation. *All of the exams will be closed book.*

Grade distribution and exam schedule:

- Homework assignments (25%)
- Each midterm exam (24%): TBA
- Final exam (27%): TBA

Grade Disputes

A digital repository will be created for every homework assignment. A student may submit a digital copy (electronic file, picture of the written solutions, etc.) of his/her solutions to a hw assignment to the repository *before* the assignment deadline. Grade disputes for the hw assignments will *only* be considered if a digital copy of the respective solutions has been submitted.

The instructor will keep the original copies of all the exams (you may, if you would like, make a copy of your solutions to an exam for your personal use). *All grade disputes*, for hw assignments or exams, must be submitted *in written*, including a *detailed description* on why you believe we should reconsider the grading of your hw or exam. If your description does not satisfactorily describe why you believe that we may have made a mistake in grading, it will *not* be considered.

No exceptions will be granted.

Course Topics

We will cover most of chapters 1, 4, 5, 6, and 7, and selected topics from chapters 8, 11, and 13. Note that some of the topics in chapters 4, 5, and 6 have already been covered in CSE 310, so we will focus on the new material in these chapters. We may also cover a few selected topics which are not covered by the textbook (e.g., splay trees, skip lists, amortized analysis).

Below is a tentative schedule of topics:

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- Stable Matching (and 5 representative problems, Section 1.2) (1 week)
- Greedy Algorithms (2.5 weeks)
  * Interval Scheduling
  * Interval Partitioning
  * Min Lateness Scheduling
  * Caching
  * Min Spanning Trees
  * Shortest Paths
  * Huffman codes (time permitting)

- Amortized Analysis (1 week)
  * log^* n analysis on Union-Find Data structure
    (and basic knowledge about the data structure)

- Splay Trees (1 week)

- Divide-and-Conquer (1.5 weeks)
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  * General technique (including MergeSort)
  * Closest Pair of Points
  * Fast Integer and Matrix Multiplication
    (Karatsuba's and Strassen's algorithms)
  * FFT (time permitting)

- Dynamic Programming (2 weeks)
  * General Technique
  * Weighted Interval Scheduling
  * Knapsack
  * Shortest Paths: Bellman-Ford

- Network Flows (2 weeks)
  * Ford-Fulkerson Algorithm
  * max flow-min cut theorem
  * capacity scalling algorithm\Edmonds-Karp algorithm
  * max cardinality bipartite matching

- Polynomial Time Reductions and NP-completeness (2 weeks)
  * classes P and NP
  * NP-completeness

- Approximation algorithms (1 week)
  * Traveling Salesman Problem
  * List scheduling (time permitting)
  * Knapsack

- Skip Lists (1 week) (time permitting)
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Homework assignments

Here is the tentative schedule of the homework assignments.

TBA

Late homework, Make-Up, and Attendance Policies

The *late homework policy* is as follows, assuming hw is due at the beginning of class:

- if submitted by the end of class on the day the hw is due, then 5% penalty
- if submitted by 3pm on the day hw is due, then 10% penalty
- if submitted by midnight on the day hw is due, then 15% penalty
- if submitted the day after hw is due, then 20% penalty (upon prior approval by instructor)

In rare circumstances, when a student has a compelling reason for submitting the hw past the day after the hw is due, I will extend my policy on a case-by-case basis, requiring advance instructor approval.

No late hws will be accepted after the solutions have been posted (usually by midnight on the day the hw is due).

You must submit a typed hardcopy of your hw at the beginning of class when the hw is due. In addition, you should submit a digital copy of your hw to the digital dropbox located under Assignments, which will only be used in case you have a grade dispute for the respective assignment.

If you *miss an exam*, you must have a compelling reason and submit proof (e.g., a hospitalization report) to the instructor. At her discretion, the instructor will review each case individually and decide whether a makeup exam shall be given.

Accommodations will be made for religious observances provided that students notify the instructor at the beginning of the semester concerning those dates. Students who expect to miss class due to officially university-sanctioned activities should inform the instructor early in the semester. Alternative arrangements will generally be made for any examinations and other graded in- class work affected by such absences. The preceding policies are based on ACD 304-04, "Accommodation for Religious Practices" and ACD 304-02, "Missed Classes Due to University- Sanctioned Activities.".

Classroom Behavior

Cell phones and pagers (must be/or state alternative rule) turned off during class to avoid causing distractions. The use of recording devices is not permitted during class. Any violent or threatening conduct by an ASU student in this class will be reported to the ASU Police Department and the Office of the Dean of Students.

Academic Integrity

All students in this class are subject to ASUâ's Academic Integrity Policy (available at http://provost.asu.edu/academicintegrity) and should acquaint themselves with its content and requirements, including a strict prohibition against plagiarism. All violations will be reported to the Dean's office, who maintain records of all offenses. Students are expected to abide by the FSE Honor Code (http://engineering.asu.edu/integrity/).

Any incidence of cheating in this class will be severely dealt with. This applies to homework assignments, programming assignments, quizes and tests. The *minimum* penalty for cheating will be that the student will not obtain any credit for that particular assignment. (This means that if in a test or assignment a student is found to have cheated, he/she will obtain zero in that test/assignment.) For the homework assignments students are *encouraged to discuss* the problems with others, but one is expected to turn in the results of one's own effort (not the results of a friend's efforts). If it is a group assignment, the same applies for the members of each group — that is, the whole group is supposed to be involved in solving all different parts of the assignment. One tends to get very suspicious if two identically wrong results show up in the homework assignment and/or tests. The names of the offenders will be maintained in the departmental files. The repeat offenders may be debarred from the University.

Disability Accomodations

Suitable accommodations will be made for students having disabilities and students should notify the instructor as early as possible if they will require same. Such students must be registered with

the Disability Resource Center and provide documentation to that effect.

Sexual Discrimination

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs.

As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling, is available if you wish discuss any concerns confidentially and privately.

Note: Any information in this syllabus (other than grading and absence policies) may be subject to change with reasonable advance notice.

Note: All contents of these lectures, including written materials distributed to the class, are under copyright protection. Notes based on these materials may not be sold or commercialized without the express permission of the instructor. [Note: Based on ACD 304-06.]