CSCI 256: Algorithm Design and Analysis

Spring 2020

Instructor:	Sam McCauley	**Time:**	MWF 10:40-11:30
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Webpage: https://williams-cs.github.io/cs256-f20/

Office Hours: Wednesday 1-3PM, Thursday 3:30-5:30PM

Textbooks: The primary text for the course is *Algorithm Design* by Jon Kleinberg and Éva Tardos, Addison-Wesley 2006. This will be supplemented by readings from the *Algorithms* textbook by Jeff Erickson freely available at http://jeffe.cs.illinois.edu/teaching/algorithms/book/Algorithms-JeffE.pdf

Objectives: This course is about mathematical modeling of computational problems, developing common algorithmic techniques to solve them, and about analyzing the correctness and running time of the algorithms. By clearly formulating and carefully analyzing the structure of a problem, it is often possible to dramatically decrease the computational resources needed to solve it. In addition, by analyzing algorithms you can provide provable guarantees of their performance. We will study several algorithm design strategies that build on data structures and programming techniques introduced in CS 136 and mathematical tools introduced in MATH 200. The course will roughly cover the following topics in order: graph algorithms, greedy algorithms, divide-and-conquer, dynamic programming, NP completeness and problem reductions, approximation algorithms and randomized algorithms. At the end of the course, the students should be able to:

- Analyze worst-case running time and space usage of algorithms using asymptotic analysis.
- Formulate real-world optimization problems mathematically (using concepts like sets and graphs) and apply algorithmic paradigms such as divide-and-conquer and dynamic programming to solve them.
- Identify and prove that certain computational problems are NP-hard or NP-complete, that is, show that they are unlikely to admit an efficient solution.
- Design and analyze simple randomized algorithms for computational problems.

Prerequisites: CSCI 136, and either MATH 200 or passing the Discrete Math Proficiency Exam.

Tentative Course Outline:

- Section 1: Graphs: Matching and Traversals
- Section 2: Greedy and Divide & Conquer
- Section 3: Dynamic Programming
- Section 4: Reductions: Network Flow and NP hardness
- Section 5: Randomized and Approximation Algorithms

Grading Policy: Assignments (50%), Midterm (20%), Final (25%), Participation (5%)

Attendance: Attendance is required in this class; students who cannot attend class regularly will need permission from the instructor in order to complete the class. In general, attendance will be one part of the participation grade. Students who cannot attend a particular class session should email the instructor; excused absences will not count against your participation grade.

Academic Honesty: For a full description of the Computer Science Honor Code, please see: https://csci.williams.edu/the-cs-honor-code-and-computer-usage-policy/. If you have any doubt about what is appropriate, please email me at sam@cs.williams.edu.

Midterm and final exams are to be the sole work of each student. No collaboration or discussion is allowed. Internet resources may not be used to obtain any solutions; however they may be used for diagnostic purposes (i.e. help with Latex solutions). The exams are open-book, and students are encouraged to use course materials—textbooks, notes from lectures, and slides—as a reference when answering questions.

For assignments, the student must submit their own answers to any questions. On these questions, students may only discuss high-level strategies and small syntax issues. The best way to ensure that this rule is followed is to never write the content of discussions with other students while they are taking place—instead, discuss at a high level, and write down the details alone after the discussion completes.

On assignments, students may use online resources for things like debugging (generally this will just be Latex). Students should never look up answers to assignment questions, or to similar assignment questions. Students are encouraged to use course materials—textbooks, notes from lectures, and slides—as a reference when answering questions.

Assignments: This course will have assignments, released (approximately) weekly. Assignments are graded largely on completion: while a correct answer is required to get full credit, there will be considerable partial credit given for an attempt at a solution.

All assignments must be typset using Latex using the template provided. Latex is free and available on all lab computers; it can also be installed on your personal computer, or accessed via a web interface (Overleaf). The goal of Latex is to allow users to focus on content, rather than typsetting concerns, while still allowing flexibility and the ability to make beautiful documents. Latex has many useful tools—in this course we will often be using the tools for mathematical typsetting, but Latex can be used in a wide variety of circumstances. This syllabus was typeset using Latex.

A (small) portion of the grade for each assignment will be based on correctly using Latex. We will provide resources to help students get up to speed with effective Latex typesetting.

Midterm: The midterm will occur approximately halfway through the semester. It will be a 24 hour take home midterm. No collaboration or online resources (except Latex debugging) are allowed.

The midterm will begin at 10:40AM on October 28th.

Final: 24 hour take-home final. The final will be comprehensive, but with more focus on the second half of the course. As with the midterm, all work must be completed individually, without any collaboration or online resources (except for Latex debugging).

Remote vs In-Person Lectures: This is a hybrid class, and the intention is to offer both remote and in-person materials for students. The primary goal of this setup is to allow students to make the best choices for their health, their learning, and the well-being of those around them. This means that both remote and in-person attendance are to be fully supported, encouraged, and given equal resources in the course.

Currently, the plan is for the primary teaching method to be in-person lectures that are also broadcast over Zoom. Remote students will be able to call in, and what they see on the Zoom call will be identical to what in-person students see on the projector. Everything presented in class will be done through this method—for example, diagrams will be done using a computer (viewable on the projector in class or on the Zoom call), not done on blackboards. Students may ask questions in class, via voice in the Zoom call, or via the Zoom chat feature.

This plan is subject to change at any time. In particular, at least some lectures will be fully remote—in particular, the first class will be—and some may be prerecorded. Students will be notified if any lecture does not follow the primary method specified in the previous paragraph.

Privacy and Recordings: Classes may be recorded for the benefit of students enrolled remotely and those who may be unable to attend live. Your professor will inform you whether the course or any particular sessions are being recorded. By participating with your camera on, using a profile image, or with audio unmuted, you are consenting to having your video, image, and audio recorded. If you do not want to be recorded, please be sure to keep your camera off, do not use a profile image, and keep your microphone muted. Students who choose to not be recorded may participate by means of the chat feature.