CSCI 256: Algorithm Design and Analysis

Spring 2024

Instructor:	Sam McCauley	**Time:**	MR 1:10–2:25, 2:35–3:50
Email:	sam@cs.williams.edu	**Place:**	Schow 30B

Webpage: https://williams-cs.github.io/cs256-s24/index.html

Office Hours: Tuesday 2–4PM, Wednesday 2–4PM, Friday 2–2:30PM

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 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.

Course Outline:

- Part 1: Graph Algorithms and Greedy Algorithms
- Part 2: Divide & Conquer, Dynamic Programming, Network Flows
- Part 3: Reductions, NP Hardness, Randomized and Approximation Algorithms

Grading Policy: Assignments (20%), Midterm 1 (25%), Midterm 2 (25%), Final (30%)

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.

For assignments, the student must submit their own answers to any questions. Students should not discuss their solutions with other students.

On assignments, students may use online resources for Latex debugging. 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.

Grading and Late Policy: All assignments, midterms, and the final exam will be graded anonymously. Assignments will be weighted equally toward the final grade. Each student's lowest assignment grade will be dropped. Late assignments will have a penalty of 10% per day late.

Midterms: We will have two in-class midterms. The first will be on February 29, and the second will be on April 15, during each student's normal class time.

Final Exam: We will have a 2.5 hour scheduled exam during finals period. The date and time will be announced by the registrar a week or two after add/drop is over.

Inclusion and Classroom Culture: The Williams community embraces diversity of age, background, beliefs, ethnicity, gender, gender identity, gender expression, national origin, reli- gious affiliation, sexual orientation, and other visible and non visible categories. As a group, I expect that us to contribute to a respectful, welcoming and inclusive environment. If you have any concerns about classroom climate, please reach out to me to share your concern.

Health and Accessibility Resources: Students with disabilities of any kind who may need accommodations for this course are encouraged to contact Dr. GL Wallace (Director of Acces- sible Education) at 597-4672. Also, students experiencing mental or physical health challenges that are significantly affecting their academic work or well-being are encouraged to contact me and/or to speak with a Dean so we can help you find the right resources. The Deans office can be reached at 597-4171.