CSCI-570: Analysis of Algorithms

Fall 2024

Prof. Victor Adamchik

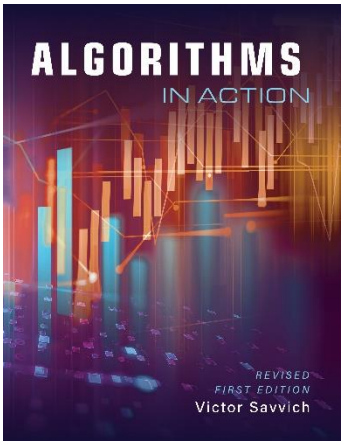
Course Description:

This course is about designing algorithms for computational problems, and how to think clearly about analyzing correctness and running time. The main goal of this course is to provide the intellectual tools needed for designing and analyzing your own algorithms for new problems you need to solve in the future. The course explores fundamental algorithm design techniques such as greedy, divide and conquer, dynamic programming, network flow, reduction, approximation, linear programming and randomization for efficient algorithm construction. The course describes Turing machines and explains what *NP*-completeness means with respect to possibilities for solving these problems efficiently. There are no programming assignments in this course.

Learning Objectives:

- Understanding a variety of techniques for designing algorithms.
- Develop skills to reason about and prove properties of algorithms such as their correctness and running time.
- Design experiments to evaluate and compare different algorithm techniques on real-world problems
- Use approximation and linear programming to find near-optimal solutions for challenging problems.
- Use the concept of randomization to find efficient algorithms for challenging problems.
- Use the theory of *NP*-completeness to argue for the difficulty of some problems.

Textbook:



Algorithms in Action, by V. Savvich, Revised First Edition, 2022.
Purchase the textbook either from the publisher at:

https://store.cognella.com/82372-1C-NI-005

If you select an ebook, you will have immediate access upon purchase. If you select the paperback for this title, you will receive immediate online access to the first 30% of the book

Optional textbooks:

Introduction to Algorithms, by T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein

Algorithms, by S. Dasgupta, C.H. Papadimitriou, and U.V. Vazirani.

Algorithm Design, by J. Kleinberg and E. Tardos

Prerequisites:

Students in the class are expected to have a reasonable degree of mathematical sophistication, and to be familiar with the basic notions of algorithms and data structures, discrete mathematics, and probability. Undergraduate classes in these subjects should be sufficient. If you have no previous background in these, I suggest a more thorough introduction such as "*Mathematics for Computer Science*", by Eric Lehman, Thomson Leighton and Albert Meyer, Samurai Media Limited, 2017. The course does not emphasize nor require programming, just pseudocode to encourage students on conceptual understanding.

Theory Assignments:

- There will be five written theory assignments.
- The assignments should be submitted electronically to DEN.
- Theory assignments must be typed, for example in MS Word, and then converted to pdf.
- You may work in groups of 2-3. However, each person should hand-in their own solution.
- Collaboration should be limited to high level talking about the problems, so that your writeup is written entirely by you and not copied from your partner.
- We won't accept late submissions.
- We won't regrade assignments.

Homework's Purpose:

Algorithms is a pivotal course in computer science studies. The course will require a significant amount of work on your part to follow what is taught in class and complete homework successfully. We stress that the homework is an essential part of your course work. We devote a fairly large amount of time for designing, writing, grading and explaining the homework, so that you can test yourselves and see how well you understand and implement the course's material.

Quizzes:

There will be online quizzes in DEN. The quizzes are an individual effort. You may not use any means to communicate to other students on quizzes for any reason. The goal of quizzes is to ensure that students are attending/watching the lectures and understanding some of the concepts covered. They are closed book and will consist of 10 questions. Quizzes will be available starting on Thursday at 7pm with the deadline Friday at 7p.m. There are no makeup quizzes. Students can take the quiz (only once) at any time during this time frame. The quiz length is 15 mins. There will be no quiz on the exam weeks. Accommodations for students with letters from DSP/OSAS will be provided ("Students should make arrangements directly with their faculty member at least one week in advance of the quiz, test or exam date").

Exams:

- There will be two midterm in-person exams.
- Each exam is 2 hrs and 20 mins long.
- No makeup exams will be provided.
- The exam solutions and grading rubric will be posted.
- There will be a regrading session for each exam where you can discuss grading errors. A regrade is allowed only when there are clear and obvious grading errors. Grading errors are simple mistakes made on the part of the graders, and not differences in interpretation of a question or answer.
- If you missed the last exam, you may be eligible for an IN grade for the course. The incomplete grade has to be completed within one year. However, in order to get an IN you have to have a valid cause. Please read the University policy on IN grade for more details.
- Accommodations for students with letters from OSAS will be provided.

Grading:

Assignments	**15%**
Online Quizzes	**10%**
Midterm exam 1	**35%**
Midterm exam 2	**40%**

Letter Grade Distribution:

≥ 90	A	70 – 75	B-	53 – 57	D
85 – 90	A-	67 – 70	C+	50 – 53	D-
80 – 85	B+	63 – 67	C	<50	F
75 – 80	B	57 – 60	D+		

Tentative Schedule:

This schedule is meant as an outline. Depending on progress, material may be added or removed. Each lecture is 2hrs and 20 mins long followed by a 50 mins discussion session.

Week	Topics Covered
Aug. 26 – 30	Lecture 1: Algorithmic Thinking, Timing Analysis, Mathematical Proofs
Sep. 2 – 6	Lecture 2: Runtime Analysis. Amortized Analysis. **HW1** (due Sep. 8) Sep. 2 – no classes (recorded video lecture)
Sep. 9 – 13	Lecture 3: Advanced Heaps **Quiz1**
Sep. 16 – 21	Lecture 4: Greedy Algorithms **HW2** (due Sep. 22)
Sep. 23 – 27	Lecture 5: Dijkstra's Algorithm Divide-and-Conquer Algorithms. **Quiz2**
Sep. 30 – Oct. 4	Lecture 6: Dynamic Programming **HW3** (due Oct. 6)
Oct. 7 – 11	Lecture 7: Dynamic Programming **Quiz3** October 10-11 - Fall recess Practice Exam 1
Oct. 14 – 18	Review for exam. **Exam-1 on Friday Oct.18 at 6pm**
Oct. 21 – 25	Lecture 8: Network Flow **HW4** (due Nov. 3)
Oct. 28 – Nov. 1	Lecture 9: Flow Circulation **Quiz4**
Nov. 4 – Nov. 8	Lecture 10: Linear Programming **HW5** (due Nov. 24)
Nov. 11 –15	Lecture 11: NP-Completeness Nov. 11 – no classes (recorded video lecture)
Nov. 18 – 22	Lecture 12: NP-Completeness **Quiz5**
Nov. 25 – 29	Lecture 13: Approximation Algorithms Practice Exam 2 Nov. 27-Dec. 1 – no classes Nov. 27 – no classes (recorded video lecture)
Dec. 2 – Dec. 6	Review for exam. **Exam-2 on Friday Dec. 6 at 6pm**

HWs and Quizzes:

Assignment	Content
HW1 & Quiz1	runtime, proofs, AC: lectures 1, 2
HW2 & Quiz2	heaps, greedy: lectures 3, 4
HW3 & Quiz3	D&C, DP: lectures 5, 6
HW4 & Quiz4	NF, curculation: lectures 8, 9
HW5 & Quiz5	LP, NP: lectures 10, 11, 12

Office Hours: posted to Piazza

Piazza & Emails:

If you have a question about the material or logistics of the class, please do not use e-mail but instead post it on the Piazza at piazza.com/usc/fall2024/csci570. You may post it on Piazza publicly to the whole class or privately to the instructors. Often times, if one student has a question/comment, other also have a similar question/comment. Please DO NOT send emails to the course staff unless your issue is private and/or a private post on Piazza is unsuitable.

Attendance:

There is no lecture attendance requirement that counts towards your grade in the class. However, students who do not attend lecture are responsible for everything covered in lecture. The lectures will be recorded and posted on DEN for students to watch if they are unable to attend a lecture.

Academic Integrity:

The USC Student Conduct Code prohibits plagiarism. All USC students are responsible for reading and following the Student Conduct Code, which appears on https://policy.usc.edu/files/2018/07/SCampus-2018-19.pdf.

In this course we encourage students to study together. This includes discussing general strategies to be used on individual assignments. However, all work submitted for the class is to be done individually. Some examples of what is not allowed by the conduct code: copying all or part of someone else's work (by hand or by looking at others' files, either secretly or if shown), and submitting it as your own; giving another student in the class a copy of your assignment solution; consulting with another student during an exam. If you have questions about what is allowed, please discuss it with the instructor.

Honor Code Pledge:

I pledge to uphold the highest academic standards and integrity. In accordance with USC Viterbi's Honor Code (https://viterbischool.usc.edu/academic-integrity/), I affirm that I have not used any unauthorized materials in completing the exams, and have neither given assistance to others nor received assistance from others. Further, I affirm that I have not observed any other students in this class acting to gain an unfair advantage, or I have reported to my instructor any activity I have observed that is not in accordance with USC Viterbi's Honor Code. I do so to sustain a Viterbi culture of integrity, responsibility, community and "excellence in all our endeavors." I understand that there are significant consequences for violating academic integrity (https://policy.usc.edu/scampus-part-b/) and that suspected violations will be reported to the School and the University.

For Students with Disabilities:

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs each semester. A letter of verification for approved accommodations can be obtained from OSAS. Please be sure the letter is delivered to me as early in the semester as possible. OSAS is located in STU 301 and is open 8:30 a.m.-5:00 p.m., Monday through Friday.

Support Systems:

Counseling and Mental Health

(213) 740-9355 – 24/7 on call http://studenthealth.usc.edu/counseling Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline

(800) 273-8255 – 24/7 on call http://suicidepreventionlifeline.org Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services

(213) 740-9355(WELL), press "0" after hours – 24/7 on call http://studenthealth.usc.edu/sexual-assault Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity

(213) 740-5086 | Title IX – (213) 821-8298 http://equity.usc.edu, http://titleix.usc.edu Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment

(213) 740-5086 or (213) 821-8298 http://usc-advocate.symplicity.com/care_report Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

USC Emergency

(213) 740-4321 – 24/7 on call, http://emergency.usc.edu Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety

(213) 740-6000 – 24/7 on call, http://dps.usc.edu Non-emergency assistance or information.