



Course ID and Title: CSCI 570 Analysis of Algorithms

Units: 4

Term—Day—Time: Spring 2025

TH 5:00-8:20 PM Location: SGM 101

F 2:00-5:20 PM Location: SGM 123

Instructor: Shawn Shamsian

Office: GCS 302

Office Hours:

T 12:00 AM-2:00 PM Online <https://usc.zoom.us/j/8466668303>

TH 12:00 AM-2:00 PM in person (location TBD)

Contact Info:

Email: sshamsia@usc.edu

will respond within 24 hours

Phone: (213) 740-5972

please do not leave messages, and use email instead

Teaching Assistant:

A link to a Google Calendar showing all TAs and their office hours will be provided through DEN/D2L

IT Help:

For DEN/D2L related issues: <https://viterbigrad.usc.edu/technical-support/>

For any other tech support issues: <https://viterbi.usc.edu/servicedesk/>

Course Description

This course is intended as a first graduate course in the design and analysis of algorithms. The focus is on developing an understanding for the major algorithm design techniques. Algorithmic techniques covered include divide and conquer, greedy, and dynamic programming. Other topics also include network flow, NP-completeness, approximation algorithms, and linear programming. At times, the practical side of algorithm design and implementation is also explored with interesting examples of their usage in solving industry problems.

Learning Objectives: At the end of this course, students should have

- A good understanding of major algorithm design and analysis techniques
- Ability to design, analyze complexity of, and prove correctness of moderately difficult problems
- A good understanding of the NP, NP-complete, and NP-hard classifications and ability to demonstrate hardness of NP-complete problems
- Ability to solve problems through reduction such as reduction to network flow problems (max flow, min cut, feasible circulation) or linear programming
- An understanding of different methods to solving problems approximately
- Overall better problem-solving skills

Prerequisite(s):

Students in the class are expected to have a reasonable degree of mathematical sophistication, and to be familiar with the basic notions of algorithms, data structures and discrete mathematics.

More specifically the knowledge of the following prerequisite topics is a must:

- Proof techniques (Mathematical induction, proof by contradiction, etc.)
- Graph basics (directed, undirected, DAG, trees, adjacency list, cycles, BFS, DFS, etc.)
- Asymptotic notation (Big O, etc.)
- Sorting methods
- Basic data structures (arrays, linked lists, stacks, queues)

The following textbooks are possible resources on these prerequisite topics:

Mathematics for Computer Science, by Eric Lehman, Thomson Leighton and Albert Meyer

Discrete Mathematics and its Applications, by Kenneth H. Rosen, 8th Edition

Recommended Preparation: It is highly recommended to first brush up on the prerequisite topics before the start of classes, especially if the prerequisite topics were studied more than two years ago.

Course Notes

Lecture notes: There will be two sets of notes posted for each lecture:

- Pre-lecture notes will contain the skeleton/template and will identify the topics to be covered in that lecture. Pre-lecture notes are posted before each lecture and can be used as basis to take/add notes during lectures.
- Post-lecture notes will contain all details that are covered during the lecture and will be posted after the lecture.

Lecture notes will be available on the DEN/D2L platform

Lecture videos: All lectures are recorded. Recordings will be available on DEN/D2L after each lecture. Live links to lectures will also be available to DEN students.

Discussion board: We will be using the Piazza discussion board. Piazza will also be used for all announcements.

Assignment Submission Policy

Homework assignments are assigned on a weekly basis and are due within 4-7 from the date posted. The exact due date for each assignment will be provided when the assignment is posted.

Additional Policies

Exam dates will be announced by first week of classes. Students need to make sure they can take exams on those dates and times. No alternate exam dates or times will be provided.

Technological Proficiency and Hardware/Software Required

None

Required Readings and Supplementary Materials

The main textbook used for the course is **Algorithm Design** by Jon Kleinberg and Eva Tardos.

Optional Readings and Supplementary Materials

Additional material will occasionally be drawn from the following textbook:

Introduction to Algorithms by Thomas Cormen, et al.

Description and Assessment of Assignments

Homework assignments are posted on a weekly basis and will focus on the topics covered that week.

Participation

Participation in lecture and discussion sessions is highly encouraged however there is no credit associated with class participation.

Grading Breakdown

Exams	Date	% of Grade
Exam 1	February 21	30%
Exam 2	April 4	30%
Exam 3	May 2	23%
Homework	Weekly	12%
Final project	May 12	5%
Total		100%

Exam 1 covers the material corresponding to weeks 1 through 5.

Exam 2 covers the material corresponding to weeks 7 through 11.

Exam 3 covers the material corresponding to weeks 13 through 15.

Grading Scale

Letter grade	Corresponding numerical point range
A	90-100
A-	86-89.99
B+	80-85.99
B	70-79.99
B-	65-69.99
C+	60-64.99
C	55-59.99
C-	50-54.99
D	45-49.99
F	44.99 and below

The instructor reserves the right to lower some or all grade boundaries at the end of the semester.

Assignment Submission Policy

HW assignments are due within 4-7 days of the release of the assignment. Each HW assignment will have its due date specified.

Late HW submissions are not accepted and will be given a grade.

Grading Timeline

The course staff will strive to have all assignments graded within one week of the assignment's due date.

Course Specific Policies

Homework scores of 60% and above will be considered as Pass, and those below 60% will be considered as No Pass. There will be 12 HW assignments each contributing to 1% of the overall grade in the course. A Pass grade on a HW assignment will therefore add 1% to your overall score in the class while a No Pass grade for that assignment will not add to your overall score.

Attendance

Attendance is highly recommended however there is no credit associated with class attendance.

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the [USC Student Handbook](#). All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

Academic dishonesty has a far-reaching impact and is considered a serious offense against the university. Violations will result in a grade penalty, such as a failing grade on the assignment or in the course, and disciplinary action from the university itself, such as suspension or even expulsion.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment or what information requires citation and/or attribution.

Policy on AI tools

Generative AI tools can sometimes be useful in this course in coming up with ideas and approaches on how to solve certain homework problems. If you choose to use AI tools for homework assignments keep in mind the following:

- Proceed with caution when using AI tools and do not assume the solutions provided are accurate. It works best if you use it to get ideas on how to solve the problem, and then solve it on your own.

- AI is a tool, but one that you need to acknowledge using. Please include a paragraph at the end of any assignment that uses AI explaining how (and why) you used AI and indicate/specify the questions you used it for. Failure to do so is a violation of academic integrity policies.
- No electronic devices are allowed during exams and quizzes. You will need to know how to solve exam problems on your own.

Example:

The question below comes from an old exam for this course. The question is asking for the truth or falsehood of the statement: "If $P = NP$, then the Shortest Path problem is NP-complete."

Below is the response to this question from one of the popular generative AI tools. Although some of the arguments presented are correct, the conclusion is incorrect.

*The statement is **false**.*

Explanation:

1. **Shortest Path Problem:**
 - The Shortest Path problem (e.g., finding the shortest path between two nodes in a weighted graph) can be solved in polynomial time using algorithms like Dijkstra's or Bellman-Ford.
 - Problems that can be solved in polynomial time are in the class **P**.
2. **NP-Complete Problems:**
 - A problem is **NP-complete** if it satisfies two conditions:
 1. It is in **NP** (its solution can be verified in polynomial time).
 2. It is **NP-hard** (every problem in NP can be reduced to it in polynomial time).
3. **If $P=NP$:**
 - If $P=NP$, it means that every problem in NP can also be solved in polynomial time. However, for a problem to be NP-complete, it must still satisfy the NP-hardness condition.
4. **Why the Shortest Path problem is not NP-complete:**
 - The Shortest Path problem is already in **P**, meaning it is solvable in polynomial time.
 - It is not **NP-hard**, because other NP problems cannot be reduced to it in polynomial time.
 - Intuitively, the Shortest Path problem does not capture the computational complexity required to solve all NP problems, as its solution is straightforward compared to problems like SAT or 3-SAT.

Conclusion:

*Even if $P=NP$, the Shortest Path problem does not become NP-complete because it is not NP-hard. It remains a polynomial-time problem in **P**.*

Other Academic Integrity Policies

Group work: Unless specifically designated as a 'group project,' all assignments are expected to be completed individually.

Computer programs: Plagiarism includes the submission of code written by, or otherwise obtained from someone else.

If found responsible for an academic violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an "F" grade on the assignment, exam, or in the course.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonesty and is strictly prohibited. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Course Evaluations

Course evaluation occurs at the end of the semester university-wide. It is an important review of students' experience in the class. It is highly recommended that students complete course evaluations as they provide the school, instructor and the course staff valuable information on how to continually improve the quality of the content and instructions. Students will be notified by email about the exact details on the time window and URL to provide their evaluations.

Course Schedule

	Topics/Daily Activities	Readings and Homework	Homework Due Date
Week 1	intro, stable matching	Reading: chapter 1 Home assignment 1	Week 2
Week 2	Asymptotic notation, BFS, DFS, greedy algorithms	Reading: chapters 2, 3, 4 Home assignment 2	Week 3
Week 3	Greedy algorithms	Reading: chapter 4, supplemental text chapters 6,19 Home assignment 3	Week 4
Week 4	heaps, MST, shortest path	Reading: chapter 4, 5 Home assignment 4	Week 5
Week 5	divide and conquer	Reading: chapter 5 Home assignment 5	Week 6
Week 6	exam I		
Week 7	dynamic programming	Reading: chapter 6 Home assignment 6	Week 8
Week 8	dynamic programming	Reading: chapter 6 Home assignment 7	Week 9
Week 9	network flow - max flow	Reading: chapter 7 Home assignment 8	Week 11
Week 10	Spring Break		
Week 11	network flow - circulation	Reading: chapter 7	Week 12

		Home assignment 9	
Week 12	exam II		
Week 13	NP-completeness	Reading: chapter 8 Home assignment 10	Week 14
Week 14	NP-completeness	Reading: chapter 8, supplemental text chapter 34 Home assignment 11	Week 15
Week 15	approximation algorithms randomized algorithms linear programming	Reading: chapter 11, supplemental text chapter 35 Home assignment 12	Week 16
Week 16	exam III		

Statement on University Academic and Support Systems

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. [The Office of Student Accessibility Services](#) (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Student Financial Aid and Satisfactory Academic Progress:

To be eligible for certain kinds of financial aid, students are required to maintain Satisfactory Academic Progress (SAP) toward their degree objectives. Visit the [Financial Aid Office webpage](#) for [undergraduate](#)- and [graduate-level](#) SAP eligibility requirements and the appeals process.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline consists of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

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) 740-2500

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

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](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323) 442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.