Course Syllabus

CS 5050 Advanced Algorithm

Fall 2023

Time: Tuesday and Thursday, 10:30 a.m. to 11:45 a.m.

Location: Old Main 115

Instructor: Dr. Hamid Karimi

Email: hamid.karimi@usu.edu

Phone: (435) 797-1233 (office)

Office: 418 Old Main Building

Office Hours: Thursdays 12:00 p.m. to 2:00 p.m. (Old Main 418)

Delivery Mode: Face-to-face

Course Fees: $180 for Graduate Teaching Assistant

Graduate Teaching Assistants (GTAs):

Course Description

This course offers an in-depth examination of algorithmic techniques and their analytical evaluation, focusing on the mathematical assessment of average-case complexity. It covers foundational algorithms in sorting, graph theory, number theory, and heuristic optimization. Students will derive upper and lower computational bounds, which will serve as valuable tools for guiding algorithmic design choices. Key learning objectives include mastering the application of heuristic and approximate solutions to NP-hard problems and employing problem-reduction strategies for establishing lower bounds and problem-solving. The curriculum may encompass a range of topics, such as inductive design methodologies, algorithms targeting sequences and sets, specialized graph and geometric algorithms, algebraic algorithmic approaches, problem reductions, the theory of NP-completeness, and parallel computing algorithms.

Privacy and Security in Computing

This course features an in-depth exploration of secure computing principles and practices, harmonizing with the educational objectives detailed in the influential paper, "Infusing Principles and Practices for Secure Computing Throughout an Undergraduate Computer Science Curriculum." Pertinent to this course's goals are topics such as Symmetric Key Cryptography, Public Key Infrastructure, Digital Signatures, Hash Functions, and Secure Multi-party Computation, as delineated in the said paper. This alignment aims to cultivate a robust understanding of secure computing frameworks within the larger context of advanced algorithmic studies.

Student Outcomes

- SO1 - Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.
- SO2 - Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.

- SO6 - Apply computer science theory and software development fundamentals to produce computing-based solutions.

Prerequisites

CS 2420 (Algorithms and Data Structures); you are expected to know the following topics: mathematical induction, arrays, linked lists, stacks, queues, heaps, binary search trees, AVL trees, hash tables, sorting algorithms, basic knowledge of graphs, etc.

Course Topics

Note: Some adjustments may be made during the course. Also, some additional materials might be used as well.

Course Topics with Descriptions

- ✎ **Introduction.**
- ✎ **Algorithm Analysis:** This topic focuses on the rigorous evaluation of algorithms, covering aspects such as asymptotic notation, recurrence relations, and amortized analysis to assess algorithmic performance.
- ✎ **Divide-and-conquer:** In this section, students will explore algorithms that solve problems by recursively breaking them into smaller subproblems, solving each subproblem, and combining these solutions to solve the original problem.
- ✎ **Prune-and-search:** This topic introduces students to optimization techniques that narrow down the search space by eliminating suboptimal solutions, thus making search algorithms more efficient.
- ✎ **Data Structure Design:** This part of the course delves into the design and implementation of advanced data structures like heaps, hash tables, and trees, emphasizing their role in algorithmic efficiency.
- ✎ **Dynamic Programming:** Students will learn how to use dynamic programming to solve problems that exhibit overlapping subproblems, allowing for the optimization of recursive algorithms through memoization or tabulation techniques.
- ✎ **Graph Algorithms:** This topic covers a variety of algorithms designed to solve problems related to graphs, such as shortest paths, traversals, and network flows.
- ✎ **Computational Complexity:** This section introduces foundational concepts like P, NP, NP-hard, and NP-completeness, equipping students with a framework for assessing the tractability and computational difficulty of different problems.

Textbook (recommended but not required)

T.H. Cormen, C.E. Leiserson, R.L. Rivest, and C. Stein, *Introduction to Algorithms*, 3rd Edition, the MIT Press, Cambridge, Massachusetts, 2009.

Coursework

Assignments

The purpose of the assignments is to help you understand the concepts introduced in the lectures. Below, there are some policies regarding the assignments:

- You will submit your assignment using the **Canvas System**. The assignment is due by 11:59 p.m. on the due date. No late assignment will be accepted unless you have a legitimate excuse, e.g., an emergency.
- You will be responsible for ensuring that your assignment is submitted correctly. If you have multiple files to submit, you need to zip multiple files into one file before submission. If the assignment is submitted incorrectly, you can resubmit it. The system keeps track of the last file submitted for each assignment. If you do not get the confirmation information within a few minutes, you can assume the assignment has not been submitted.
- Please type in the answers to written questions. If you handwrite the answers, ensure they are legible and properly scan them in a PDF file.
  - **For each typed assignment, a 5% bonus point will be added.**
- At the top of the assignment, please include your name and A-number.

Guidelines for Assignment Collaboration and Attribution

Note: Discussions about assignment problems are permitted only under specific conditions to maintain academic integrity.

- **Assignments Discussions:** Students may discuss assignment problems with peers only if none of the participants already knows the solution.
- **Attribution:** If a solution is discovered during such a discussion, the names of all participants must be listed on the submitted assignment alongside the solved problem.
- **Guidance Restrictions:** Individuals who already have a solution should refrain from offering direct insights, approaches, or methods for solving the problem to others. However, they may provide "negative information," such as pointing out a flaw in another's approach via a counterexample.
- **Solution Confidentiality:** No one, regardless of whether they already know the answer, should read another student's written solutions before assignment submission.
- **Citation Requirements:** If solutions or partial solutions are drawn from external written sources other than the prescribed textbooks or lecture notes, those sources must be appropriately cited in the submitted assignment.

Mid-term Exam

There will be an in-class exam on Thursday, October 26, 2023, from 10:30 a.m. to 11:45 a.m., covering the topics that will have been presented by then.

Final Exam

There will be an in-class exam on Tuesday, December 12, 2023, from 9:30 a.m. to 11:20 a.m., covering all topics that will have been presented by then.

Breakdown of Points

Item	Percentage
Assignments	50%
Mid-term Exam	20%
Final Exam	30%
Attendance and in-class activities	-5%

Grading Scheme

Grade	Points Range
A	[93%, 100%]
A^-	[87%, 93%)
B^+	[81%, 87%)
B	[75%, 81%)
B^-	[70%, 75%)
C^+	[65%, 70%)
C	[60%, 65%)
C^-	[58%, 60%)
D^+	[55%, 58%)
D	[50%, 55%)
F	[0%, 50%)

Grading Policy and Grades

- Your score for each assignment and exam will be available through the Canvas System. You will be shown each individual score, your percentage to date, and any comments. You will be notified via email whenever you receive a score or when a change is made to a score.
- If you want to dispute a score, contact GTAs within two days of having received the original score. If the disagreement is not resolved after communicating with the GTA, contact me by email (hamid.karimi@usu.edu). I will review your submission, talk to the GTA, and then respond to you. I will not consider changes in scores if you do not contact me within one week of when the score is sent to you.

Important Dates

- Late Adds: The last day to add this class is September 18, 2023. Attending this class beyond that date, without being officially registered, will not be approved by the Dean's Office. Students must be officially registered for this course. No assignments or tests of any kind will be graded for students whose names do not appear on the class list.
- Drop Date: The last day to drop classes is:
  1. September 18, 2023 - without a "W" notation on the transcript.
  2. Wednesday, October 30, 2023 - with a "W" notation on the transcript

Withdrawal Policy, "I" Grade Policy, and Dropping Courses

If a student does not attend a class during the first week of the term or by the second class meeting, whichever comes first, the instructor may submit a request to have the student dropped from the course. (This does not remove responsibility from the student to drop courses which they do not plan to attend.) Students who are dropped from courses will be notified by the Registrar's Office through their preferred email account. Students may drop courses without notation on the permanent record through the first 20 percent of the class. If a student drops a course following the first 20 percent of the class, a W will be permanently affixed to the student's record (check General Catalog for exact dates). Students with extenuating circumstances should refer to the policy regarding Complete Withdrawal from the University and the Incomplete (I) Grade policy in the General Catalog.

Library Services

All USU students attending classes in Logan, at our Regional Campuses, or online can access all databases, e-journals, and e-books, regardless of location. Additionally, the library will mail printed books to students at no charge to them. Students can also borrow books from any Utah academic library. Take advantage of all library services and learn more at Statewide Campus and Online Library Services.

Classroom Civility

Utah State University supports the principle of freedom of expression for both faculty and students. The University respects the rights of faculty to teach and students to learn. Maintenance of these rights requires classroom conditions that do not impede the learning process. Disruptive classroom behavior will not be tolerated. An individual engaging in such behavior may be subject to disciplinary action. Read Student Code Article V Section V-3 for more information.

Academic Freedom and Professional Responsibilites

Academic freedom is the right to teach, study, discuss, investigate, discover, create, and publish freely. Academic freedom protects the rights of faculty members in teaching and of students in learning. Freedom in research is fundamental to the advancement of truth. Faculty members are entitled to full freedom in teaching, research, and creative activities, subject to the limitations imposed by professional responsibility. USU Policy 403 further defines academic freedom and professional responsibilities.

Academic Integrity – "The Honor System"

The University expects that students and faculty alike maintain the highest standards of academic honesty. The Code of Policies and Procedures for Students at Utah State University (Student Conduct) addresses academic integrity and honesty and notes the following:

Academic Integrity: Students have a responsibility to promote academic integrity at the University by not participating in or facilitating others' participation in any act of academic dishonesty and by reporting all violations or suspected violations of the Academic Integrity Standard to their instructors.

The Honor Pledge: To enhance the learning environment at Utah State University and to develop student academic integrity, each student agrees to the following Honor Pledge: "I pledge, on my honor, to conduct myself with the foremost level of academic integrity". Violations of the Academic Integrity Standard (academic violations) include, but are not limited to cheating, falsification, and plagiarism.

Plagiarism and Cheating:

Plagiarism includes knowingly "representing by paraphrase or direct quotation, the published or unpublished work of another person as one's own in any academic exercise or activity without full and clear acknowledgment. It also includes the unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic materials." The penalties for plagiarism are severe. They include warning or reprimand, grade adjustment, probation, suspension, expulsion, withholding of transcripts, denial or revocation of degrees, and referral to psychological counseling.

This course adheres to the cheating policy for courses in the Department of Computer Science.

The sanction for cheating is zero (F) in the course.

Students with Disabilities

USU welcomes students with disabilities. If you have, or suspect you may have, a physical, mental health, or learning disability that may require accommodations in this course, please contact the Disability Resource Center (DRC) as early in the semester as possible (University Inn # 101, 435-797-2444, drc@usu.edu). All disability-related accommodations must be approved by the DRC. Once approved, the DRC will coordinate with faculty to provide accommodations.

Sexual Harassment

Utah State University is committed to creating and maintaining an environment free from acts of sexual misconduct and discrimination and to fostering respect and dignity for all members of the USU community. Title IX and USU Policy 339 address sexual harassment in the workplace and academic setting.

The university responds promptly upon learning of any form of possible discrimination or sexual misconduct. Any individual may contact USU's Affirmative Action/Equal Opportunity (AA/EO) Office for available options and resources or clarification. The university has established a complaint procedure to handle all types of discrimination complaints, including sexual harassment (USU Policy 305), and has designated the AA/EO Director/Title IX Coordinator as the official responsible for receiving and investigating complaints of sexual harassment.

Grievance Process

Students who feel they have been unfairly treated [in matters other than discipline, admission, residency, employment, traffic, and parking - which are addressed by procedures separate and independent from the Student Code] may file a grievance through the channels and procedures described in the Student Code: Article VII Grievances.

Students with Disabilities

USU welcomes students with disabilities. If you have, or suspect you may have, a physical, mental health, or learning disability that may require accommodations in this course, please contact the Disability Resource Center (DRC) as early in the semester as possible (University Inn # 101, 435-797-2444, drc@usu.edu). All disability-related accommodations must be approved by the DRC. Once approved, the DRC will coordinate with faculty to provide accommodations.

Assumption of Risk

All classes, programs, and extracurricular activities within the University involve some risk, and some involve travel. The University provides opportunities to participate in these programs on a voluntary basis. Therefore, students should not participate in them if they do not care to assume the risks. Students can ask the respective program leaders/sponsors about the possible risks a program may generate, and if students are not willing to assume the risks, they should not select that program. By voluntarily participating in classes, programs, and extracurricular activities, students do so at their own risk. General information about University Risk Management policies, insurance coverage, vehicle use policies, and risk management forms can be found at http://www.usu.edu/riskmgt/.

Mental Health

Mental health is critically important for the success of USU students. As a student, you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce your ability to participate in daily activities. Utah State University provides free services for students to assist them with addressing these and other concerns. You can learn more about the broad range of confidential mental health services available on campus at Counseling and Psychological Services (CAPS).

Students are also encouraged to download the "SafeUT App" to their smartphones. The SafeUT application is a 24/7 statewide crisis text and tip service that provides real-time crisis intervention to students through texting and a confidential tip program that can help anyone with emotional crises, bullying, relationship problems, mental health, or suicide related issues.