CSPB 3104 - Park - Algorithms

CSPB 3104 Algorithms Syllabus

4 Credits, Spring 2024

Instructor Information

Name: Chanheum Park (he/him)
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My office hours are

- Tuesday 10:00 - 11:00 AM (M.T.)
- Thursday 5:00 - 6:00 PM (M.T.)

Course Information

This course covers the fundamentals of algorithms and various algorithmic strategies. Topics include time and space complexity, sorting algorithms, recurrence relations, divide and conquer algorithms, greedy algorithms, dynamic programming, linear programming, graph algorithms, problems in P and NP, and approximation algorithms.

Learning Goals

By the end of this course, you will learn a set of "standard" or canonical algorithms for computational problem solving. For each of these algorithms, you should be able to

- Understand its basic properties,
- Prove these properties mathematically,
- Prove rigorous time and space complexity bounds on its performance, and
- Understand the relative merits or demerits of each algorithm, in practice.

You will also learn how to adapt and combine algorithms creatively to solve problems. Given a problem, you should be able to identify its key subproblems and know which standard algorithms you can use to solve those subproblems. You will also learn key tricks (motifs) underlying the design of new algorithms.

Textbook and Materials

We will primarily use the textbook by Cormen, Leiserson, Rivest and Stein (CLRS):

Introduction to Algorithms (3rd ed.),
Cormen, Thomas H.; Leiserson, Charles E., Rivest, Ronald L., Stein, Clifford (2009) [1990]
MIT Press and McGraw-Hill. ISBN 0-262-03384-4.

(Available from CU Bookstore or online booksellers).

Supplemental Textbook: A recent book by Bhargava offers highly accessible introductions to many of the topics covered in class. This book can be a great guide to some students in the class.

Grokking Algorithms: An illustrated guide for programmers and other curious people,
Aditya Y. Bhargava.
Manning Publishers. ISBN 978161729223.

Course Work

Each week you will be expected to watch the lecture videos and read the assigned passages in the book. There is an associated quiz and problem set based on this material that must be completed by the following Thursday. Besides the weekly assignments there are three longer programming projects and a total of five tests.

Homework (40% of the grade)

Weekly homework consists of an online quiz and a problem set.
The quizzes test your comprehension of the material and are multiple-choice or fill-in the blank. Multiple attempts are allowed.
The problem sets consist of longer theoretical problems, tutorials, or short programming assignments that need to be solved. We use Jupyter notebooks for the problem sets. If you need to include images with your notebook file, you may submit a zip file.

All assignments must be submitted by the indicated deadline: no exceptions. However, we will drop the lowest problem set score.

Homework is due on Thursday of the week following the topic, and quizzes close the Monday of the week following the topic.
For example, the quiz and homework for topics from week 1 are due Monday and Thursday of week 2 respectively, etc. at midnight.

Exams (45% of the grade)

We will have 4 "spot exams" spread through the semester and a final exam at the end. Each exam along with a list of covered topics will be announced at least 1 week in advance. Please take note of the dates now. The four spot exams combined will be worth 20% of the grade and the final exam will be worth 25% of the total grade.

The spot exams will be on Tuesdays, February 6, February 27, April 2, April 23.

The final will be on Tuesday May 7th

Programming Projects (10% of the grade)

We will assign three programming projects that will involve writing simple algorithms and implementing them for a mathematical problem.

Class Participation (5% of the grade)

Students are expected to contribute to discussion via the Piazza discussion forum or by attending office hours at least once every week. This can include sharing interesting outside resources, helping fellow students with conceptual difficulties, or getting clarification on the material.

Exam Dates

The spot exams will be on Tuesdays, February 6, February 27, April 2, April 23.

The final will be on Tuesday May 7th

Topics Covered

We will cover the following topics:

- Introduction to Algorithms: Complexity analysis.
- Divide and Conquer Algorithms.
- Sorting and Order Statistics.
- Advanced Data Structures: heaps, balanced trees and hash-functions.
- Dynamic Programming.
- Greedy Algorithms.
- Graph Algorithms: Search, Minimum Spanning Trees, Shortest Paths, Network Flows.
- Introduction to Linear and Integer Programming.
- Basics of Computational Complexity: P, NP, reductions and open problems.

Course Calendar (subject to change)

Week 0
- Get acquainted with Moodle, test deadlines, and course expectations
- Read the syllabus
- Take the syllabus quiz

Week 1

- Read Chapter 1, 2, & 3
- Video Lectures
- Online Quiz on Introduction to Algorithms
- Problem Set on Introduction to Algorithms

Week 2

- Read Chapter 4.1 - 4.5
- Video Lectures
- Online Quiz on Divide and Conquer Algorithms
- Problem Set on Divide and Conquer Algorithms
- Supplemental Material: Proof of Master Theorem 4.4

Week 3

- Read Chapter 5, 6.1- 6.5, and 7
- Video Lectures
- Online Quiz on Partitioning
- Problem Set on Partitioning
- Programming Project 1

Week 4

- Read Chapter 81., 9.1-9.3, & 12
- Video Lectures
- Online Quiz on Quicksort and Quick Select
- Problem Set on Quicksort and Quick Select
- Exam # 1 covering material up to week 2

Week 5

- Read Chapter 13.1-13.4, 14.1-14.2, and 11.1-11.3
- Video Lectures
- Online Quiz on Red-Black Trees and Augmented Data Structures
- Problem Set on Red-Black Trees and Augmented Data Structures
- Supplemental Material: Treaps

Week 6

- Read Chapter 15
- Video Lectures
- Online Quiz on Dynamic programming
- Problem Set on Dynamic programming (You have two weeks to complete this assignment)

Exam 2 Study Week

- Spot Exam #2 covering material from weeks 2-5

Week 7

- Read Chapter 16
- Video Lectures
- Online Quiz on Greedy Algorithms
- Programming Project 1 (Due)
- Programming Project # 2 Posted.

Week 8

- Read Chapter 22.1, 22.2, 22.3, 22.4
- Video Lectures
- Online Quiz on Graph Basic Algorithms, DFS, BFS and Topological Sorting
- Problem Set on Graph Basic Algorithms, DFS, BFS and Topological Sorting

Exam 3 Study Week

- Study

Week 9

- Read Chapter 22.5 & 23
- Video Lectures
- Online Quiz on Strongly Connected Components and Spanning Trees

- Problem Set on Strongly Connected Components and Spanning Trees
- Exam #3 Covering material from weeks 6-8

Week 10
- Read Chapters 24, 25.1, 25.2
- Video Lectures
- Online Quiz on Shortest Path Algorithms
- Problem Set on Shortest Path Algorithms
- Programming Project 2 (Due)
- Programming Project 3 (Posted)

Fall Break

- Have fun!

Week 11
- Read Chapters 29.1-29.3 and 34.1-34.5
- Video Lectures
- Online Quiz on linear programming and NP Completeness
- Problem Set on linear programming and NP Completeness

Exam 4 Study Week
- Exam # 4: Material from weeks 9 and 10

Week 12
- Advanced Topic: Quantum Algorithms
- Video Lectures
- Revision of Concepts to prepare for final
- Programming Project 3 (Due)

Finals Week
- The final exam will take place on Tuesday, December 19th.

Grading Scale

93%-100%	A
90%-93%	A-
87%-90%	B+
83%-87%	B
80%-83%	B-
77%-80%	C+
73%-77%	C
70%-73%	C-
67%-70%	D+
63%-67%	D
60%-63%	D-
0%-59.9%	F

Individual Check-In

If you have a unique situation that may be affecting your work or class experience -or-

you need clarification of an email, Piazza, or ZOOM exchange, please email your instructor with the subject line "Individual Check-In". Your instructor will email you back to set up a Zoom call to discuss the specific situation and work with you to develop a solution and/or strategy to move forward.

Service Interruptions and Support

Due to the online nature of the program, there is always the possibility of service interruptions. If you are unable to access the course materials (Moodle, Piazza, etc), we encourage you to visit https://www.isitdownrightnow.com/applied.cs.colorado.edu.html.

For non-urgent issues relating to platform support, please contact cscihelp@colorado.edu.

For urgent issues, for example, attempting to upload a homework assignment near a deadline, email your instructor directly.

In cases of documented exceptional illness or circumstances affecting assignments, instructors may or may not offer an alternative assessment (which may differ in form or content) at the instructor's discretion. Please consult the campus policy for medical leave if needed.

Collaboration Policy

We welcome collaboration! Sharing insights, asking questions, learning by doing, and learning by helping others are essential skills in learning computer science.

Collaboration is discussing ideas of the course with others, sharing insights and extra resources, working through similar questions to an assignment, sharing resources, and helping others. The Piazza forum in your class is an ideal place to share ideas, lead a discussion or be the hero that asks the "dumb question" everyone else is afraid to ask. And Piazza is often a source for content for instructors to include in letters of recommendations. Your leadership, courage, and determination will not go unnoticed.

Collaboration is not:

- "Having a partner." In particular, Group Projects, or projects that specify "working with a partner" will have individual guidelines.

- One student solving problems 1-4, and another solving 6-10.

- An identical group solution submitted by multiple students.

Unless specified in the assignment, all submitted coursework is individual.

In general:

- You must document resources and collaboration on any assignment. This should be in the form of comments at the start of code and/or within solution notes.

- Cite Your Sources: If you collaborated with someone on an assignment, or if your submission includes quotes from a book, a paper, or a web site, you must clearly acknowledge the source.

- Plagiarism is forbidden. Copying answers directly or indirectly from solution manuals, web pages, or your peers is a violation of honor code. The assignments and code that you turn in should be written entirely on your own.

- Copying/soliciting a solution to a problem from the internet or another classmate constitutes a violation of the course's collaboration policy and the honor code and may have serious consequences.

- You may not actively search for a solution to the problem from the internet. This includes posting to sources like StackOverflow, Reddit, Chegg, CourseHero, etc.

- StackExchange Clarification: Searching for basic techniques in Python/C++ is totally fine.

- If you have taken this course prior to this semester and have done some/all of homeworks previous code or previous homework solutions may not be reused. You must start each homework from scratch.

- When in doubt, ask. If something doesn't seem right - you are not sure if you can use a resource or if you are feeling pressure to share a specific solution - please reach out to your instructor.

- Note: Other information on the Honor Code can be found at www.colorado.edu/policies/honor.html and https://www.colorado.edu/sccr/honor-code.

Final Projects

We understand students taking multiple courses may have more than one Final Project due at the end of the semester.

To give students flexibility in preparing and submitting their projects:

- All CSPB Final Projects are due by the established deadline, but may be turned in at any point during the Submission Window.

- Final Projects will be available three weeks or more before the final day of classes.

Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy.

For more information, see the classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Requirements for Infectious Diseases

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all public health orders to reduce the risk of spreading infectious diseases.

The CU Boulder campus is currently mask optional. However, if masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class. Students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct & Conflict Resolution. Students who require accommodation because a disability prevents them from fulfilling safety measures related to infectious disease will be asked to follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

For those who feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the further guidance of the Public Health Office. For those who have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

Disability Services determines accommodations based on documented disabilities in the academic environment. If you qualify for accommodations because of a disability, submit your accommodation letter from Disability Services to your faculty member in a timely manner so your needs can be addressed. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance.

If you have a temporary medical condition or required medical isolation for which you require accommodation or if you do face any illness which is affecting your class performance, please let me know by email ASAP. Also see Temporary Medical Conditions on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: honor@colorado.edu, 303-492-5550. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our

community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, **reporting options**, and support resources can be found on the **OIEC website**.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive an outreach from OIEC about their options for addressing a concern and the support resources available. To learn more about reporting and support resources for a variety of issues, visit **Don't Ignore It**.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please let me know via email at least 1 week beforehand to resolve the schedule conflict.

See the **campus policy regarding religious observances** for full details.

Mental Health and Wellness

Free and unlimited telehealth is available through **Academic Live Care**. Please note that at this time this service is not available to students outside of the United States.

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