CPSC 462: Analysis of Algorithms

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Office: Trexler 365B
Office Hours (in-person/zoom) : MWF 11:30 - 1:00 PM, or by appointment
Zoom : https://roanoke-edu.zoom.us/j/89319677413
Class : TTh 2:50-4:20PM, Trexler 166

Course Description

This course is a continuation of the study of the design and analysis algorithms we began in CPSC 250. It covers more advanced algorithm design paradigms and data structures; it also includes techniques for proving the correctness of algorithms.

Required Materials

- Introduction to Algorithms, 3rd Edition, by Cormen, Leiserson, Rivest and Stein, McGraw Hill.

Course Objectives

Successful students will be able to:

- analyze and design algorithms for typical problems,

- prove the correctness of algorithms,

- analyze the efficiency of algorithms, and

- design algorithms using foundational paradigms.

Course Structure

The concepts studied in class will be complemented by written and programming assignments. The programming assignments will be turned in as C++ source files or Jypyter notebooks. For

each programming assignment I will specify which language you should use. Your C++ assignments should compile on the lab computers using the C++17 standard version. Your jupyter notebooks should run on the latest version of Anaconda.

In case of scheduling conflicts, make-up tests will be available by **pre-arrangement only**. Make-ups will also be available in case of documented medical emergencies.

There will also be quizzes given throughout the semester. Always come to class with a sheet of paper and a pen.

This course expects you to spend at least 12 hours of work each week inside and outside of class.

Homework: On all assignments, your name must be written clearly as it **appears on Inquire**. Your homework must be neat and legible, you will **lose points** for submitting rough work.

Co-curricular Requirement: The Mathematics, Computer Science and Physics department offers a series of discussions that appeal to a broad range of interests related to these fields of study. These co-curricular sessions will engage the community to think about ongoing research, novel applications and other issues that face these disciplines. Each student is required to attend **at least two** of these sessions, and turn in (**physically or via email**) a short paper describing the contents of the session, and your critical reflections about the topic and content. **These papers are due in class (or via email) within a week of the session**. A paper submitted beyond a week from the event being discussed in the paper will NOT be accepted. The MCSP Conversation Series website has the schedule of talks in the series.

Grading Policy

The final grade will be computed based on the grades in the quizzes, tests, the final exam, home works and programming projects according to the following weights:

- **1%**: Co-curricular **9%**: Quiz **30%**: Homework • **30%**: Midterm exam **30%**: Final

  exam

The final course grade will be calculated as follows:
- **> 92%**: A   **90-92%**: A-   **86-89%**: B+   **83-85%**: B   **80-82%**: B-   **76-79%**: C+
- **73-75%**: C   **70-72%**: C-   **66-69%**: D+   **63-65%**: D   **60-62%**: D-   **< 60%**: F

All grades will be posted on Inquire. These grades are not weighted, pay no attention to the total graded on Inquire. The grades on Inquire are for record purposes only.

Course Policies

During Class

If you use an electronic device such as a tablet or a laptop for note-taking or to read the textbook, the content that is open on the screen should be strictly restricted to documents and pages of relevance to the class. For example, you should not have any social media websites open in your browser window, even if it is in a tab that is not currently in focus.

I encourage you to take hand written notes as you may be allowed to use them during pop quizzes.

Phones are prohibited as they are rarely useful for anything in the course. Eating and drinking are allowed in class but please refrain from it affecting the course. Try not to eat your lunch in class as the classes are typically active.

Attendance Policy

Regular attendance in class is highly recommended. Regardless of attendance, students are responsible for all material covered or assigned in class.

Inquire Announcements

I will regularly communicate to the entire class via Inquire announcements. You are responsible for reading these emails.

Policies on Incomplete Grades and Late Assignments

Late assignments will be accepted for no penalty if a valid excuse is communicated to the instructor before the deadline. Otherwise, you will receive no credit.

Academic Integrity and Honesty

Students are expected to adhere to the Academic Integrity policies of Roanoke College. All work submitted for a grade is to be strictly the work of the student unless otherwise specified by the instructor. The policies as outlined in the Academic Integrity handbook will be enforced in the course.

Graded programs are subject to the Roanoke College Academic Integrity policies. Copying a program or a portion of a program (even a single line) or reading another person's program to obtain ideas for solving a problem is plagiarism. Other examples of integrity violation include writing code for someone else, using code written by someone else, telling someone else how to solve a problem or having someone tell you how to solve a problem (and using his/her method). These cases apply to any work that is handed in for a grade under the instructor's assumption that the work is your own. Unless specified otherwise by the instructor, discussion among students should be limited to general discussion of concepts and language details, not specific aspects of a solution to the assigned problem

You will receive no points for turning in work that you can't competently defend.

Face Covering

The College has issued a mask mandate for the start of the semester that requires masks to be worn in indoor common spaces such as our classroom. You must wear a mask in this class. If you arrive without a mask, you will not be allowed to stay and may lose credit for attendance or in-class work. The Bookstore sells masks if you need to make a quick purchase. If the mandate is extended, you will be required to continue to wear a mask.

Absence for Health Reasons

If you have a temperature of 100.4 or higher or other COVID symptoms, don't come to class.
Call Health Services IMMEDIATELY. Do not come to class or go to any public area on campus. In order for your absence to be excused, you must give Health Services permission to notify me that you have consulted them about COVID symptoms. If Health Services informs you that you should isolate and not attend class for multiple days, inform me so that we can make a plan to keep you current in the course. All absences caused by consultation with Health Services about coronavirus symptoms or isolation ordered by Health Services will be excused but you will need to do the work and graded assignments even if we extend a deadline for you.

Subject Tutoring

Subject Tutoring, located on the lower level of Fintel Library (Room 5), is open 4 pm – 9 pm, Sunday – Thursday. We are a Level II Internationally Certified Training Center through the College Reading and Learning Association (CRLA). Subject Tutors are friendly, highly-trained Roanoke College students who offer free, one-on-one tutorials in a variety of general education and major courses such as: Business, Economics, Mathematics, INQ 240, Modern Languages, Lab Sciences, INQ 250, and Social Sciences (see all available subjects at www.roanoke.edu/tutoring). Tutoring sessions are available in-person or online in 30 or 60-minute appointments (please specify if you prefer to meet with a tutor online or in-person when you make your appointment). All in-person appointments will maintain at least 6 feet of physical distance, desks will be cleaned between appointments, and masks must be worn in all indoor, public spaces. In the event that all classes go online this semester, Subject Tutoring will remain available online, too. Schedule an appointment at www.roanoke.edu/tutoring or contact us at 540-375-2590 or subject_tutoring@roanoke.edu. We hope to see you soon!

Writing Center

The Writing Center @ Roanoke College, located on the Lower Level of Fintel Library, offers tutorials focused on writing projects and oral presentations for students working in any field. Writers and presenters at all levels of competence may consult the Writing Center at any point in their process— including brainstorming, drafting, organizing, editing, or polishing presentation skills—to talk with trained peer tutors in informal, one-on- one sessions. Schedule a virtual or in-person appointment by going to www.roanoke.edu/ writingcenter, where our staff members and workshops are also posted. If it becomes necessary to temporarily discontinue face-to-face services at any time, online tutorials will still be available. Questions? Email writingcenter@roanoke.edu or call 375-4949.

Disability Support Services

The Office of Disability Support Services, located in the Goode-Pasfield Center for Learning and Teaching in Fintel Library, provides reasonable accommodations to students with identified disabilities. Reasonable accommodations are provided based on the diagnosed disability and the recommendations of the professional evaluator. In order to be considered for disability services, students must identify themselves to the Office of Disability Support Services. Students requesting accommodations are required to provide specific current documentation of their disabilities. Please contact Rick Robers, M.A., Coordinator of Disability Support Services, at 540-375-2247 or e-mail robers@roanoke.edu. If you are on record with the College's Office of Disability Support Services as having academic or physical needs requiring accommodations, please schedule an appointment with Mr. Robers as soon as possible. You need to discuss your accommodations with him before they can be implemented. Also, please note that arrangements for extended time on exams, testing, and quizzes in a distraction-reduced environment must be made at least one week before every exam.

Topics

Mathematical Background

- Asymptotic notation notation

- Divide and Conquer Algorithms

- Solving Recurrence Relations

Sorting in Linear Time

- Lower bounds for sorting

- Counting sort

- Radix sort

- Bucket sort

Probabilistic Analysis and Randomized Algorithms

- Balls and Bins

- The Birthday Paradox

- Analysis of Quicksort

- Analysis of Selection in Expected Linear Time

- Selection in worst-case linear time

- Randomly built binary search trees

- Matrix Multiplication Verification

Hashing

- Universal Hashing

- Perfect hashing

Data Structures for Disjoint Sets

- Disjoint-set operations

- Linked-list representation of disjoint sets

- Disjoint-set forest

Elementary Graph Algorithms

- Representations of graphs

- Breadth-first search

- Depth-first search

- Topological sort

- Strongly connected components

Dynamic Programming

- Matrix-chain multiplication

- Elements of dynamic programming

- Longest common subsequence

- Optimal binary search trees

Greedy Algorithms

- Greedy Algorithms

- An activity-selection problem

- Elements of the greedy strategy

- Huffman codes

Amortized Analysis

- Aggregate analysis

- The accounting method

- The potential method

- Dynamic tables

Graph Algorithms

- The Bellman-Ford algorithm

- Single-source shortest paths in directed acyclic graphs

- Dijkstra's algorithm

- Difference constraints and shortest paths

- All-Pairs Shortest Paths

- Shortest paths and matrix multiplication

- The Floyd-Warshall algorithm

- Johnson's algorithm for sparse graphs

NP-Completeness

- NP-Completeness

- Polynomial time

- Polynomial-time verification

- NP-completeness and reducibility

- NP-complete problems

Approximation Algorithms

- The vertex-cover problem

- The traveling-salesman problem

- The set-covering problem

Midterm: Thursday, March 3rd, 02:20-03:20

Final: Friday, April, 29th, 02:00-05:00