CPSC 250: Data Structures and Algorithms

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Office: Trexler 365B
Office Hours (in-person/zoom) : MWTF 12:00 - 1:00 PM, or by appointment
Zoom : https://roanoke-edu.zoom.us/j/84884111790?pwd=Oc7DnsoyhflA3rwhRKeVHWCeuJGNzo.1
Class : MWF 01:10-02:10PM, Trexler 363
Lab : Th 2:50-5:50PM, Trexler 363

Course Description

In this course we will study data structures and algorithms that use and operate on these data structures. We will learn how to prove the correctness and determine the efficiency of various algorithms. C++ will be our main programming language.

Optional Materials

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

Prerequisites

CPSC 170, or permission of the instructor. Familiarity with Unix is assumed.

Course Objectives

Successful students will be able to:

1. design, implement, and test algorithms in C++,
2. analyze the efficiency of various data structures and algorithms,
3. informally prove the correctness and efficiency of various data structures and algorithms, and
4. evaluate the practical implications of different implementations of data structures and algorithms.

Course Structure

We will meet for 3 hours of class time during the week, along with a 3-hour laboratory period. The concepts covered in class will be reinforced through programming and laboratory assignments. In class, our focus will be on theory, while in the lab, we will emphasize implementation in C++. There will be a midterm and a final exam during the semester.

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

In addition to the exams, you will have homework assignments, short weekly programming projects, and a co-curricular requirement.

This course requires a commitment of at least 12 hours of work per week, including both in-class and out-of-class activities.

Homework: Your name must be clearly written on all assignments exactly as it **appears on Inquire**. Homework must be neat and legible; **points will be deducted** for rough or messy work.

Programming Assignments: There will be weekly programming assignments given during the semester. Programs will be graded on correctness, style, and documentation. All programs must be submitted electronically; instructions for submission will be provided in the assignment handout. **No late work (programs, homework, quizzes, etc.) will be accepted**.

Oral Examinations: Some assignments will include an oral examination component. We will schedule a meeting where you will explain the reasoning behind your answers. These exams can impact your grade on the corresponding assignment: performing well can improve your grade, while performing poorly may lower it. The examination will last approximately five minutes.

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 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:

- **Extra Credit**: Co-curricular **30%**: Programming Assignments **30%**: Homework
- **20%**: Midterm exam **20%**: 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 displayed on your screen should be strictly limited to documents and pages relevant to the class. For instance, you should not have any social media websites open in your browser, even if they are in a background tab.

I strongly encourage you to take thorough notes during class, as this will help reinforce your understanding of the material. All class notes will be posted on Inquire after each session for your reference.

Phones are prohibited as they are rarely useful for anything in the course. Eating and drinking are allowed in class, but please ensure it does not disrupt the course.

Attendance Policy

Regular attendance in class is 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. 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.

AI Policy

Students are encouraged to leverage AI tools, such as code assistants and language models, as supplementary resources for learning. However, their use must adhere to the following guidelines:

1. **Understanding Over Reliance**: AI tools should be used to aid in understanding concepts, not as a substitute for learning. Students are expected to fully grasp any code or solutions generated by AI tools. Submitting AI-generated content without understanding it is considered academic dishonesty.

2. **Attribution**: Any work that involves AI assistance must be properly attributed. If an AI tool is used to generate or refine code, or to help with problem-solving, students must indicate this in their submission. For example, include a comment in the code or a note in the assignment specifying the tool used and how it was applied.

3. **Original Work**: Assignments, including programming projects, problem sets, and written work, must reflect the student's own effort and understanding. AI tools may be used for brainstorming and debugging, but the final submission should be the student's original work. Copying solutions directly from AI tools without modification is prohibited.

4. **Instructor's Discretion**: The instructor reserves the right to specify when AI tools are not permitted, such as for particular assignments or projects. These instances will be clearly communicated in advance.

Failure to adhere to this AI policy will be considered a violation of academic integrity and may result in disciplinary action.

Subject Tutoring

Subject Tutoring at Roanoke College provides free peer tutoring for current students in over 100 courses! Students can schedule tutoring appointments through the Navigate Student app (first-

time users should select Roanoke College, login with their RC username & password, and create a profile). Walk-ins are also welcome! We are located on the ground floor of Fintel Library (Room 05). Subject Tutoring is open from 4 to 9 p.m. Sunday-Thursday each Fall & Spring semester. You can contact us via email at subject_tutoring@roanoke.edu or by phone at 540-375-2590 or 540-375-2247.

Writing Center

Roanoke College's Writing Center can assist current students with any writing or presentation project, at any stage of the creative process. Are you having trouble starting a project? Do you have questions about your thesis, argument, organization, citations, grammar, or any part of your paper? Perhaps your assignment is essentially ready to turn in, but you would like someone to look over it with you? The Writing Center can help! Students can schedule appointments through the Navigate Student app (first-time users should select Roanoke College, login with their RC username & password, and create a profile). Walk-ins are also welcome! We are located on the lower level of Fintel Library (Room 15). The Dr. Sandee McGlaun Writing Center is open from 4 to 9 p.m. Sunday through Thursday during the Fall and Spring semesters. You can also contact us via email at writingcenter@roanoke.edu or by phone at 540-375-4949 or 540-375-2247.

Accessible Education Services

Accessible Education Services (AES) is located in the Goode-Pasfield Center for Learning and Teaching in Fintel Library. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Dustin Persinger, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Dustin Persinger at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester. This course expects you to spend at least 12 hours of work each week inside and outside of class.

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!

Schedule

Week 1-2 Introduction and Motivation

- Mathematical Background
- Standard Notations and Common Functions: Floors, Ceilings, Polynomials, Exponentials, Logs, Laws of Indices, Summations
- Correctness of Algorithms
- Asymptotic Notation and Complexity of Algorithms (best/worst case analysis)
- Insertion Sort
- Lab: Sorting

Week 3-4 Divide and Conquer Algorithms

- Recursive algorithms.
- Recurrence relations, Recursive Definition of Functions
- Mergesort, Maximum Subarray Sum
- Lab: Experimental verification of time complexity, Maximum Subarray

Week 5 Heaps

- Heaps
- Heapsort
- Priority Queues
- Lab: Heap and Heap sort

Week 6 Linked lists, Stacks, and Queues

- Doubly Linked Lists
- Implementing Stacks and Queues with Lists
- Applications of Stacks: Matching Parenthesis, Evaluating Infix
- Lab: Evaluating Infix Using Stacks

Midterm
Written Exam: 02:20-03:20, Monday, October 7
Oral Exam: 02:20-03:20, Thursday, October 10

Week 7 Brute Force Backtracking

- Generating Permutations and Subsets with Backtracking
- Subset Sum Problem
- n-queens Problem
- Lab: n-queens Problem

Week 8 Randomized Algorithms

- Expected Runtimes
- Random Variables, Expectations
- Random Permutations
- Lab: Random Derangements

Week 9 Quicksort, Medians and Order Statistics

- Quicksort Correctness and Complexity
- Medians and Order Statistics
- Lab: Quicksort

Week 10 Hash Table

- Direct-address tables
- Hash functions
- Open addressing
- Lab: Hash Table

Week 11 Binary Search Trees

- Insertion and Deletion
- Red-Black Tree Properties
- Red-Black Tree Rotation
- Lab: Red-Black Tree group project (Interface)
- Red-Black Tree Insertions
- Red-Black Trees Deletion
- Lab: Red-Black Tree group project (Implementation)

Week 12-13 Dynamic Programming

- Optimal Substructure
- Rod Cutting
- Matrix-chain Multiplication
- Longest Common Subsequence
- Lab: Rod cutting

Final: Wednesday, December, 11, 02:00-05:00