CPSC 250: Data Structures and Algorithms

Adewale Sekoni

Fall, 2020

E-mail: sekoni@roanoke.edu
Office Hours: MWF 12:00-1:30pm, or by appointment
Office: Trexler 365B
Lab Room: Trexler 363
Class Hours: MWF 10:50-11:50pm
Class Room: Trexler 363
Lab Hours: T 3-6pm

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 efficiency of various algorithms. C++ will be our main programming language.

Required 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 the 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 in class for 3 hours during the week, and there will be a 3 hour laboratory period. The class will be split in two groups (group A & B). The groups will alternate in attending classes in person and via Zoom, the labs will be split into two sections. Group A will meet from 3:00 to 4:25, Group B will meet from 4:35 to 6:00. The concepts studied in class will be complemented by programming and laboratory assignments. In class, we will focus on theory, while the lab will focus on implementation in C++. There will be a midterm and a final exam during the semester. 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.

Besides the exams, there will be homework assignments, short programming projects, and a co-curricular requirement.

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.

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

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 three** 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 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:

- **3%**: Co-curricular **27%**: 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 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

Face coverings/masks must be worn over the mouth and nose by all students and instructors in classrooms and hallways of academic buildings. By wearing face coverings, we protect our college community and its most vulnerable members. Students who come to class without a face mask that is being worn properly will be asked to leave and will be readmitted only after they are wearing one.

Absence for Health Reasons

If you have a temperature of 100.4 or higher or other coronavirus symptoms, don't come to class. Call Health Services IMMEDIATELY. Do not come to class or go to any public area on campus. Do keep up with all readings, assignments, and deadlines. In order for your absence to be excused, you must give Health Services permission to notify me that you have consulted them about coronavirus symptoms. If Health Services informs you that you should isolate and not attend class for multiple days or weeks, 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.

Going Fully Online

If the college is forced to suspend in-person attendance as was done during Spring Semester 2020, this class will continue to meet via Zoom at our regular time. I will distribute an amended syllabus. I will email the class that plan. You will need internet connectivity. If you have technology challenges, I need you to email me as soon as the decision is made to go remote so that we can discuss how you can keep up. I will continue to have office hours at my regular times via Zoom.

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.

Schedule

Week 1 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: Insertion Sort

Week 2 Divide and Conquer Algorithms

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

Week 3 Heaps

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

Week 4 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

Week 5 Brute Force Backtracking

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

Midterm: 9:50-10:50, Monday, September 28

Week 6 Randomized Algorithms

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

Week 7 Quicksort, Medians and Order Statistics

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

Week 8 Hash Table

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

Week 9 Binary Search Trees

- Insertion and Deletion
- Red-Black Tree Properties

- Red-Black Tree Rotation
- Lab: Red-Black Tree group project (Interface)

Week 10 Binary Search Trees

- Red-Black Tree Insertions
- Red-Black Trees Deletion
- Lab: Red-Black Tree group project (Implementation)

Week 11 Graphs

- Graph representations
- Breadth first search
- Depth first search
- Lab: Directed graph

Week 12-13 Dynamic Programming

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

Final: Friday, November, 20 08:00-9:50 (Group A), 10:00-11:50 (Group B)