CS 5008 Data Structures, Algorithms & Their Applications in Computer Systems

Graduate Course, Khoury College of Computer Sciences
Northeastern University, Spring 2025
Maryam Farahmand

Class Time	Tue 9-12:30 pm, 1045 SV Campus
Course Corequisite:	CS 5009 Recitations, Thursdays 9-10:30 am, 11-12:30 pm, 1012 SV Campus
Instructor:	Dr. Maryam Farahmand (m.farahmandasil@northeastern.edu)
Office Hours	On the Course Canvas Home page
Teaching Assistants	On the Course Canvas Home page
Textbook (Optional):	1. "Grokking Algorithms" (1st Edition) by Aditya Bhargava, Free, Online, Orelly 2. "Dive Into Systems" by Matthews, Newhall, and Webb 3. "C Programming Language" (2nd Edition) by Kernighan and Ritchie (Free ebook)
Course Material:	On the Course Canvas Home page

Note: CS 5008 requires at least 20 hours of work per week as a graduate course!

Additional Course Information

HOMEWORK POLICIES:

- Homework will be assigned weekly.
- Homework due dates: Next Friday at Midnight.
- Lab assignments due date: Friday Midnight.
- All homework assignments should be submitted in Gradescope.
- Late assignments will not be accepted, so please plan ahead!
- No make-up for missed homework; one lowest homework and one lowest lab grade will be dropped.

EXAM POLICIES:

- Two Midterm exams (on Tuesdays Feb 11 and March 18)
- Final exam (on April 22).

COURSE ASSESSMENT:

- Homework: 30% (about 10 sets of Homework)
- Lab assignments: 15% (about 10 Lab assignments)
- Quiz: 5% (about 5 quizzes)
- Exams: 30% (3 exams, 10% each)
- Mock interview: 10%
- Final Project:10%

GRADE CALCULATIONS:

We will use the following scale to convert numerical scores into letter grades:

A	93.00% – 100.00%
A-	90.00% – 92.99%
B+	87.00% – 89.99%
B	83.00% – 86.99%
B-	80.00% – 82.99%
C+	77.00% – 79.99%
C	73.00% – 76.99%
C-	70.00% – 72.99%
F	Less than 69.99%

ATTENDANCE POLICIES:

Students are expected to attend classes regularly, take tests, and submit assignments and other work at the times specified by the instructor. Students who are repeatedly missing assignments will be evaluated by the faculty responsible for the course to ascertain their ability to achieve the course objectives and continue. Instructors may include marks for the quality and quantity of the student's participation in class as part of the semester's grades.

REASONABLE ACCOMMODATIONS :

One goal of instructors is that every student should be able to participate in this course. If you require any special accommodations, please let me know so we can make appropriate arrangements.

STUDENTS WITH DISABILITIES:

Students with disabilities who wish to receive academic services and/or accommodations should visit the Disability Resource Center or call (844) 688-6287.

If you have already done so, please provide your letter from the DRC to the instructor early in the semester to arrange those accommodations.

Course Discerption & Objectives

This course presents an integrated approach to studying data structures, algorithms, and their applications within computer systems. We introduce various systems-related topics (models of computation, computer architecture, compilation, system software) and fundamental techniques for solving algorithms (divide-and-conquer, dynamic programming, graph algorithms) as they apply to computer systems. The integration of topics is demonstrated by implementing fundamental data structures (lists, queues, trees, maps, graphs) in the C programming language. Additional breadth topics can include programming applications that expose students to primitives of different subsystems, such as multi-threading or sockets.

By the end of this course, you should be able to:

1. Implement common data structures (lists, stacks, queues, trees, maps, graphs) and explain the implications of data structure choice on program efficiency
2. Analyze the computation and storage complexity of algorithms by employing the substitution method, the Master method, and recursion trees.
3. Explain the designs of, and tradeoffs between, different algorithmic approaches to a problem (e.g., searching, sorting, scheduling)
4. Explain proofs related to algorithm correctness and write a simple proof using loop invariants.
5. Implement programs using the C language.
6. Explain the basic terminology of computing systems, various models of computation (e.g., sequential, multithreaded, parallel), and the role of the operating system as a resource manager for executing processes.
7. Analyze assembly code and its relationship to C code, the fetch/execute cycle, and basic system architecture.
8. Explain the basic terminology and architecture of networks and implement basic programs that include socket programming.
9. Gain experience with common systems programs, including compilers, linkers, and debuggers.
10. Explain how to choose appropriate data structures and algorithms based on problem definition, input data size, and performance characteristics of underlying computer systems.

General Policies

ACADEMIC INTEGRITY

- This class has very strict standards for borrowing code: if you borrow anything for use in your project, you must have a citation.
- A good guideline is that if you take more than three lines of code from some source, you must include the information on where it came from.
- A URL or a notation (e.g., "MATLAB help files") is fine.
- If it is an entire function, note it at the beginning of the code segment and include any original credit information.
- Provide a qualitative description of what you used and what you changed/contributed.

Here are a few examples of academic dishonesty:

- Working with one or more partners on an assignment to be completed individually.
- Submitting a copy of work done by another student, with or without their knowledge.
- Submitting work primarily found online or provided by someone else outside of this class.
- Submitting work by anybody who took this course in the past, whether the course was here at Northeastern or at another campus or institution.
- Providing or receiving significant help to another student on an assignment.

Please ask if you have a question about what is considered a policy violation!

Unless stated otherwise (e.g., group project), assignments reflect individual work.

- While you may discuss concepts and ideas with other students, there will be no direct collaboration.
- If you steal someone else's work, you fail the class.
- If someone uses your work, you fail the class.

If you are unsure about this policy, **ask the instructor.**

The university's academic integrity policy discusses actions regarded as violations and consequences for students http://www.northeastern.edu/osccr/academic-integrity.

POLICY ON AI SYSTEM

You may use AI tools, e.g. ChatGPT, as a study aid and intelligent tutor. Beware that heavily relying on these tools may stifle your independent thinking and problem-solving skills. You may not submit any work generated by an AI tool as your own. Always remember that AI makes many mistakes when solving math and programming problems.

STUDENT FEEDBACK

Your opinions are very important to me. All students are strongly encouraged to use the TRACE (Teacher Rating and Course Evaluation) system https://www.northeastern.edu/trace/ near the end of the course to evaluate this course. A reminder about TRACE should arrive via email about two weeks before the end of the course. In addition, I will be asking for your feedback at least once about halfway through the semester. However, if you have concerns about the course, don't wait until you are asked. You can contact me anytime!

CLASSROOM ENVIRONMENT

- To create and preserve a classroom atmosphere that optimizes teaching and learning, all participants share responsibility for creating a civil and non-disruptive forum for the discussion of ideas.
- Students are expected to conduct themselves at all times to avoid disrupting teaching or learning.
- Your comments to others should be constructive and free from harassing statements.
- You are encouraged to disagree with other students and the instructor, but such disagreements must be respectful and based on facts and documentation (rather than prejudices and personalities).
- The instructor reserves the right to interrupt conversations that deviate from these expectations.
- Repeated, unprofessional, or disrespectful conduct may result in a lower grade or more severe
  consequences.
- Part of the learning process in this course is the respectful engagement of ideas with others.

TITLE IX

Title IX of the USA Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender identity, in educational programs and activities that receive federal financial assistance.

Northeastern's Title IX Policy prohibits Prohibited Offenses, defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, and transgender students, faculty, and staff. Faculty members are considered "responsible employees" at Northeastern University, meaning they are required to report all allegations of sex or gender-based discrimination to the Title IX Coordinator.

The university offers confidential resources for medical treatment, emotional support, and counseling through Confidential Employees. Confidential Employees are not required to disclose information about Prohibited Offenses to the Title IX Coordinator without the student's prior consent. Confidential Resources on campus include University Health and Counseling Services (UHCS) staff, the Sexual Violence Resource Center (SVRC), the Office of Prevention and Education, and the Center for Spiritual Dialogue and Service (CSDS). [From Title IV Policy, Section III.C]

Alleged violations can be reported to the Title IX Coordinator within The Office for University Equity and Compliance at: titleix@northeastern.edu and/or through NUPD (844) 688-6287. Reporting Prohibited Offenses to NUPD does NOT commit the victim/affected party to future legal action.

In case of an emergency, please call 911.

Please visit The Office for University Equity and Compliance for the full Title IX Policy, a complete list of reporting options and resources both on- and off-campus.

GLOBAL LEARNER SUPPORT

Global Learner Support (GLS) offers one-to-one tutorials for NU learners in the areas of academic writing, academic presentations, APA/MLA citation, English language conversation, and professional communication.
Learners can visit the GLS booking page to make a tutoring appointment.
GLS also offers monthly virtual and in-person workshops on topics related to avoiding plagiarism, paraphrasing, APA/MLA guidelines, grammar and punctuation, academic presentations, writing professional emails, etc. Learners can visit the GLS Workshops page to view and register for upcoming workshops.

The GLS website lists all available services.