Northeastern
College of Engineering

INFO 6205 Program Structure and Algorithms

Course Information

Course Title: Program Structure and Algorithms
Course Number: INFO 6205
Term and Year: Winter 2024
Credit Hour: 4
CRN: 37824
Course Format: On-Ground

Instructor Information

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Course Prerequisites

Students should have basic knowledge of discrete mathematics and basic programming skills (especially in Java). It is assumed that the students know Java sufficiently to understand all simple codes used in the slides and textbook.

Course Description

The mission of this course is to give students an understanding of the foundations of data structures and algorithms, to teach them basic implementation techniques and to show how they can be applied to solve practical problems. Focuses on understanding the application of the abstract data structure and the circumstances that affect implementation decisions. Covers lists, stacks, queues, trees, hash tables, graphs, strings, and dynamic programming. Covers recursion and searching and sorting algorithms in detail. Emphasizes data abstraction and encapsulation in code design. Explores external storage structures, time permitting.

Standard Learning Outcomes

Learning outcomes common to all College of Engineering Graduate programs:

1. *An ability to identify, formulate, and solve complex engineering problems.*
2. *An ability to explain and apply engineering design principles, as appropriate to the program's educational objectives.*
3. *An ability to produce solutions that meet specified end-user needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.*

The Information Systems Program accepts students of different engineering backgrounds with minimum programming skills and produces first class Information Systems engineers that operate at the intersection of

real-world complexity, software development, and IT management. Graduating students will be able to construct end-to-end advanced software applications that meet business needs.

Specific Learning Outcomes for the Information Systems program:

1. *Create a strong technical foundation through diverse, high-level courses*
2. *Built crucial interpersonal skills needed to succeed in any industry*
3. *Foster a deep level of applied learning through project-based case studies*

Learning Objectives

Students should know and understand:

- Worst case analysis of algorithms
- Basic sorting algorithms (elementary sorts, quicksort, mergesort, heapsort)
- Basic searching algorithms (binary search, search trees, hashing)
- Elementary data structures (stacks, queues, priority queues, search trees, heaps, hash tables, tries, graph representations)
- Graph algorithms (breadth/depth-first-search, minimum spanning trees, shortest paths)
- Basic string algorithms

Students should be able to:

- Analyze the running time of algorithms
- Identify the time/space trade-offs in designing data structures and algorithms
- Given a problem such as searching, sorting, graph and string problems, select from a range of possible algorithms, provide justification for that selection
- Understand implementation issues for the algorithms studied
- Reduce a given application to (or decompose it into) problems already studied
- Prepare for a coding interview

Required Tools and Course Textbooks

Textbook: Algorithms, 4th Edition by Robert Sedgewick and Kevin Wayne, Addison-Wesley Professional, 2011.
Lecture Notes designed by the authors of the textbook can be found at https://algs4.cs.princeton.edu/home/.
Other resources:

- Algorithm Visualizer: https://algorithm-visualizer.org/
- Algorithm Practice: https://leetcode.com/
- Algorithm Bible: The Art of Computer Programming (Completed: Volume 1, 2, 3, 4A, 4B; Planned: Volume 4C, 5, 6, 7), by Donald Knuth, 1968

Topic Covered

Lecture	Topic	Content
1	Introduction and Data Structure	1. Abstract data types (ADT) 2. Array and List 3. Stacks and Queues
2	Basic of Algorithms Analysis	1. Running time 2. Complexity and notation

3	Sorting	1. Elementary sort 2. Mergesort 3. Bound 4. Quick sort
4	Priority Queues and Heapsort	1. Priority queue 2. Binary heap 3. Heapsort
5	Trees	1. Binary search tree: search, insert, delete, and traversal 2. Balanced Search Trees: 2-3 trees, read-black trees, B-trees
6	Hash Tables and Hash Functions	1. Hash function and hash table 2. Separate chaining 3. Open addressing 4. Bitmap and hash
7	Graphs	1. Undirected graphs and directed graphs 2. Breadth first search (BFS) and depth first search (DFS) 3. Connected components
8	Minimum Spanning Trees	1. Union-find 2. Minimum spanning tree 3. Kruskal's algorithm 4. Prim's algorithm
9	Shortest Paths	1. Generic algorithm 2. Dijkstra's algorithm 3. Acyclic shortest path 4. Bellman-ford algorithm
10	Strings	1. String sorts and tries 2. Bucket sort 3. Substring search: brute force algorithm, Knuth-Morris-Pratt algorithm, Boyer-Moore algorithm, and Rabin-Karp algorithm
11	Dynamic Programming (optional)	1. Dynamic programming

Grading Scale

Evaluation: There will be two 1.5 hours coding tests (35% per test, closed book) and one presentation (30%).
Detailed grading scheme: Grade = 2 * 0.35* coding test + 0.3*presentation.
Presentation

- Find a medium level problem (acceptance ≤ 60%) in Leetcode: https://leetcode.com/. The problem is related to one of the followings topics: lists, trees, graphs, strings and dynamic programming.
- Send the problem to the instructor at least one week in advance before the presentation date.
- Solve the problem with at least two different approaches.
- Present your solution in the class, solution should include (a) your thoughts of solving the problem, (b) the detailed code, and (c) the complexity analysis.
- The evaluation is based on the difficulty of the problem, solutions, presentation, and Q&A.

95-100% A	87-89.9% B+	77-79.9% C+	69.9% or below F
	84-86.9% B	74-76.9% C	
90-94.9% A-	80-83.9%B-	70-73.9% C-	

End-of-Course Evaluation Surveys

Your feedback regarding your educational experience in this class is particularly important to the College of Professional Studies. Your comments will make a difference in the future planning and presentation of our curriculum.

At the end of this course, please take the time to complete the evaluation survey at **https://neu.evaluationkit.com**. Your survey responses are **completely anonymous and confidential**. For courses 6 weeks in length or shorter, surveys will be open one week prior to the end of the courses; for courses greater than 6 weeks in length, surveys will be open for two weeks. An email will be sent to your Husky Mail account notifying you when surveys are available.

Academic Integrity

A commitment to the principles of academic integrity is essential to the mission of Northeastern University. The promotion of independent and original scholarship ensures that students derive the most from their educational experience and their pursuit of knowledge. Academic dishonesty violates the most fundamental values of an intellectual community and undermines the achievements of the entire University.

As members of the academic community, students must become familiar with their rights and responsibilities. In each course, they are responsible for knowing the requirements and restrictions regarding research and writing, examinations of whatever kind, collaborative work, the use of study aids, the appropriateness of assistance, and other issues. Students are responsible for learning the conventions of documentation and acknowledgment of sources in their fields. Northeastern University expects students to complete all examinations, tests, papers, creative projects, and assignments of any kind according to the highest ethical standards, as set forth either explicitly or implicitly in this Code or by the direction of instructors.

Go to http://www.northeastern.edu/osccr/academic-integrity-policy/ to access the full academic integrity policy.

University Health and Counseling Services

As a student enrolled in this course, you are fully responsible for assignments, work, and course materials as outlined in this syllabus and in the classroom. Over the course of the semester if you experience any health issues, please contact UHCS.

For more information, visit https://www.northeastern.edu/uhcs.

Student Accommodations
Northeastern University and the Disability Resource Center (DRC) are committed to providing disability services that enable students who qualify under Section 504 of the Rehabilitation Act and the Americans with Disabilities Act Amendments Act (ADAAA) to participate fully in the activities of the university. To receive accommodations through the DRC, students must provide appropriate documentation that demonstrates a current substantially limiting disability.

For more information, visit https://drc.sites.northeastern.edu.

Library Services
The Northeastern University Library is at the hub of campus intellectual life. Resources include over 900,000 print volumes, 206,500 e-books, and 70,225 electronic journals.

For more information and for education specific resources, visit https://library.northeastern.edu.

24/7 Canvas Technical Help
For immediate technical support for Canvas, call 617-373-4357 or email help@northeastern.edu

Canvas Faculty Resources: https://canvas.northeastern.edu/faculty-resources/

Canvas Student Resources: https://canvas.northeastern.edu/student-resources/

For assistance with my Northeastern e-mail, and basic technical support:
Visit ITS at https://its.northeastern.edu
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Diversity and Inclusion
Northeastern University is committed to equal opportunity, affirmative action, diversity, and social justice while building a climate of inclusion on and beyond campus. In the classroom, members of the University community work to cultivate an inclusive environment that denounces discrimination through innovation, collaboration, and an awareness of global perspectives on social justice.

Please visit http://www.northeastern.edu/oidi/ for complete information on Diversity and Inclusion

Title IX
Title IX of the 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, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty, and staff.

In case of an emergency, please call 911.

*Please visit **https://www.northeastern.edu/ouec** for a complete list of reporting options and resources both on- and off-campus.*