Northeastern
College of Engineering

INFO 6205: Program Structures and Algorithms
Fall 2025

Course Information
Course Title: Program Structure and Algorithms
Course Number: INFO 6205
Term and Year: Fall 2025
Credit Hour: 4
CRN: 17665 (01) and 17666 (02)
Course Format: Classroom

Instructor Information
Full Name: Robin Hillyard
Email Address: r.hillyard@neu.edu
Office Hours: Tuesday 2pm—6pm; Friday all day (online/Teams only)

Instructor Biography
Associate Teaching Professor Robin Hillyard has taught at Northeastern University since 2015. Before that, he enjoyed a long and successful career in software development and consulting. He has served in every capacity from Chairman/President on down—in startups and more established companies—and in many industries: financial, healthcare, eCommerce, and computer-aided design. Throughout this time, he was an innovator, especially in the areas of unit testing and agile development. He wrote his first program in 1968, and it worked first time (an accomplishment in those days!). His undergraduate degree was in Engineering Science at the University of Oxford (1st class honours) with a specialty in control engineering. Switching to the "other" place, he received his Ph.D. in Computer Science in 1978 from the University of Cambridge, with a dissertation on dimensions and tolerances in computer-aided design. Always fascinated by the expressiveness of computer languages for solving problems, Dr. Hillyard has become proficient in a wide range of languages, from assembly language, BCPL, Algol68, Fortran, C, Perl, Java, to Scala and many others. A long-time proponent of unit testing, he wrote his first unit test suite (for assembly language) in 1972. Having developed perhaps the world's first object-relational database, he has previously taught relational databases at the Khoury College of Computer Sciences. He has a patent concerning the use of reactive programming for healthcare information systems. Most recently, he has been involved with "big data" on a Hadoop platform using Spark, GraphX, Scala, Elastic Search, and Zeppelin for the recognition of gaps in (health) care. Other classes taught: CSYE 7200 (Big Data System Engineering with Scala), CSYE 7374 (Cryptography).

Teaching Assistant Information
Full Names: to be determined. For details on specific sections, see Canvas
Email Address: See Canvas
Office Hours: See Canvas

Course Prerequisites
Some experience with Java is helpful.
Course Description
Introduction to Algorithms and Data Structures with emphasis on *why* things work.

Course Learning Outcomes

1) Students will be able to explain fundamental abstract data types, including identifying their data structures, algorithms, and invariants.
2) Students will be able to predict the complexity of problems and their solutions based on theoretical considerations and will know how to validate said complexity via benchmarking and other tools.
3) Students will understand the primary forms of reduction: defeat-in-detail, divide-and-conquer, and dynamic programming.
4) Students will have a thorough knowledge of sorting and searching techniques, as well as graphs.
5) Comprehension of Program Structures and Algorithms: By the end of the course, students will be able to explain fundamental program structures, data structures, and algorithms. They will have the ability to analyze diverse computational challenges using various methods and tools.
6) Proficiency in Algorithmic Problem Solving: Upon completion of the course, students will be proficient in designing, implementing, and analyzing algorithms for tasks such as searching, sorting, and recursion.
7) Application of Data Abstraction and Encapsulation Principles: Emphasizing modular and reusable programming practices, students will develop proficiency in applying principles of data abstraction and encapsulation in code design.

Required Tools and Course Textbooks.
Data Structures, Algorithms, and Invariants: A Practical Guide (First Edition) by Robin Hillyard (published by Cognella).
Ebook: 979-8-8233-8115-4
Print: 978-1-7935-8884-5
See: https://cognella.com/inclusive-access/
This book is *required*. It is an integral part of the course.

Course Schedule/Topics Covered.

Chapter 1: Solving Problems

- Solving problems
  - Search Problems
  - Reduction
    - Modeling the Problem
    - Divide-and-Conquer & Defeat-in-Detail
    - The Master Theorem
    - P & NP
  - Invariants
  - The Arbitrary Substitution Principle
- Representing state
  - Modeling the Solution to a Problem
    - Abstract Data Types

Chapter 5: Positional ADTs

Chapter 6: Ordered ADTs

Chapter 7: Sorting Part 1: Creating Order with Comparison

- Creating Order out of Comparison
    - Sorting
    - Order
    - Comparison—Total Order
    - Keys
    - Comparison in Java
    - Counting Sorts
- Comparisons sorts
    - Adaptive Sorts
        - Bubble Sort
        - Swaps
        - Insertion Sort
        - Stable Sorting
    - Non-Adaptive Sorts
        - Selection Sort
        - Optimal Sorting
        - Merge Sort
        - Quicksort
        - Merge Sort vs. Quicksort
        - Timsort
        - Heapsort
        - Shellsort
- Conclusion

Chapter 8: Order Part 2

- Sorting by Counting
    - Classification
    - Bucket sort
        - Analysis
    - Counting sorts
        - LSD Radix Sort
        - MSD Radix Sort
- Hybrid Sorts
    - Husky Sort
- Selection
    - Quickselect
- Shuffling
- Conclusion

Chapter 9: Graphs: The Ultimate Abstract Data Type

- Graph: the Ultimate Abstract Data Type
- Definitions
    - Graph
        - Disjoint Sets (Edgeless Graphs)
        - Edge-based Graphs
    - Types of Edge
    - Directed vs. Undirected Graph
    - Directed Acyclic Graphs (DAG)
    - Tree
    - Directed Tree

    - Undirected Tree
    - Spanning Tree
- Graph Representations
    - Model E
    - Model V
    - Model A
- Graph Complexity
- Graph Applications
    - Depth-first search
    - Breadth-first search
    - Connectivity
    - Ordering
    - Strong Connectivity
    - Minimum Spanning Tree
        - Kruskal's Algorithm
        - Prim's Algorithm
    - Shortest Paths
        - Dijkstra's Algorithm
        - Acyclic Algorithm
        - Bellman-Ford Algorithm
    - Interesting Graph Problems
        - The Seven Bridges of Königsberg
        - Hamilton Cycle
        - Subgraph Isomorphism
- Conclusion

Chapter 10: Other Graph Topics

- Part 1: Union-Find (Disjoint Sets)
    - The Best Case
    - Eager Solution
    - Lazy Solution
    - An Optimal Solution?
    - Summary
- Part 2: Dynamic Programming
    - Introduction
    - Dynamic Programming
        - Reduction by Directed Graph
        - Reduction by Directed Acyclic Graph
        - Reduction by Directed Cyclic Graph
        - Applying the Dynamic Programming Method
            - Fibonacci
            - Knapsack Problem

Week	Date	In Class Topic	Assignment Due
1	**09/01**	**Introduction and Solving Problems**	
2	**09/08**	**Invariants, State, Reduction, Search Problems**	
3	**09/15**	**Complexity part 1**	
4	**09/22**	**Compexity part 2**	
5	**09/29**	**Abstract Data Types**	
6	**10/06**	**Unordered, Positional ADTs, Hash tables**	
7	**10/13**	**Ordered ADTs: binary heap, BST, red-black tree**	
8	**10/20**	**Sorting**	

9	**10/27**	**Merge Sort**	
10	**11/03**	**Quicksort**	**Team Project**
11	**11/10**	**Quickselect, shuffling, Radix Sorts**	**Team Project**
12	**11/17**	**Graphs part 1**	**Team Project**
13	**11/24**	**Graphs part 2**	**Project/Thanksgiving**
14	**12/01**	**Union-Find, Dynamic Programming**	**Team Project**
	12/08	**Final Exams (date/time TBD)**	
	12/16	**Final Grades**	

Assignment Grading

- Attendance – 4 %
- Assignments – 17%
- Quizzes – 18%
- Team Project – 22 %
- Midterm Exam – 17%
- Final Exam – 22%

Grading Scale

There is no fixed scale for determining final grades. As a rough guide, 95% or above will generally earn an A. 80% or more should get you a B-. But I repeat: there is no fixed scale for grading.

Please take no notice of Canvas when it predicts your future final grade. It's generally pessimistic.

Attendance/Late Work Policy

Attendance Policy

Students registered in MGEN courses (INFO, CSYE, and DAMG) are allowed **a maximum of 2 absences per course, with 3 or more absences resulting in an automatic 'F' for that course.** Students are expected to inform their instructors of any absences in advance of the class; if a student is sick long-term or experiences a medical issue that prevents class attendance, it is strongly encouraged that they speak with their Academic Advisor (coe-mgen-gradadvising@northeastern.edu) to learn more about the Medical Leave of Absence. Should a student anticipate being unable to attend 3 or more classes, they should discuss their situation with their Academic Advisor to explore other types of leave in accordance with the University's academic and global entry expectations. International students should review the Office of Global Services webpage to understand their visa compliance requirements.

Teaching Assistants (TAs) or Instructional Assistants (IAs) will be present at each class to collect student attendance.

Late Work Policy

Students must submit assignments by the deadline in the time zone noted in the syllabus. Students must communicate with the faculty prior to the deadline if they anticipate work will be submitted late. Work submitted late without prior communication with faculty will not be graded.

End-of-Course Evaluation Surveys

Your feedback regarding your educational experience in this class is particularly important to the College of Engineering. 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 Northeastern University 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.

MGEN Student Feedback
Students who would like to provide the MGEN unit with anonymous feedback on this particular course, Teaching Assistants, Instructional Assistants, professors, or to provide general feedback regarding their program, may do so using this survey: https://neu.co1.qualtrics.com/jfe/form/SV_cTlAbH7ZRaaw0Ki

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
Network Campus Library Services: Northeastern University Library Global Campus Portals

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

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
Email: help@northeastern.edu
ITS Customer Service Desk: 617-373-4357

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*.