SD 311: Data Structures and Scalability

Course Policy, Fall AY27 (v1.0)

Coordinator: Dr. Muhammad Rahman, HP447, mrahman@usna.edu
Course Description: This course is an examination of computational efficiency, and how it relates to the manipulation of very large datasets.

Instructor Website: https://faculty.cs.usna.edu/~mrahman/ Credits: 3-0-3 Pre-requisites: SD212

Learning Objectives:

- Students will become familiar with the use and performance characteristics of common data structures including stacks, queues, lists, trees, heaps, and hash tables.
- Students will understand the techniques of asymptotic analysis using big-O notation as a formal tool to understanding how computer programs scale in resource use for increasingly large inputs.
- Students will learn how to implement these data structures efficiently in Python and solve programming problems with them (Student Outcome 1).
- Students will learn the fundamentals of algorithmic analysis and development.

Student Outcomes:
Students successfully completing this course will be able to:

1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.

Textbook(s): There is no required textbook.

Syllabus: A detailed week-by-week calendar is posted on the course website along with major due dates. The course covers the following brief topics:

Week 1 Course Introduction, Asymptotic Analysis (Foundations, Big-O Notation)

Week 2 Advanced Asymptotic Analysis, Analyzing Two Key Algorithms, Pointers & Arrays

Week 3 Linked Lists, Recursion, Recursive Linked Structures

Week 4 Advanced Recursion, Structural Recursive Applications

Week 5 Recurrence Relations, Abstract Data Types (ADTs), List Implementations

Week 6 Stacks & Queues

Week 7 Sets & Maps, Introduction to Binary Search Trees (BSTs)

Week 8 Binary Search Trees (Operations & Efficiency), B+ Trees

Week 9 Hashtables (Collision Resolution), Ordered Maps vs. BSTs

Week 10 Priority Queues (ADT Concepts, Heap Implementations, Operations)

Week 11 Bloom Filters

Week 12 Skip Lists, Greedy Algorithms, Introduction to Divide and Conquer

Week 13 Divide and Conquer (Advanced Applications and Analysis)

Week 14 Divide and Conquer Wrap-up, Introduction to Dynamic Programming

Week 15-17 Dynamic Programming

Extra Instruction: Extra instruction (EI) is strongly encouraged and should be scheduled by email with the instructor. EI is not a substitute lecture; students should come prepared with specific questions or problems.

Grading Policy and Collaboration: The guidance in the Honor Concept of the Brigade of Midshipmen and the Computer Science Department Honor Policy must be followed at all times. See `www.usna.edu/CS/resources/honor.php`. Specific instructions for this course:

- Homework: Homework is an opportunity for you to check your understanding. It is graded for completion, not correctness. You may collaborate with anybody on homework, in whatever way helps you understand the material. However, the final submission must be your own work.
- Projects: Projects are done individually. You may talk with me in EI, but otherwise must do things on your own. You may Google for programming assistance, but may not search for solutions to the larger problem.
- Exams: There will be two midterms and a comprehensive final. Should a make-up exam be needed, inform the instructor at least one week in advance.

Generative AI Policy: PROVOSTNOTE 1531 defines an AI Usage Framework that courses use to prescribe what kinds of AI usage are allowed for given assignments and/or problems. In this course, generative AI is not allowed except when explicitly stated otherwise.

Classroom Conduct: The section leader will record attendance and bring the class to attention at the beginning and end of each class. If the instructor is late more than 5 minutes, the section leader will keep the class in place and report to the Computer Science department office. If the instructor is absent, the section leader will direct the class. Drinks are permitted, but they must be in reclosable containers. Food, alcohol, smoking, smokeless tobacco products, and electronic cigarettes are all prohibited. Cell phones must be silent during class. All discussions will be civil, and both faculty and midshipmen will be treated with dignity and respect at all times.

Chatham House Rule: USNA follows the practice of non-attribution to protect all faculty, staff, midshipmen, and guests. To foster an environment where ideas are openly exchanged, this class follows the practice of non-attribution for all communications (in-person, written, and electronic). If you wish to refer to another person's ideas or comments outside of this class, you may refer to them as 'a fellow class member' or 'a speaker,' but you may not disclose the speaker's identity without their express permission.

Late Policy: PROVOSTINST 1531.91 defines a minimal policy for work submitted late at USNA. The specific penalties for late submission of graded work may vary among courses or from semester to semester, but CS Department expectation is that they be the same for all sections of a given course. For this course, nothing will be accepted late without a good reason.

Grading: Student performance will be translated to the following letter grades: A, A-, B+, B, B-, C+, C, C-, D+, D, F.
The breakdown of the final course grade will be:

- **30% Final Exam** - the final exam will be cumulative.
- **30% Midterm Exams**- Written exams focusing on the previous 6 weeks.
- **30% Programming Projects**
- **10% Homework**

The 6 week grade will be calculated as:

- **50% of 6 Week Exam**

- **50% of Homework**

The 12 week grade will be calculated as:

- **50% of 12 Week Exam**
- **50% of Homework**

We will use the following mapping from percentages to letter grades.

A : $x \geq 93$

A- : $90 < x < 93$

B+ : $87 < x < 90$

B : $83 < x < 87$

B- : $80 < x < 83$

C+ : $77 < x < 80$

C : $73 \leq x < 77$

C- : $70 \leq x < 73$

D+ : $67 \leq x < 70$

D : $60 \leq x < 67$

F : Otherwise

Submitted: Dr. Muhammad Rahman