

Course Syllabus

Data Structures and Algorithms

Course Description

The focus of this course is how data structures and algorithms impact the computational complexity (time and space) of programs. It is assumed that you have some familiarity with the data structures of stacks, queues, linked lists, and binary search trees (BSTs). This course additionally covers the data structures of heaps, hash tables, balanced variants of BSTs (for example, red-black, 2-3, or splay trees), and graphs (undirected and directed, weighted and unweighted). Algorithmic techniques covered include divide-and-conquer, dynamic programming, and greedy. While most algorithms are analyzed in the worst or average case, also of interest are lower bounds, and amortized and probabilistic analyses.

Specific topics covered include:

- Introduction to Essential Data Structures
- Implementation of Data Structures
- Introduction to Algorithms and Algorithm Strategies
- Introduction to Run Time Analysis and Big-O
- Analysis of Algorithms
- Implementation of Algorithms

Learning Outcomes

Learners completing this course will be able to:

- Define data structures such as heaps, balanced trees, and hash tables.
- Explain how to use a specific data structure in modeling a given problem.
- Identify, construct, and clearly define a data structure that is useful for modeling a given problem.
- State some fundamental algorithms such as merge sort, topological sort, Prim's and Kruskal's algorithm, and algorithmic techniques such as dynamic programming and greedy algorithms.
- Use a specific algorithmic technique in solving a given problem.
- Design an algorithm to solve a given problem.
- Define the notions of worst-, best-, and average-case running times of algorithms.
- Analyze and compare different asymptotic running times of algorithms.
- Analyze a given algorithm and determine its asymptotic running time.
- Combine fundamental data structures and algorithmic techniques in building a complete algorithmic solution to a given problem.

- Create several algorithmic solutions to a given problem and choose the best one among them according to given requirements on time and space complexity.

Time Commitment Per Week

- About 5 to 7 hours per module
- 30 to 60 minutes per practice quiz
- 2 hours for Practice Final Exam
- 2 hours for Final Exam

Required Textbook

Introduction to Algorithms, Third Edition, By Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein. c 2009 by Massachusetts Institute of Technology. ISBN 978-0-262-03384-8.

This textbook is your primary resource for this course. It is an industry standard and authoritative text on the subject. It is strongly recommended that you should read the first six sections (first 26 chapters) of this textbook page for page. While the text will work as a reference book, its value as such is will be severely limited if you are not fluent in the material covered in the previous sections and chapters. Your success on the Final Exam will be directly related to your fluency with the topics covered in this text.

In addition to the required text, there are many very good resources available online. Wikipedia is one excellent recourse for technical information regarding specific data structures and algorithms and data structures and algorithms in general. Participants in this course are highly encouraged to seek out and use additional resource - both books, and online materials - as they build their mastery of the topics.

Course Completion

You will need to pass the final exam with an 80% or better, and successfully pass proctoring requirements for the final exam.

Course Outline with Assignments

Module 1: Introduction to Essential Data Structures

- 1.0: Overview
- 1.1: Getting Started
- 1.2: Quick Tour of Fundamental Data Structures
- 1.3: Visualizing Data Structures
- 1.4: Summary

Data Structures and Algorithms Prerequisite (Non-credit version)

1.5: Practice Quiz - Essential Data Structures

Module 2: Implementation of Data Structures

2.0: Overview.

2.1: Fundamental Structures and Implementation

2.2: Implementation of Specific Data Structures

2.3: Summary

2.4: Practice Quiz - Implementation of Data Structures

Module 3: Introduction to Algorithms and Algorithm Strategies

3.0: Overview

3.1: Algorithm Strategies

3.2: Overview of Specific Algorithms

3.3: Summary

3.4: Practice Quiz - Introduction to Algorithms and Algorithm Strategies

Module 4: Introduction to Run Time Analysis and Big-O

4.0: Overview

4.1: Asymptotic Run Time Complexity

4.2: Big-O Notation

4.3: Summary

4.4: Practice Quiz - Introduction to Run Time Analysis and Big-O

Module 5: Analysis of Algorithms

5.0: Overview

5.1: Algorithm Analysis

5.2: Summary

5.3: Practice Quiz - Analysis of Algorithms

Module 6: Implementation of Algorithms

6.0: Overview

6.1: Implementation of Specific Algorithms

6.2: Summary

6.3: Practice Quiz - Implementation of Algorithms

Module 7: Practice Final Exam

Practice Final Exam

Course Completion

Final Exam Proctoring Setup
Final Exam - Proctored