

Fundamentals of Data structures and Algorithm Analysis

Course Code: SITE-2082

Instructors: Minase M. (meketeminase4@gmail.com)
Tewodros W. (tewodros.wondifraw@aau.edu.et)
Absalat D. (absalat.dawit@aait.edu.et)
Kabila H. (kabila.haile@aait.edu.et)

Course Summary

What are algorithms? Why is the study of algorithms worthwhile? What is the role of algorithms relative to other technologies used in computers? In this course, we will answer these questions.

This course provides an introduction to mathematical modeling of computational problems. It covers the common algorithms, algorithmic paradigms, and data structures used to solve these problems. The course emphasizes the relationship between algorithms and programming, and introduces basic performance measures and analysis techniques for these problems.

Course Objective

At the end of the course, students will be able to

- Explain the techniques involved for design and analysis of algorithms
- Determine where and how to use various data structures
- Implement data structures and algorithms

Prerequisites: Fundamentals of computer science and programming

Course Topics

Chapter I: Introduction

- 1.1 What are Algorithms and data structures?
- 1.2 Algorithms as a technology
- 1.3 Why Algorithms and data structures?

Chapter 2: Recursion

- 2.1. Recursive Algorithms
- 2.2. Recursion vs iteration

Case study: Fibonacci's sequence, Tower of Hanoi

Chapter 3: Asymptotic analysis

3.1 Time and space complexity

3.2 Asymptotic notation

3.2.1 Big-O Notation

3.2.2 $\Omega(n)$, $\Theta(n)$, $o(n)$, and $\omega(n)$

3.3 Divide and conquer

Chapter 4: Elementary data structures

4.1 Array

4.2 Stack and Queues

4.3 Linked lists

Chapter 5: Sorting and Searching

5.1 The 'search' problem

5.2 Linear search

5.3 Binary search

5.4 The 'sort' problem

5.5 Bubble sort

5.6 Quick sort and Bogo sort

5.7 Merge sort

Case study: Audio search (Shazam)

Chapter 6: Algorithmic design paradigms

6.1 Divide and conquer

6.2 Greedy Algorithms

6.3 Dynamic Programming

Case study: Change making algorithm

Chapter 7: Graph Algorithms

7.1 What are Graphs?

7.2 Graph Representations

7.3 Types of Graphs

7.4 Graph search

7.4.1 Breadth First Search Algorithm

7.4.2 Depth First Search Algorithm

7.4.3 Dijkstra's search algorithm

Case study: Google PageRank, Bacon's number, PacMan

Chapter 8: Miscellaneous Algorithms and data structures

8.1 Matrix manipulation

8.2 Hash tables

8.4 Trees

8.5 Binary search trees

8.6 P vs NP

Assessment

Lab: 20%

Project: 15%

Midterm: 20%

Assignments and Quiz: 15%

Final Exam: 30%

Text Book:

Introduction to Algorithms(CLRs),

Thomas Cormen et al

References:

Algorithm Design

Jon Kleinberg and Éva Tardos