Data Structures and Algorithms [1]

A Study Guide for Students of Sorsogon State University - Bulan Campus[2]

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[1] A course in the Bachelor of Science in Computer Science

[2] This book is a study guide for students of Sorsogon State University - Bulan Campus taking up the course Data Structures and Algorithms.

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Sorsogon State University - Bulan Campus

Contents

List of Figures

List of Tables

List of Codes

Preface

> *"Bad programmers worry about the code. Good programmers worry about data structures and their relationships."*
>
> – Linus Torvalds

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1

Introduction to Data Structures and Algorithms

1.1 Introduction

Data structures and algorithms are one of the fundamental components of computer science. They are essential for solving complex problems efficiently and effectively. Data structures are used to store and organize data in a computer so that it can be accessed and manipulated efficiently. Algorithms are step-by-step procedures or formulas for solving a problem. They are the instructions that tell a computer how to perform a task.

In this course, we will learn about the fundamental data structures and algorithms that are used in computers. We will study how to design, implement, and analyze data structures and algorithms to solve real-world problems. By the end of this course, you will have a solid foundation in data structures and algorithms that will help you become a better programmer and problem solver.

1.2 Setup and Installation

In this course, we will be using the C++ programming language to implement data structures and algorithms. C++ is a powerful and versatile programming language that is widely used in the field of computer science. To get started, you will need to install a C++ compiler and an integrated development environment (IDE) on your computer.

1.2.1 C++ Compiler Installation

The first step is to install a C++ compiler on your computer. A compiler is a program that translates source code written in a programming language into machine code that can be executed by a computer. There are several C++ compilers available, but we recommend using the GNU Compiler Collection (GCC) which is a free and open-source compiler that supports multiple programming languages including C++.

1.2.1.1 Windows

To install GCC on Windows, you can use the MinGW (Minimalist GNU for Windows) project which provides a port of GCC to Windows. You can download the MinGW installer from the MinGW website and follow the installation instructions. You can install MinGW

by following the instructions here: https://code.visualstudio.com/docs/languages/cpp#_example-install-mingwx64-on-windows

1.2.2 Visual Studio Code Installation

The next step is to install an integrated development environment (IDE) on your computer. An IDE is a software application that provides comprehensive facilities to computer programmers for software development. We recommend using Visual Studio Code which is a free and open-source IDE developed by Microsoft. You can download Visual Studio Code from the official website and follow the installation instructions: https://code.visualstudio.com/Download

Other than Visual Studio Code, you also need to install the C/C++ extension for Visual Studio Code. You can install the C/C++ extension by following the instructions here: https://code.visualstudio.com/docs/languages/cpp

1.2.3 Testing the Installation

To test if the installation was successful, you can create a simple C++ program and compile it using the C++ compiler. Open Visual Studio Code and create a new file with the following C++ code:

```cpp
#include <iostream>
namespace std;

int main() {
    cout << "Hello, World!" << endl;
    return 0;
}
```

Code 1.1: Hello World Program

Save the file with a .cpp extension (e.g., hello.cpp) and open a terminal window in Visual Studio Code. Compile the program using the following command:

```
g++ hello.cpp -o hello
```

Code 1.2: Compiling the Program

If there are no errors, you can run the program by executing the following command:

```
./hello
```

Code 1.3: Running the Program

If everything is set up correctly, you should see the output "Hello, World!" printed on the screen.

1.3 What are Data Structures?

A ***data structure*** is a way of organizing and storing data in a computer so that it can be accessed and manipulated efficiently. Data structures provide a way to manage large amounts of data effectively for various applications. They define the relationship between the data, and the operations that can be performed on the data. There are many different types of data structures that are used in computer science, each with its own strengths and weaknesses. The use of the right data structure can significantly improve the performance of an algorithm and make it more efficient.

1.4 What are Algorithms?

An ***algorithm*** is a step-by-step procedure or formula for solving a problem. It is a sequence of well-defined instructions that take some input and produce an output. Algorithms are used to solve complex problems and perform various tasks efficiently. They are the instructions that tell a computer how to perform a task. Algorithms are essential for writing computer programs and developing software applications. The efficiency of an algorithm is measured by its time complexity and space complexity.

1.5 Why Study Data Structures and Algorithms?

Data structures and algorithms are essential topics in computer science and software engineering. They are one of the fundamental components of computer science and are used in various applications such as operating systems, database management systems, networking, artificial intelligence, and many others. A good understanding of data structures and algorithms will help you become a better programmer and problem solver. In addition, many companies use data structures and algorithms as part of their technical interviews to assess the problem-solving skills of candidates. Therefore, studying data structures and algorithms is essential for anyone pursuing a career in software engineering or software development.

1.6 Basic Terminologies

Before we dive into the details of data structures and algorithms, let's understand some basic terminologies that might be helpful in understanding the concepts better.

1.6.1 Data

Data is a collection of facts, figures, or information that can be used for analysis or reference. It can be in the form of numbers, text, images, audio, video, or any other format. Data is the raw material that is processed by a computer to produce meaningful information.

1.6.2 Data Object

A ***data object*** is an instance of a data structure that contains data along with the operations that can be performed on the data. It is an abstraction of a real-world entity that is represented in a computer program.

1.6.3 Data Type

A ***data type*** is a classification of data that tells the compiler or interpreter how the programmer intends to use the data. It defines the operations that can be performed on the data, the values that can be stored in the data, and the memory space required to store the data.

1.6.3.1 Primitive Data Types

Primitive data types are the basic data types that are built into the programming language. They are used to store simple values such as integers, floating-point numbers, characters, and booleans. Examples of primitive data types include int, float, char, and bool. The following are the common primitive data types used in programming:

Integer (int)

The integer data type is used to store whole numbers without any decimal points. It can be either signed or unsigned, depending on whether it can store negative values or not. An integer's value can range from -2,147,483,648 to 2,147,483,647 and takes 4 bytes of memory.

```
int x = 10;
```

Code 1.4: Integer Data Type

Character (char)

The character data type is used to store a single character such as a letter, digit, or special symbol. It is represented by a single byte of memory. A char value can range from -128 to 127 or 0 to 255, depending on whether it is signed or unsigned. These values are represented using ASCII codes.

```
char c = 'A';
```

Code 1.5: Character Data Type

Boolean (bool)

The boolean data type is used to store true or false values. It is represented by a single byte of memory. A bool value can be either true or false.

```
bool flag = true;
```

Code 1.6: Boolean Data Type

Floating-Point (float)

The floating-point data type is used to store real numbers with decimal points. It can represent both integer and fractional parts of a number. It can be either single precision or double precision, depending on the number of bits used to store the value. A float value can range from 1.2E-38 to 3.4E+38 and takes 4 bytes of memory.

```
float y = 3.14;
```

Code 1.7: Floating-Point Data Type

Double (double)

The double data type is used to store real numbers with double precision. It can represent both integer and fractional parts of a number with higher precision than the float data type. A double value can range from 2.3E-308 to 1.7E+308 and takes 8 bytes of memory.

```
1 double z = 3.14159;
```

Code 1.8: Double Data Type

1.6.3.2 Non-primitive Data Types

1.6.4 Abstract Data Type

1.6.5 Complexity of an Algorithm

1.6.5.1 Time Complexity

1.6.5.2 Space Complexity

1.7 Asymptotic Notations

1.7.1 Big-O Notation

1.7.2 Omega Notation

1.7.3 Theta Notation

1.8 Summary

2

Arrays and Linked Lists

2.1 Introduction

2.2 Arrays

2.2.1 Types of Arrays

2.2.1.1 One-dimensional Array

2.2.1.2 Multi-dimensional Array

2.2.2 Array Operations

2.2.2.1 Insertion

2.2.2.2 Deletion

2.2.2.3 Searching

2.2.3 Complexity Analysis of Arrays

2.3 Linked Lists

2.3.1 Types of Linked Lists

2.3.1.1 Singly Linked List

2.3.1.2 Doubly Linked List

2.3.1.3 Circular Linked List

2.3.2 Operations on Linked Lists

2.3.2.1 Insertion

2.3.2.2 Deletion

2.3.2.3 Searching

2.3.3 Complexity Analysis of Linked Lists

2.4 Comparison of Arrays and Linked Lists

2.5 Summary

3

Stacks and Queues

3.1 Introduction

3.2 Stacks

3.2.1 Operations on Stacks

3.2.1.1 Push

3.2.1.2 Pop

3.2.1.3 Peek

3.2.1.4 isEmpty

3.2.1.5 isFull

3.2.2 Complexity Analysis of Stacks

3.2.3 Implementation of Stacks Using Arrays

3.2.4 Implementation of Stacks Using Linked Lists

3.3 Queues

3.3.1 Types of Queues

3.3.1.1 Linear Queue

3.3.1.2 Circular Queue

3.3.1.3 Priority Queue

3.3.1.4 Double-ended Queue (Deque)

3.3.2 Operations on Queues

3.3.2.1 Enqueue

3.3.2.2 Dequeue

3.3.2.3 Front

3.3.2.4 Rear

3.3.3 Complexity Analysis of Queues

3.3.4 Implementation of Queues Using Arrays

3.3.5 Implementation of Queues Using Linked Lists

3.4 Comparison of Stacks and Queues

4

Trees

4.1 Introduction

4.2 Properties of Trees

4.2.1 Root Node

4.2.2 Parent Node

4.2.3 Child Node

4.2.4 Leaf Node

4.2.5 Ancestors

4.2.6 Siblings

4.2.7 Descendants

4.2.8 Height of a Tree

4.2.9 Depth of a Node

4.2.10 Degree of a Node

4.2.11 Level of a Node

4.2.12 Subtree

4.3 Types of Trees

4.3.1 Binary Tree

4.3.1.1 Types of Binary Trees

Left-skewed Binary Tree

Right-skewed Binary Tree

Complete Binary Tree

4.3.2 Ternary Tree

4.3.3 N-ary Tree

4.3.4 Binary Search Tree

4.3.5 AVL Tree

4.3.6 Red-Black Tree

4.4 Basic Operations on Trees

5

Graphs

5.1 Introduction

5.2 Properties of Graphs

5.2.1 Vertex

5.2.2 Edge

5.2.3 Degree of a Vertex

5.2.4 Path

5.3 Types of Graphs

5.3.1 Finite Graph

5.3.2 Infinite Graph

5.3.3 Trivial Graph

5.3.4 Simple Graph

5.3.5 Multi Graph

5.3.6 Null Graph

5.3.7 Complete Graph

5.3.8 Pseudo Graph

5.3.9 Regular Graph

5.3.10 Bipartite Graph

5.3.11 Labelled Graph

5.3.12 Weighted Graph

5.3.13 Directed Graph

5.3.14 Undirected Graph

5.3.15 Connected Graph

5.3.16 Disconnected Graph

5.3.17 Cyclic Graph

5.3.18 Acyclic Graph

5.3.19 Directed Acyclic Graph (DAG)

6

Sorting and Searching

6.1 Introduction

6.2 Sorting

6.2.1 Types of Sorting Algorithms

6.2.1.1 Bubble Sort

6.2.1.2 Selection Sort

6.2.1.3 Insertion Sort

6.2.1.4 Merge Sort

6.2.1.5 Quick Sort

6.2.1.6 Heap Sort

6.2.1.7 Radix Sort

6.2.1.8 Counting Sort

6.2.1.9 Bucket Sort

6.2.2 Comparison of Sorting Algorithms

6.3 Searching

6.3.1 Types of Searching Algorithms

6.3.1.1 Linear Search

6.3.1.2 Binary Search

6.3.1.3 Jump Search

6.3.1.4 Interpolation Search

6.3.1.5 Exponential Search

6.3.1.6 Fibonacci Search

6.3.1.7 Ternary Search

6.3.2 Comparison of Searching Algorithms

6.4 Summary

7

Hashing

8

Advanced Data Structures and Algorithms

8.1 Introduction

8.2 Advanced Data Structures

8.2.1 Segment Tree

8.2.2 Fenwick Tree

8.2.3 Suffix Tree

8.2.4 Suffix Array

8.2.5 Trie

8.2.6 Heap

8.2.7 Disjoint Set

8.2.8 Skip List

8.2.9 Splay Tree

8.2.10 Bloom Filter

8.2.11 KD Tree

8.2.12 Quad Tree

8.2.13 Octree

8.2.14 B-Tree

8.2.15 B+ Tree

8.2.16 R-Tree

8.2.17 X-Tree

8.2.18 Y-Tree

8.2.19 Z-Tree

8.3 Advanced Algorithms

8.3.1 Dynamic Programming

8.3.2 Greedy Algorithms

9

Applications of Data Structures and Algorithms

9.1 Applications in Computer Science

9.1.1 Operating Systems

9.1.2 Database Management Systems

9.1.3 Compiler Design

9.1.4 Networking

9.1.5 Artificial Intelligence

9.1.6 Machine Learning

9.1.7 Computer Graphics

9.1.8 Computer Vision

9.1.9 Robotics

9.1.10 Web Development

9.1.11 Mobile Development

9.1.12 Game Development

9.1.13 Cybersecurity

9.1.14 Quantum Computing

9.2 Applications in Real Life

9.2.1 Social Media

9.2.2 E-commerce

9.2.3 Healthcare

9.2.4 Finance

9.2.5 Transportation

9.2.6 Education

9.2.7 Agriculture

9.2.8 Manufacturing

9.2.9 Entertainment

10

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