

Data Structures and Algorithms

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What is data?

Data

- A collection of facts from which conclusion may be drawn
- e.g. Data: Temperature 35°C; Conclusion: It is hot.

Types of data

- Textual: For example, your name (Muhammad)
- Numeric: For example, your ID (090254)
- Audio: For example, your voice
- Video: For example, your voice and picture
- (...)

What is data structure?

- A particular way of storing and organizing data in a computer so that it can be used efficiently and effectively.
- Data structure is the logical or mathematical model of a particular organization of data.
- A group of data elements grouped together under one name.
 - For example, an array of integers

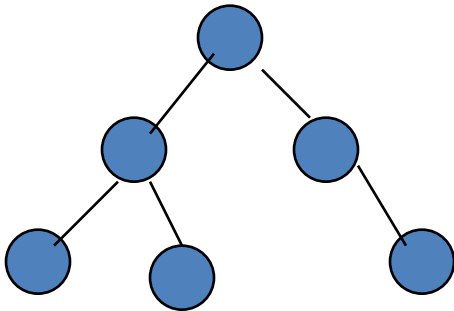
Types of data structures



Array



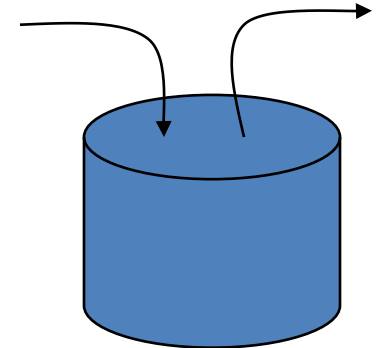
Linked List



Tree



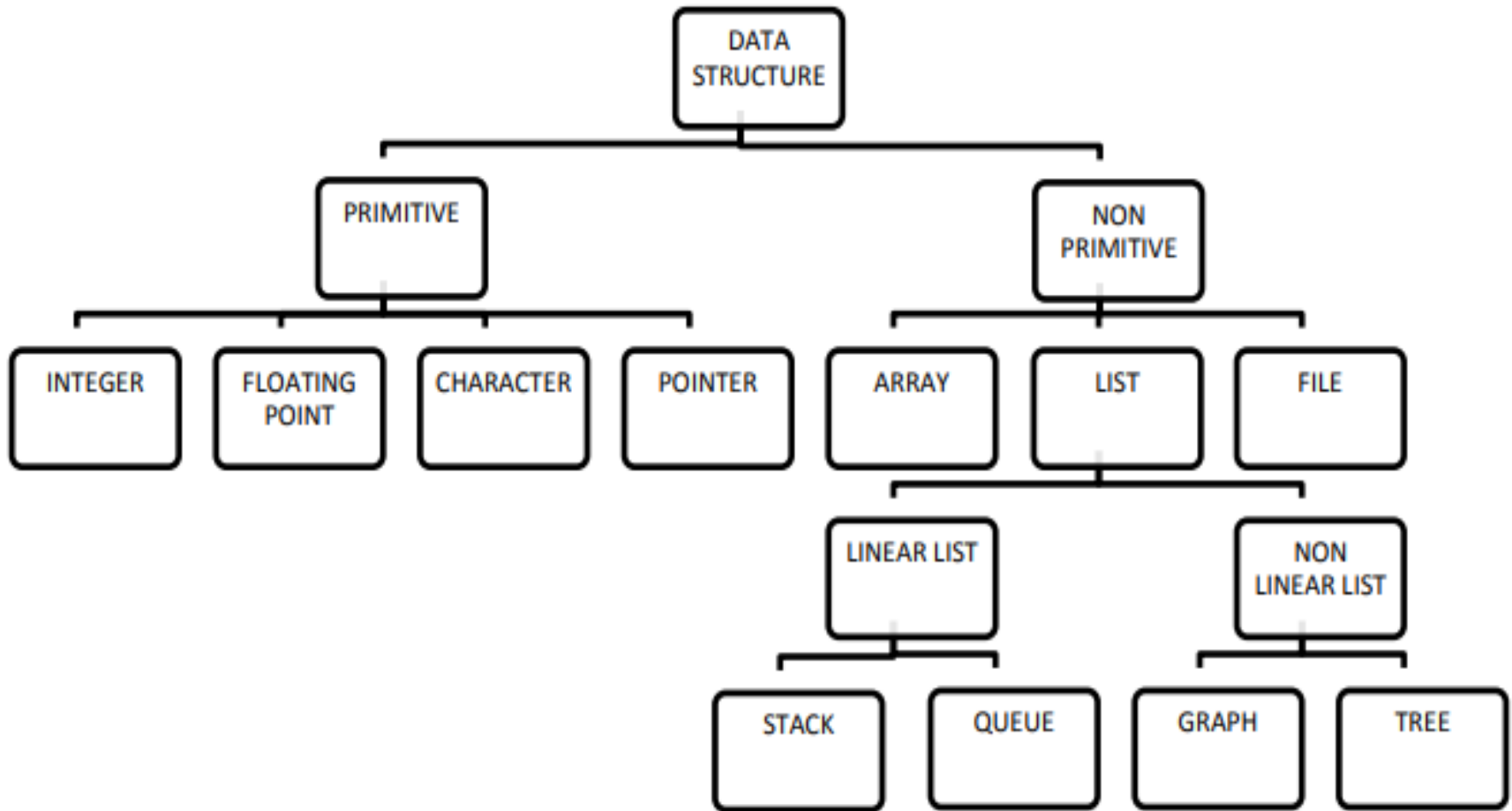
Queue



Stack

There are many, but we named a few. We'll learn these data structures in great detail!

Classification of Data Structures



The Need for Data Structures

- **Goal:** to organize data
- **Criteria:** to facilitate **efficient**
 - **storage** of data
 - **retrieval** of data
 - **manipulation** of data
- **Examples:**
 - Telephone Directory
 - What if it is not sorted?
 - Queue at Box office for movie ticket
 - What if it is not necessary to maintain queue?

Data Structure Operations

- Traversing

- It is used to access each data item exactly once so that it can be processed.

- Searching

- It is used to find out the location of the data item if it exists in the given collection of data items.

- Insertion

- It is used to add a new data item in the given collection of data items.

Data Structure Operations (cont.)

■ Deletion

- It is used to delete an existing data item from the given collection of data items.

■ Sorting

- It is used to arrange the data items in some order i.e. in ascending or descending order in case of numerical data and in dictionary order in case of alphanumeric data.

■ Merging

- It is used to combine the data items of two sorted files into single file in the sorted form.

What is an algorithm?

- An algorithm is a finite set of instructions or logic, written in order, to accomplish a certain predefined task.
- Algorithm is not the complete code or program, it is just the core logic(solution) of a problem
- can be expressed either as an informal high level description as **pseudo code** or using a **flowchart**.

Characteristics of an Algorithm

- **Input-** There should be 0 or more inputs supplied externally to the algorithm.
- **Output-** There should be at least 1 output obtained.
- **Definiteness-** Every step of the algorithm should be clear (Unambiguous) and well defined.
- **Finiteness-** The algorithm should have finite number of steps.
- **Correctness-** Every step of the algorithm must generate a correct output.

How to express an algorithm?

- A sequence of steps to solve a problem
- We need a way to express this sequence of steps
 - Natural language (NL) is an obvious choice, but not a good choice. Why?
 - NLs are notoriously ambiguous (unclear)
 - Programming language (PL) is another choice, but again not a good choice. Why?
 - Algorithm should be PL independent
- We need some balance
 - We need PL independence
 - We need clarity
 - Pseudo-code provides the right balance

What is pseudo-code?

- Pseudo-code is a short hand way of describing a computer program
- Rather than using the specific syntax of a computer language, more general wording is used
- It is a mixture of NL and PL expressions, in a systematic way
- Using pseudo-code, it is easier for a non-programmer to understand the general workings of the program

Importance of Data Structures and Algorithms

Programs = Data Structures + Algorithms

-- Niklaus Wirth, author of Pascal language

From above we can say that

Efficient Programs = Efficient (Data Structures + Algorithms)

Efficient Programs = Efficient Data Structures

+

Efficient Algorithms

Homework

1. Write pseudo-code to display first N odd/even numbers.
2. Write an algorithm in pseudo code that finds the average of (n) numbers.

References

- Course notes from **Mr. Mohammad Alqahtani**