University of Anbar
College of Computer Science
and Information Technology
Computer Network Systems
Department

Data Structures

Lecture One

Second Stage

First Course - 2024-2025

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Overview

Data Structure is a systematic way to organize data in order to use it efficiently. Following terms are the foundation terms of a data structure.

- Interface − Each data structure has an interface. Interface represents the set of operations that a data structure supports. An interface only provides the list of supported operations, type of parameters they can accept and return type of these operations.
- Implementation − Implementation provides the internal representation of a data structure. Implementation also provides the definition of the algorithms used in the operations of the data structure.

Characteristics of a Data Structure

- Correctness − Data structure implementation should implement its interface correctly.
- Time Complexity − Running time or the execution time of operations of data structure must be as small as possible.
- Space Complexity − Memory usage of a data structure operation should be as little as possible.

Need for Data Structure

As applications are getting complex and data rich, there are three common problems that applications face now-a-days.

- Data Search − Consider an inventory of 1 million(10^6) items of a store. If the application is to search an item, it has to search an item in 1 million (10^6) items every time slowing down the search. As data grows, search will become slower.
- Processor speed − Processor speed although being very high, falls limited if the data grows to billion records.
- Multiple requests − As thousands of users can search data simultaneously on a web server, even the fast server fails while searching the data.

To solve the above-mentioned problems, data structures come to rescue. Data can be organized in a data structure in such a way that all items may not be required to be searched, and the required data can be searched almost instantly.

Basic Terminology

- Data − Data are values or set of values.
- Data Item − Data item refers to single unit of values.
- Group Items − Data items that are divided into sub items are called as Group Items.
- Elementary Items − Data items that cannot be divided are called as Elementary Items.
- Attribute and Entity − An entity is that which contains certain attributes or properties, which may be assigned values.
- Entity Set − Entities of similar attributes form an entity set.
- Field − Field is a single elementary unit of information representing an attribute of an entity.
- Record − Record is a collection of field values of a given entity.
- File − File is a collection of records of the entities in a given entity set.

Implementation Data Structures

From the data structure point of view, following are some important categories of implementation data structures:−

- Search − Algorithm to search an item in a data structure.
- Sort − Algorithm to sort items in a certain order.
- Insert − Algorithm to insert item in a data structure.
- Update − Algorithm to update an existing item in a data structure.
- Delete − Algorithm to delete an existing item from a data structure.

Course Description

Introduce the students to data structures using an object-oriented programming language. This includes logical and physical representation of data structures, collection types, array-based lists, linked lists, stacks, queues, binary trees, binary search trees, hashing, searching, sorting and recursion. Applications and algorithms based on data structures are covered in this course.

Text book and references

- The Main Book
  Title: Data Abstraction and Solving with C++
  Author(s): Frank Carrano, D.J. Henry, 2012
  Edition: 6th edition
  Publisher: Pearson Education, Inc.,
- The Second Book
  Title: Data Structures and Algorithm Analysis in C++
  Author(s): Mark Allen Weiss, 2014
  Edition: 4th edition
  Publisher: Pearson Education, Inc.,

Grading Policy

Activity	Weight
Exam 1	15
Exam 2	15
Lab.	10
Interactive & Registrations	10
Final Exam	50

References:

- Frank Carrano, D.J. Henry: Data Abstraction and Solving with C++, 2012, 6th edition, Pearson Education, Inc.
- Mark Allen Weiss: Data Structures and Algorithm Analysis in C++, 2014, 4th edition, Pearson Education, Inc.