Standard Template Library (STL) - c++

Basics of Ds & Algo

This study can be broadly classified in two groups - **Data** and **functions** which modify the data

1. To store data efficiently we need **Data Structures**. 2. To perform action on stored data we need **Algorithms.**

Basics of Ds & Algo

For example; Consider you are given a notebook which has page numbers written at the bottom of every page. Now your task is to find a particular page. Imagine two scenarios:

1. Page numbers are not sorted [Inefficient data structure. Efficient Algorithm] No matter how good your algorithm is, it

cannot predict where the required page lies. It is going to take long time in worst/average case] 2. Page numbers are sorted [Efficient data structure, Inefficient algorithm]. Let's say we give the book to someone who starts iterating pages one by one from the start. So the algorithm is going to take a lot of time, correct? Ideally what that should have done is use binary search.

We will judge a DS on the basis of - Insert, Delete, and Find. Based on these parameters, every data structure has its own pros and cons.

1. Containers 2. Iterators 3. Algorithms

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Types of containers

- Sequence Containers
  - Array (Array)
  - Vector (ArrayList)
  - Deque (Deque)

- Container Adapters
  - Stack (Stack)
  - Map (TreeMap)
  - Unordered Set (Hashset)
  - Unordered Map (Hashmap)
  - Queue (Queue)
  - Priority Queue (Priority Queue)
- Associative Containers (Ordered/Unordered)
  - Set (Treeset)

Sequence containers

Array - Primitive data type. Fixed size containers.

Vector - Dynamic/Variable size containers. Arrays that can change in size

Deque - Doubly ended queue are containers with dynamic/variable sizes that can be expanded or contracted on both ends.

Container Adaptors

Stack - Supports LIFO. i.e. Elements are inserted and popped only from one end of the container. For ex: Washing piles of plates.

Queue - Supports FIFO. i.e Elements are inserted into one end of the container and popped from the other. For ex.: Movie ticket lane.

Priority Queue - Implemented as a heap. Depending upon implementation it provides the largest/smallest element when popped.

Associative containers

Set - Stores unique elements (no duplicates) in sorted order. Sorting can be either increasing, decreasing or even user defined way

Map - Stores elements formed by a combination of a key value pair. Elements are sorted according to keys and can be either increasing, decreasing or even user defined. For

example: Your roll number in your universities.

Unordered Set - Similar to set but elements are not sorted.

Unordered Map- Similar to map but elements are not sorted.

1. Containers 2. Iterators 3. Algorithms

Iterators

Consider this scenario: You have an audio file on your laptop which you want to play. How will you open it?

1. Your file is on the disk in a specific format [It can have header, metadata info, audio data etc, etc] You can learn how to read binary data and learn formatting of that file and then read it. 2. Or you can simply use a VLC media player to play.

Iterators

● Similarly, a container (data structure) can be stored on a disk in a different manner for the purpose of efficiency. You don't need to reinvent the wheel to read what value the given container (DS) holds. You can use something called **iterators**.

● In simple words, Iterators are used to traverse from one element to another element in a container. It is a concept common to both C++ and Java. In case of C++ iterators are pointers however in case of Java iterators are objects.

1. Containers 2. Iterators 3. Algorithms

Algorithms

○ Searching

○ Sorting

○ Backtracking

○ Divide and Conquer

○ Greedy

- Dynamic Programming
- Pattern Searching
- Graph Algorithms

Deep Dive into Containers

Vectors

- **Insert**
- `push_back()`
- `insert()`
- **Iterators**
- `begin() and end()`
- `rbegin() and rend()`
- **Delete**
- `pop_back()`
- `erase()`
- `clear()`
- **Access**
- `[] operator`
- `at()`
- **Capacity**
- `size()`
- `capacity()`

Stack Queue Priority Queue

- **Insert**
- push()
- **Iterators**
- top()
- **Delete**
- pop()
- clear()
- **Capacity**
- size()
- empty()
- **Insert**
- push()
- **Iterators**
- front()
- **Delete**
- pop()
- clear()
- **Capacity**
- size()
- empty()
- **Insert**
- **Insert**
- **Insert**
- **Insert**
- push()
- push()
- push()
- push()
- **Iterators**
- **Iterators**
- **Iterators**
- **Iterators**
- top()
- top()
- top()
- top()
- **Delete**
- **Delete**
- **Delete**
- **Delete**
- pop()

- pop()
- pop()
- pop()
- clear()
- clear()
- clear()
- clear()
- **Capacity**
- **Capacity**
- **Capacity**
- **Capacity**
- size()
- size()
- size()
- size()
- empty()
- empty()

Note: Stack, Queue and Priority Queue do not support iterators as such. However there are methods to fetch the top element.

Stack

QUEUE

Deque - Doubly Ended queue

- **Insert**
- push_back()
- push_front()
- insert()
- **Iterators**
- begin() and end()
- rbegin() and rend()
- **Delete**
- pop_back()

- pop_front()
- erase()
- clear()
- **Access**
- [] operator
- at()
- front()
- back()
- **Capacity**
- size()
- empty()
- capacity()

DEQUE

Set/Unordered Set - Collection of Unique elements

- **Insert**
- insert()
- **Iterators**
- begin() and end()
- rbegin() and rend()
- **Delete**
- erase()
- clear()
- **Capacity**
- size()
- empty()
- **Operations**
- find()

- lower_bound()
- upper_bound()

Map/unordered map- Collection of Key Value Pair

- **Insert**
- insert()
- **Iterators**
- begin() and end()
- rbegin() and rend()
- **Delete**
- erase()
- clear()
- upper_bound()
- **Access**
- [] operator
- at()
- **Capacity**
- size()
- empty()
- **Operations**
- find()
- lower_bound()

unordered Set(Contd...)

unordered map (Contd...)

- **Buckets**
- bucket_count()
- bucket_size()
- **Hash Policy**
- load_factor()
- max_load_factor()
- rehash()
- **Observer**
- hash_function()
- key_eq()

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We'll dive into these functions more once we learn about hashing.