Array Notes

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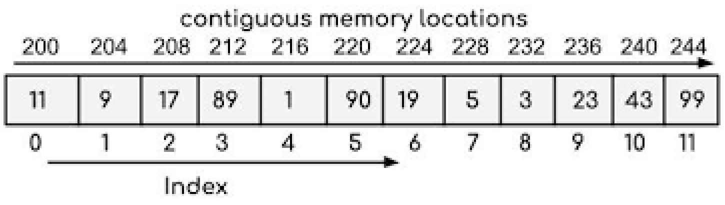
Arrays

An array is defined as a **fixed-size** collection of elements of the **same data type** stored in **contiguous memory** locations. It is the simplest data structure where each element of the array can be accessed by using its index.

Properties of arrays

- Each element of the array is of the same data type and same size. For example: For an array of integers with the int data type, each element of the array will occupy 4 bytes.
- Elements of the array are stored in contiguous memory locations. For example :

200 is the starting address (base address) assigned to the first element of the array and each element of the array is of integer data type occupying 4 bytes in memory.



Accessing array elements

The elements of the array are accessed by using their index. The index of an array of size N ranges from **0** to **N-1**.

For example: Accessing element at index 5: Array[5] -> this is the 6th element in the array.

- Every array is identified by its **base address** i.e the location of the first element of the array in memory. So, basically, the base address helps in identifying the address of all the elements of the array.
- Since the elements of an array are stored in contiguous memory locations, the address of any element can be accessed from the base address itself.

For example : 200 is the base address of the array, so address of element at index 4 will be 200 + 4 * (sizeof(int)) = 216.

Where can arrays be used?

- **Arrays** should be used where the number of elements to be stored is already known.
- **Arrays** are commonly **used** in computer programs to organize data so that a related set of values **can** be easily **sorted** or **searched**.
- Generally, when we require **very fast access times**, we usually prefer arrays since they provide O(1) access times.
- Arrays work well when we have to **organize data in multidimensional format**. We can declare arrays of as many dimensions as we want.
- If the index of the element to be modified is known beforehand, it can be efficiently modified using arrays due to **quick access time** and **mutability**.

Disadvantages of arrays

- Since **arrays** are **fixed-size** data structures you cannot dynamically alter their sizes. It creates a problem when the number of elements the array is going to store is not known beforehand.
- **Insertion** and **Deletion** in arrays are difficult and costly since the elements are stored in contiguous memory locations, hence, we need to shift the elements to create/delete space for elements.
- If more memory is allocated than required, it leads to the **wastage of memory** space and **less allocation of memory** also leads to a problem.

Time Complexity of various operations

- **Accessing elements:** Since elements in an array are stored at contiguous memory locations, they can be accessed very efficiently (random access) in **O(1)** time using indices.
- **Inserting elements:** Insertion of elements at the end of the array (at the index located to the right of the last element and there is still available space) takes **O(1)** time.

Insertion of elements at the beginning or at any index of the array involves moving elements to the right if there is available space.

- If we want to insert an element at index i, all the elements starting from index i need to be shifted to the right by one position. Thus, the time complexity for inserting an element at index i is **O(N - i)**.
- Inserting an element at the beginning of the array involves moving all elements by one position to their right, if there is available space, and takes **O(N)** time.
- **Finding elements:** Finding an element in an array takes **O(N)** time in the worst case, where N is the size of the array, as you may need to traverse the entire array.
- **Deleting elements:** Deletion of elements from the end of the array takes **O(1)** time.

Deleting elements from the beginning or at any index of the array involves moving elements to the left.

- If we want to delete an element at index i, all the elements starting from index (i + 1) need to be shifted to the left by one index. Thus, the time complexity for deleting an element at index i is **O(N - i)**.
- Deleting an element from the beginning involves moving all elements starting from index 1 to left by one position, and takes **O(N)** time.