

Arrays

In java arrays are created using the `int array[]` syntax or using `ArrayList`. You don't need to worry about the size if you use an `ArrayList` because they are dynamically sized (more on this later).

Theory Questions about Arrays

- What is an array?

Array is a set of elements of the same type stored contiguously in memory.

- What is the difference between an array and a linked list?
 1. A linked list is a chain of discrete memory locations while arrays are stored contiguously in memory.
 2. The chaining requires extensive pointer usage; so linked lists take more memory than an array.
 3. A random element in an array can be directly accessed (constant time) while a node must be traversed sequentially (linear time) in a linked list. So it is more efficient to access a random element in an array than a linked list
 4. Deleting a particular element from a linked list can be done in constant time but it is not possible to actually delete (and free the memory space) from an array
 5. Likewise arrays are of fixed size and it is not possible to insert new elements into an array.
 6. Lastly, because arrays are stored in memory contiguously, they provide better performance (refer to locality of reference).

Complexity Analysis

Complexity can informally be explained as the rate of change in program execution time with size of input.

Time complexity for Arrays

- Read element: constant
- Modify element: constant
- Delete element (without changing order of other elements): $O(n)$

Core Questions

- iPhone music player question: Given an array of Integers, print a random number from the array without repetition till all the elements have been printed.

Generate a random element from 0 to $n-1$ of the array, print it and swap that element with the last element of the array. Now your effective array size has been reduced by 1. Repeat the process till all the elements are printed. Complexity is $O(n)$

- Consider an array of numbers that indicate the stock prices of a particular stock from day 0 to day $n-1$. Calculate the maximum profit that a trader could have made? Example: {1,7,3,2,4,3,7}

Traverse the array for $i = 0$ to $n-1$ and calculate the best profit you can make if you were to sell your stock on the i th day. To calculate this in $O(n)$ time, you just need the minimum stock price before the i th day.

- Given an array of Integers, move all zeros to the end of array. Example: I/P: {3,4,0,6,7,0} O/P: {3,4,6,7,0,0} Order of the numbers don't matter.

Take two pointers, one at the beginning and other at the end of the array. Move the end pointer to your left till you encounter a non zero element, and

move the beg pointer to your right till you encounter a zero element, then swap and continue.

Practice Programming Questions

- Given an array, find an index, if any, such that the sum to the right of the index (excluding that index) is equal to the sum of the elements on the left of the index (excluding that index). For example: {1,3,5,4} => -Here 2 (the index of 5) is the answer because the sum of the elements to the left of index 2 (1 + 3) is equal to sum of the element on the right hand side (4).
- Replace an array of numbers by the greatest number on the right hand side. Example: I/P: {2,6,7,4,3,2} O/P: {7,7,4,3,2,0}
Explanation: The largest element to the right hand side of index 0 is 7, so we place 7 in index 0. Likewise for index 1. There is no number to the right hand side of index 5, so we replace it with 0.
- Given an array of Integers, find the minimum distance between the given pair of numbers. For example in the array {1,3,6,2,7,9,8,2}, the minimum distance between (3,9) is 3 because 3 is at index 1 and 9 is at index 4. Likewise the minimum distance between (2,8) is 1 because 8 is at index 6 and 2 is at index 7 (it is also at index 3 but we want the minimum distance).
- Given an array of 0's and 1's, move all 0's to the beginning of the array and all 1's to the end of the array, in a single pass of the array.
- Find the longest palindrome in a string

- In an array of 0's and 1's, find the length of the smallest subset of array that contains exactly k 1's. For example, if the array is 0010101001011, and k is 3, the answer is 4, because the smallest sub-array that has 3 1's is 1011. It is of length 4.

Additional Practice Questions

- a. Rotate a 2d $n \times n$ matrix by 90 degrees.

I/P:

```
1 2 3
4 5 6
7 8 9
```

O/P:

```
7 4 1
8 5 2
9 6 3
```

- b. Identify the celebrity in the party: In a party everyone know the celebrity but the celebrity does not know anyone. Also nobody knows himself or herself. In the matrix below element at ith row and jth column is t (true) if i knows j and f (false) otherwise.

	a	b	c
a	f	t	t
b	f	f	t
c	f	f	f

As C is known to everyone but does not know anyone else, C is the celebrity.

- c. Given an array of Integer's, move all the negative numbers to the beginning, zeros to the middle and positive numbers to the end. The relative order of the negative numbers or positive

numbers don't matter (i.e the resultant array need not be sorted)

Additional Practice Question Hints

- a. Look at how the elements change positions in the given example. Try a few more examples and identify a pattern.
- b. Try a solution with $O(n^2)$ complexity first, but obviously we need something better. Try to use both the properties of a celebrity: does not know anyone AND is known by everyone.
- c. Try doing it in two passes first, and then with three variables – low, mid and high in a single pass.