

# NEXT PERMUTATION

★ In this problem we are supposed to give the next permutation of an array of integers (may contain repetitions as well)

When we get an array, all permutations are sequenced in a sorted array. For eg:

$$\text{arr}[] = [3 \ 2 \ 1]$$

The permutations for this array are

1	2	3
1	3	2
2	1	3
2	3	1
3	1	2
3	2	1

Next permutation in this case is  
1 2 3 (treated like a circular array)

Brute force solution is to generate all permutations, do a linear search for given array's position and return the next element.

Time Complexity is too much for this solution ( $N! \times N$ ).

Optimal Solution is to attempt to match a prefix and maximise the pair that doesn't match such that it is the smallest

Eg : [2 1 5 4 3 0 0]

Next permutation is supposed to have a matching prefix with the current one. We need to find the first point where right element is greater than the left one, and then find the element in the rightward half which is greater than the left one but smaller than all others. So in example array, we start from the right, 0 is equal to 0 so we move left, 3 is greater than 0 so we move left again, 4 is greater than 3 so we move to the left again and find 5, which is again greater than 4 so we move to the left again, to find 1 which is lesser than 5 and we stop. Now we need to find a number in the elapsed array which is greater than 1 but smaller than all others which are greater than one. i.e. 3 ( $3 > 1$  but  $3 < 4, 5$ )

We swap these 2, sort the remaining half of the array to get our next permutation

Pseudocode :

```
nextPermutation(arr, N) {  
    break = 0 ;  
    for(i = 0 → N) {  
        if (arr[i] < arr[i + 1]) {  
            break = 1  
            break  
        }  
    }  
    if (break == 0) {  
        sort(arr, 0, N)  
    } else {  
        a = arr[break]  
        largest = arr[break + 1]  
        for(i = break + 1 → N) {  
            if (arr[i] > a && arr[i] < largest) {  
                largest = i  
            }  
        }  
        swap(largest, break)  
    }  
}
```