C++

PROBLEMS ON SORTING

Lecture-23

Raghav Garg

Today’s checklist

1) MCQ
2) Programming questions

Ques : Which sorting technique is used here?
A player is sorting a deck of cards numbered from 1 to 52. She first picks one card then picks the next card and puts it after the first card if if it is bigger or before the first card if it is smaller, then she picks another card and puts it into its proper position.

a) Bubble sort
b) Insertion sort
c) Selection sort
d) None of these

Ques : Which of the following is not a stable sorting algorithm?

a) Insertion sort
b) Selection sort
c) Bubble sort
d) None of these

Ques : Majority Element

[LeetCode 169]

1) Bubble → $O(n^2)$

2) Selection → $O(n^2)$

3) Insertion → $O(n^2)$

4) Built in Sort → $O(n \log n)$

2 2 1 1 1 2 2 2

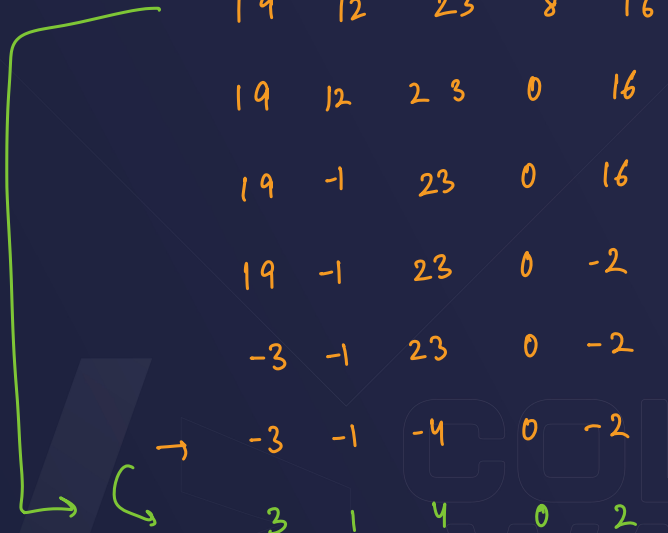
$n = 7$

$n/2 = 3$

Sort()

1 1 1 2 2 2 2

Ques : Given an array with N distinct elements, convert the given array to a form where all elements are in the range from 0 to N-1. The order of elements is the same, i.e., 0 is placed in the place of the smallest element, 1 is placed for the second smallest element, ... N-1 is placed for the largest element.



Insertion Sort

T.C. → $O(n^2)$

**S.C. → $O(1)$

0	1	2	3	4
3	1	4	0	2

isVisited

0	1	2	3	4
1	1	0	1	1

T.C. → $O(n^2)$

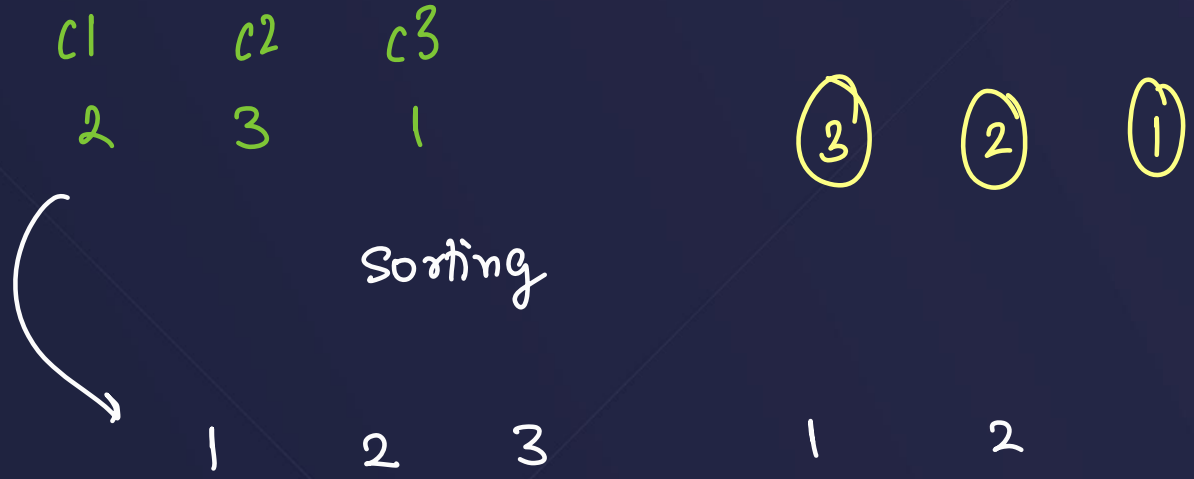
S.C. → $O(n)$

Hashmaps : → T.C. $O(n \log n)$

S.C. $O(n)$

Ques : Assign Cookies

[LeetCode 455]



Ques : Assign Cookies [LeetCode 455]

Greed Array

16 15 14 7

7 14 15 16

i

Cookie Array

5 6 7 8 9 15 14 13 10 16

5 6 7 8 9 10 13 14 15 16

j

```
while(      )
    if (s[i] >= g[i]){      else j++;
        count ++;
        i++;
        j++;
    }
```

Ques : Given an array, arr[] containing 'n' integers, the task is to find an integer (say K) such that after replacing each and every index of the array by $|a_i - K|$ where ($i \in [1, n]$), results in a sorted array. If no such integer exists that satisfies the above condition then return -1.

'Find the range of K'

0	1	2
5	3	8
a_1	a_2	a_3
|0|	|-2|	|3|
0	2	3 → sorted

$K = 5$

5	2	10	
|-1|	|-4|	|4|	K=6
1	4	4	sorted

SKILLS

5 2 10 8

$|5-K|$ $|2-K|$ $|10-K|$ → Sorted

$|a| \leq |b|$

$\downarrow$

$a^2 \leq b^2$

$a^2 - b^2 \leq 0$

$|2-K| \geq |5-K|$ and $|10-K| \geq |2-K|$

↳ $(2-K)^2 \geq (5-K)^2$

$\Rightarrow (K-2)^2 - (K-5)^2 \geq 0$

$\Rightarrow (K-2+K-5)(K-2-(K-5)) \geq 0$

$\Rightarrow (2K-7)(3) \geq 0 \Rightarrow 2K-7 \geq 0$

$K \geq \frac{7}{2}$

$K \geq 3.5$

$\downarrow$

$K \geq 4$

$a_1 \quad a_2 \quad a_3 \quad a_4 \quad a_5 \quad a_6$

$|K-a_1| \quad |K-a_2| \quad |K-a_3|$

Generalizing...

$$|K-a_m| \geq |K-a_{m-1}|$$

$$(K-a_m)^2 - (K-a_{m-1})^2 \geq 0$$

$$(K-a_m + K-a_{m-1})(K-a_m - K + a_{m-1}) \geq 0$$

$$(2K - [a_m + a_{m-1}])(a_{m-1} - a_m) \geq 0$$

If $a_{m-1} - a_m \geq 0$

$$2K - [a_m + a_{m-1}] \geq 0$$

$$\Rightarrow 2K \geq a_m + a_{m-1}$$

$$\Rightarrow K \geq \frac{a_m + a_{m-1}}{2} \quad \text{min}$$

If $a_{m-1} - a_m < 0$

$$K < \frac{a_m + a_{m-1}}{2} \quad \text{max}$$

K range [A, B]

↓

K_{max} , K_{min} → values

if $K_{max} < K_{min}$ → return -1;

arr[0]	1	2
5	2	10

$|10-K| \geq |2-K|$

$|K-10| \geq |K-2|$

$(K-10)^2 \geq (K-2)^2$

$(K-10)^2 - (K-2)^2 \geq 0$

$(K-10+K-2)(K-10-K+2) \geq 0$

$(2K-12)(-8) \geq 0$

$-ve \quad -ve \quad -ve$

$\Rightarrow \quad 2K-12 \leq 0$

$\Rightarrow \quad 2K \leq 12$

$\Rightarrow \quad K \leq 6$

$|a-b| = |b-a|$

$K \leq 6.1 \qquad K \geq 3.5$

$K \leq 6 \qquad K \geq 4$

5 4 10

K = 5

0 1 5 ✓

K = 6

1 2 4 ✓

K = 7

2 3 3 ✓

K = 4

1 0 6 4

K = 8

3 4 2 2

5 2 10

K = 5

0 3 5 ✓

K = 6

1 4 4 ✓

K = 7

2 5 3 ✗

K = 4

1 2 6 ✓

K = 8

3 6 2 ✗

K = 9

4 2 1 ✗

K = 3

2 1 7 ✗

5 3 6 8

$5 - 3 \geq 0$

$k \geq \frac{5+3}{2} \Rightarrow \boxed{k \geq 4}$

k_{min}

$k_{min} = \max\left(k_{min}, \frac{a[i] + a[i+1]}{2}\right)$

$3 - 6 < 0$

$k < \frac{3+6}{2} \Rightarrow \boxed{k < 4.5}$

k_{max}

$k_{max} = \min\left(k_{max}, \frac{a[i] + a[i+1]}{2}\right)$

$6 - 8 < 0$

$k < \frac{6+8}{2} \Rightarrow \boxed{k < 7}$

k_{max}

5 3 10

K=4 1 1 6 ✓

K=6.5

1.5 3.5 3.5 ✓

$K_{max} = 8.7$

$K_{max} = 8$

5 3 10 6

$5 - 3 \geq 0$

$K_{min} = \frac{5+3}{2} = 4$

$3 - 10 < 0$

$K_{max} = \frac{3+10}{2} = 6.5$

$10 - 6 \geq 0$

$K_{min} = \frac{10+6}{2} = 8$

$[K_{min}, K_{max}] = (8, 6.5)$ ∅

5 3 7

$5 - 3 \geq 0$

$K_{min} = \frac{5+3}{2} = 4$

$3 - 7 < 0$

$K_{max} = \frac{7+3}{2} = 5$

5 3 6 2

$K_{max} = 6.8$

$K \le 6.8 \rightarrow (int)$

$K \le 6$

$K_{min} = 6.5$

$(int) + 1$

$K \ge 6.5$

but K is integer

$K \ge 7$

$5 - 3 \ge 0$

$K_{min} = \frac{5+3}{2} = 4$

$3 - 6 < 0$

$K_{max} = \frac{6+3}{2} = 4.5$

$6 - 2 \ge 0$

$K_{min} = \frac{6+2}{2} = 4$

$K_{min} = 4$

$K \geq 4$

$K_{min} = 4.6$

$K \geq 5$

$(int)(4.6) + 1$

$\Rightarrow 4 + 1$

Binary Search → VVVIMP for Interview

THANK YOU