

# Sorting

Apr 25, 2022

## AGENDA :

- Introduction ! What / Why of sorting
- \* Min cost to remove elements
  - \* Closest element
  - \* Noble element
- Comparator (\*\*)

## Introduction.

What?

→ Sorting is arranging some data in an Orderly manner.

↳ based on some parameters.

\*  $[1, 3, 5, 11, 14]$  → Is this sorted?

Yes → Ascending order

\*  $\cancel{[14, 11, 5, 3, 1]}$  → Is this sorted?  
Yes → Descending order.

\*  $\rightarrow [0, 0, -1, -1, 1, 1] \rightarrow$   
Ascend X  
Descend X  
Parameter =  $|x|$   
 $[0, 0, 1, 1, 1, 1]$

\*  $\rightarrow [1, 5, 3, 9, 6, 10, 12] \rightarrow$   
Sorted  
Parameter = No. of factors of  $X$ .

\* Sorting of  $\alpha$  type.  
(Based on Parameters.  
Ascending and Descending)

## \* Why sorting ?

- Page Rank.
  - Prioritising .
  - Amazon.com ( sort on the basis of price)
  - Searching -
    - (Dictionary is sorted)  
(\*\* Binary search)

## Sorting in programming languages.

## Python

$$l = [1, 3, -2, 0, -1, 3]$$

`l.sort()`  $\leftarrow l = [-1, 0, 1, 2, 3, 3]$

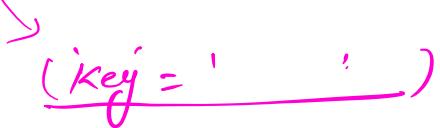
`sorted(l)`.       $\leftarrow$  A lot in place.

l. `sort(reverse=True)`

 l-sort() ← Ascending order

l-sort( reverse=False ) ← Ascending order.

l-sort( reverse=True ) ← Descending order.

TC:  $O(N \log N)$   (key=' ')

~~\*\*~~ l-sort( key=' ' ).  custom ordering

## Q. 1 Min cost to remove all elements

Given an array of size  $N$ , you have to remove all the elements of the array.

Cost to remove an element

Price = sum of all elements present in the array before the removal of.

Find the min cost to remove all elements.

~~[2, 1, 4]~~

Remove 2. -  $2+1+4 = 7$

~~[1, 4]~~

Remove 1  $4+1 = 5$ .

[4]

Remove 4. 4.

Total cost = 16

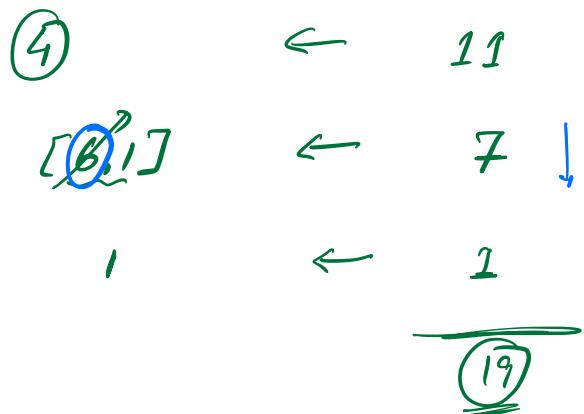
$2 \rightarrow 1 \rightarrow 4 = 16$

$4 \rightarrow 1 \rightarrow 2 = 12$

$4 \rightarrow 2 \rightarrow 1 = 11$

Q

[~~4~~, 6, 1]



\*

[4, 6, 1]      4 + 6 + 1

[4, 6]      4 + 6

[6]      6

[4, ~~6~~, 1]      4 + 6 + 1

[4, 1]      4 + 1

[1]      1

$$= 4 + 6 + 1 + 4 + 1 + 1$$

\* At every step, you remove the max element.

## Mathematical explanation.

$$q_0 \quad \underline{q_1} \quad q_2 \quad q_3$$

$$1st \ removal = \underline{a_0 + a_1 + a_2 + a_3} \quad \checkmark$$

$$2^{\text{nd}} \text{ removal} = a_1 + a_2 + a_3$$

$$3rd \quad \sim \quad = \quad Q_2 \subset Q_3$$

$$7th \quad " \quad = \quad \underline{93}$$

$$\text{Total cost} = \underline{\underline{a_0}} + \underline{\underline{2a_1}} + \underline{\underline{3a_2}} + \underline{\underline{4a_3}}$$

$a_3$  is contributing most.  
 $\therefore a_3$  should be minimum.

$\alpha$  should be maximum.

## Pseudo code

```

def min-cost(A):
    A.sort(reverse=True)
    sum = 0

    for i in A:
        sum += i
        ans = 0

    for i in A:
        ans += sum
        sum -= i

    return ans

```

7

[Q4, 1]

$$\text{Sum} = 11$$

$$\text{Ans} = 0.$$

$$ans = 0 + 11 = 11$$

$$\text{sum} = 11 - 6 = 5$$

$$\text{ans} = \underline{11} + \underline{5} = \underline{\underline{16}}$$

$$\text{sum} = 5 - 4 = \overline{1}$$

$$\text{Ans} = 16 + 1 = 17$$

Math.

[6, 4, 1]

ans = 0

$$= 6 + 2 * 4 + 3 * 1$$

A. sort (reverse = True)

for i in range (len (A)) :

$$\text{ans} += \underline{\underline{A[i] * (i+1)}}$$

$$6 * 1 + 4 * 2 + 1 * 3.$$

return ans .

[4, 2, 2]

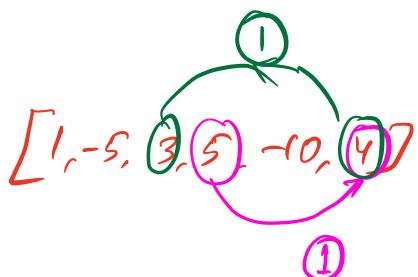
$$\begin{array}{r} \textcircled{4} \\ \textcircled{2} \\ \textcircled{2} \\ = \textcircled{14} \end{array}$$

8.  
4  
2.  
= 14

$$\begin{aligned} & 4 * 1 + 2 * 2 + 2 * 3 \\ & = 4 + 4 + 6 \quad \textcircled{14} \end{aligned}$$

## Q. Min difference.

Given an array of size  $N$ , find out min value of  $|A[i] - A[j]|$ , where  $i, j$  are distinct indexes.



$$|A[i] - A[j]| \times$$

$$|A[i] - A[j]|$$

$$|A[i] - A[j]|$$

Distance b/w 2 values.



\*\* Find the closest 2 numbers in the array.

Brute force.

ans =

for i in range(len(A)):

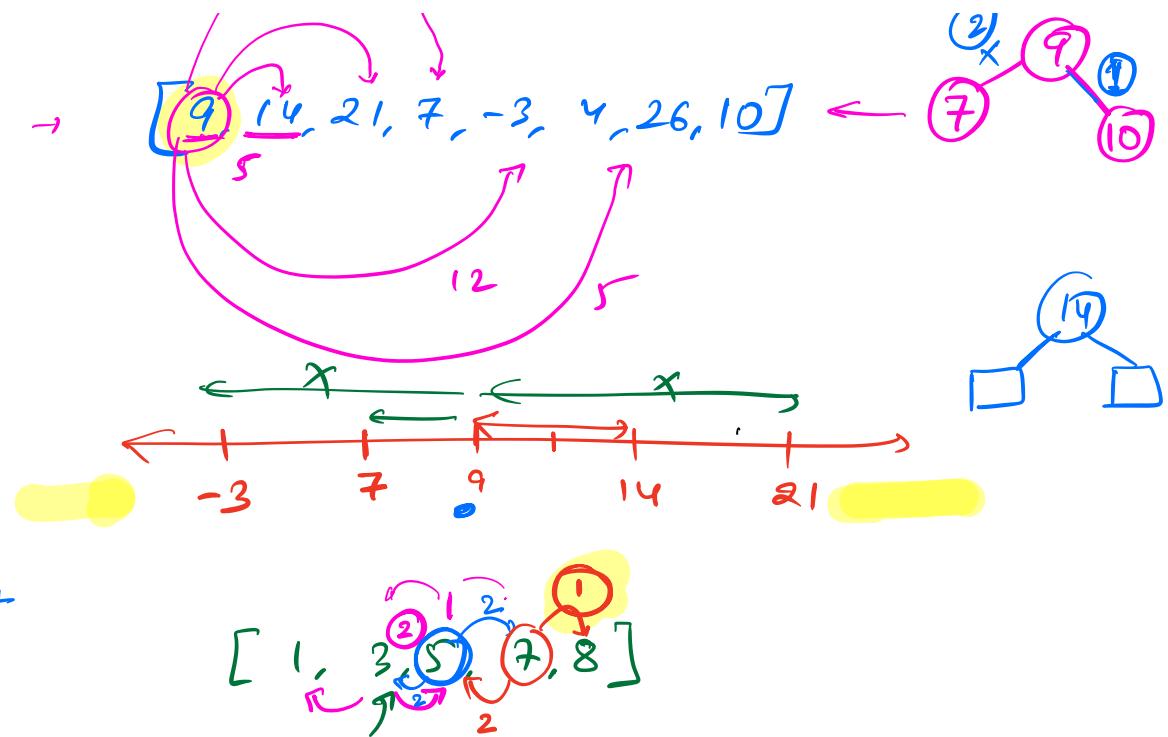
    for j in range(i+1, len(A)):

        ans = min(ans, abs(A[i] - A[j]))

$O(N^2)$

return ans.

12 ~ 2



Pseudo - code.

```

ans = INT-MAX
 $\Theta(N \log N)$  A.sort()
 $O(N)$  for i in range(len(A)-1):
    ans = min(ans, abs(A[i] - A[i+1]))
        ↗ identity of min operator?

```

$O(N \log N)$

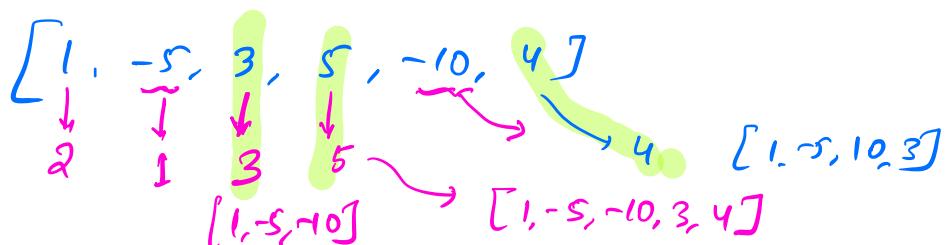
$\overbrace{N + N \log N}$  ↗ ignore
   
 $\frac{O(N \log N)}{O(N^2)}$  >  $O(N^2)$ 
 ↗ Better!

Break till 10:16 !

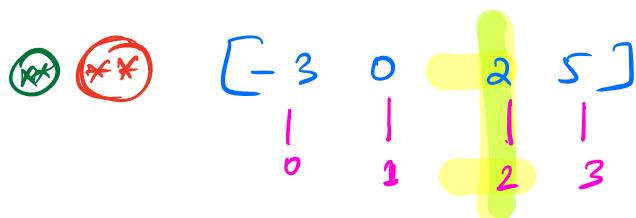
### Q.3. Noble element:

Given an array containing  $N$  distinct elements, find count of noble elements.

Noble element  $\rightarrow$  The no. of elements strictly less than  $A[i]$  should be  $A[i]$ .



Ans = 3.



$$[0, 1, 2, 0, -1, 2]$$

$$[7, 0, -1, 3, 1, 2]$$

$$[-1, 0, 1, 2, 3, 7]$$

index gives you  
no. of elements  
smaller than that  
no.

$$[0, 1, 2]$$

 3 noble elements

## Pseudo-code

cnt = 0

A.Sort()

for i in range(len(A)):

if A[i] == i :

cnt + = 1

return cnt

$$\begin{bmatrix} 2 & 4 & 6 & 8 \\ 0 & 1 & 2 & 3 \end{bmatrix} \times$$

$\{ \begin{matrix} i+1 \\ i-1 \\ \vdots \\ i \end{matrix} \}$

$$\underline{O(N \log N)}$$

## Follow up - question

\* What if the array elements are not distinct?

Above approach.

$$\boxed{\text{Ans} = 2}$$

Correct ans = 3.

**\*\*** If first no. is noble, all its duplicates will also be noble.

$\{ \text{ans} = 0.$   
 if  $A[i] == i :$       // earlier.  
 {  
    $\boxed{\text{cnt} = i}$  if  $A[i] != A[i-1]$   
    $\underline{\text{cnt} = \text{cnt}}$  if  $A[i] == A[i-1]$   
 if  $\underline{A[i] == \text{cnt}}:$   
    $\text{ans} += 1$

( a, b )

$\text{arr} = [1, 3, 5]$     ← Mutable

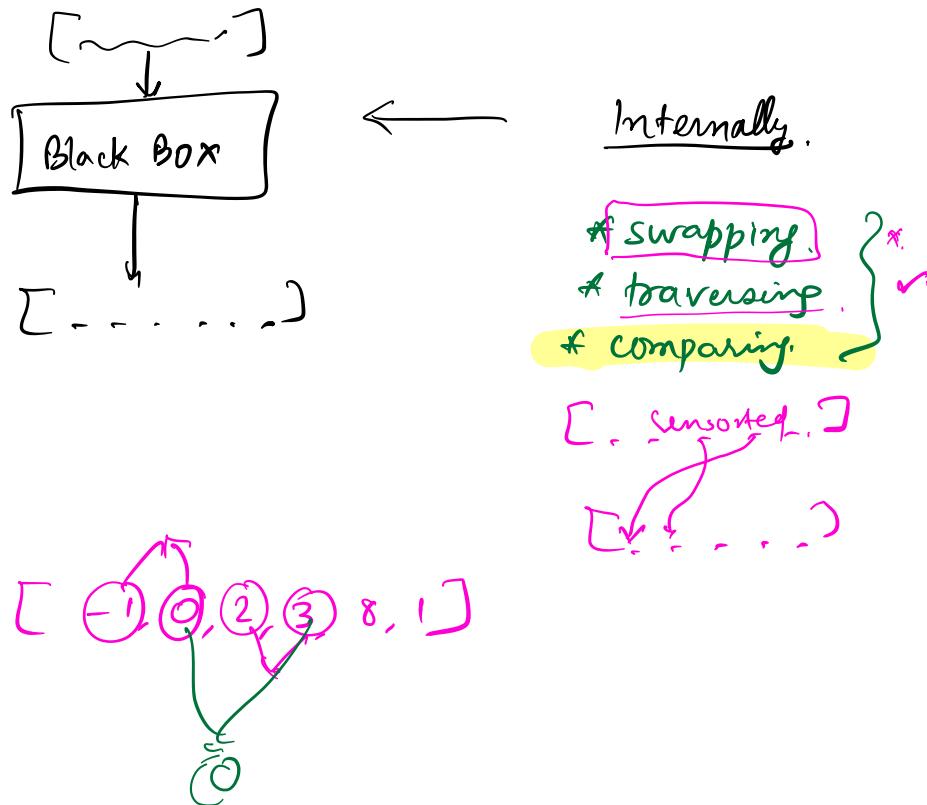
$\text{tup} = (1, 3, 5)$     ← Immutable

↖ You cannot append new elements

∴

## Comparators.

\*



\* Comparator → compares two elements in the array.

def comp(a, b):

    ↓ ↓  
    if  $a < b$ :  
        return -1  
    if  $a > b$ :  
        return 1  
    return 0

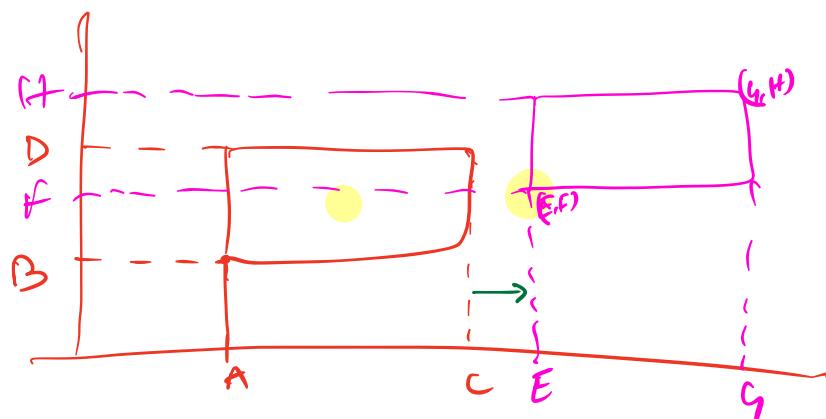
Same data types.  
(data types or element inside list).

arr.sort(key = \_\_\_\_\_(comp))



link to online code:

<https://replit.com/join/kannelnakq-nitinchoudhary1>



$$\leftarrow \underline{E \geq C \text{ || } E < A}$$

\*

\$

,



maj1 = NULL  
cnt1 = 0  
maj2 = NULL  
cnt2 = 0

maj1 = 1, cnt1 = 1  
maj2 = ~~NULL~~, cnt2 = 0

maj1 = 1, cnt1 = 1  
maj2 = 3, cnt2 = 1



②

for

maj1 = 2  
cnt = 1

maj1 = 2  
cnt = 2

maj@1=NUL  
maj 2=NUL  
cnt=0  
cnt=0.

maj1=~~2~~, maj2=~~1~~  
cnt=2, cnt=0.

