26-6-2023

# Count Reverse Pairs →

arr[] = [40 25 19 12 9 6 2]

we have to find no. of pairs, which satisfy below condn
left element should be greater than twice of right ele.

$a[i] > 2 \times a[j]$ && $i < j$

e.g. (6, 2) can be pair bc2 $6 > (2) \times 2 = 6 > 4$
(9, 2), (12, 2), (19, 2), (25, 2) ---- can be pairs

Brute force solution →

arr[] = [40, 25, 19, 12, 9, 6, 2]

How can be generate all pairs?
first stand at 40 & go through all elements to right.

[40, 25, 19, 12, 9, 6, 2]

```
cnt=0;
For( i=0 ⟶ n-1){
    for(j=i+1 ⟶ n-1){
        if(a[i] > 2*a[j]){
            cnt++;
        }
    }
}
```

Time complexity → nearly $O(n^2)$
Space complexity → $O(1)$

optimal solution

for sake of understanding lets consider 2 sorting arrays

[6 13 21 25] [1 2 3 4 4 5 9 11 13]

↑

(6, 1) 6 can form pair with [1, 2]
(6, 2)

[6 13 21 25] [1 2 3 4 4 5 9 11 13]

↑

for 13 can form pair with [1, 2, 3, 4, 4, 5]
for 21 can form pair with [1, 2, 3, 4, 4, 5, 9]
for 25 can form pair with [1, 2, 3, 4, 4, 5, 9, 11]

Here we can see a pattern

→ if (1, 2) can form pair with (6) then they can also form pair with (13), (21), & (25)

→ simply (1, 2, 3, 4, 4, 5) can form pair with (13) so they can form pair with (21) & (25)

(1) [6 13 21 25] [1 2 3 4 4 5 9 11 13]

↑ ↑ ↑ ↑

✓ ✓ ✗ → stop here

6 > 2×1 | 6 > 2×2 | 6 is not > than 2×3

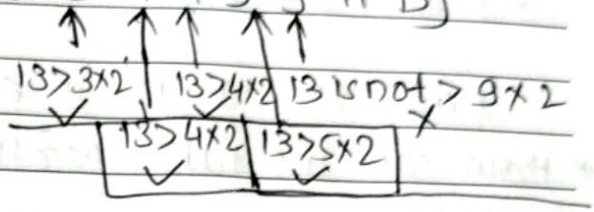
so +2 in answer (2 pairs)

(2) [6 13 21 25] [1 2 3 4 4 5 9 11 13]

↑ ↑

no need to start from 1st again start from 3

[6 13 21 25] [1 2 3 4 4 5 9 11 13]




13 → [1, 2, 3, 4, 4, 5]

Add +6 to the answer

③ [6 13 21 25] [1 2 3 4 4 5 9 11 13]

Do not need to start from 1 start from 9

21 → 21 > 9×2 ✓

21 > 11×2 ✗ [1, 2, 3, 4, 4, 5, 9]

Add +7 to the answer

④ [6, 13 21 25] [1 2 3 4 4 5 9 11 13]

start from 11

25 → 25 > 11×2 ✓

25 > 13×2 ✗ [1, 2, 3, 4, 4, 5, 9, 11]

Add +8 to the answer

0+2+6+7+8 = 23

This is what we will try to implement in mergesort.

Why merge sort?

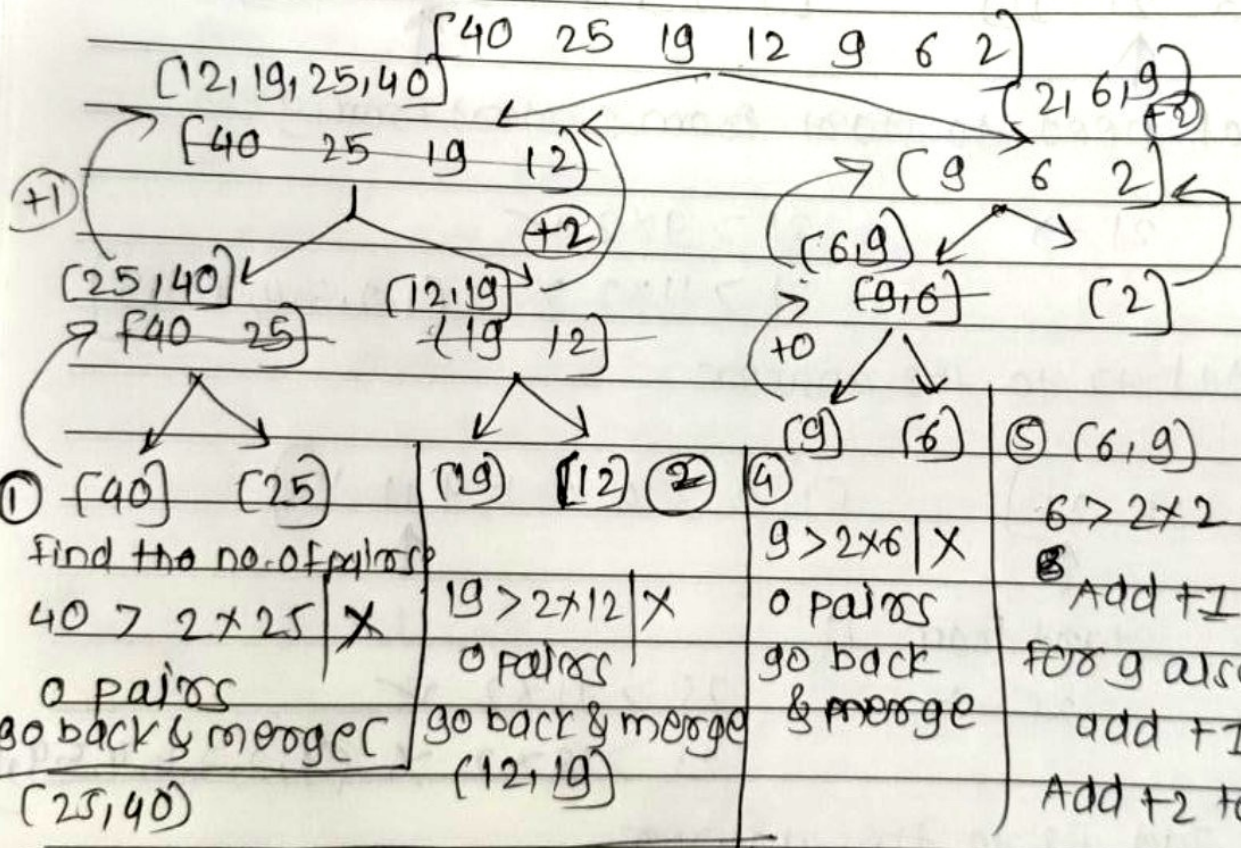
bc2 both the parts are sorted.

original problem?

[40 25 19 12 9 6 2]

* How can we take partition where we can take sorted arrays?

→ perform merge sort
divides & divides & auto convert to sorted array.




① [40] [25]
Find the no. of pairs?
40 > 2×25 | X
0 pairs
go back & merge [25,40]

② [19] [12]
19 > 2×12 | X
0 pairs
go back & merge [12,19]

④
9 > 2×6 | X
0 pairs
go back & merge

⑤ [6,9] [2]
6 > 2×2 ✓
Add +1 for 9 also
add +1
Add +2 to answer

③ [25,40] [12,19]

25 > 12×2 ✓
25 > 19×2 X
25 can form pair with 12
Add +1 to answer

40 > 19×2 ✓
40 can form pair with [12,19]
Add +2 to answer = (+3)

[2 6 9 12 19 25 40] cnt → 15

[40 25 19 12 9 6 2]

[12 19 25 40] [2 6 9]

12 > 2×2 ✓ 12 can form pair wd [2]

12 > 6×2 ✗

Add (+1) in answer

19 > 2×6 ✓ 19 can form pair wd [2,6]

19 > 2×9 ✗

Add (+2) in answer

25 there are no ele's to compare. you already finish all 3 nos [2 6 9]

Add +3 to answer

19 40,

Add +3 to answer

low mid

[6 13 21 25]

40 can form pair with [2 6 9]

[1 2 3 4 4 5 9 11 13]

mid+1 high

write fun for merge sort

```
cnt = 0;   right = mid+1;
for( i = low → mid) {
    while(right <= high && a[i] > 2*a[right]
        right++;
    cnt = cnt + (right - (mid+1))
```