

41. Reverse Pairs | Hard Interview Question

Given an integer array `nums`, return the number of **reverse pairs** in the array.

A **reverse pair** is a pair (i, j) where:

- `0 <= i < j < nums.length` and
- `nums[i] > 2 * nums[j]`.

Example 1:

Input: nums = [1,3,2,3,1]

Output: 2

Explanation: The reverse pairs are:

```
(1, 4) --> nums[1] = 3, nums[4] = 1, 3 > 2 * 1
```

```
(3, 4) --> nums[3] = 3, nums[4] = 1, 3 > 2 * 1
```

$$\text{arr}[J] = [40 \quad 25 \quad 19 \quad 12 \quad 9 \quad 6 \quad 2]$$

 ↑ ↑
find the no of pairs

$$i < j \quad \&\& \quad a[i] \geq 2 * arr[j]$$

left element should be \geq right element

$(6, 2)$ $6 > 2 * 2$
 $(9, 2)$
 $(12, 2)$, $(19, 2)$ $(\cancel{25}, 2)$ $(40, 2)$

no of pairs = 15

1) Brute Force :

i

$$\text{arr}[j] = [40 \quad 25 \quad 19 \quad 12 \quad 9 \quad 6 \quad 2]$$

cnt = 0

for (i = 0 \rightarrow n-1)

{

for (j = i+1 \rightarrow n-1)

{

if (a[i] > 2 * a[j])

cnt++;

}

}

T.C $\Rightarrow O(n^2)$ S.C $\Rightarrow O(1)$

2) Optimal Solution :

$\text{arr}[i] > 2 * \text{arr}[j]$

[6 13 21 25]

↑ ↑ ↑ ↑

[1 2 3 4 4 5 9 11 13]

$$6 \rightarrow 1, 2$$

$$13 \rightarrow 1, 2, 3, 4, 5$$

$$21 \rightarrow 1, 2, 3, 4, 5, 9$$

$$25 \rightarrow 1, 2, 3, 4, 5, 9, 11$$

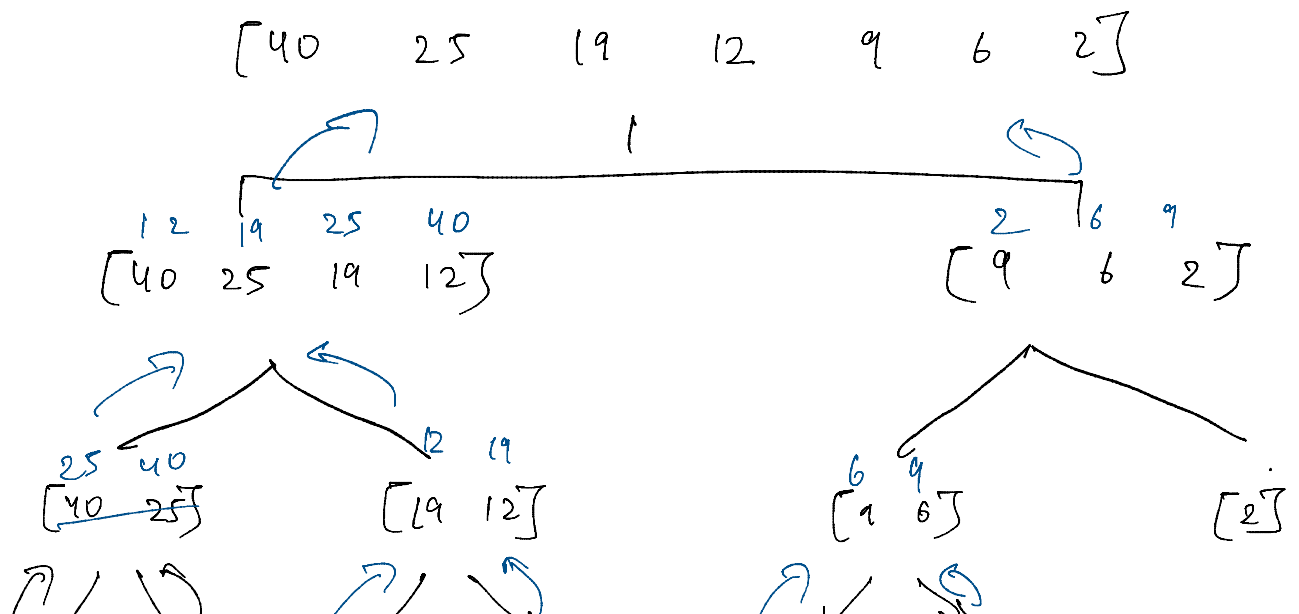


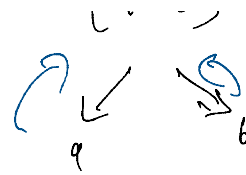
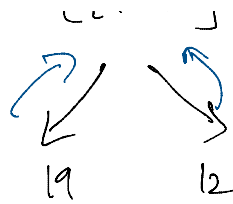
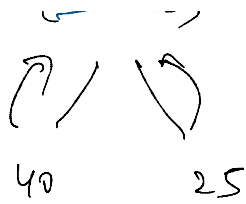
You can see a pattern here, if 1, 2 can form a pair with 6 then it can form pair with 13, 21, 25 the reason is 13 is greater than 6.

As it stored, we will iterative.

$$+2 + 6 + 7 + 8 = 23$$

this we will implement in mergesort.





$d\{40\}$

$d\{25\}$

$d\{19\}$

$d\{12\}$

$$40 > 25 * 2 \quad \times$$

$$19 > 12 * 2 \quad \times$$

$\begin{bmatrix} 25 & 40 \end{bmatrix}$
 $\uparrow \quad \uparrow$

$\begin{bmatrix} 12 & 19 \end{bmatrix}$

$25 > 12 * 2 \quad \checkmark$ (+1) so everything before 12 is possible

$$25 > 19 * 2 \quad \times$$

$$40 > 19 * 2 \quad \checkmark$$

$\begin{bmatrix} 6 & 9 \end{bmatrix} \quad \begin{bmatrix} 2 \end{bmatrix}$
 \uparrow

$$6 > 2 * 2 \quad \checkmark$$

$$9 > \quad \checkmark$$

$\begin{bmatrix} 12 & 19 & 25 & 40 \end{bmatrix}$
 $\uparrow \quad \uparrow \quad \uparrow \quad \uparrow$

$\begin{bmatrix} 2 & 6 & 9 \end{bmatrix}$
 $\uparrow \quad \uparrow \quad \uparrow$

$$12 > 2 * 2 \quad \checkmark \quad +1$$

$$12 > 2 * 2 \checkmark \quad +1$$

$$12 > 2 * 1 \times$$

$$19 > 2 * 6 \checkmark$$

$$19 > 2 * 9 \checkmark$$

Pseudo Code

[6 13 21 25]

↑
low

↑
mid

[1 2 3 4 4 5 9 11 13]

↑
mid+1

↑
low

cnt = 0, right = mid + 1

for (i = low → mid)

{

while (right ≤ high && $a[i] > 2 * a[right]$)

→ if the cond. is met

{

right ++;

}

cnt = cnt + (right - (mid + 1)) // will give no. of

}

element



x

$$T.C \Rightarrow O(\log n \times (n + n))$$
$$= O(2n \log n)$$

$$S.C \Rightarrow O(n)$$



x