

Ques Merge 2 sorted arrays

$$\boxed{1 \mid 3 \mid 7 \mid 11 \mid 13} \quad n_1$$

$$\boxed{2 \mid 4 \mid 5 \mid 6 \mid 8 \mid 14 \mid 15} \quad n_2$$

Res

$$\boxed{1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 11 \mid 13 \mid 14 \mid 15}$$

$$n_1 + n_2 = n$$

Create new array ($n_1 + n_2$)

Copy both the array ($n_1 + n_2$) $\Rightarrow O(n)$

Sort the resultant array $\Rightarrow n \log n$

$$T C \geq n + n \log(n) \Rightarrow O(n \log n)$$

L =

$$\boxed{1 \mid 3 \mid 7 \mid 11 \mid 13}$$

$$\boxed{2 \mid 4 \mid 5 \mid 6 \mid 8 \mid 14 \mid 15}$$

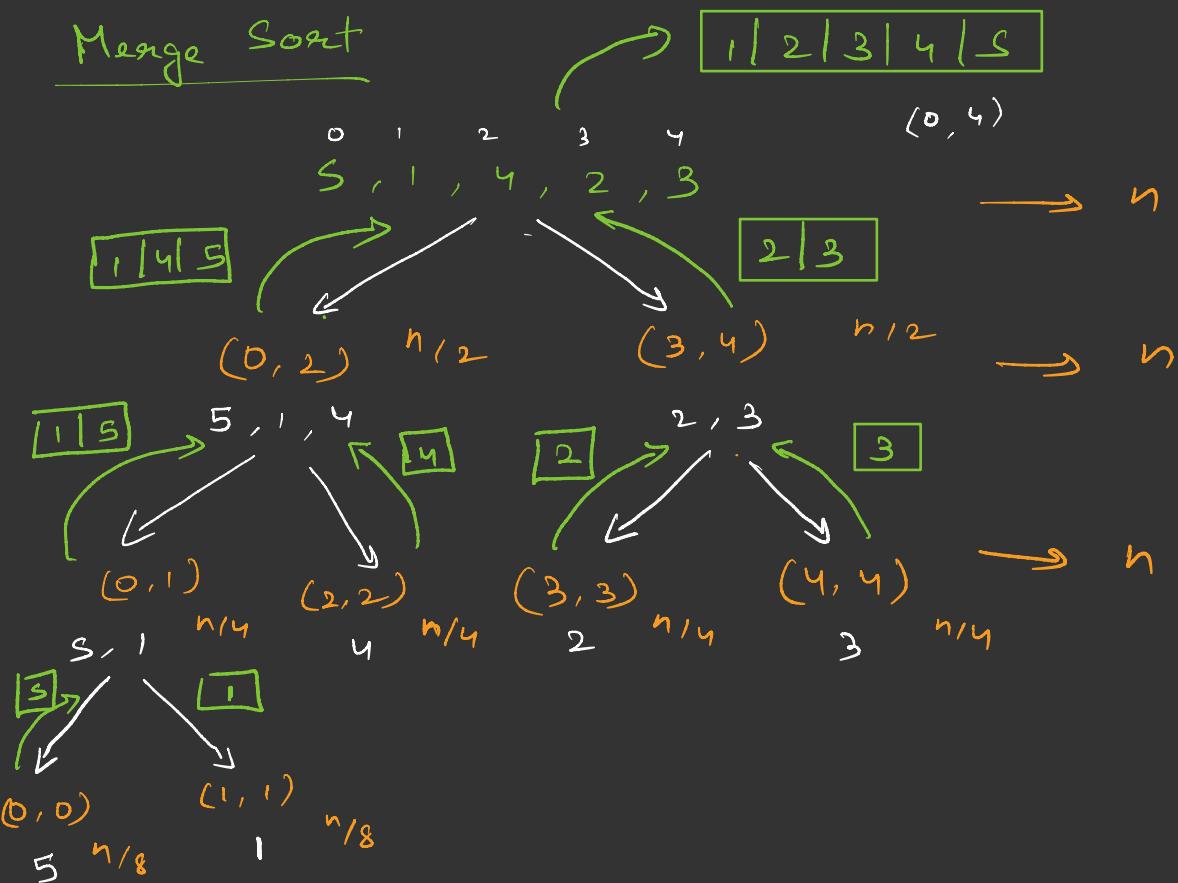
Res

$$\boxed{1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 11 \mid 13 \mid 14 \mid 15}$$

$$T C \geq O(n)$$

$$n = n_1 + n_2$$

Merge Sort



$$\frac{n}{2^k} = 1$$

$$k \Rightarrow \log_2(n)$$

$T_C \Rightarrow$ no of operations \times no of levels
per level

$$n \times \log_2 n$$

$T_C \Rightarrow O(n \log n)$

Ques Partition your array 4

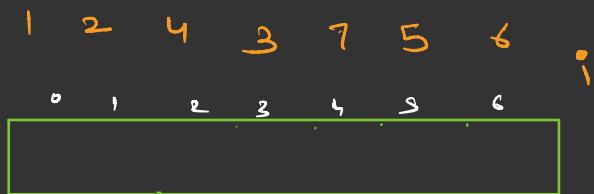
$\boxed{5 | 1 | 2 | 4 | 7 | 3 | 6}$ $\leq =$

all elements on left of pivot
should be smaller or equal to pivot

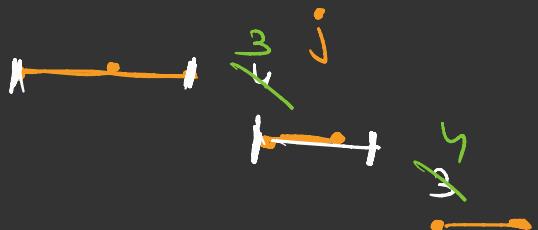
all elements on right of pivot
should be greater than pivot

$\boxed{3 | 1 | 1 | 2 | 4 | 7 | 5 | 6}$

pivot = 4



① 0 to $j - 1 \leq \text{pivot}$



② j to $i - 1 > \text{pivot}$

③ i to end unknown

①
swap(i, j)
 $i++$
 $j++$

②
 $i++$

③
 $0 - \cancel{3}^{j-1}$
 $4 - \cancel{5}^{i-1}$
 j $i-1$
swap

0 1 4 3 0 0 1 3 1 0
 0 0 0 0 1 3 4 3 1 3 1

Ques Sort 0, 1
 partition odd even

i
Ques
 0 ~~1~~ 3 ~~1~~ 0 1 4 2 1 0
 j

$\Rightarrow 0 \rightarrow j-1$
 $j \rightarrow i-1$
 unknown $i \rightarrow \text{end}$

(1)
 $\text{swap}(i, j)$

$i++$
 $j++$

(2)
 $i++$





$i = 3$

$j = 2$

3 Way Partitioning

Sort 0, 1, 2

Ques
Partition

$p=4$

Pivot = 4

< pivot 0 to $q-1$ ①
= pivot q to $m-1$ ②

Unknown $m+1$ to r

> pivot $r+1$ to end ③

l or

1	2	3	4	5	6	7	8	9
✓	✓	✓	4	✓	✓	✓	✓	✓

1 2

4

5

③

swap(m, r)
 $r--$

①
swap(m, l)

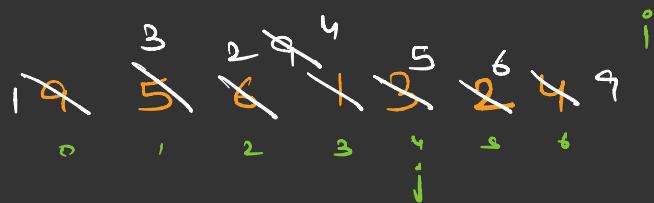
②
 $m++$

$m++$
 $q++$

— — (m) r —

Ques partition around index

Pivot = 4

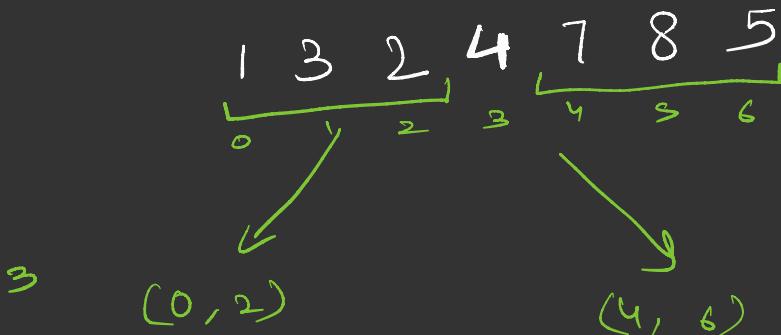


\leq pivot $0 \rightarrow$ ①

> pivot $j \rightarrow$ ②

unknown $i \rightarrow$ end

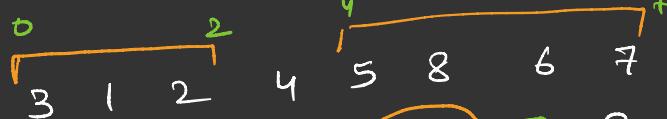
Ques Quick Sort (arr, s, e)



```
int pivot = arr[end];
int pi = partition(arr, pivot, start, end); → 3
quickSort(arr, start, pi - 1);
quickSort(arr, pi + 1, end);
```

$\begin{matrix} \cdot & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\ 5 & 8 & 3 & 1 & 6 & 2 & 7 & 4 \end{matrix}$ $(0, 8)$

$p_1 = 3$



$p_1 = 1$ 1 2 3 = 4

$p_1 = 6$

5 6 7 8 $p_1 = 5$

$(0, 7) p_1 = 3$

$(0, 2) p_1 = 1$

$(4, 7) p_1 = 6$

$(0, 0)$

$(2, 2)$

$(4, 5) p_1 = 5$

$(7, 7)$

$(4, 4)$

$(6, 5)$

$$l = \frac{n}{2^k}$$

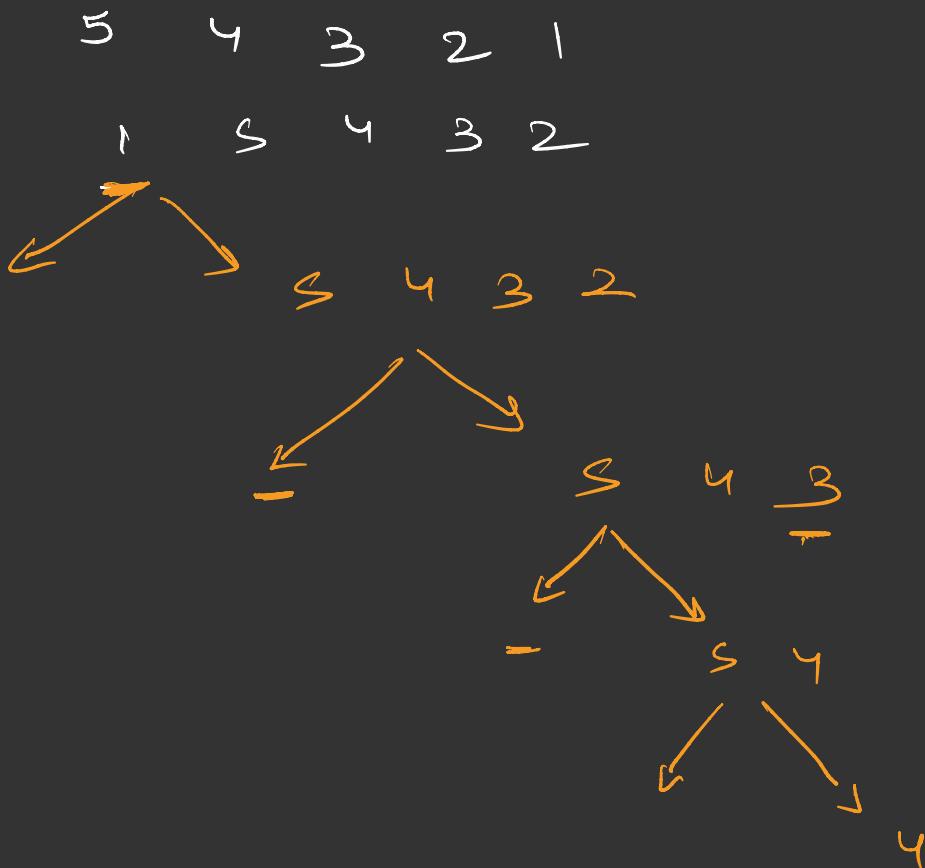
$\underbrace{n + n + n + \dots + n}_k$

$$k = \log n$$

$$n \times k$$

$$\Rightarrow n \times \log_2 n$$

$T C O(n \log n)$



Worst case $\Rightarrow O(n^2)$

→ choose pivot randomly

TC $\Rightarrow O(n \log n)$

Auxiliary Space $O(1)$

Inplace sorting

not stable