

divide & conquer

↳ Class of Problem

- works on concept of partitioning.
- Choose one pivot elem^t [last elem].
- pivot elem^t & partition \Rightarrow array \rightarrow subarray.

1 8 3 9 4 5 7
↓
Pivot

① Choose a Pivot element.

less than
7

7

Greater
than 7

1 3 4 5

7

Pivot

8 9

9 4 3 6 2 8 1 7

< 7

Pivot

> 7

Relative
Order

4 3 2 7 9 8

4 3 2

1 4 3 6 2 7 9 8

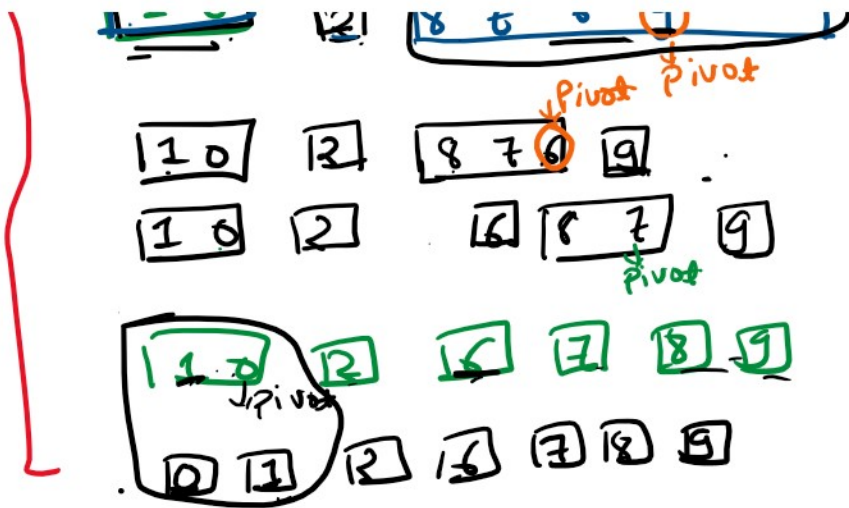
1 2 4 3 6 7 9 8

1 4 3 6 7 9 8

1 3 4 6 7 2 8

1 3 4 6 7 9 8

8 7 6 4 0 9 2
low ↓ high ↓ Pivot
1 0 2 8 7 6 9
Pivot Pivot



Pseudo code:-



QuickSort (arr, low, high) {

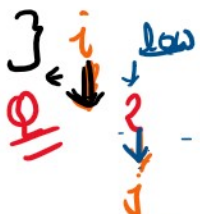
if (low \geq high) {
return;

}

let Pi = Partition (arr, low, high)
index of Pivot elem.

QuickSort (arr, low, Pi - 1)

QuickSort (arr, Pi + 1, high)



0 1 2 3 4 5 6 7 8 9

→ Before i pointer, all elem. should be less than Pivot elem.

let pivot = arr[high]

for (let j = low; j < high; j++) {

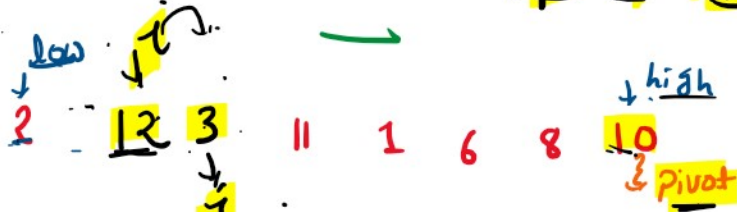
if (arr[j] < pivot) {

→ j++

→ Swap (arr[j], arr[high])

→ swap (arr[i], arr[j])

arr[i] arr[j] arr[i]



2 < 10
 12 > 10

2 3 12 11 1 6 8 10

3 < 10

2 3 1 11 12 6 8 10

11 < 10
 1 < 10

2 3 1 6 12 11 8 10

6 < 10

8 < 10

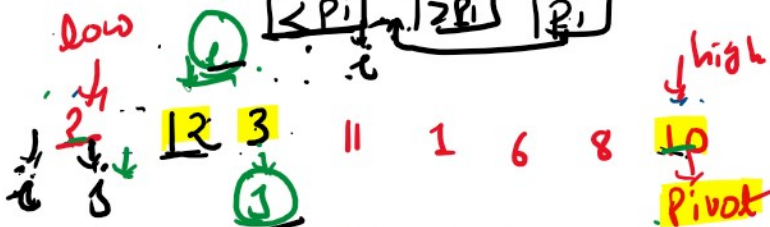
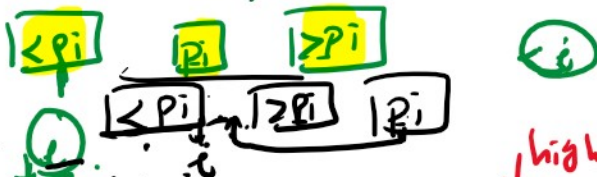
2 3 1 6 8 11 12 10

j < high



swap (arr[i], arr[pivot])

2 3 1 6 8 10 12 11



arr[i] < pivot

2 < 10 ✓

12 < 10 ✗

between

$2 < 10$ ✓ $10 < 10$ ✗
 $3 < 10$ ✓ before i
 $12 < 10$ ✗ $< \text{pivot}$

$\downarrow \text{low}$ $\downarrow \text{high}$
 2 12 3 11 1 6 8 10
 -1 0 1 2 3 4 5 6 idx
 $< i$ $2 < 10$ ✓ it's swap itself
 $< \text{Pivot}$ $12 < 10$ $3 < 10$

2 3 12 11 1 6 8 10
 $\downarrow i$ $\downarrow j$
 $\downarrow \text{low}$ $\downarrow \text{high}$
 2 12 3 11 1 6 8 10
 $\downarrow i$ $\downarrow j$
 let $pi = \text{arr}[\text{high}]$ Pivot $j = \text{low} \rightarrow \text{high}$

$i = \text{low} - 1$ // $0 - 1 = -1$
 $\text{arr}[i] < \text{Pivot}$ $2 < \text{Pivot}$ $\text{arr}[j] < \text{Pivot}$
 $\text{arr}[i] < \text{Pivot}$ $2 < 10$ ✓
 i^{th} region $12 < 10$ ✗
 $3 < 10$

$\downarrow \text{low}$ $\downarrow \text{high}$
 2 12 3 11 1 6 8 10
 $\downarrow i$ $\downarrow j$
 Pivot

swap i & j
 2 3 12 11 1 6 8 10
 $\downarrow i$ $\downarrow j$
 \rightarrow 2 3 1 11 12 6 8 10 $1 < 10$

$\rightarrow 2 \ 3 \ 1 \ 11 \ 12 \ 6 \ 8 \ 10$
 $\rightarrow 2$
 $1 < 10$
 $6 < 10$

$2 \ 3 \ 1 \ 6 \ 12 \ 11 \ 8 \ 10$
 $\downarrow \quad \downarrow$
 $[2 \ 3 \ 1 \ 6 \ 8 \ 11 \ 12 \ 10]$
 $\downarrow \quad \downarrow$
 $< P_i \quad > P_i \quad P_i$
 Swap [Pivot, i+1]
 Pivot Pivot Pivot Pivot
 $1 \ 2 \ 3 \ 1 \ 6 \ 8 \ 10 \ 12 \ 11$
 $> \text{Pivot}$

$8 \ 4 \ 3 \ 6 \ 2 \ 9 \ 1 \ 7$

$5 \ 6 \ 9 \ 1 \ 10 \ 12 \ 15$
 Pivot

$5 \ 6 \ 9 \ 10 \ 12 \ 15$

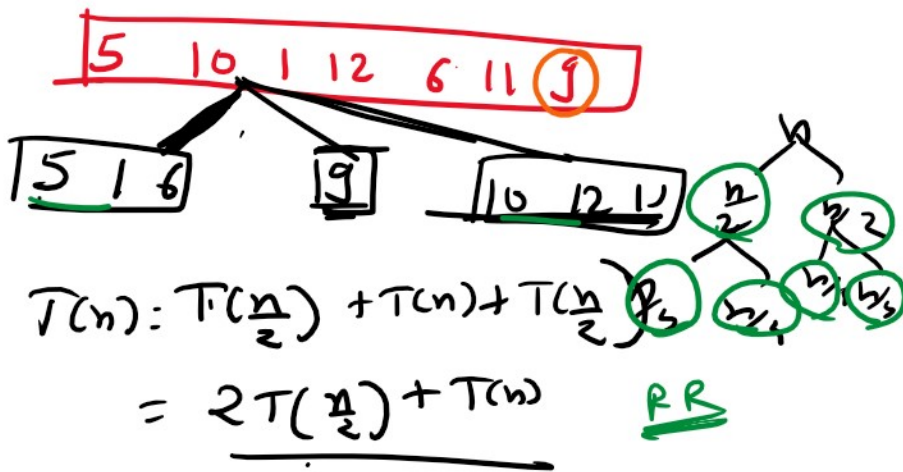
$5 \ 6 \ 9 \ 10 \ 12 \ 15$ Worst

$5 \ 6 \ 9 \ 10 \ 12 \ 15$

$1 \ 5 \ 6 \ 9 \ 10 \ 12 \ 15$
 14

$$T(n) = T(n-1) + T(1) + O(n)$$

$$T(n) = O(n^2)$$



$T(n) = n \log n$

Merge

Avg - $O(n \log n)$
 Worst - $O(n \log n)$
 Best - $O(n \log n)$

SC: $O(n)$

Quick

Avg - $O(n \log n)$
 Worst - $O(n^2)$
 Best - $O(n \log n)$

SC: $\log n$

Monday

8 PM \Rightarrow Quick sort - 2

5 PM

[Signature]