20/10/2023

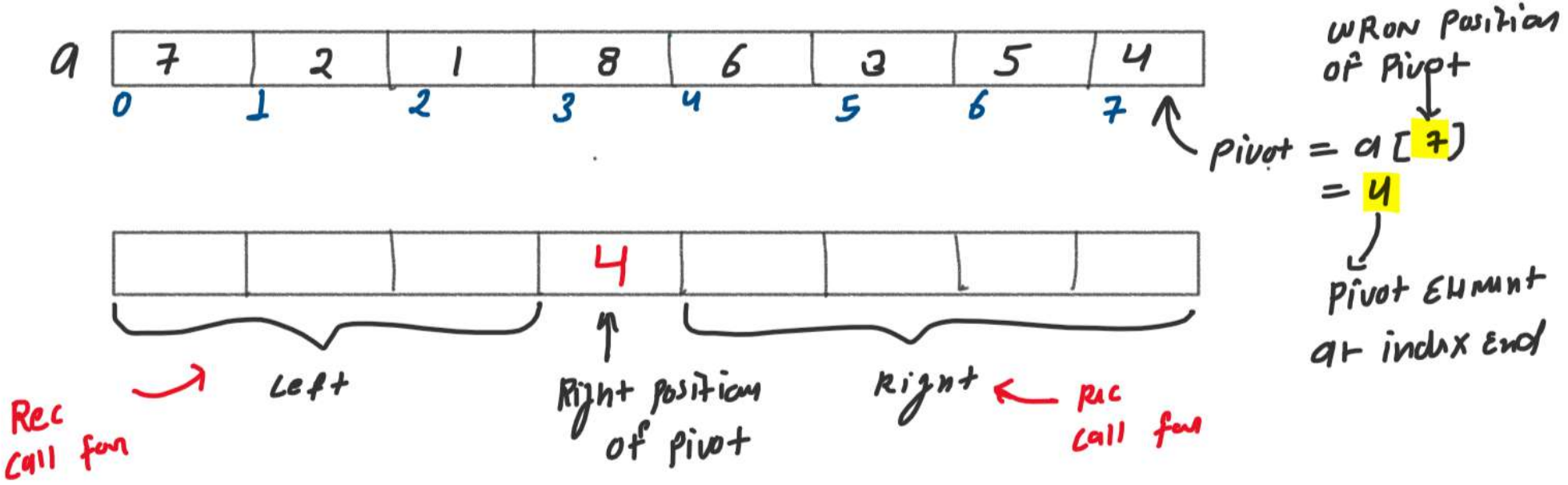
QUICK SORT ALGORITHM

QUICK SORT ALGORITHM

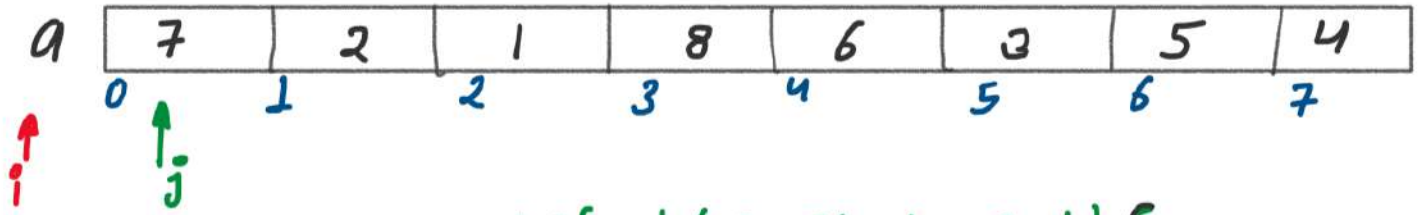
New way to partitioning of array (Ek Step Chalna Mujhe Aata hai)

Step 01: *Find pivot (It is always end element of array)*
- *To place pivot such that the element to the* ***right of pivot > a[pivot]***
- *To place pivot such that the element to the* ***left of pivot < a[pivot]***

Step 02: *Now apply recursion for left and right part of pivot (Baki ka recusion sambhal Lega)*



STEP:01



start = 0

End = 7

pivot = end

i = start - 1

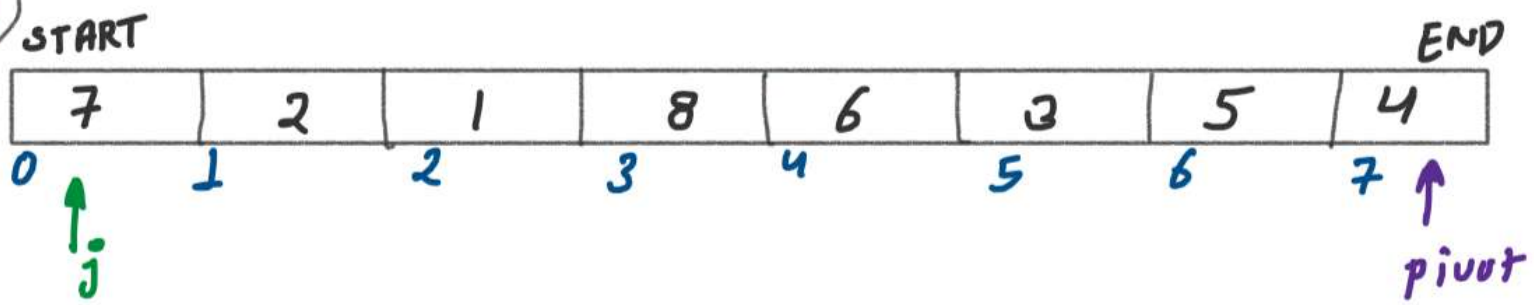
j = start

```
quickSort ( a , start , end ) {
    while ( j < pivot) {
        if ( a[j] < a[pivot] ) {
            i++;
            swap( a[j], a[i]) ;
        }
        j++;
    }
    i++;
    swap( a[i], a[pivot]) ;
}
```

MUJHE **First STEP** Chalna AATA Hai jaha par me 4 ko uski **Right Position** par RAKhana jata HU.

DRY RUN FOR

STEP 1



①

start = 0

End = 7

pivot = End

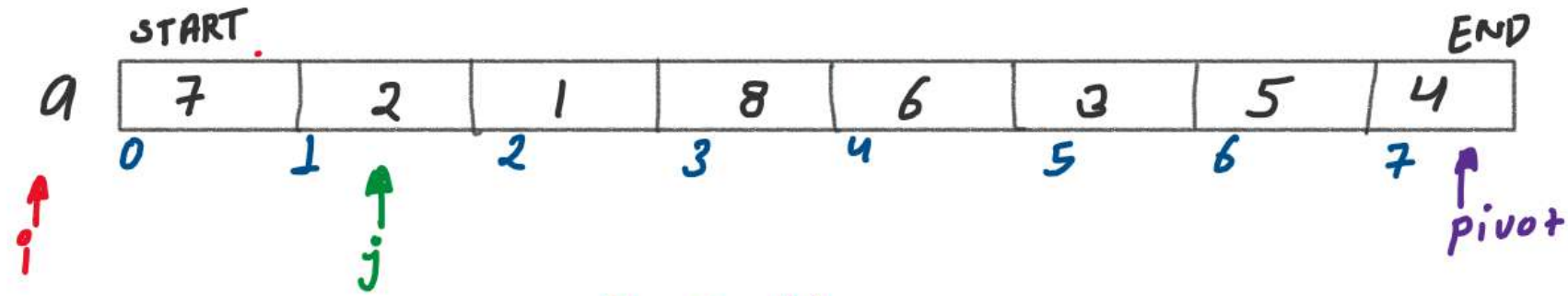
i = start - 1

j = ~~start~~ 1

a[j] > a[pivot]

7 > 4

j++



(2)

start = 0

End = 7

pivot = End

i = ~~start~~ -1 0

j = ~~1~~ 2

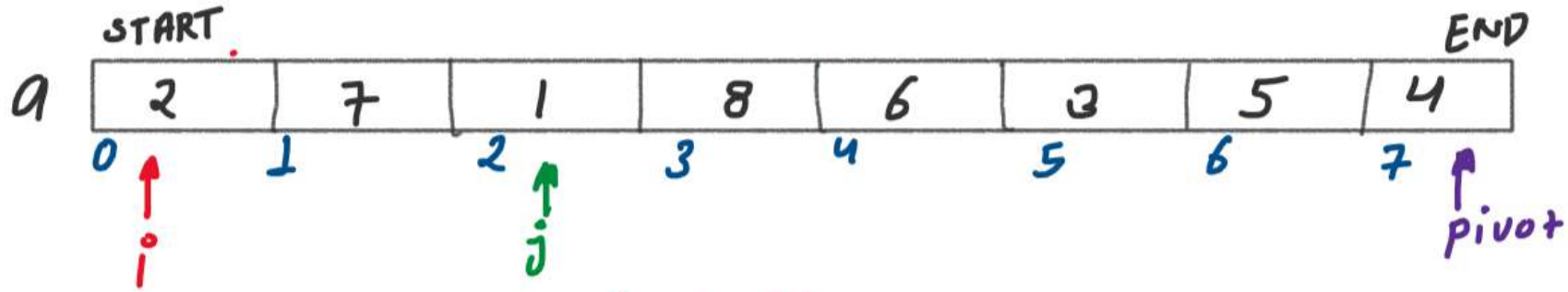
2 < 4

a[j] < a[pivot]

i++

swap(a[i] , a[j])
7 2

j++



③

start = 0

end = 7

pivot = end

i = ~~0~~ 1

j = ~~7~~ 3

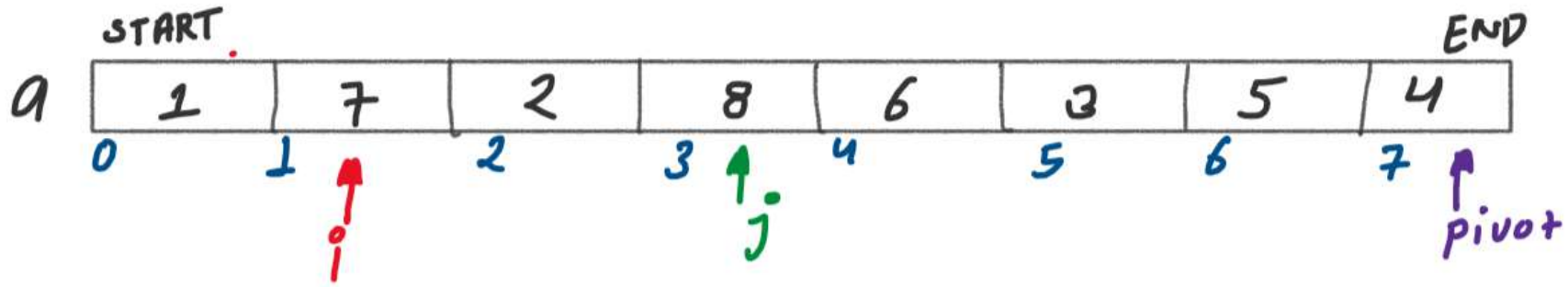
1 < 4

a[j] < a[pivot]

i++

swap(a[i], a[j])
2 1

j++



(4)

start = 0

end = 7

pivot = end

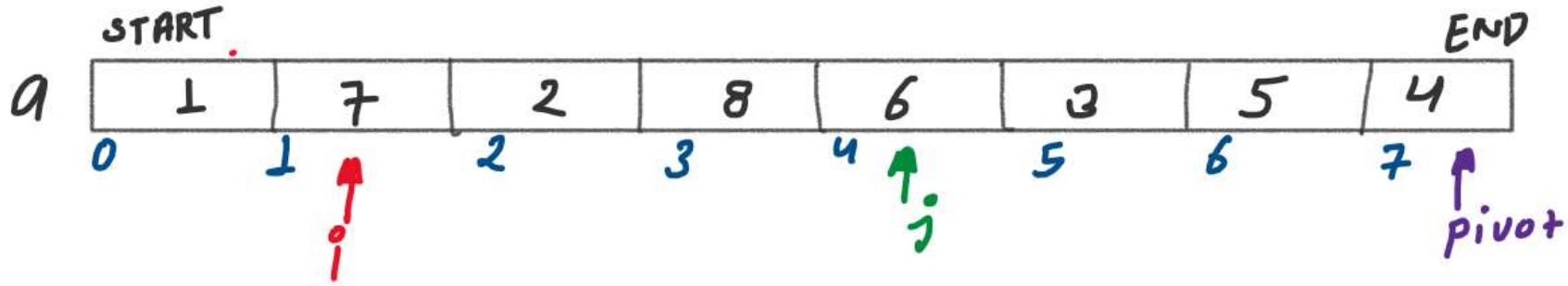
i = 1

j = ~~3~~ 4

a[j] > a[pivot]

8 > 4

j++



(5)

start = 0

End = 7

pivot = End

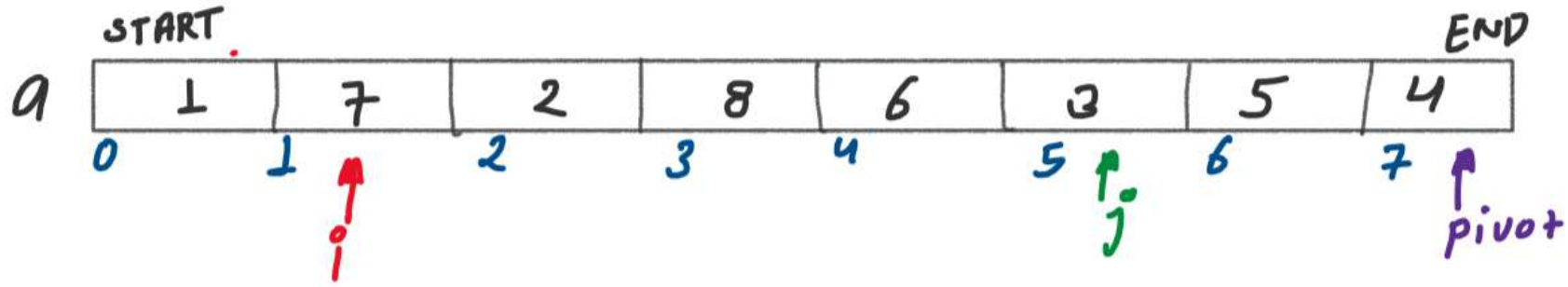
i = 1

j = ~~4~~ 5

a[j] > a[pivot]

6 > 4

j++



(6)

start = 0

End = 7

pivot = End

i = ~~1~~ 2

j = ~~5~~ 6

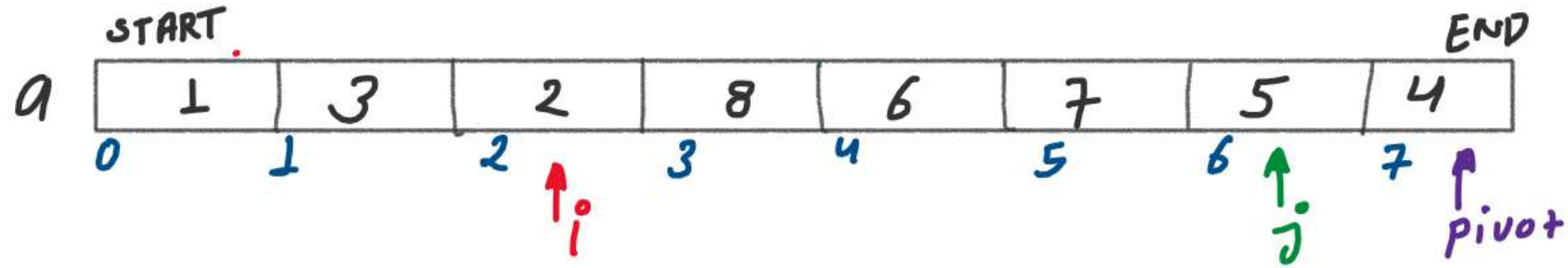
a[j] < a[pivot]

3 < 4

i++

swap(a[i] , a[j])

j++ 7 3



(7)

start = 0

end = 7

pivot = end

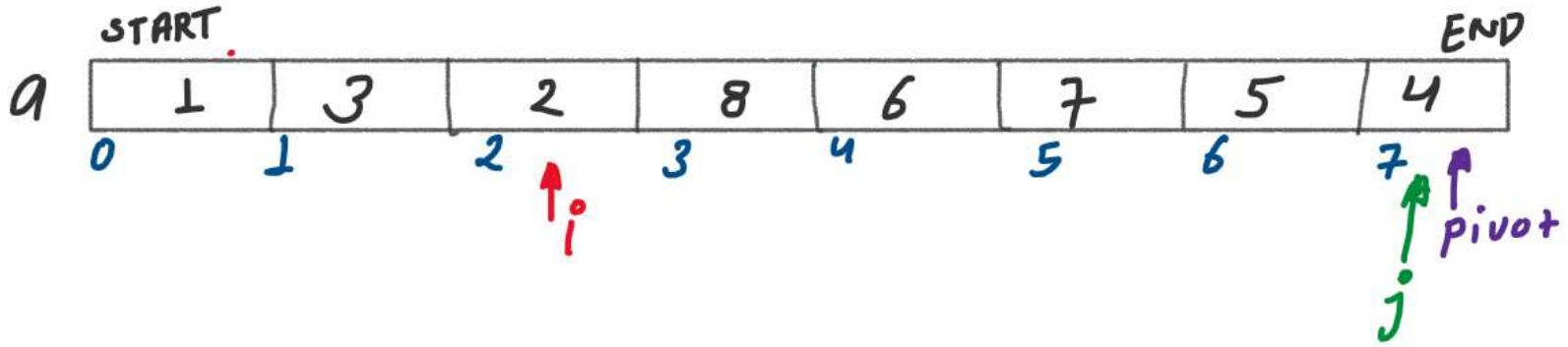
i = 2

j = ~~6~~ 7

a[j] > a[pivot]

5 7 4

j++



(8)

start = 0

End = 7

pivot = End

i = ~~2~~ 3

j = 7

while(j < pivot) {---}

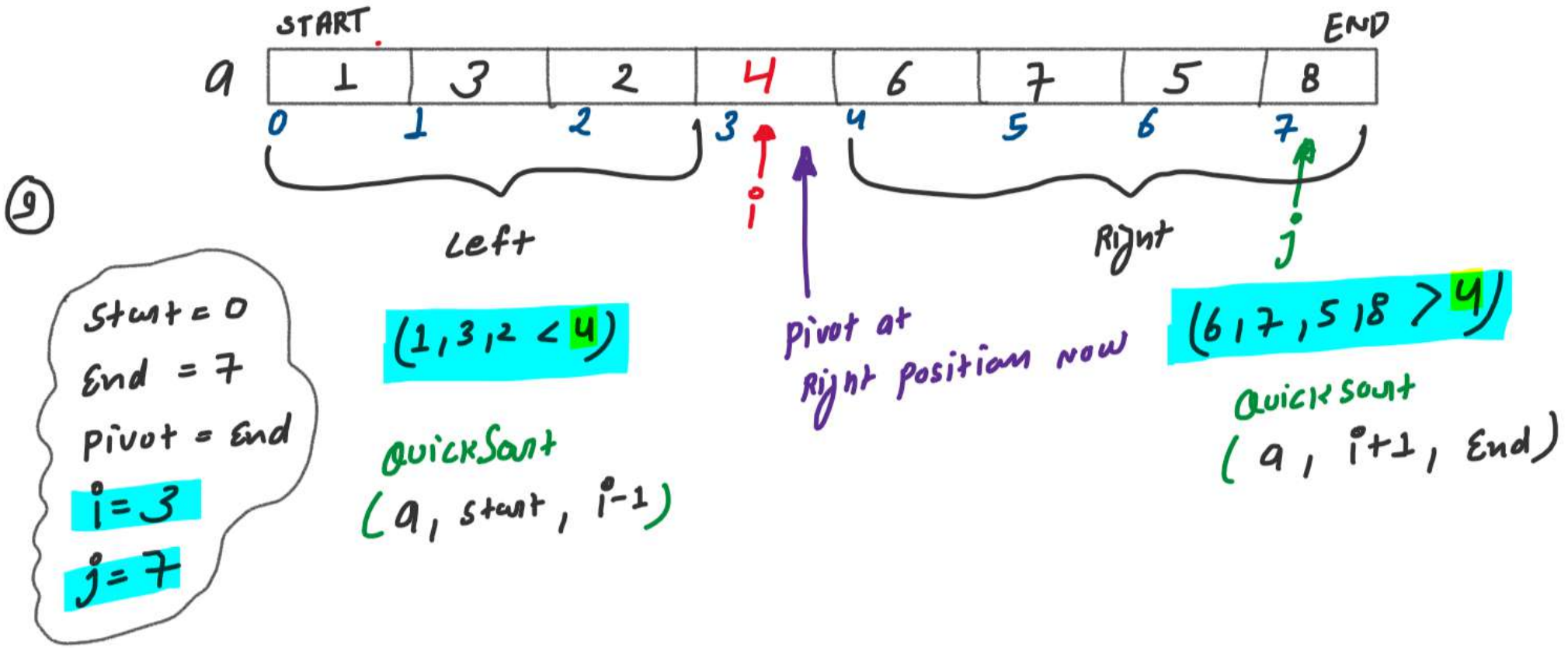
↓ 7 < 7 X while loop me entry nahi karungi

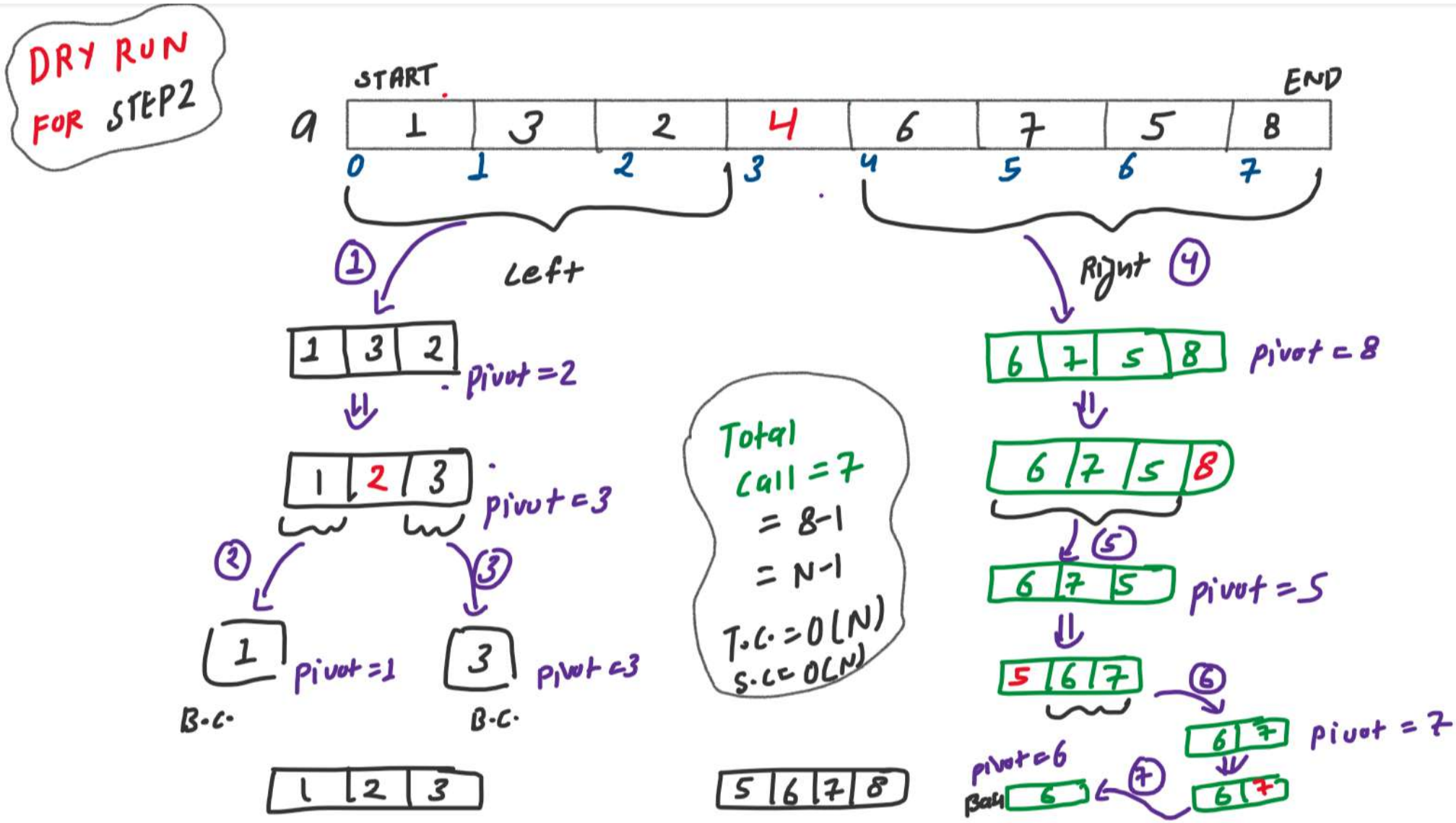
Outside of while loop

i++

swap(a[i], a[pivot]);

8 4


START
END
a
1
3
2
4
6
7
5
8
0
1
2
3
4
5
6
7
i
j
Left
Right
Pivot at
Right position now
(1,3,2 < 4)
(6,7,5,8 > 4)
quickSort
(a, start, i-1)
quickSort
(a, i+1, End)
start = 0
End = 7
pivot = End
i = 3
j = 7


DRY RUN FOR STEP2
START
END
a
1 3 2 4 6 7 5 8
0 1 2 3 4 5 6 7
Left
Right
1 3 2
pivot = 2
1 2 3
pivot = 3
1
pivot = 1
B.C.
3
pivot = 3
B.C.
1 2 3
Total call = 7
= 8-1
= N-1
T.C. = O(N)
S.C. = O(N)
5 6 7 8
6 7 5 8
pivot = 8
6 7 5
pivot = 5
5 6 7
6 7
pivot = 7
pivot = 6
Bas
6
6 7

```
//Function to sort an array using quick sort algorithm.
void quickSort(int arr[], int start, int end)
{
    // Base Case
    if(start>=end) {
        return;
    }

    int pivot = end;
    int i = start - 1;
    int j = start;

    while(j < pivot){
        if(arr[j] < arr[pivot]){
            i++;
            swap(arr[i], arr[j]);
        }
        j++;
    }
    i++;
    swap(arr[i], arr[pivot]);

    // Recursive call karlo Left part ke liye
    quickSort(arr, start, i - 1);
    // Recursive call karlo Right part ke liye
    quickSort(arr, i + 1, end);
}
```

SWAP 2 T.C. = O(N)
S.C = O(N)

SWAP: 01
T.C = O(N²)
S.C = O(1)

STEP 1 WORST CASE T.C.

EX | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

T.C. = O(N²) S.C. = O(1)

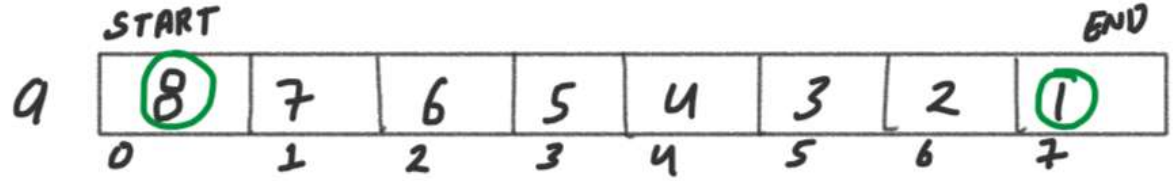
STEP 2 RECURSIVE CALL

S.C = O(N)
T.C. = O(N)

Total T.C. = O(N²) + O(N)
= O(N²)

Total S.C. = O(N) + (1)
= O(N)

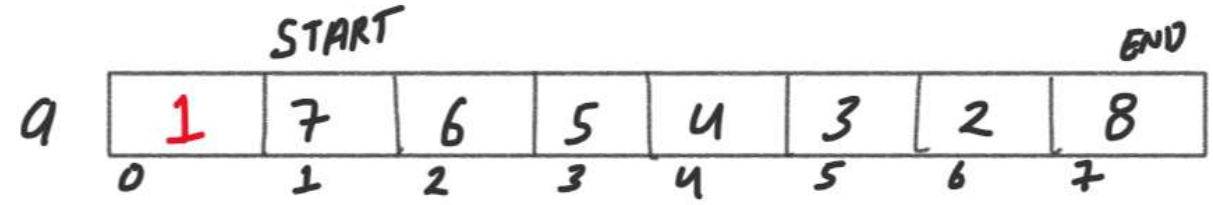
EX = 2 DRY RUN



(1) start = 0 End = 7 PI = 7 i = -1 j = 0

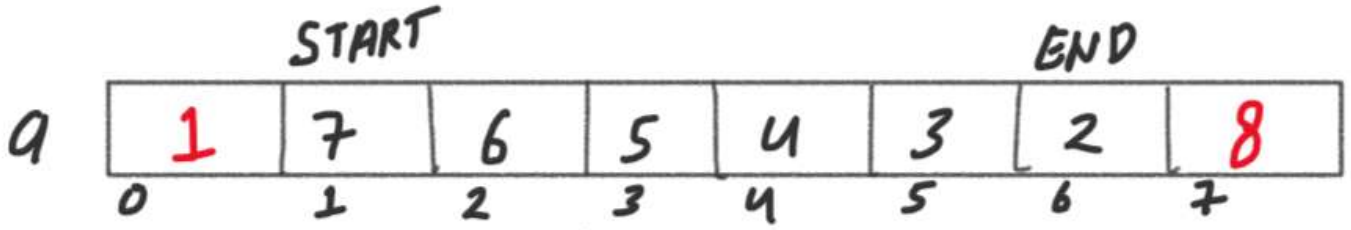
i=-1	j=0	8>1	j=1	8 7 6 5 4 3 2 1
i=-1	j=1	7>1	j=2	"
i=-1	j=2	6>1	j=3	"
i=-1	j=3	5>1	j=4	"
i=-1	j=4	4>1	j=5	"
i=-1	j=5	3>1	j=6	"
i=-1	j=6	2>1	j=7	"
i=-1	j=7 X	→	i=0	swap(8, 1) ⇒ 1 7 6 5 4 3 2 8

1 at right position



(2) start = i+1 = 1 End = 7 PI = 7 i = 0 j = 1

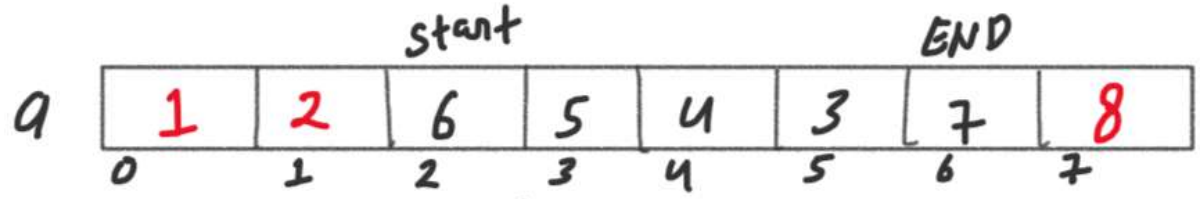
i=0	j=1	7<8	i=1	swap(7,7)	j=2	1	7 6 5 4 3 2 8
i=1	j=2	6<8	i=2	swap(6,6)	j=3		11
i=2	j=3	5<8	i=3	swap(5,5)	j=4		11
i=3	j=4	4<8	i=4	swap(4,4)	j=5		11
i=4	j=5	3<8	i=5	swap(3,3)	j=6		11
i=5	j=6	2<8	i=6	swap(2,2)	j=7	1	7 6 5 4 3 2 8
i=6	j=7 X	→ i=7	swap(8,8) ⇒			1	7 6 5 4 3 2 8 → 8 at Right Index



(3) start = 1 End = i - 1 = 7 - 1 = 6 PI = 6 i = 0 j = 1

i=0	j=1	7 > 2	j=2	[1] 7 6 5 4 3 2 [8]
i=0	j=2	6 > 2	j=3	"
i=0	j=3	5 > 2	j=4	"
i=0	j=4	4 > 2	j=5	"
i=0	j=5	3 > 2	j=6	"
i=0	j=6 X	→ i=1	swap(7,2) ⇒	[1 2] 6 5 4 3 7 [8]

2 at right positions



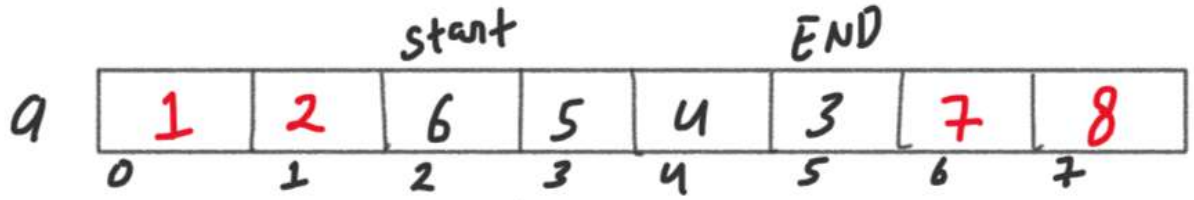
(4) start = i+1 End = 6 PI = 6 i = 1 j = 2

= 1+1

= 2

i=1	j=2	(6<7)	i=2	swap(6,6)	j=3	[1] [2] 6 5 4 3 7 [8]
i=2	j=3	(5<7)	i=3	swap(5,5)	j=4	
j=3	j=4	(4<7)	i=4	swap(4,4)	j=5	
i=4	j=5	(3<7)	i=5	swap(3,3)	j=6	
i=5	j=6 X →	i=6	swap(7,7) =>	[1|2] 6 5 4 3 [7|8]		

7 at right position



(5) start = 2 End = i - 1 = 6 - 1 = 5 pi = 5 i = 1 j = 2

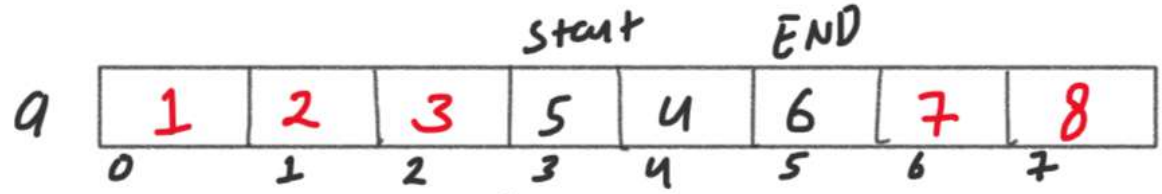
i = 1 j = 2 6 > 3 j = 3 [1] [2] 6 5 4 3 [7] [8]

i = 1 j = 3 5 > 3 j = 4

i = 1 j = 4 4 > 3 j = 5

i = 1 j = 5 ✗ → i = 2 swap(6, 3) ⇒ [1] [2] [3] 5 4 6 [7] [8]

3 at Right position



(6) start = i+1 End = 5 Pi = 5 i = 2 j = 3

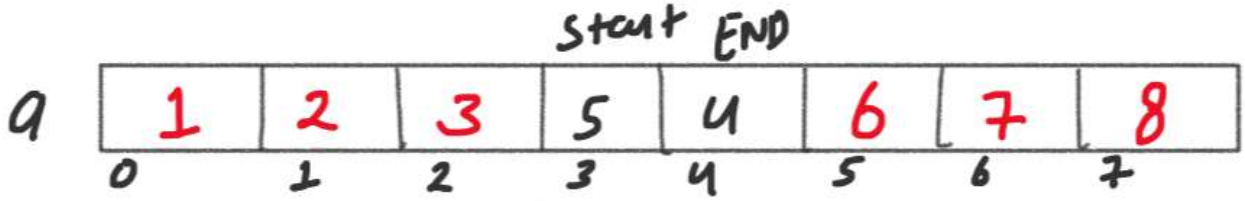
= 2+1

= 3

i=2 j=3 5<6 i=3 swap(5,5) j=4 1 2 3 5 4 6 7 8

i=3 j=4 4<6 i=4 swap(4,4) j=5 ||

i=4 j=5 X → i=5 swap(6,6) ⇒ 1 2 3 5 4 6 7 8 ← 6 at Right position

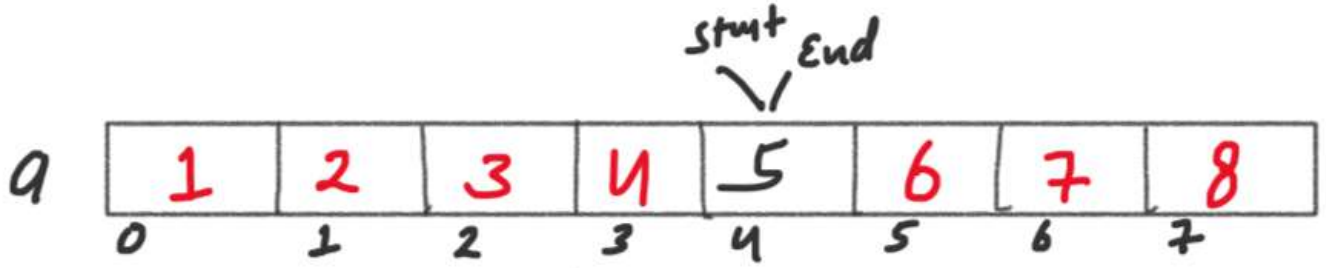


(7) start = 3 End = i-1 = 5-1 = 4 PI = 4 i = 2 j = 3

i = 2 j = 3 5 > 4 j = 4 1 2 3 5 4 6 7 8

i = 2 j = 4 X → i = 3 swap (5, 4) ⇒ 1 2 3 4 5 6 7 8

4 at right position

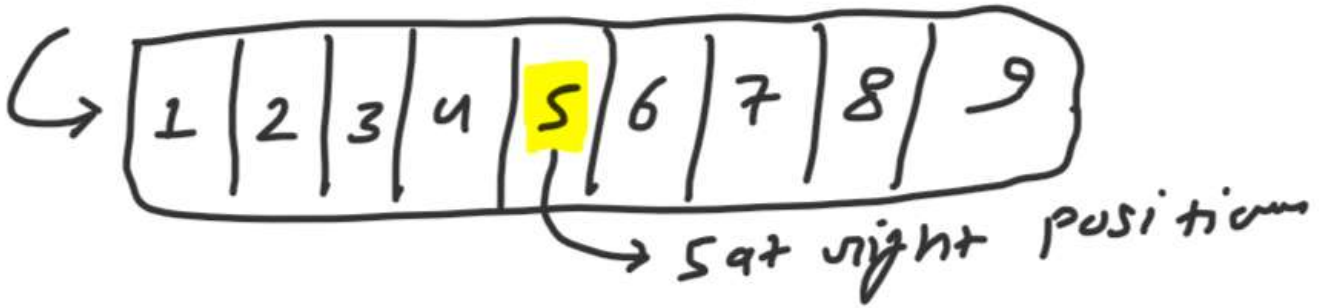


(B) start = i+1 End = 4 PI = 4 i = 3. j = 4

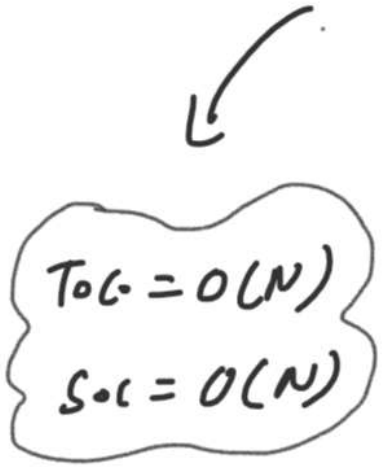
= 3+1

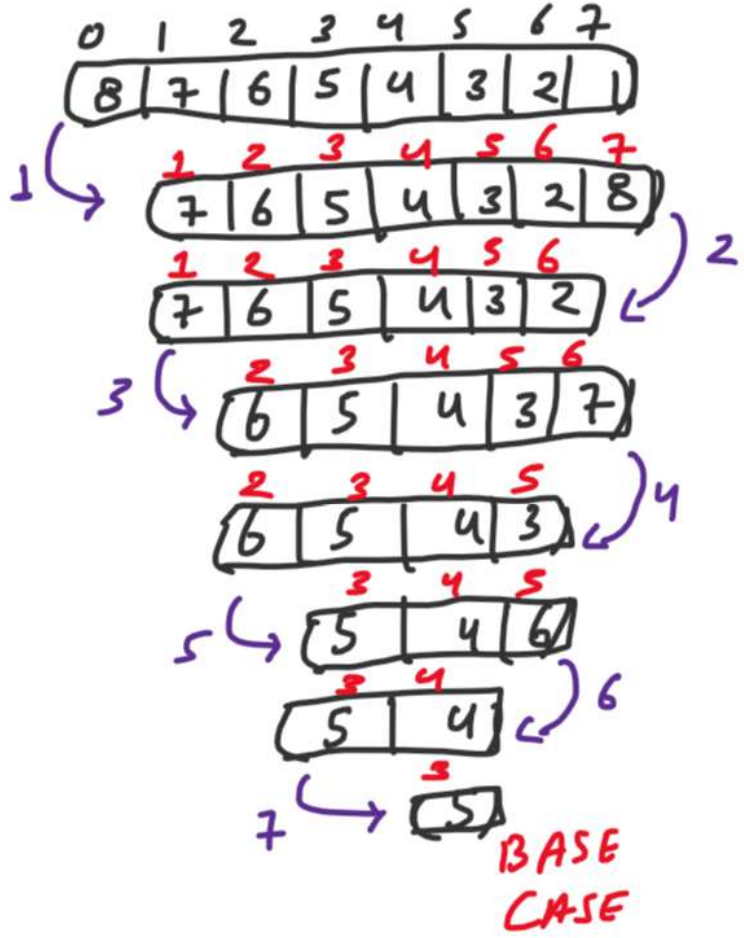
= 4

(start > = End) RUK jao ... --



RECURSIVE TREE





s+ = 0 En = 7

s = 1 end = 7

s = 1 end = 6

s = 2 end = 6

s = 2 end = 5

s = 3 end = 5

s = 3 end = 4

s = 3 end = 3

(S >= E) BASE CASE