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YOUVA

Data Structures and Algorithms.

Assignment - 2.

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2303014200 5.

Consider the following array of integer numbers:

3, 5, 78, 89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 6.

Sort above using:

1. Bubble Sort.
2. Insertion Sort
3. Selection Sort
4. Quick Sort
5. Merge Sort.

Show every pass of sorting.

2 Insertion Sort

3, 5, 78, 89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 6.

Step 1: Select (5) and compare with (3), no swap.

3, 5, 78, 89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 6.

Step 2: Select (78) and compare with (5), no swap.

3, 5, 78, 89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 6.

Step 3: Select (89) and compare with (78), no swap.

3, 5, 78, 89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 6.

Step 4: Select (456) and compare with (89), no swap.

3, 5, 78, 89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 6.

Step 5: Select (123) and compare with (456), (123) < (456), so place infront of (456).

3, 5, 78, 89, ~~123~~ 456, [123] ~~456~~, 23, 9, 7, 200, 308, 196, 345, 6.

Step 6: Select (23) and compare with elements on the left and insert it accordingly.

3, 5, 78, 89, 123, 456, [23], 9, 7, 200, 308, 196, 345, 6.

Step 7: Select (9) and compare with elements on the left and insert accordingly.

3, 5, 23, 78, 89, 123, 456, [9], 7, 200, 308, 196, 345, 6.

Step 8: Select (7) and compare with elements on the left and insert accordingly.

3, 5, 9, 23, 78, 89, 123, 456, [7], 200, 308, 196, 345, 6.

Step 9: Select (200) and compare with elements on the left, and insert accordingly.

3, 5, 7, 9, 23, 78, 89, 123, 456, [200], 308, 196, 345, 6.

Step10: Select (308) and compare with elements on the left and insert accordingly.

3, 5, 7, 9, 23, 78, 89, 123, 200, 456, [308], 196, 345, 6.

Step 11: Select (196) and compare with elements on the left and insert accordingly.

3, 5, 7, 9, 23, 78, 89, 123, 200, 308, 456, [196], 345, 6.

Step 12: Select (345) and compare with elements on the left. and insert accordingly.

3, 5, 7, 9, 23, 78, 89, 123, 196, 200, 308, 456, [345], 6.

Step 13: Select (6) and compare with elements on the left and insert accordingly.

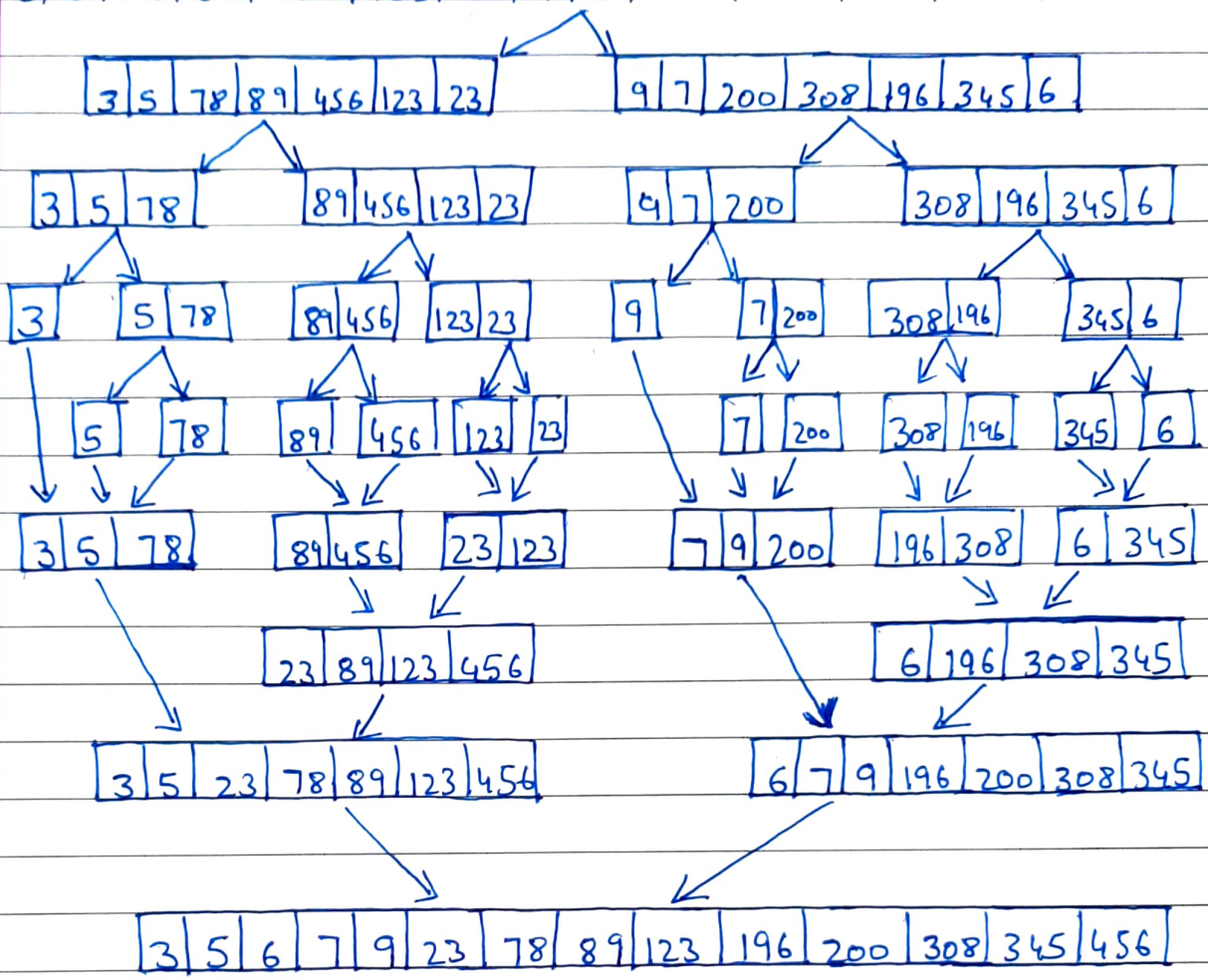
3, 5, 7, 9, 23, 78, 89, 123, 196, 200, 308, 345, 456, [6]

Therefore, the sorted array of elements is :

3, 5, 6, 7, 9, 23, 78, 89, 123, 196, 200, 308, 345, 456

5. Merge Sort

3, 5, 78, 89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 6.



Bubble Sort

Pass 1													
3	5	78	89	456	123	23	9	7	200	308	196	345	6
3	5	78	89	456	123	23	9	7	200	308	196	345	6
3	5	78	89	456	123	23	9	7	200	308	196	345	6
3	5	78	89	456	123	23	9	7	200	308	196	345	6
3	5	78	89	456	123	23	9	7	200	308	196	345	6
3	5	78	89	123	456	23	9	7	200	308	196	345	6
3	5	78	89	123	23	456	9	7	200	308	196	345	6
3	5	78	89	123	23	9	456	7	200	308	196	345	6
3	5	78	89	123	23	9	7	456	200	308	196	345	6
3	5	78	89	123	23	9	7	200	456	308	196	345	6
3	5	78	89	123	23	9	7	200	308	456	196	345	6
3	5	78	89	123	23	9	7	200	308	196	456	345	6
3	5	78	89	123	23	9	7	200	308	196	345	456	6
3	5	78	89	123	23	9	7	200	308	196	345	6	**456**

Legend
= Swap
= No Swap

Pass 2													
3	5	78	89	123	23	9	7	200	308	196	345	6	**456**
3	5	78	89	123	23	9	7	200	308	196	345	6	**456**
3	5	78	89	123	23	9	7	200	308	196	345	6	**456**
3	5	78	89	123	23	9	7	200	308	196	345	6	**456**
3	5	78	89	123	23	9	7	200	308	196	345	6	**456**
3	5	78	89	23	123	9	7	200	308	196	345	6	**456**
3	5	78	89	23	9	123	7	200	308	196	345	6	**456**
3	5	78	89	23	9	7	123	200	308	196	345	6	**456**
3	5	78	89	23	9	7	123	200	308	196	345	6	**456**
3	5	78	89	23	9	7	123	200	308	196	345	6	**456**
3	5	78	89	23	9	7	123	200	196	308	345	6	**456**
3	5	78	89	23	9	7	123	200	196	308	345	6	**456**
3	5	78	89	23	9	7	123	200	196	308	6	**345**	**456**

Pass 3													
3	5	78	89	23	9	7	123	200	196	308	6	**345**	**456**
3	5	78	89	23	9	7	123	200	196	308	6	**345**	**456**
3	5	78	89	23	9	7	123	200	196	308	6	**345**	**456**
3	5	78	89	23	9	7	123	200	196	308	6	**345**	**456**
3	5	78	23	89	9	7	123	200	196	308	6	**345**	**456**
3	5	78	23	9	89	7	123	200	196	308	6	**345**	**456**
3	5	78	23	9	7	89	123	200	196	308	6	**345**	**456**
3	5	78	23	9	7	89	123	200	196	308	6	**345**	**456**
3	5	78	23	9	7	89	123	200	196	308	6	**345**	**456**
3	5	78	23	9	7	89	123	196	200	308	6	**345**	**456**
3	5	78	23	9	7	89	123	196	200	308	6	**345**	**456**
3	5	78	23	9	7	89	123	196	200	6	**308**	**345**	**456**

Pass 4													
3	5	78	23	9	7	89	123	196	200	6	**308**	**345**	**456**
3	5	78	23	9	7	89	123	196	200	6	**308**	**345**	**456**
3	5	78	23	9	7	89	123	196	200	6	**308**	**345**	**456**
3	5	23	78	9	7	89	123	196	200	6	**308**	**345**	**456**
3	5	23	9	78	7	89	123	196	200	6	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	200	6	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	200	6	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	200	6	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	200	6	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	200	6	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	6	**200**	**308**	**345**	**456**

Pass 5

3	5	23	9	7	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	23	9	7	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	9	23	7	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	196	6	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**

Pass 6													
3	5	9	7	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**
3	5	9	7	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	123	6	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**

Pass 7													
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	89	6	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	6	**89**	**123**	**196**	**200**	**308**	**345**	**456**

Pass 8													
3	5	7	9	23	78	6	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	6	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	6	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	6	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	6	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	78	6	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	6	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**

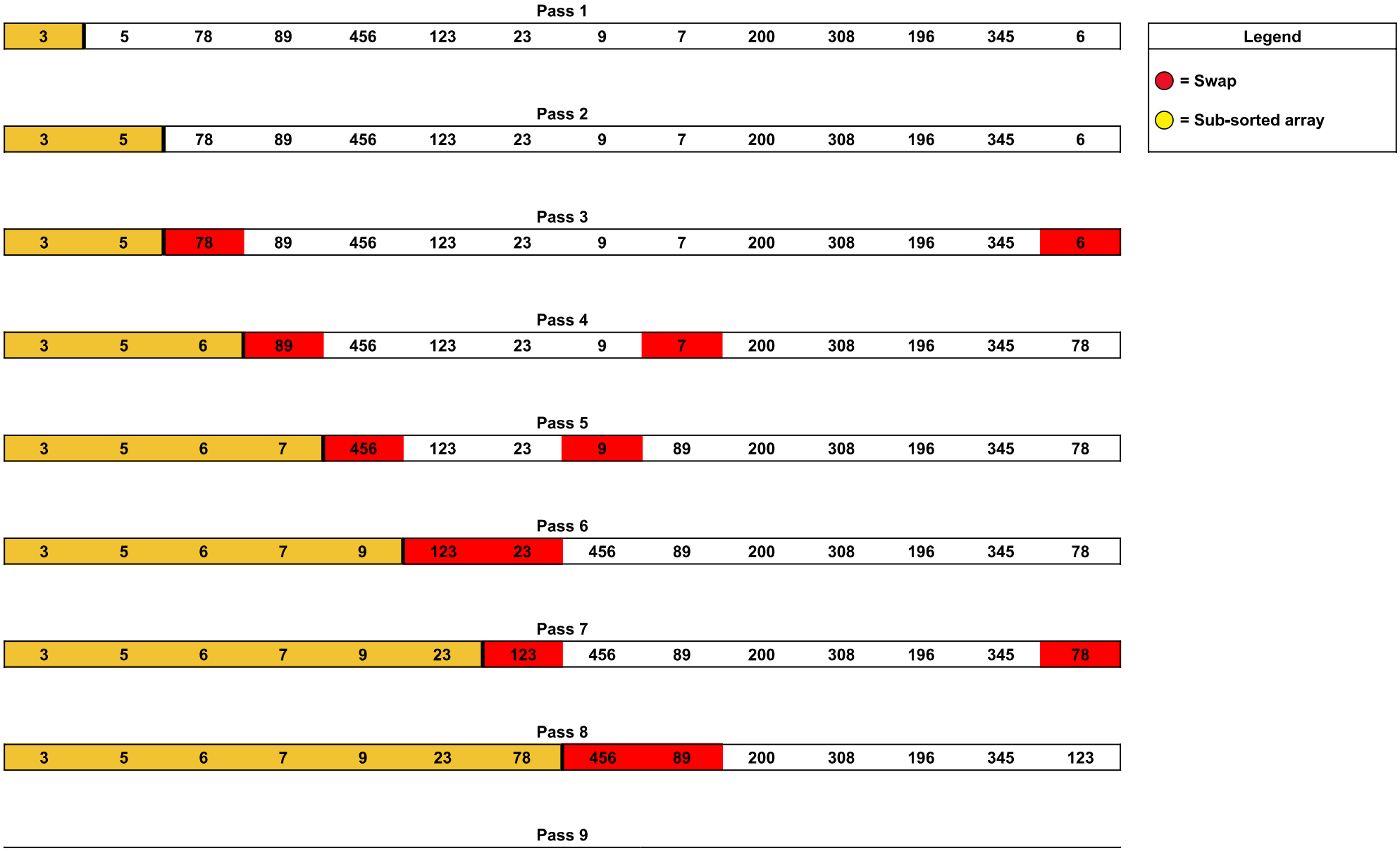
Pass 9													
3	5	7	9	23	6	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	6	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	6	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	6	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	23	6	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	6	**23**	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**

Pass 10													
3	5	7	9	6	23	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	6	23	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	6	23	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	9	6	23	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	6	**9**	**23**	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**

Pass 11													
3	5	7	6	**9**	**23**	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	6	**9**	**23**	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	5	7	6	9	**23**	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**
3	**5**	**6**	**7**	**9**	**23**	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**

Final Result After all the passes, the array is sorted in ascending order:													
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
3	**5**	**6**	**7**	**9**	**23**	**78**	**89**	**123**	**196**	**200**	**308**	**345**	**456**

Selection Sort



3	5	6	7	9	23	78	89	456	200	308	196	345	123

Pass 10

3	5	6	7	9	23	78	89	123	200	308	196	345	456

Pass 11

3	5	6	7	9	23	78	89	123	196	308	200	345	456

Pass 12

3	5	6	7	9	23	78	89	123	196	200	308	345	456

Pass 13

3	5	6	7	9	23	78	89	123	196	200	308	345	456

Pass 14

3	5	6	7	9	23	78	89	123	196	200	308	345	456

Pass 15

3	5	6	7	9	23	78	89	123	196	200	308	345	456

Final Result
After all the passes, the array is sorted in ascending order:

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	7	9	23	78	89	123	196	200	308	345	456

Quick Sort

Consider 6 as the pivot element

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	78	89	456	123	23	9	7	200	308	196	345	6

Legend
= Swap
= Sub-sorted elements
= Sub array

Pass 1
i=0, j=1
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	78	89	456	123	23	9	7	200	308	196	345	6
i	j												

Pass 2
i=0, j=2
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	78	89	456	123	23	9	7	200	308	196	345	6
i		j											

Since j (78) > pivot (6), swap the elements

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	78	89	456	123	23	9	7	200	308	196	345	6
i		j											

Pass 3
i=1, j=3
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i		j										

Pass 4
i=1, j=4
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i			j									

Pass 5
i=1, j=5
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i				j								

Pass 6
i=1, j=6
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i					j							

Pass 7
i=1, j=7
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i						j						

Pass 8
i=1, j=8
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78

	i								j				

Pass 9
i=1, j=9
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i								j				

Pass 10
i=1, j=10
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i									j			

Pass 11
i=1, j=11
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i										j		

Pass 12
i=1, j=12
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i											j	

Pass 13
i=1, j=13
pivot=6

0	1	2	3	4	5	6	7	8	9	10	11	12	13

3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i												j

Now that we have reached the end of the array, we partition the array into two sub-arrays: **[3, 5]** and **[89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 78].**

Pass 14
Consider sub array [3,5]

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	89	456	123	23	9	7	200	308	196	345	78
	i												j

Since the sub-array has only two elements, it is already sorted.

Pass 15
Sorting sub-array [89, 456, 123, 23, 9, 7, 200, 308, 196, 345, 78]

Consider 78 as the pivot
i=0, j=1

0	1	2	3	4	5	6	7	8	9	10
89	456	123	23	9	7	200	308	196	345	78
i	j									

Consider 78 as the pivot
i=0, j=1
Since 78 < 89, swap

0	1	2	3	4	5	6	7	8	9	10
89	456	123	23	9	7	200	308	196	345	78
i	j									

Pass 16

Pivot=78
i=1, j=2

0	1	2	3	4	5	6	7	8	9	10
78	456	123	23	9	7	200	308	196	345	89

	i	j								

Pass 17

Pivot=89
i=1, j=3
Since j < pivot, bring j to the left of the array

0	1	2	3	4	5	6	7	8	9	10
78	456	123	23	9	7	200	308	196	345	89
	i		j							

Pass 18

Pivot=78
i=1, j=4
Since j < pivot, bring j to the left of the array

0	1	2	3	4	5	6	7	8	9	10
78	23	456	123	9	7	200	308	196	345	89
	i			j						

Pass 19

Pivot=78
i=1, j=5
Since j < pivot, bring j to the left of the array

0	1	2	3	4	5	6	7	8	9	10
78	23	9	456	123	7	200	308	196	345	89
	i				j					

Pass 20

Pivot=78
i=1, j=6

0	1	2	3	4	5	6	7	8	9	10
78	23	9	7	456	123	200	308	196	345	89
		i				j				

Pass 21

Pivot=78
i=2, j=7

0	1	2	3	4	5	6	7	8	9	10
78	23	9	456	123	7	200	308	196	345	89
		i					j			

Pass 22

Pivot=78
i=2, j=8

0	1	2	3	4	5	6	7	8	9	10
78	23	9	7	456	123	200	308	196	345	89
		i						j		

Pass 23

Pivot=78
i=3, j=9

0	1	2	3	4	5	6	7	8	9	10
78	23	9	7	456	123	200	308	196	345	89
			i						j	

Pass 24

Pivot=78
i=3, j=10

0	1	2	3	4	5	6	7	8	9	10
78	23	9	7	456	123	200	308	196	345	89
			i							j

Pass 25

The pivot is placed in the correct position

0	1	2	3	4	5	6	7	8	9	10

7	23	9	78	456	123	200	308	196	345	89
				i						j

Pass 26 We now have two sub-arrays: **[7, 23, 9]** and **[456, 123, 200, 308, 196, 345, 89]**										
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
7	23	9	78	456	123	200	308	196	345	89

Pass 27 Consider 9 as the pivot i=0, j=1		
0	**1**	**2**
7	23	9
i	**j**	

Pass 28 Swapping these 2 elements		
0	**1**	**2**
7	23	9
i	**j**	

Pass 29 The sub array is sorted		
0	**1**	**2**
7	9	23
	i	**j**

Pass 30 Consider sub-array: [456, 123, 200, 308, 196, 345, 89] i=0, j=1 Pivot=89						
0	**1**	**2**	**3**	**4**	**5**	**6**
456	123	200	308	196	345	89
i	**j**					

Pass 31
i=0, j=1
Pivot=89
Since i > pivot, swap

0	1	2	3	4	5	6
456	123	200	308	196	345	89
i	j					

Pass 32
i=1, j=2
Pivot=89

0	1	2	3	4	5	6
89	123	200	308	196	345	456
	i	j				

Pass 33
i=1, j=3
Pivot=89

0	1	2	3	4	5	6
89	123	200	308	196	345	456
	i		j			

Pass 34
i=1, j=4
Pivot=89

0	1	2	3	4	5	6
89	123	200	308	196	345	456
	i			j		

Pass 35
i=1, j=5
Pivot=89

0	1	2	3	4	5	6
89	123	200	308	196	345	456
	i				j	

Pass 36
i=1, j=6
Pivot=89

0	1	2	3	4	5	6
89	123	200	308	196	345	456
	i					j

Now, we consider sub-array [123, 200, 308, 196, 345, 456], as 89 is already in the correct position

Pass 36
i=0, j=1
Pivot=456

0	1	2	3	4	5
123	200	308	196	345	456
i	j				

Pass 37
i=0, j=2
Pivot=456

0	1	2	3	4	5
123	200	308	196	345	456
i		j			

Pass 38
i=0, j=3
Pivot=456

0	1	2	3	4	5
123	200	308	196	345	456
i			j		

Pass 39
i=0, j=4
Pivot=456

0	1	2	3	4	5
123	200	308	196	345	456
i				j	

Pass 40
i=0, j=5
Pivot=456

0	1	2	3	4	5

123	200	308	196	345	456
i					j

Since 456 is in the correct position, therefore consider a new sub array **[123, 200, 308, 196, 345]**

Pass 41
i=0, j=1
Consider 345 as the pivot

0	1	2	3	4
123	200	308	196	345
i	j			

Pass 42
i=0, j=2
Pivot=345

0	1	2	3	4
123	200	308	196	345
i		j		

Pass 43
i=0, j=3
Pivot=345

0	1	2	3	4
123	200	308	196	345
i			j	

Since 345 is in the correct position, partition the array and repeat the process

0	1	2	3	4
123	200	308	196	345
i			j	

Pass 44
i=0, j=1
Pivot=196

0	1	2	3
123	200	308	196
i	j		

Since j > pivot, swap the elements			
0	1	2	3
123	200	308	196
i	j		

Now, 196 is in the correct position.			
0	1	2	3
123	196	308	200
	i	j	

Since **123** is a single element, we consider the second half of the array **[308, 200]**

Pass 45

0	1
308	200

Considering 200 as the pivot, it is smaller than 308, hence we swap it

0	1
308	200

After Swapping	
0	1
200	308

Final Result
After all the passes, the array is sorted in ascending order:

0	1	2	3	4	5	6	7	8	9	10	11	12	13
3	5	6	7	9	23	78	89	123	196	200	308	345	456