

Name → SOM BIR

Roll no. → 11911025.

Branch → C.S.E.

Best case time complexity of Insertion sort

Given array: 2, 3, 4, 5

i	0	1	2	3	4
Element					
j					
key			3	4	5
no. of Comparison			0	0	1
Movements			1	1	1

$$\begin{aligned}\text{Time complexity} &= 1 + 1 + 1 = 3 \\ &= O(n-1) \\ &\approx O(n)\end{aligned}$$

12.00 ② find elements smaller than 10.

01.00
main ⑩ 20 30 40 ✓
i i

02.00
03.00 Step ③ swap the main element
04.00 with jth element

05.00
06.00 1 + in
swap comparison

07.00
⇒ 20 30 40 50 ✓

do step 1
with 20.

do step 2
with 20

Bubble Sort

08.00

09.00

10.00

11.00

12.00

01.00

02.00

03.00

04.00

05.00

06.00

07.00

```
void bubbleSort(int arr[], int n)
{
    int i, j;
    for (i = 0; i < n - 1; i++)
    {
        for (j = 0; j < n - i - 1; j++)
        {
            if (arr[j] > arr[j + 1])
                swap(&arr[j], &arr[j + 1])
        }
    }
}
```

Worst case :-

When

$i = 0$

$i = 1$

$i = 2$

$i = n - 2$

inner loop run

n times

$n - 1$ times

$n - 2$ times

2 times

$$\begin{aligned} \text{Total} &= n + n - 1 + n - 2 + n - 3 + \dots + 2 \\ &= \frac{n(n+1)}{2} - 1 \approx O(n^2) \end{aligned}$$

29

2016
january
friday

December 2015							January 2016						
Su	M	T	W	T	F	S	Su	M	T	W	T	F	S
29	1	2	3	4	5	6	1	2	3	4	5	6	7
30	7	8	9	10	11	12	13	8	9	10	11	12	13
31	14	15	16	17	18	19	20	14	15	16	17	18	19
	21	22	23	24	25	26	27	20	21	22	23	24	25
	28	29	30	31				26	27	28	29	30	31

⇒ 40

08.00

do step 1
with 40

50

do step 2
with 40

09.00

10.00

40

50

j

i

11.00

$$\underbrace{1}_{\text{swap}} + \underbrace{n-3}_{\text{comparisons}}$$

12.00

01.00

If a list contain 'n' elements then
time complexity :-

02.00

03.00

04.00

$$= (1+n) + (1+n-1) + 1+n-2 + 1+n-3 + \dots + 1$$

05.00

$$= \left(1 + 1 + \dots + 1\right)_{n \text{ times}} + (n + n-1 + n-2 + \dots + 1)$$

06.00

$$= n + \frac{n(n+1)}{2}$$

07.00

$$= \frac{2n + n^2 + n}{2} = \frac{3n + n^2}{2}$$

$$\approx O(n^2) \text{ worst case}$$

Sambir

Algorithm name	Cases	Time
Quick Sort	Best	$n \log n$
	Average	
	Worst	n^2
Merge Sort	Best case Average Worst	$n \log n$

Algorithm name	Cases	Time
Quick sort	Best	$n \log n$
	Average	
	Worst	
		n^2
Merge sort	Best case	$n \log n$
	Average	
	Worst	
Insertion sort	Best	n
	Average	n^2
	Worst	n^2
Bubble sort	Best	n
	Average	n^2
	Worst	n^2

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