

2. Insertion Sort :-

Insertion sort algorithm sorts a set of values by inserting value into an existing sorted file.

- The element is inserted at a position where it gives sorted list.
- That is, we start with the second element, compare it with the first and then the third is compared with the first two and so on.
- Not suitable for large data sets.

Working:-

Pass 1:- $A[1]$ by itself is trivially sorted.

Pass 2:- $A[2]$ is inserted either before or after $A[1]$ so that: $A[1], A[2]$ is sorted

Pass 3:- $A[3]$ is inserted into its proper place in $A[1], A[2]$, that is, before $A[1]$, between $A[1]$ and $A[2]$, so that: $A[1], A[2], A[3]$ is sorted.



PASS 4:- $A[4]$ is inserted into its proper place in $A[1], A[2], A[3]$. So that: $A[1], A[2], A[3], A[4]$ is sorted.

PASS N:- $A[N]$ is inserted into its proper place in $A[1], A[2], \dots, A[N-1]$. So that: $A[1], A[2], \dots, A[N]$ is sorted.

* Algorithm (Insertion Sort)

Step 1:- If it is the first element, it is already sorted.
return 1;

Step 2:- pick next element.

Step 3:- Compare with all elements in the sorted sub list.

Step 4:- Shift all the elements in the sorted sub list that is greater than the value to be sorted.

Step 5:- insert the value.

Step 6:- Repeat until list is sorted.

193 971 80 7 92 20 USORTED NUMBERS

FIRST ITERATION

TEMP = 971

193 971 80 7 92 20

Compare 971 with

193 971 80 7 92 20

193, 193 < 971 < 193

false so no operation

SECOND ITERATION

TEMP = 80

193 971 80 7 92 20

Compare 80 with 971, 80

193 ? 971 7 92 20

971 971 inserted to 3rd pos.

?

Compare 80 with 193, 80 < 193

? 193 971 7 92 20

193 inserted 2nd position

80 193 971 7 92 20

80 inserted to 1st position

THIRD ITERATION

TEMP = 7

80 193 ? 971 92 20

Compare 7 with 971, 7 < 971

971 inserted at 4th position

80 ? 193 971 92 20

Compare 7 with 193, 7 < 193

193 inserted at 3rd position

? 80 193 971 92 20

Compare 7 with 80, 7 < 80

80 inserted at 2nd position

7 80 193 971 92 20

7 inserted at 1st position

FOURTH ITERATION

TEMP = 99

$99 < 971$

- 7 80 123 ? 971 90 compare 99 with 971
 $\hat{971}$ inserted at 5th position
- 7 80 ? 123 971 90 compare 99 with 123, $99 < 123$
 123 inserted at 4th position
- 7 80 99 123 971 90 compare 99 with 80, $99 < 80$
 99 inserted at 3rd position

FIFTH ITERATION

TEMP = 90

- 7 80 99 123 ? 971 compare 90 with 971, $90 < 971$
 971 inserted at 6th position
- 7 80 99 ? 123 971 compare 90 with 123, $90 < 123$
 123 inserted at 5th position
- 7 80 ? 99 123 971 compare 90 with 99, $90 < 99$
 99 inserted at 4th position
- 7 ? 80 99 123 971 compare 90 with 80, $90 < 80$
 80 inserted at 3rd position
- 7 90 80 99 123 971 compare 90 with 7, $90 > 7$
 90 inserted at 2nd position

Complexity :-

Insertion Sort	Time Complexity	Space Complexity
Average Case	$O(n^2)$	0
Worst Case	$O(n^2)$	0