

Step-by-step example of InsertionSort

algorithm InsertionSort(*list* L)

```
for  $i = 2$  to  $n$  do
     $value = L[i]$ 
     $j = i - 1$ 
    ▷ Insert  $L[i]$  into the sorted subarray  $L[1 : i - 1]$ 
    while  $j > 0$  and  $L[j] > value$  do
         $L[j + 1] = L[j]$ 
         $j = j - 1$ 
    end while
     $L[j + 1] = value$ 
end for
```

Example: 17 12 14 15 13 11

At the beginning, the input array is: $L[1] = 17$, $L[2] = 12$, $L[3] = 14$, $L[4] = 15$, $L[5] = 13$, $L[6] = 11$

Here, $n=6$ because the array L contains 6 elements.

Let's recall the logical **and** operator: the result of x **and** y is true if both x and y evaluate to true; otherwise, the result is false.

Let's now run through the algorithm pseudocode.

1st iteration of for loop: $i = 2$

$value = L[2] = 12$

$j = 2 - 1 = 1$

Run the while loop

Condition of while loop is true, because $(1 > 0)$ and $(L[1]=17 > 12)$ are both true

$L[2] = L[1] = 17$

$j = 1 - 1 = 0$

Condition of while loop is false, because $(0 > 0)$ is false: end while

$L[1] = 12$

In the 1st iteration of for loop, we shift 17 to the right and insert 12 at position 1:

$L[1] = 12$, $L[2] = 17$, $L[3] = 14$, $L[4] = 15$, $L[5] = 13$, $L[6] = 11$

2nd iteration of for loop: $i = 3$

$value = L[3] = 14$

$j = 3 - 1 = 2$

Run the while loop

Condition of while loop is true, because $(2 > 0)$ and $(L[2]=17 > 14)$ are both true

$L[3] = L[2] = 17$

$j = 2 - 1 = 1$

Condition of while loop is false, because $(1 > 0)$ is true but $(L[1]=12 > 14)$ is false: end while

$L[2] = 14$

In the 2nd iteration of for loop, we shift 17 to the right and insert 14 at position 2:

$L[1] = 12$, $L[2] = 14$, $L[3] = 17$, $L[4] = 15$, $L[5] = 13$, $L[6] = 11$

3rd iteration of for loop: $i = 4$

$value = L[4] = 15$

$j = 4 - 1 = 3$

Run the while loop

Condition of while loop is true, because $(3 > 0)$ and $(L[3]=17 > 15)$ are both true

$L[4] = L[3] = 17$

$j = 3 - 1 = 2$

Condition of while loop is false, because $(2 > 0)$ is true but $(L[2]=14 > 15)$ is false: end while

$L[3] = 15$

In the 3rd iteration of for loop, we shift 17 to the right and insert 15 at position 3:

$L[1] = 12, L[2] = 14, L[3] = 15, L[4] = 17, L[5] = 13, L[6] = 11$

4th iteration of for loop: $i = 5$

value = $L[5] = 13$

$j = 5 - 1 = 4$

Run the while loop

Condition of while loop is true, because $(4 > 0)$ and $(L[4]=17 > 13)$ are both true

$L[5] = L[4] = 17$

$j = 4 - 1 = 3$

Condition of while loop is true, because $(3 > 0)$ and $(L[3]=15 > 13)$ are both true

$L[4] = L[3] = 15$

$j = 3 - 1 = 2$

Condition of while loop is true, because $(2 > 0)$ and $(L[2]=14 > 13)$ are both true

$L[3] = L[2] = 14$

$j = 2 - 1 = 1$

Condition of while loop is false, because $(1 > 0)$ is true but $(L[1]=12 > 13)$ is false: end while

$L[2] = 13$

In the 4th iteration of for loop, we shift 15 and 17 to the right and insert 14 at position 3:

$L[1] = 12, L[2] = 13, L[3] = 14, L[4] = 15, L[5] = 17, L[6] = 11$

5th iteration of for loop: $i = 6$

value = $L[6] = 11$

$j = 6 - 1 = 5$

Run the while loop

Condition of while loop is true, because $(5 > 0)$ and $(L[5]=17 > 11)$ are both true

$L[6] = L[5] = 17$

$j = 5 - 1 = 4$

Condition of while loop is true, because $(4 > 0)$ and $(L[4]=15 > 11)$ are both true

$L[5] = L[4] = 15$

$j = 4 - 1 = 3$

Condition of while loop is true, because $(3 > 0)$ and $(L[3]=14 > 11)$ are both true

$L[4] = L[3] = 14$

$j = 3 - 1 = 2$

Condition of while loop is true, because $(2 > 0)$ and $(L[2]=13 > 11)$ are both true

$L[3] = L[2] = 13$

$j = 2 - 1 = 1$

Condition of while loop is true, because $(1 > 0)$ and $(L[1]=12 > 11)$ are both true

$L[2] = L[1] = 12$

$j = 1 - 1 = 0$

Condition of while loop is false, because $(0 > 0)$ is false: end while

$L[1] = 11$

In the 5th iteration of for loop, we shift 12, 13, 14, 15, and 17 to the right and insert 11 at position 1:

$L[1] = 11, L[2] = 12, L[3] = 13, L[4] = 14, L[5] = 15, L[6] = 17$

After the last iteration, the for loop ends, and the array is fully sorted.