

## Lesson March 18<sup>th</sup> 2024 - 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 is:  $L[1] = 17$ ,  $L[2] = 12$ ,  $L[3] = 14$ ,  $L[4] = 15$ ,  $L[5] = 13$ ,  $L[6] = 11$   
 $n=6$  because the array  $L$  has 6 elements.

Let's run through the algorithm pseudocode.

for  $i=2$  to 6 do

1<sup>st</sup> iteration of for loop:  $i = 2$

value =  $L[2] = 12$

$j = 2 - 1 = 1$

Let's 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

$L[1] = 12$  because value is equal to 12

After 1<sup>st</sup> iteration of for loop:  $L[1] = 12$ ,  $L[2] = 17$ ,  $L[3] = 14$ ,  $L[4] = 15$ ,  $L[5] = 13$ ,  $L[6] = 11$

2<sup>nd</sup> iteration of for loop:  $i = 3$

value =  $L[3] = 14$

$j = 3 - 1 = 2$

Let's 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

$L[2] = 14$  because value is equal to 14

After 2<sup>nd</sup> iteration of for loop:  $L[1] = 12$ ,  $L[2] = 14$ ,  $L[3] = 17$ ,  $L[4] = 15$ ,  $L[5] = 13$ ,  $L[6] = 11$

3<sup>rd</sup> iteration of for loop:  $i = 4$

value =  $L[4] = 15$

$j = 4 - 1 = 3$

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

$L[3] = 15$  because value is equal to 15

After 3<sup>rd</sup> iteration of for loop:  $L[1] = 12$ ,  $L[2] = 14$ ,  $L[3] = 15$ ,  $L[4] = 17$ ,  $L[5] = 13$ ,  $L[6] = 11$

4<sup>th</sup> iteration of for loop:  $i = 5$

value =  $L[5] = 13$

$j = 5 - 1 = 4$

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

$L[2] = 13$  because value is equal to 13

After 4<sup>th</sup> iteration of for loop:  $L[1] = 12, L[2] = 13, L[3] = 14, L[4] = 15, L[5] = 17, L[6] = 11$

5<sup>th</sup> iteration of for loop:  $i = 6$

value =  $L[6] = 11$

$j = 6 - 1 = 5$

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

$L[1] = 11$  because value is equal to 11

After 5<sup>th</sup> (and last) iteration of for loop, the array is sorted:

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