

Note: $A[1 \rightarrow A.length]$

INSERTION-SORT(A)

```
for (j = 2 to A.length)
    itemToInsert = A[j]
    k = j - 1
    while(k > 0 and A[k] > itemToInsert)
        A[k+1] = A[k]
        k = k - 1
    A[k+1] = itemToInsert
```

Proof of correctness:

Loop invariant: We show that for every j , the subarray $A[1, j - 1]$ is sorted.

Initialization: If $j = 2$, the array $A[1, 2 - 1]$ is sorted.

Maintenance: If $A[1, j - 1]$ is sorted then k will hold either 0 (meaning $A[j]$ is the smallest value) or the index of the first element of $A[1, j - 1]$ which is smaller than $A[j]$, then $A[j]$ gets inserted at either 1 or after the first element that is smaller than it. Thus $A[1, j - 1]$ maintains the state of being sorted.

Termination: $j = A.length + 1$, $A[1, A.length]$ is therefore sorted. Therefore the algorithm is correct.