Correctness of selection sort:

Pseudo code.

```
n = A.length
for i = 0 to n-2
    minIndex = i
    for j = i+1 to n-1
        if A[j] < A[minIndex]
            minIndex = j
    if minIndex ≠ i
        swap A[i] with A[minIndex]
```

Loop invariant for inner loop (4-6)

Initialization: Before the first iteration of the inner loop (when j = i+1), minIndex is initialized to 'i'. This correctly identifies the smallest element in the subarray 'A[i...i]' because a single element is the smallest.

Maintenance: Each iteration of the inner loop, if A[j] is smaller than A[minIndex], the algorithm updates minIndex to j ensuring that minIndex always holds the index of the smallest element in A[i...j]

Termination: When the inner loop terminates (when 'j = n') 'minIndex' points to the index of the smallest element in A[i ... n-1].

Outerloop (2-8):

Initialization: Before the first iteration of the outer loop (when i=0) the subarray A[0..i-1] is empty. An empty array is sorted.

Maintenance: Assume that the loop invariant holds at the start of iteration i of the outer loop. The inner loop finds the smallest element in the subarray 'A[i ... n-1]. and swaps it with A[i]. As a result, the subarray A[0..i] now contains the smallest 'i+1' elements in sorted order, and each element in A[0...i] is less than or equal to each element in A[i+1 ... n-1]. Thus loop invariant is maintained.

Termination: When the outer loop terminates after i=n-1 the loop invariant guarantees that the subarray 'A[0 ... n-2] is sorted and that every element A[0..n-2] is less than or equal

to the remaining element A[n-1]. Since A[n-1] is already the largest element in the array, the entire array is sorted.

Since loop invariant holds true for both inner & outer loops, and the algorithm terminates, we can conclude that selection sort correctly sorts the input array.

Time complexity

The time complexity is $O(n^2)$ in the worst case. The outer loop runs n-1 times and the inner loop performs a linear search over the unsorted part of the array for each iteration of the outer loop