

Homework 2

COMP221 Spring 2026 - Suhas Arehalli

Complete the problems below. Note that point values are roughly correlated with effort, but inversely correlated with expected difficulty. Check the course website & syllabus for further instructions.

If any problem is unclear, or you think you found a typo, please let me know ASAP so I can clarify!

Problems

1. **Another Quadratic Sort** (15pts): Consider the sorting algorithm in Alg. 1 called Selection-Sort:

Algorithm 1 Selection Sort and the Select helper function.

```
function SELECTIONSORT(Array  $A[1 \dots n]$ )
  for  $i \leftarrow 1$  to  $n - 1$  do
     $idx \leftarrow \text{SELECT}(A, i)$ 
    SWAP( $A[idx]$ ,  $A[i]$ )
  end for
  return A
end function

function SELECT(Array  $A[1 \dots n]$ , Integer  $i$ )
   $idx \leftarrow i$ 
  for  $j \leftarrow i + 1$  to  $n$  do
    if  $A[idx] > A[j]$  then
       $idx \leftarrow j$ 
    end if
  end for
  return  $idx$ 
end function
```

Prove its correctness in the following steps:

- (a) (0pts) Run SELECTIONSORT on an example array (or arrays!). Before moving on, ensure you (1) are convinced the algorithm works, (2) understand what the Select function does, and (3) intuitively understand what each iteration of each loop is doing and how it gets us toward a sorted array.
- (b) (2pts) Provide a loop invariant that will help us prove the correctness of SELECTIONSORT.

- (c) (2pts) Provide a loop invariant that will help us prove the correctness of SELECT (and therefore help us prove the correctness of SELECTIONSORT).
- (d) (5pts) Prove the loop invariant you provided in part c is correct using induction. Conclude that SELECT is correct, for some definition of correct.
- (e) (5pts) Prove the loop invariant you provided in part b is correct using induction. Use the correctness of SELECT from problem c to help you.
- (f) (1pt) Conclude that the array A is sorted using your loop invariant from part b.

2. Recursive Linear Search (15pts)

- (a) Write pseudocode for a **recursive** linear search algorithm called RECURSIVELINEARSEARCH. This algorithm should solve the ARRAYSEARCH problem we saw in class, as defined below, and do so using recursion:

Problem Statement (ArraySearch).

Input: Array $A[1 \dots n]$, Element e

Output: r with

$$r = \begin{cases} i \in \{1, \dots, n\} \text{ such that } A[i] = e, & e \in A \\ NULL, & e \notin A \end{cases}$$

(5pts)

- (b) Prove the correctness of this algorithm, using the definition of correctness for search we discussed in class (and is summarized in part a). (10pts)