Homework #0 — CS 430 SP25 - Design & Analysis of Algorithms

1) Searching in a $n \times n$ matrix: You are given a square matrix of size n of integers. The matrix is stored in a 2D array. The matrix is stored so that every row is in increasing order and every colum is in increasing order. For example:

1	4	5
10	11	16
23	25	60

Devise a brute force (exhaustive) algorithm to search the array for an integer k. Return true if k is in the matrix and false otherwise. Show (provide a convincing argument) your algorithm has a worst case complexity of $O(n^2)$.

2) Devise an improved algorithm for problem #1 to search the matrix with a worst case complexity of $O(n)$. Show (provide a convincing argument) your improved algorithm has a worst case complexity of $O(n)$.

3) Identify the loop invariant for the selection sort algorithm shown below and describe how it is established and maintained. Finally, argue the algorithm is correct using the loop invariant.

```
procedure select(A[1...n])    // n > 0
  for i := 1 to n-1 do
    min := i
    for j := i+1 to n do
      if (A[j] < A[min]
        min := j
    temp := A[i]
    A[i] := A[min]
    A[min] := temp
end procedure
```

★ Problem #2 is commonly used as an interview question. Therefore it is fairly easy to find discussions of it online. Don't copy a solution from the Internet, engage your neurons and learn. If you are absolutely stuck, email or drop by my office for a hint.

Due date: At the start of class Thursday 30th

How to submit: Neatly write or type out your response. If you are familiar with LaTeX, please use it. LaTeX is installed on all math and csis machines. It may be used in the browser (without installing anything) at `overleaf.com`.