CS3000: Algorithms & Data — Summer 2025 — Laney Strange

APP 3
Due: May 15th, 2025 @ 11:30am via Gradescope

Name:

- APPs will be assigned towards the end of roughly two lectures each week. You'll put together a solution to a short problem that we'll all use in the following lecture. We'll have time set aside to do these in class, or you can work on your own.
- You may handwrite your solutions, or typeset them in LaTeXor another system.
- APPs will be graded on completeness. They must be submitted by 11:30am (just before lecture) on the due date. They will not be accepted late, but we drop 3 of them (out of 8 total).
- Collaboration is strongly encouraged for APPs!

Problem 1.

Below is the pseudocode for Quicksort. Complete the proof we started in class to show the correctness of PARTITION. In particular, use a loop invariant to show that, at the beginning of each iteration of the loop at lines 3-6, for any array index k, if $i+1 \leq k \leq j-1$ then $A[k] > x$.

```
QUICKSORT(A, p, r)
1  if p < r
2      q = PARTITION(A, p, r)
3      QUICKSORT(A, p, q − 1)
4      QUICKSORT(A, q + 1, r)
```

```
PARTITION(A, p, r)
1  x = A[r]
2  i = p − 1
3  for j = p to r − 1
4      if A[j] ≤ x
5          i = i + 1
6          swap A[i], A[j]
7  swap A[i + 1], A[r]
8  return i + 1
```

Solution: