## DSC 40B - Discussion 01

## Problem 1.

In lecture, we analyzed dynamic arrays which had *geometric* growth rate. That is, when a resize occurred, the new size was a constant factor times the old. Now consider a *linear* growth rate, where the new size is the old size plus a constant. Show that the amortized time complexity of the append operation is  $\Theta(n)$ .

## Problem 2.

In each of the problems below state the best case and worst case time complexities of the given piece of code using asymptotic notation. Note that some algorithms may have the same best case and worst case time complexities. If the best and worst case complexities *are* different, identify which inputs result in the best case and worst case. You do not need to show your work for this problem.

Example Algorithm: linear search as given in lecture.

Example Solution: Best case:  $\Theta(1)$ , when the target is the first element of the array. Worst case:  $\Theta(n)$ , when the target is not in the array.

```
a) def f_1(data):
       """ data is a two-dimensional array of size n*n""
       n = len(data)
       for i in range(n):
           for j in range(n):
               if data[i, j] == 42:
                   return (i,j)
b) def f_2(data):
       """ data is an array of n numbers"""
       n = len(numbers)
       swapped = True
       while swapped:
           swapped = False
           for i in range(1,n):
               if numbers[i-1] < numbers[i]:</pre>
                   # next line swaps elements in Theta(1) time
                   numbers[i], numbers[i-1] = numbers[i-1], numbers[i]
                   swapped = True
c) def median(numbers):
       """computes the median. `numbers` is an array of n numbers"""
       n = len(numbers)
       for x in numbers:
           less = 0
           more = 0
           for y in numbers:
               if y \le x:
                   less += 1
               if y >= x:
                   more += 1
           if less >= n/2 and more >= n/2:
               return x
d) def mode(data):
       """computes the mode. `data` is an array of n numbers."""
       mode = None
       largest_frequency = 0
       for x in data:
           count = 0
           for y in data:
               if x == y:
                   count += 1
           if count > largest_frequency:
```

```
largest_frequency = count
    mode = x
    if count > n/2:
        return mode

return mode

e) def index_of_median(numbers):
    """ numbers is an array of size n"""
    # the median() from part c
    m = median(numbers)
    # the linear_search() from lecture
    return linear_search(numbers, m)
```