Homework 1

COSC-2010

Due: F 9/29 @ 11:59 PM EST

You must upload a PDF document to Canvas. Feel free to use pencil and paper to do this homework. If you do, please do not submit a PDF document containing high-resolution digital photographs. Use a PDF scanner such as GeniusScan to produce black-and-white scans for a PDF document.

1. Write the algorithm enqueue that inserts an item at the back of a queue. Use an array as the queue's internal representation. Derive $f(n)$ and $O(g(n))$.

2. Write the algorithm dequeue that removes the item at the front of a queue. Use an array as the queue's internal representation. Derive $f(n)$ and $O(g(n))$.

3. Write the algorithm remove that removes and returns the ith item in an unsorted list. Use an array as the list's internal representation. Assume that the ith element in the list is stored in the ith component of the array. What is the worst case? Derive $f(n)$ and $O(g(n))$.

4. Write the algorithm remove that removes and returns the ith item in an sorted list. Use an array as the list's internal representation. Assume that the ith element in the list is stored in the ith component of the array. What is the worst case? Derive $f(n)$ and $O(g(n))$.

5. Write the iterative algorithm remove that removes and returns a specified object in a sorted list. Use an array as the list's internal representation. What is the worst case? Derive $f(n)$ and $O(g(n))$.

6. Consider BUBBLE-SORT (Cormen et al., 2009, p. 40):

```
1: procedure BUBBLE-SORT(A)
2:     for i = 1 to A.length − 1 do
3:         for j = A.length downto i + 1 do
4:             if A[j] < A[j − 1] then
5:                 exchange A[j] with A[j − 1]
6:             end if
7:         end for
8:     end for
9: end procedure
```

   (a) What is the best case? Explain why.

(b) What is the worst case? Explain why.

(c) Derive expressions for the number of primitive operations for each step of BUBBLE-SORT.

(d) Derive $f(n)$ for the worst case.

(e) Derive $\Theta(g(n))$, $O(g(n))$, and $\Omega(g(n))$. State the constants for these running times.

(f) Compute $f(n)$, $c'g(n)$, and $c''g(n)$ for $1 \leq n \leq 5$.

(g) Plot $f(n)$, $c'g(n)$, and $c''g(n)$.

References

T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein. *Introduction to Algorithms*. MIT Press, Cambridge, MA, 3rd edition, 2009.