University of Nevada, Las Vegas Computer Science 477/677 Spring 2015

Practice Examination for February 19, 2015

The entire practice examination is 260 points.

No books, notes, scratch paper, or calculators. Use pen or pencil, any color. Use the rest of this page and the backs of the pages for scratch paper. If you need more scratch paper, it will be provided.

1. True or False. [5 points each]

   (a) ________ Computers are so fast today that complexity theory is only of theoretical, but not practical, interest.

   (b) ________ If any problem can be precisely formulated in a mathematical way, there is an algorithm that solves it.

   (c) ________ If S is a set of distinct items, we say that an $x \in S$ has *rank* k if there are exactly k members of S which are less than or equal to x. If, while implementing quicksort to sort a set of n distinct items, we always pick the pivot (cut) item to be an item whose rank is at least 10% of the size of the subset we are currently sorting, and never more than 90% of the size of that subset, the time complexity of our implementation will be $\Theta(n \log n)$.

   (d) ________ Any comparison-based sorting algorithm must use at least $\log_2(n!)$ comparison to sort n items, in the worst case.

2. Fill in the blanks. [5 points each blank.]

   (a) What is the **only** difference between the abstract data types *queue* and *stack*?

   ____

   (b) Name a well-known divide-and-conquer searchng algorithms.

   ____

   (c) Name three well-known quadratic time sorting algorithms.

   ____

   ____

   ____

   (d) Name two well-known divide-and-conquer time sorting algorithms.

   ____

   ____

3. Solve the recurrences. Give asymptotic answers in terms of n, using either O, Ω, or Θ, whichever is most appropriate. [10 points each.]

   (a) $F(n) = 4F(n/2) + n^2$.

   (b) $G(n) \geq G(n-1) + \lg n$

   (c) $H(n) \leq 2H(\sqrt{n}) + O(\log n)$.

   (d) $K(n) = K(n - \sqrt{n}) + 1$.

   (e) $F(n) = 4F\left(\frac{3n}{4}\right) + n^5$ (No, you don't need a calculator.)

4. [15 points] Consider the following procedure:

```
void george(int n)
 {
 & int m = n;
 & while (m > 1)
 &  {
 &    for (int i = 1; i < m; i++)
 &     cout << "I cannot tell a lie.  I chopped down the cherry tree." << endl;
 &    m = m/2;
 &  }
 }
```

Consider the question of how many lines of output the execution of `george(n)` would produce. Write down an appropriate recurrence for this question, and give an asymptotic solution in terms of `n`, using either O, Ω, or Θ, whichever is most appropriate.

5. [20 points] Walk through radix (or bucket) sort, where you sort the following zip codes:

`89110 89154 89254 91245 90016 90004 90005 21014`

6. [30 points]

   (a) Illustrate a queue implemented as a circular linked list with a dummy node. The contents of the queue, from front to rear, should be the four items Ann, Ted, Sue, Tom.

   (b) Show the steps of dequeue, using the same example.

   (c) Redraw the original figure, and show the steps of enqueue, were the item Bob is added to the queue.

7. [30 points] Consider the SPLIT procedure used in Quicksort, also known as PARTITION, or (in our textbook) PIVOT. Write pseudo-code for that procedure (not any of the other parts of quicksort) and write a loop invariant for your code.

8. [30 points] Walk through heapsort, where the input file is as given below.

`MDYCOSEZVQWBANLH`

9. [30 points] Walk through polyphase mergesort, where the input file is as given below.

`MDYCOSEZVQWBANLH`