CSE 373 Fall 2015, Homework 2

Due Friday, October 16th in homework Dropbox

Please show work where applicable
*Name:*____________
*uwid (not your student number):*____________

1) For each of the following, show that $f \in O(g)$. That is, you will need to find values for c and n_0 such that the definition of big-O holds true as we did with the examples in lecture.

a) $f(n) = 12n$ $\qquad$ $g(n) = \frac{n}{5}$

b) $f(n) = 6n^2 + 1000$ $\qquad$ $g(n) = n^4$

c) $f(n) = 6\log(n)$ $\qquad$ $g(n) = .5n$

2) For each of the following program fragments, determine the asymptotic runtime in terms of n

a)

```
public void mysteryOne(int n) {
   int x = 0;
   for (int i = n; i >= 0; i--) {
      if ((i % 5) == 0) {
         break;
      } else {
         for (int j = 1; j < n; j *= 2) {
            x++;
         }
      }
   }
}
```

b)

```
public void mysteryTwo(int n) {
   int x = 0;
   for (int i = 0; i < n; i++) {
      for (int j = 0; j < ((n * n - 1)/ 3);  j++) {
         x += j;
      }
   }
}
```

c)

```
public void mysteryThree(int n) {
   for (int i = 0; i < n; i++) {
      methodTwo(i);
   }
}

private void methodTwo(int x) {
    if (x > 0) {
        methodTwo(x -1);
    }
}
```

3) For each of the following, determine if $f \in O(g)$, $f \in \Omega(g)$, $f \in \Theta(g)$, several of these, or none of these.

a) $f(n) = \log n$ $\qquad$ $g(n) = \log \log n$

b) $f(n) = 2^{2n}$ $\qquad$ $g(n) = 2^n$

c) $f(n) = 25n^3$ $\qquad$ $g(n) = n^3 + 25n$

4) Psuedocode and recurrence relations

a) Write pseudocode for a function that calculates the largest difference between any two numbers in an array of positive integers with a runtime in $\Theta(n^2)$.

For example, the largest difference between any two numbers in the following array would be 19.

```
a = [4, 6, 3, 9, 2, 1, 20]
```

b) Can this function be written with a runtime in $\Theta(n)$? If yes, write pseudocode below. If no, why? What would have to be different about the input in order to do so?

c) Can this function be written with a runtime in $\Theta(1)$?. If yes, write pseudocode below. If no, why? What would have to be different about the input in order to do so?

5) Recurrence Relations

a) Find the tightest Big-Oh bound for the following recurrence relation $T(n) = n + T(n/2)$. Justify your answer.

b) Find a Big-Oh bound for the following recurrence relation $T(n) = n + 2T(n/2)$. Justify your answer.

6) Growth Rates

a) Order the following functions from slowest to fastest growth rate

- 2^{72}
- $n^2 \log n$
- $2^{n/2}$
- $\log n$
- $n \log n^2$
- n^6
- $n \log \log n$
- $n \log^2 n$
- n
- n^2
- $n \log n$
- 2^n
- $\log^2 n$
- $2/n$
- $n^{1/2}$

7) Big-Oh Definition

Suppose T1(n) is O(f(n)) and T2(n) is O(f(n)). Which of the following are always true (for all T1, f, and T2)? You do not need to prove an item is true (just saying true is enough for full credit), but if an item is false, you need to give a counterexample to demonstrate it is false. To give a counterexample, give values for T1(n), T2(n), and f(n) for which the statement is false (for example, you could write, "The statement is false if T1(n) = 100n, T2(n) = $2n^2$, and f(n) = n^3"). Hints: Think about the definitions of big-O, big-Ω, and big-Θ.

a) T1(n)/T2(n) is O(1).

b) T1(n) + T2(n) is Ω(f(n)).

c) T1(n) − T2(n) is O(f(n)).

d) T1(n) is O(T2(n)).

e) T2(n) is Θ(T1(n)).