Computer Science 501
Data Structures & Algorithms
The College of Saint Rose
Fall 2013

Lab 3: Analysis
Due: 11:59 PM, Monday, September 30, 2013

This lab, which is really more of a problem set than a lab, will give you a chance to practice with the analysis tools we have considered in class. You may again discuss the lab with your classmates and give and receive some help, but your submission **must be your own work**.

Written Problems

1. Compare the asymptotic growth rates of the following pairs of functions and decide if one grows faster than the other or if they grow at the same rate. Prove your answers using limits. All logarithms are base 2, unless otherwise noted. (4 points)

   (a) $5N^2 + 2N + 5$ and N^2

   (b) $N \log N$ and N^2

   (c) $2^{\log N}$ and N

   (d) 2^N and 2^{2N}

2. Prove the following using limits (4 points):

   (a) $N \in \Omega(\log N)$

   (b) $5N + 6 \in \Theta(N)$

   (c) $N \log N \in \Omega(N)$

   (d) $N \in \Theta(N - N^{\frac{1}{2}})$

3. For each of the following functions, indicate the class $\Omega(g(n))$ to which the function belongs. Use the simplest $g(n)$ possible. Prove your assertions. (6 points)

   (a) $762n^2 - 56n + 37$

   (b) $(n^3 + 100)^5$

   (c) $2^n + n^2$

4. Analyze the following code segment and give an exact formula involving summations for the number of times the word "hello" is printed. Then simplify your formula to obtain an exact formula for the number of times the word "hello" is printed that does not involve summations (*i.e.*, give a closed form solution). (In the code segment, `Math.pow(2,j)` is a function that returns 2 raised to the jth power.) (6 points)

```
for ( i = 1; i <= N; i++ )
    for ( j = 1; j <= N; j++ ) {
        for ( k = 1; k <= Math.pow(2,j); k++ ) {
            System.out.println("hello");
        }
        System.out.println("hello");
    }
```

Note: you may test your formula by implementing this code and then running it for different values of N.

Submission

Before 11:59 PM, Monday, September 30, 2013, submit a PDF of your responses for grading using Submission Box at `http://sb.teresco.org` under assignment "Analysis".