## Homework 2

**Out:** 9.19.17
**Due:** 9.28.17

1. [Asymptotics, 25 points]
   Place the following functions from asymptotically smallest to largest. When two functions have the same asymptotic order, put an equal sign between them. Provide an explanation for your ordering.

$$3n^7 + 2,\ \log_n \sqrt{n},\ 70{,}000,\ \sum_{k=1}^{n} \frac{n}{2^k},\ \frac{7n}{10},\ \log n^2,\ (5n+2)^n,\ 3^n,\ \sqrt[5]{n},\ (\log n)^2$$

2. [Asymptotic comparison, 25 points]
   For each of these problems enter "yes" or "no" indicating whether A is O, o, Ω, ω, Θ of B. Justify your answers.

| A | B | O | o | Ω | ω | Θ |
|---|---|---|---|---|---|---|
| n! | $e^{-n}$ | | | | | |
| $10n^2+6n-2$ | $\binom{n}{2}$ | | | | | |
| $\sum_{k=2}^{n} \frac{1}{\lg k}$ | $\log (log\ n)^n$ | | | | | |
| $\log(n^7)$ | $e^{\ln (\ln n)}$ | | | | | |
| $\sum_{k=1}^{n} \left(\frac{1}{k+1} - \frac{1}{k}\right)$ | $\sqrt{n}$ | | | | | |

3. [Algorithmic intuition, 50 points]

   Write and briefly explain the following C++ function:

   *void MaxIncSeq (int *nums, int len);*

   that accepts an integer array, *nums*, containing *len* > 0 positive integers, and prints out, in a single line, the maximum length increasing sequence in the input array. An increasing sequence is defined as a sequence of numbers increasing in magnitude. These do not need to be located in adjacent cells of the input array, but do need to be located in increasing indices of the array. If multiple maximum length increasing sequences exist in the input array, then your function should print out the one with the largest total sum. You may assume that all elements of the array are unique.

   For example, if [*nums*] contains [1 5 3 2 4] and *len*==5, the function should print the

sequence 1 3 4 (and not 1 2 4, which has a smaller sum).
If [*nums*] contains [7 4 1 10 23 2] and *len*==6, the function should print the sequence 7 10 23 (and not 1 10 23, or 4 10 23).

Your function, in a *Problem3.cpp* file, will be compiled with a *main.cpp* file containing a main function, and a *Problem3.h* file on the lab computers. You may assume that the *std* namespace is being used and the following standard libraries have been included: *iostream*, *vector*. Try to make your function as efficient as you can.

Submit your solution, in a single file, *Problem3.cpp*, containing your function. Make sure to write your name in a comment at the top of the program, and check that your program compiles with another file containing a main function on the lab computers.