## University of Nevada, Las Vegas Computer Science 477/677 Spring 2024
## Assignment 0: What you are expected to know.

There is no due date for this assignment, since you are not supposed to submit it. I will handout the answers in class on Wednesday, August 28.

## Topics

1. High school algebra, including logarithms.

2. Programming in C++, at an introductory level. C++ is the language of programming instruction in our department. If you have programmed in another language, you should be able to quickly learn the C++ concepts you need. If you have never written a program, you should not be taking CS 477/677.

3. Elementary complexity theory, that is, "Big O" notation, to measure both time and space. I will introduce $\Omega$ and $\Theta$ notation in class.

4. Elementary calculus. I will sometimes use calculus to explain things, and your eyes should not glaze over.

I realize that most high school students never understand logarithms. I certainly didn't the first time I saw them. There were just a bunch of obscure formalas to memorize. You probably memorized that the base 10 logarithm of a positive number $x$ is an exponent, the solution to the equation $10^{\log x} = x$ Logarithms are important in everyday science. There are things that are measured linearly, like temperature, length, momemntum, *etc.*But some things are measured logarithmically.

1. Sound intensity. A 7 bel sound of is ten times as loud as a 6 bel sound. The sound of traffic in the streets of Cairo, Egypt, is 85 decibels. A decibel is one tenth of a bel, but logarithmically. That is, a sound that is one decibel higher is $10^{1/10}$ times as loud. 85 decibles is $10^{5/10} = \sqrt{10}$ times a load as 8 bels, or 80 decibels.

2. Strength of acids and bases. The Ph of a solution is the logarithm of the reciprocal of the hydrogen ion concentration. A Ph 3 acid is ten times as acidic as a solution of Ph 4.

3. Magnitude of heavenly bodies. An increase of 5 magnitudes means a decrease of brightnest by a factor of 100. A first magnitude star is 100 times as bright as a sixth magnitude star.

4. The Richter scale for earthakes. A Richter 5 earthquake is 10 times as strong as a Richter 4 earthquake.

## Questions You Should be Able to Answer

While measuring time complexity, we assume that it takes one time step to compute any arithmetic operation, such as addition, subtraction, multiplication, division, or square root.

1. True or False.

    (a) **T** $n^2 = O(n^3)$

    (b) **F** $n^3 = O(n^2)$

    (c) **T** $5n^2 + 8n + 17 = O(n^2)$

    (d) **T** $\log_2 3 * \log_3 2 = 1$

    $\log_a b = \log b / \log a$.

    (e) **F** $\int_0^n x^2 dx = O(n^2)$

    (f) **T** $\int_0^n x^2 dx = O(n^3)$

    $\int_0^n x^2 dx = \frac{x^3}{3}\big|_0^n = \frac{n^3}{3} = O(n^3)$.

    (g) **T** $\lim_{n \to \infty} \frac{\log n}{n} = 0$

    (h) **T** The time complexity of the following code fragment is $O(\log n)$.

    ```
    for(int i = 1; i < n; i = 2*i)
     cout << "Hello, world!" << endl;
    ```

    (i) **F** The time complexity of the following code fragment is $O(n)$.

    ```
    for(int i = 1; i < n; i++)
     for(int j = 1; j < i; j=2*j)
      cout << "Hello, world!" << endl;
    ```

    (j) **T** The time complexity of the following code fragment is $O(n)$.

    ```
    for(int i = 1; i < n; i++)
     for(int j = i; j < n; j=2*j)
      cout << "Hello, world!" << endl;
    ```

    ## Miscellaneous

    (a) Find the value of $\log_2 8$ (Hint: it's an integer.)

    3, since $2^3 = 8$.

    (b) Find the value of $\log_4 8$ (Hint: it's not an integer, but is a simple fraction.)

    $2^2 = 4$ and $2^3 = 8$, thus $\log_4 8 = \frac{\log 8}{\log 4} = \frac{3}{2}$

    (c) The sum of the first $n$ integers is $1 + 2 + 3 + \cdots + n = \frac{n(n+1)}{2}$.

    Find a formula for $1 + 4 + 9 + \cdots + n^2$, the sum of the first $n$ squares. Ans: $\frac{n(n+1)(2n+1)}{6}$