CSE 551 Assignment 1

January 24th, 2021

Submission Instructions: Deadline is **11:59pm on 01/31**. Late submissions will be penalized, therefore please ensure that you submit (file upload is completed) before the deadline. Additionally, you can download the submitted file to verify if the file was uploaded correctly. Submit your answers electronically, in a single PDF, via *Canvas*. **Please type up the answers and keep in mind that we'll be checking for plagiarism**.
Furthermore, please note that the graders will grade 2 out of the 4 questions randomly. Therefore, if the grader decides to check questions 1 and 4, and you haven't answered question 4, you'll lose points for question 4. Hence, please answer all the questions.

1. Prove of disprove the following with valid arguments: **(5+5+5+5+5)**

   ✓ (i) $n! \in O(n^n)$. T

   ✓ (ii) $2n^2 2^n + nlog(n) \in \Theta(n^2 2^n)$. T

   ✓ (iii) $10n^2 + 9 = O(n)$. F

   ✓ (iv) $n^2 log(n) = \Theta(n^2)$. F

   ✓ (v) $n^3 2^n + 6n^2 3^n = O(n^3 2^n)$. F

2. Suppose that you have algorithms with the size running times listed below.Assume that these are the exact number of operations performed as a function of the input size n. Suppose you have a computer that can perform 10^{10} operations per second, and you need to compare a result in at most an hour of computation. For each of the algorithms, what is the largest input size n for which you would be able to get the result within an hour? **(6+6+6+7)**

   ✓ (i) n^2.
   ✓ (ii) n^3.

✓(iii) $50n^2$.
✓(iv) 3^n.

3. Algorithm A_1 takes $10^{-3} \times 2^n$ seconds to solve a problem instance of size n and Algorithm A_2 takes $10^{-2} \times n^4$ seconds to do the same on a particular machine. **(8+8+9)**

✓(i) What is the size of the largest problem instance A_2 will be able solve in one year ?
✓(ii) What is the size of the largest problem instance A_2 will be able solve in one year on a machine one hundred times as fast ?
✓(iii) Which algorithm will produce results faster, in case we are trying to solve problem instances of size less than 20?

✓4. Take the following list of functions and arrange them in ascending order of growth rate. That is, if function g(n) immediately follows f(n) in your list, then it should be the case that f(n) is O(g(n)). **(25)**

(i) $f_1(n) = n^{4.5}$.
(ii) $f_2(n) = (3n)^{0.6}$.
(iii) $f_3(n) = n^4 + 20$.
(iv) $f_4(n) = 25^n$.
(v) $f_5(n) = 260^n$

$2 < 3 < 1 < 4 < 5$