Homework 1

Out: 9.7.23
Due: 9.18.23

1. [Summations, 20 points]
   Provide a closed-form solution to the following expressions, along with a brief explanation. Show your work.
   a. $\sum_{i=11}^{37} 9^i$

   b. $\sum_{i=0}^{\infty} \frac{6}{17^i}$

   c. $\sum_{i=1}^{2N} (2i^2 - 12i + 3)$

   d. $\sum_{i=0}^{\infty} \frac{i-1}{2^i}$

   e. $\sum_{i=111}^{1230} \frac{1}{i}$

2. [Exponents and logs, 20 points]
   Simplify the following expressions, and provide a brief explanation.
   a. $x^8 \cdot x^9 \cdot x^{10} \cdots x^N$

   b. $log_{99}(33 \cdot 33 \cdot 33 \cdot 33 \cdot 33)$

   c. $log_x((3x)^x)$

   d. $44^{log_{44}330}$

   e. $\sum_{i=1}^{3^N} log_{18} i$

3. [Combinatorics, 10 points]
   a. How many 12-digit hexadecimal numbers do not contain any letters?

   b. How many ways are there to pick 3 groups of 8 students from a class of 48? Assume that the groups are unique, but there is no order within each group.

For all programming problems in this class:

- Your program must compile and run on the lab computers command-line interface as follows:
  > scl enable devtoolset-10 bash
  > g++ -std=c++17 <input_file0.cpp> [... <input_fileN.cpp>][-o <output_file>]
- Make sure to write your name and BU email in a comment at the top of the program, along with your collaborator's name and BU email, if any.
- Remember that you are not allowed to use any code not written by you. This includes

web searches, friends, and Chat bots.

4. [Programming I, 25 points]
Implement the following C++ function:

bool legalBrackets (string line);

The function receives as input a string comprising of the characters "(,),{,},[,]" as well as any other characters. There is no white space between characters. It returns true if the string is legal in the way it uses brackets.

These are some examples of expected inputs and corresponding outputs:

Input: (s)d	Output: legal
Input: a(a{b}s)d	Output: legal
Input: {a[b]c	Output: illegal
Input: ([a)d]	Output: illegal

Your main function should read lines from the standard input. For each line of input, it should call the *legalBrackets* function, and print out "legal" or "illegal", according to the output returned by the function.

For example, suppose that you compile your program to the executable *Problem4*, and your program is run as follows:

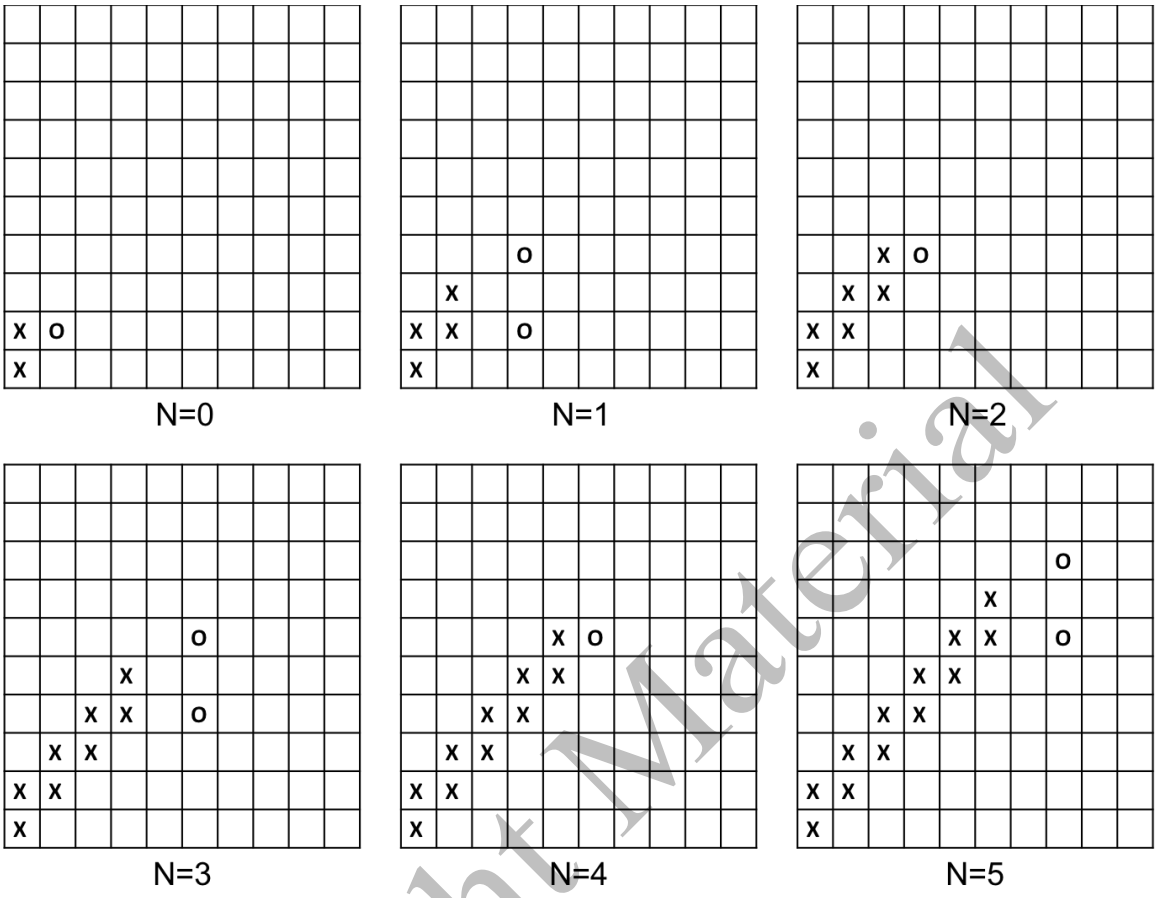
> Problem4 "(a)b"

It should then output:

> legal

Submit your solution in a single file, *Problem4.cpp*.

5. [Programming II, 25 points]
The diagrams shown below are the result of executing a function, with an input integer parameter $0 \le N \le 9$, which draws Xs and Os on a 10x10 grid of white boxes.



a. Determine the algorithm used to create these diagrams, and write the algorithm in clear step-by-step English for any input N. Assume that the coordinates start from (0,0) on the bottom left. Your algorithm should work on any grid size, not just 10x10.

b. Write a C++ program which receives a positive integer N<=9 as input from the command line, and prints to the screen the corresponding 10x10 grid of blanks, Xs and Os.

Submit your solution in a single file, *Problem5.cpp*. Include your answer to part (a) in a comment at the top of your code.