CS3331 – Assignment 2
due Oct. 22, 2021
2-day no-penalty extension until: Oct. 24, 11:55pm
(SRA's cannot be used to extend further)

1. (30pt) Consider the language L of arithmetic expressions involving integers in base 2 with the usual operations: addition $(+)$, subtraction $(-)$, multiplication $(*)$, division $(/)$, power $(\hat{\ })$, and unary minus $(-_1)$; power is right associative, the other binary ones are left associative; power has the highest precedence, followed by unary minus, multiplication and division, and then addition and subtraction; as usual, parentheses override the precedence rules. Also, the only integer that starts with 0 is 0.

   (a) Give an unambiguous grammar that generates L. Explain why your construction is correct.

   (b) Show the parse tree that your grammar produces for the string:
   $-_1 10\hat{\ }11\hat{\ }100 * (10\hat{\ }11)\hat{\ }100 - -_1 10$

2. (40pt) For any real number $x \geq 0$, consider the following language:
   $$L_x = \{a^{\lceil x^n \rceil} \mid \text{for all } n \in \mathbb{N}\} \ .$$

   For what values of x is L_x context-free? Prove your answer. (Assume $0^0 = 0$.)

3. (30pt) Show that the following problem is decidable: Given a context-free grammar G, does $L(G)$ contain only alphanumeric strings that start with a letter?

READ ME! Submit your solution as a single pdf file on `owl.uwo.ca`. Solutions should be typed but high-quality hand-written solutions are acceptable. Make sure you submit everything as a single pdf file.

   JFLAP: You are allowed to use JFLAP to help you solve the assignment. You still need to explain clearly your solution. Also, make sure you understand what it does; JFLAP will not be available during exams!

   LaTeX: For those interested, the best program for scientific writing is LaTeX. It is far superior to all the other programs, it is free, and you can start using it in minutes; here is an introduction: `https://tobi.oetiker.ch/lshort/lshort.pdf`