Winter 2022
Due Jan 31st
(11:59pm NL time)

Computer Science 1510
Problem set #1

Submit all workings!

See "Submission Details for Problem Sets and Lab Problems" under "Important Links" on the class webpage for details on how to submit your solutions.

For this Problem Set you can upload your solutions as a PDF or a text file.

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1. (a) i. Convert 67_{10} to 8-bit sign-magnitude.
   ii. Convert -89_{10} to 8-bit sign-magnitude.
   iii. Perform the calculation $67+(-89)$ in 8-bit sign-magnitude arithmetic. What is the decimal (ie. base 10) representation of your result? Did you obtain the correct value?

   (b) Repeat (a) in 2's complement. How do your results compare?

2. (a) Convert -119.627 to 32-bit IEEE floating-point representation

   (b) What is the decimal representation of the following 32-bit IEEE floating-point value?

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1 10001101 01010000000000000000000
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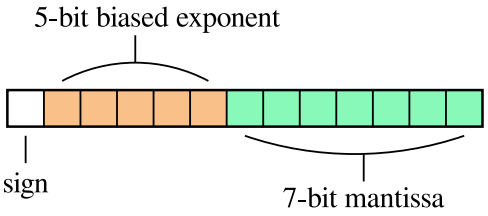
3. Consider a floating point system that uses 11 bits to store real values as follows:



   (a) What should the value of the bias be?

   (b) What is the most accurate representation of 0.7 in this system? Provide both the binary and decimal equivalent of this representation.

   (c) What is the next largest number that can be represented?

   (d) What is the next smallest number that can be represented?

   (e) Comment on the spacing between values. Is it always the same?

4. For the following problems, analyze the problem in terms of input and output (use common sense to decide which values are input, which are output and which are constants), and develop an algorithm to solve the problem. Write your algorithm in Fortran.

   (a) Compute and display the period of an oscillating pendulum T (in seconds) as given by the equation

   $$T = 2\pi\sqrt{\frac{L}{g}},$$

   where L is the length of the pendulum (in metres), and g is the acceleration due to gravity (in metres per second squared).

   (b) The potential energy (E_P) of an object due to its height above the Earth's surface is given by

   $$E_P = mgh,$$

   where m is the mass of the object, g is the acceleration due to gravity, and h is the height above the surface. The kinetic energy (E_K) of an object in motion is given by

   $$E_K = \frac{1}{2}mv^2,$$

   where m is the mass of the object and v is the object's velocity. Compute and display the total energy of an object, given by the sum of its potential and kinetic energy. Use a conditional statement to enforce a reasonable range of applicability of the formula.