Binary Integers

CS 350: Computer Organization & Assembler Language Programming

Lab 2, due Wed Jan 27 (2400 hrs) [*]

[1/26, 1/22: p.1]

A. Why?

- A basic way to store information in a computer is to use binary integers.
- There are multiple ways to represent negative integers.

B. Outcomes

After this lab, you should be able to

- Represent binary integers in sign-magnitude, 1's complement, or 2's complement; to list the pros and cons of each of these three systems and to explain why hardware commonly uses 2's complement to represent negative integers.
- List the representations of the most positive and negative values in each system; know when overflow occurs and how to recognize it.

C. Problems [50 points total]

1. [1 pt] Read as an unsigned binary number, 110111 represents what decimal value? [upd 1/26]
2. [3 pts] Let V be the decimal value from Problem 1; what is the 7-bit representation of $-V$ in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement? (Add a sign bit and possibly fiddle with the 6 bits inherited from problem 1.) [upd² 1/26]
3. [3 pts] Reading 110111 as a signed 6-bit value, what are the bitstring and decimal representations of −(110111) in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement?

[Added 1/26]: To be more concrete, if we had done the three problems using the 3-bit string 101, then for problem 1, we have 101 = 5. In problem 2, we have $V = 5$, and $-V =$

[*] Have you read the syllabus to find out how to get an automatic one-day extension?

−5 = −0101 = 1101 in sign/mag, −5 = −0101 = 1010 in 1's comp, and −5 = −0101 = 1011 in 2's comp. In problem 3, we have 101 = −1 in sign mag (since −101 = 001 = 1), 101 = −2 in 1's comp (since −101 = 010 = 2), and in 2's comp, 101 = −3 (since −101 = 011 = 3).

4. [6 = 3*2 pts] What is the bitstring and decimal value for the most negative 6-bit number in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement?
5. [6 = 3*2 pts] What is the bitstring and decimal value for the most negative *n*-bit number in (a) sign-magnitude, (b) 1's complement, and (c) 2's complement?
6. [4 pts] Which of the three systems have two forms of zero ("positive" and "negative" zero), and how do you write them in each of those systems?
7. [2 pts] In which (if any) of the three systems does taking the negative of the most negative number cause overflow? What about the negative of the most positive number?
8. [2 pts] What is 111011 + 001110, using unsigned addition? Does overflow occur?
9. [2 pts] What is 111000 – 001101, using unsigned subtraction?

For Problems 10 – 12, rewrite the following additions and subtractions in 6-bit 2's complement. E.g., −3 – 5 = −000011 – 000101 = 111101 – 000101 = 111101 + 111011 = 111000 = −001000 = −8

10. [7 pts] 13 – 30 = −17
11. [7 pts] −25 – 7 = −32
12. [7 pts] 24 + 10 = ??? (Be sure to show the decimal result; you should get overflow.)

D. How to Submit Labs

See http://cs.iit.edu/~cs350 → Syllabus > Labs > Submitting Work for your options.

