Introduction to Computer Architecture

CISC 3310 Principles of Computer Architecture
Lab Activity

Data Representation - Exercises

Signed Numbers

- CB, Chapter 2, Exercise 24 - Using a “word” of 3 bits, list all the possible signed binary numbers and their decimal equivalents that are representable in:

    a) Signed magnitude

    b) One’s complement

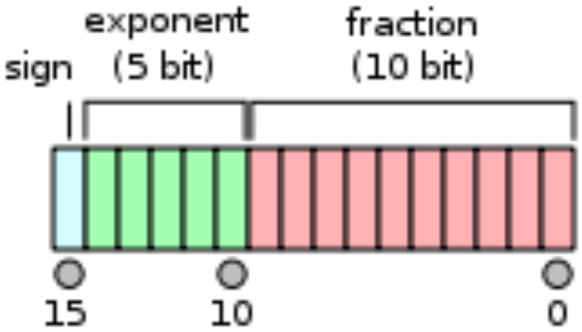
    c) Two’s complement

- CB, Chapter 2, Exercise 25 – repeat the previous question using a “word” of 4 bits

- CB, Chapter 2, Exercise 26 - From the results of the previous two questions, generalize the range of values (in decimal) that can be represented in any given x number of bits the three number representations.

Example: Using IEEE 754 Floating Point Standard
half-precision binary floating point

- IEEE 754 *half-precision binary floating point* (or binary16 for short) uses 5 bits for exponents => we get a 15 bias
  - Can represent any exponent between -15 and 16
- Uses 10 bits for the binary fraction



https://en.wikipedia.org/wiki/Half-precision_floating-point_format
https://slideplayer.com/slide/9002568/

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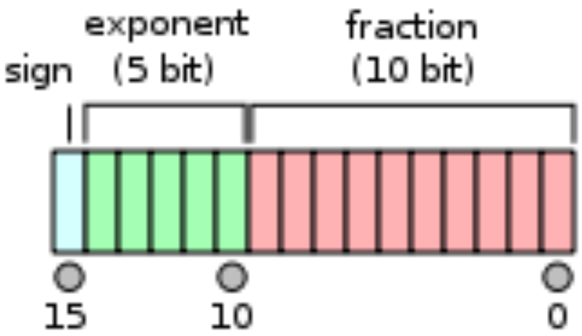

- Floating Number X calculation:

$$\boxed{x = (-1)^{S} \times (1 + \text{Fraction}) \times 2^{(\text{Exponent} - \text{Bias})}}$$

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Floating Point Numbers

- Convert 100.25_{10} to IEEE 754 *half-precision binary floating point*
- Convert 1010011010000000 in IEEE 754 *half-precision binary floating point* representation to a decimal number

* CRC Code

- Coursebook chapter 2 question 77: Generate the CRC code for the number 1011001.
  - Using the divisor 1011,

* CRC Code

- Generate the CRC code for the number 10111011
  - Using the divisor 1001

Hamming Code

- The ***(7,4)*** binary Hamming block encoder:
  - accepts blocks of ***4***-bit of information
  - adds ***3*** parity bits to each such block and produces ***7***-bits wide Hamming coded blocks
- Construct a ***(7, 4)*** binary Hamming code, using the following equations to generate the parity bits:

$$P_1 = D_1 \oplus D_2 \oplus D_3$$
$$P_2 = D_2 \oplus D_3 \oplus D_4$$
$$P_3 = D_1 \oplus D_3 \oplus D_4$$

* Hamming Code

- Generate all the possible codewords
  - For each possible message, generate a codeword
- What is the minimum distance between the code words?

Message m	Codeword c
0000	
0001	
0010	
0011	
0100	
0101	
0110	
0111	
1000	
1001	
1010	
1011	
1100	
1101	
1110	
1111	

Questions?