Chapter 2 Bits, Data Types, and Operations

bits

Computer is a binary digital system.

- digital: finite number of symbols
- binary: base 2, 0s and 1s

high voltage: 1; low voltage: 0

signed integers

n bits, 2^n distinct values, $-2^{n-1} \sim 2^{n-1} - 1$

The maximal positive 011…1 ($2^{n-1} - 1$)

The minimal: 100..000 (-2^{n-1})

negative integers (3 methods):

- sign-magnitude: sign bit, the most significant (MS) bit
- 1's complement: flip every bit to represent negative numbers (problem: +0 and -0)
- 2's complement (easy for arithmetic):

Note: ignoring carry out (overflow)

1) How to get the representation of a signed integer? -9

- get the positive version 01001 (9)
- flip → 10110
- +1 → 10111

2) How the get the decimal from binary representation? 11011

- flip → 00100
- +1 → 00101
- get the positive version → +5
- signing → -5

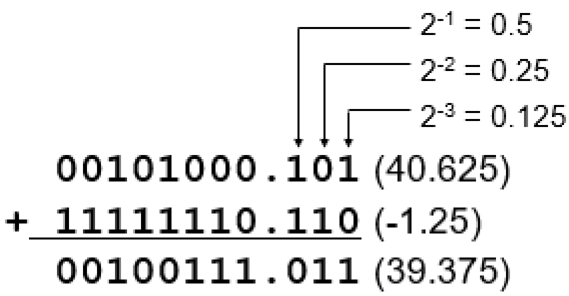
arithmetic operations: ADD, SUBTRACT, Sign Extension

logical operations: AND, OR, NOT

Sign Extension: replicate the sign bit

Fractions: fixed-point

- binary point: separate positive from negative powers of two (similar to decimal point)



Floating number

For very large or small numbers.

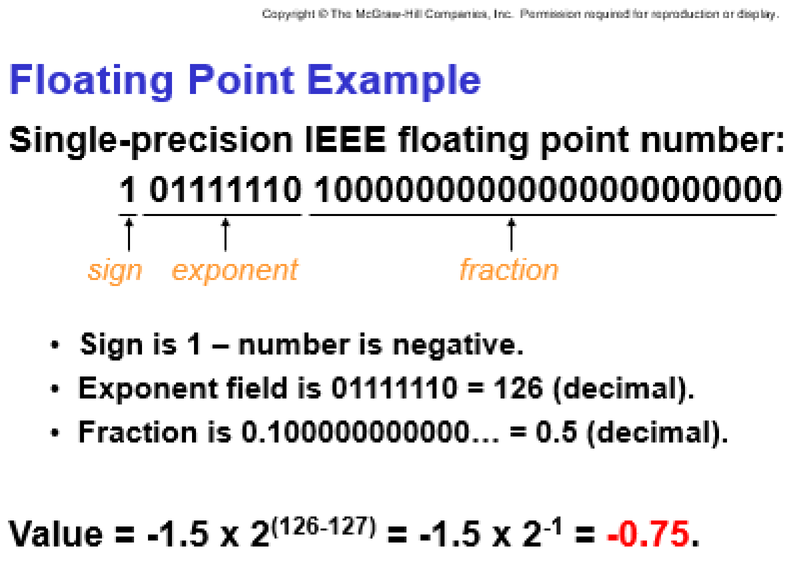
Scientific notation

1 (Sign) + 8 (Exponent, (exponent - 127)) + 23 (Fraction)

$$N = (-1)^S * 1.fraction * 2^{exponent-127}, 1 \leq exponent \leq 254$$

$$N = (-1)^S * 0.fraction * 2^{-126}, exponent = 00000000$$

See P47.



Logic operation

XOR: exclusive-OR

A	B	A XOR B
0	0	0
0	1	1
1	0	1
1	1	0

DeMorgan’s Laws (relationships between AND and OR)

NOT(NOT(A) AND NOT(B)) = A OR B

NOT(NOT(A) OR NOT(B)) = A AND B

ASCII: American Standard Code for Information Interchange