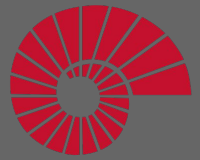
Bits, Ints and Floats, Vim



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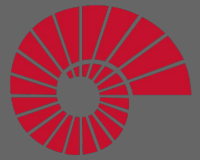
COMP201 Lab 2
Fall 2021

Vi/Vim Reminder



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Vi/Vim Reminder

- Insert mode
  - The one on the left picture.
  - To switch from normal mode to insert mode, type ‘i’ in the normal mode.
  - Every character you type is put to the file.
  - To switch back to normal mode, press <Esc>

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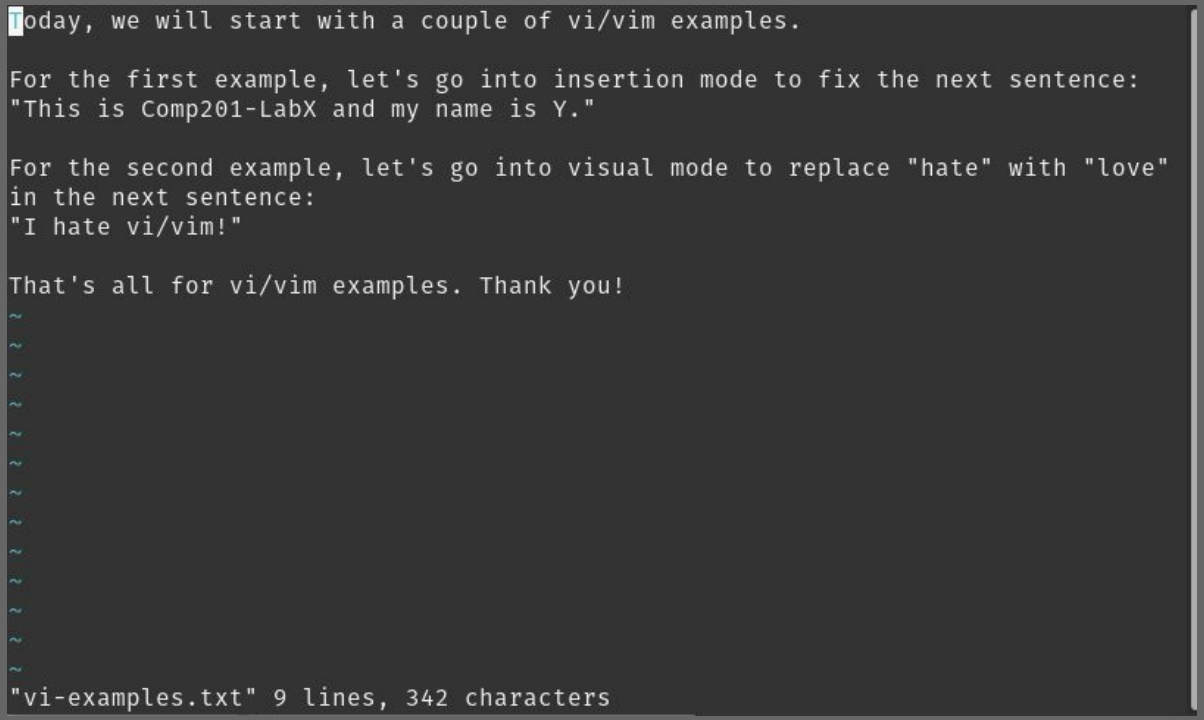
Vi/Vim Reminder

- Visual mode
  - To switch from normal mode to visual mode, type ‘v’.
  - You can select blocks of text.
  - Type d to delete the block, c to delete the block and switch to insert mode to replace the deleted block with another string.
  - To switch back to normal mode, type <Esc>.

Basic Commands in Vi/Vim (in Normal Mode)

- Basic movements: h (left), j (down), k (up), l (right)
- Moving across words: w (next word), b (beginning of word), e (end of word)
- Jumping in a line: 0 (beginning of line), $ (end of line)
- Jumping in a file: gg (beginning of file), G (end of file), :{num}<Enter> (moving to line number num)
- Searching for a string: /{regex}, n (moving forward to find the next match), N (moving backward to find a previous match)
- :q (quitting a file without saving), :q! (quitting a file by discarding modification), :w (saving a file without quitting the file), :x (saving a file and quitting it)

Vi/Vim Examples



NOTE: The initial file is available as vi-examples.txt

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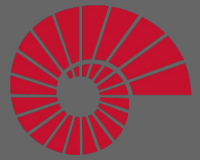
Bitwise Operations and Bit Representation of Integers & Floats



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Bitwise Operations

- In today's lab practice, you are going to use some bitwise operators.
  - & ^ >> +
  - Examples of bitwise operations:
    - 1110 & 0011 = 0010 (getting least significant 2 bits of 1110)
    - 1110 ^ 0011 = 1101 (flipping least significant 2 bits of 1110)
    - 1010 >> 2 = 1110 (arithmetic right shift by 2 bits)
    - (1010 >> 2) & 0011 = 1110 & 0011 = 0010 (getting the most significant 2 bits of 1010)

Bitwise Operations at Byte Level

- 0x6e & 0x0f = 01101110 & 00001111 = 00001110 = 0x0e (getting the least 4-bits of 0x6e)
- 0x6e ^ 0x0f = 01101110 ^ 00001111 = 01100001 = 0x061 (flipping the least significant 4-bits of 0x6e)
- 0xee >> 4 = 11101110 >> 4 = 11111110 = 0xfe (arithmetic right shift by 4 bits)
- (0xe5 >> 4) & 0x0f = (11100101 >> 4) & 00001111 = 11111110 & 00001111 = 00001110 = 0x0e (getting the most significant 4 bits of 0xe5)

Bitwise Exercise

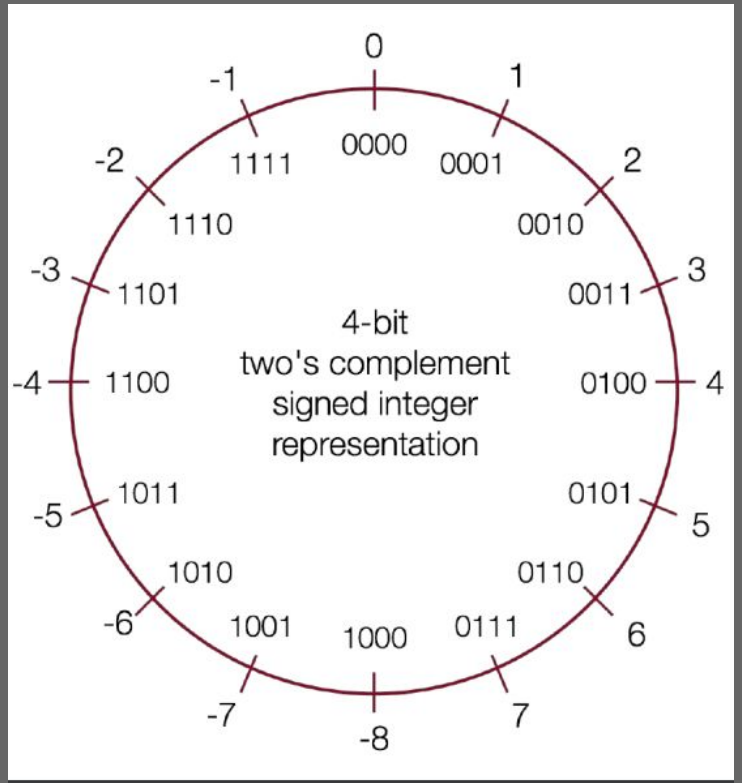
- **allEvenBits** - return 1 if all even-numbered bits in word set to 1
  - Examples: allEvenBits(0xFFFFFFFE) = 0, allEvenBits(0x55555555) = 1
  - Legal ops: ! ~ & ^ | + << >>

NOTE: The initial code is provided in bits-examples/bits.c. Solutions are available in bits-examples/bits.c-solutions. Testing with "./driver.pl" as Assignment 1.

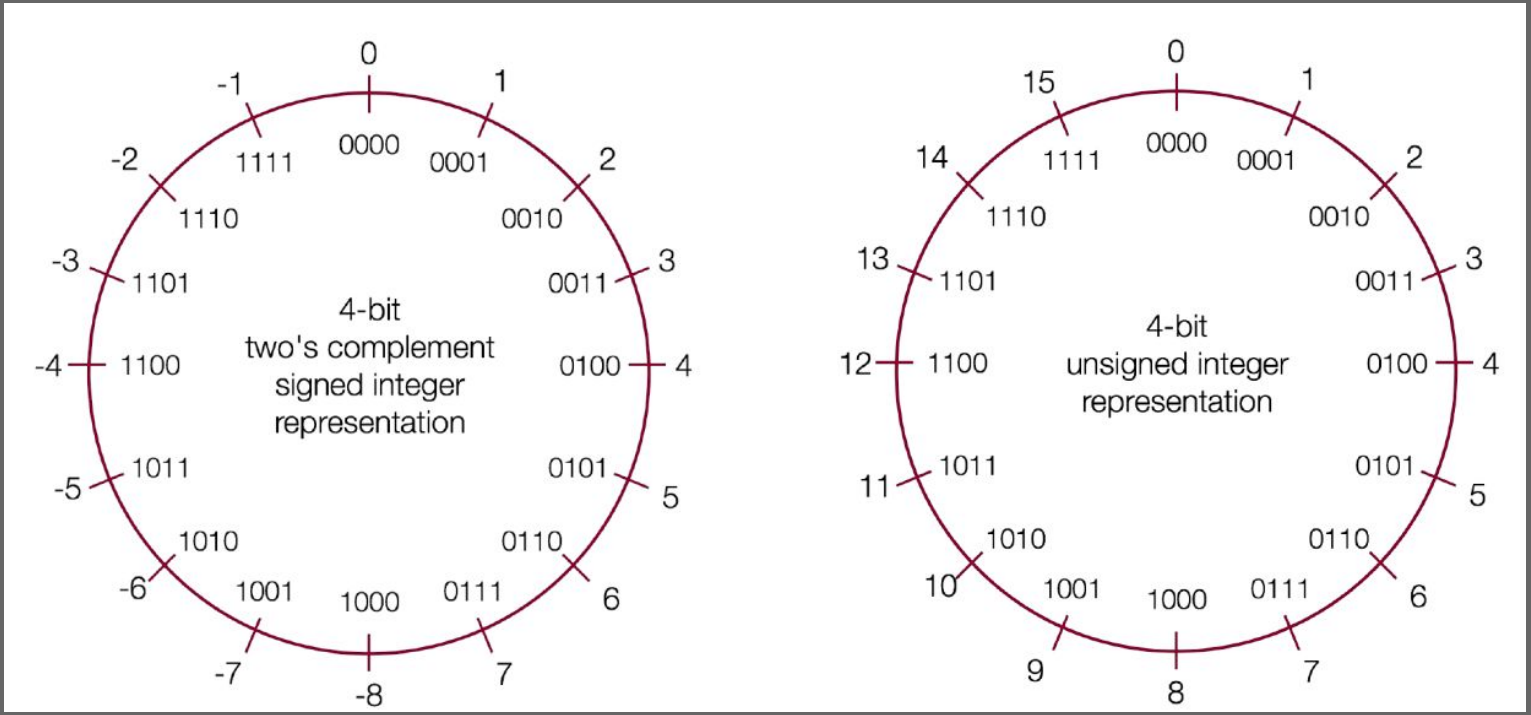
For interested students, more bitwise exercises:
https://github.com/COMP201-Fall-2020/bitwise_practice

Two’s Complement (Bit Representation of Integers)

- We represent a positive number by itself and a negative number by the two’s complement of the corresponding positive number
- The two’s complement of a number is the binary digits inverted, plus 1.
  - e.g. -0001 (1) = 1111 (-1)
- Standard addition works
  - E.g. 1111 (-1) + 0001 (1) = 0000 (0)
- All bits are used to represent as many numbers as possible (efficient)



Signed vs Unsigned

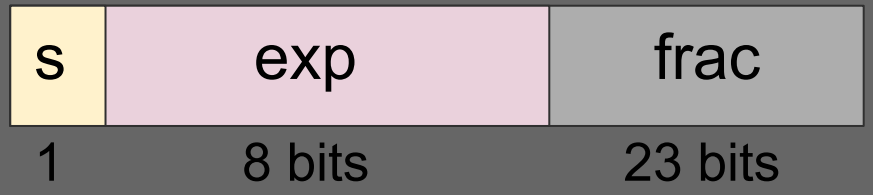


Two’s Complement Exercises

- **minusOne** - return a value of -1
  - Example: minusOne() = -1
  - Legal ops: ! ~ & ^ | + << >>
- **fitsBits** - return 1 if x can be represented as an n-bit, two's complement integer.
  1 <= n <= 32
  - Examples: fitsBits(5,3) = 0, fitsBits(-4,3) = 1
  - Legal ops: ! ~ & ^ | + << >>

NOTE: The initial code is provided in bits-examples/bits.c. Solutions are available in bits-examples/bits.c-solutions. Testing with “./driver.pl” as Assignment 1.

Bit Representation of Floating Point Numbers (32-bits)



- 1 bit is for sign
- 8 bits are for exponent
- 23 bits are for fraction
- Bias = $2^{(8-1)}-1 = 127$
- How to read:
  - If exp > 0 (normalized), floating point number = $(s\ ?\ -1 : 1) * (1.frac) * 2^{(exp - 127)}$
  - If exp = 0 (denormalized), floating point number = $(s\ ?\ -1 : 1) * (0.frac) * 2^{-126}$

Bit Representation of Floating Point Numbers (32-bits)

- **Not A Number (NaN):**

Sign	Exponent						Fraction
any	1	...	...	...	...	1	Any nonzero

- **± Infinity (± ∞):**

Sign	Exponent	Fraction
any	All ones	All zeros

- **Zero (0):**

Sign	Exponent	Fraction
any	All zeros	All zeros

Floating Point Exercise

- **float_neg** - Return bit-level equivalent of expression -f for floating point argument f.
  - Both the argument and result are passed as unsigned int's, but they are to be interpreted as the bit-level representations of single-precision floating point values.
  - When argument is NaN, return argument.

NOTE: The initial code is provided in bits-examples/bits.c. Solutions are available in bits-examples/bits.c-solutions. Testing with "./driver.pl" as Assignment 1.