Cheatography

Bit Manipulation Cheat Sheet

by [deleted] via cheatography.com/26304/cs/8563/

Abbreviations and Notations

- LSB: Least Significant Bit (right-most)
- MSB: Most Significant Bit (left-most)
- `a,b`(lower case): a single bit
- `A,B`(upper case): set of bits, e.g. `A={a_i}, i=[0,N-1]`

Bit-wise operators

Bool/Bit analogy (helps to remember effect of operators): 1 is TRUE, 0 is FALSE

While Bool operators (`&&`, `||`, `!` - no equivalence for `~`) apply to simple TRUE/FALSE operands, bit-wise operators apply to **all** bits of their operands (see *Example* block)

- `&` (AND): both operands have 1s
- `|` (OR): either or both operands have 1s
- `^` (XOR, aka *exclusive OR*): either **but not both** operands have 1s
- `~`(NOT, aka *complement*): 1 becomes 0; 0 becomes 1
- `<<` (left-shift): `a << n` shifts all bits in `a` to the left by `n` positions and pads with 0s to the right.
- `>>` (right-shift): `a >> n` shifts all bits in `a` to the right by `n` positions and pads with 0s to the left

If `a` is an int, `a << n` and `a >> n` are equivalent to multiplying an dividing respectively by 2^n

1-Bit Bit-wise Operators Summary

X	Y	X&Y	X|Y	X^Y	~(X)
0	0	0	0	0	1
0	1	0	1	1	1
1	0	0	1	1	0
1	1	1	1	0	0

Source: https://www.hackerearth.com/notes/bit-manipulation/

Examples (using A = 1010; B = 1100)

- `&`: `A&B = 1000`
- `|`: `A|B = 1110`
- `^`: `A^B = 0110`
- `~`: `~A = 11110101` (the number of 1's depends on the type of `A`)
- `<<`: `A << 2 = 0000`

Usage

- Bit accessing: 1 << 5 = 100000

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Bit-wise Operators as Operations of Sets of Bits

- Using `ALL_BIT` = 32/64 1s on a 32/64-bit machines
- Union: `A|B`
- Intersection: `A&B`
- Subtraction: `A&(~B)`
- Negation: `ALL_BITS^A`

Two's Complement (TsC)

- Most common number system to encode pos.a dn neg. numbers in a binary number representation of negative integers. One's complement is the alternative but seeimingly never used.
- In TsC, MSB used for int sign (`-` for 1, `+` for 0)
- Meaning 1: Mathematical operation on binary numbers (the *additive inverse* op.)
- Meaning 2: Binary signed number representation based on above mathematical operation, s.t. neg. numbers are represented byt hte TsC of the abs. value
- `N`-bit TsC range: $[-2^{N-1}, +(2^{N-1}-1)]$
- Conversion from TsC representation
- Conversion to TsC representation

Source: https://en.wikipedia.org/wiki/Two-%27s_complement

By **[deleted]**
cheatography.com/deleted-26304/

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