COP 3502 4/13/22

Bitwise Operators

In compiler all #s stored in base 2 (binary)

$13 = \underbrace{0\ldots0}_{28\ 0's}\underbrace{1101}_{4\ bits}$

each int is stored in 32 bits

regular int is signed => MSB (most sig bit) is worth -2^{31} not 2^{31}. (2's complement)

$\underbrace{100\ldots0}_{31\ 0's} = -2^{31}$

$\underbrace{011\ldots1}_{} = 2^{31}-1$

range int $[-2^{31}, 2^{31}-1]$

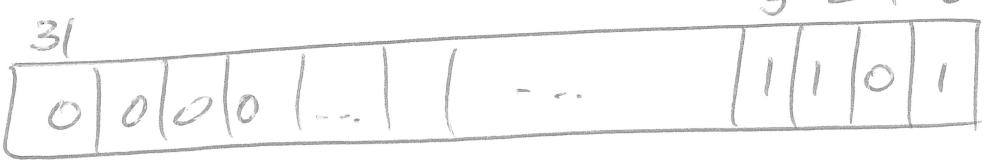
In general, if we used b bits in 2's comp range $[-2^{b-1}, 2^{b-1}-1]$.

Regular boolean operators: && (and), || (or), ! (not)

(work on individual booleans (0 or 1))

An int is really an array of "booleans"

$13 =$



array in reverse! 0 = False, 1 = True

bitwise ops

& (and) 13 & 97 = 00001101 & 01100001 = 00000001 = 1

| (or) 13 | 97 = 00001101 | 01100001 = 01101101 = 109

^ (xor) 13 ^ 97 = 00001101 ^ 01100001 = 01101100 = 108

~ (not) ~13 ⇒ all 1's ⇒ 0, 0's ⇒ 1

In practice,
~n = -(n+1) ~13 = -14
when n>0
flips all bits

>> (right shift) 97 >> 3
move over the binary representation of 97 by 3 places to the right (chop off the last 3 bits)
dividing int by 2^3.

97 1100001

97>>3 = 1100 = 12

<< (left shift) 13 << 2 → mult 2^2.
move over binary of 13 by 2 places left.

13 = 1101 , 13 << 2 = 110100

Examples of USE

① Counting differences OR similarities

```
          T T  F T  F  T T F
x =       1 1  0 1  0  1 1 0   (my quiz ans)
^ y =     1 0  1 1  1  1 0 1   (correct
-----------------------------
x ^ y =   0 1  1 0  1  0 1 1   (# bits on are differences)
```

5 bits on means 5 slots are different

my score = 8 - 5

got wrong = 5

② Union or intersection of 2 sets

```
cur       = 0 0 0 0 0 0 0 1 0 1 0 1 1 0 1
| pack    = 0 1 1 0 0 0 0 1 0 0 0 0 0 0 0
-----------------------------------------
cur v pack = 0 1 1 0 0 0 0 1 0 1 0 1 1 0 1
```

bits on = # unique cards in collection

Intersection would be 8

(only items belonging to both sets will be highlighted)