

Bit Manipulation

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XOR

No of 1's is odd = 1
No of 1's is even = 0

XOR of 2 same nos = 0

Note

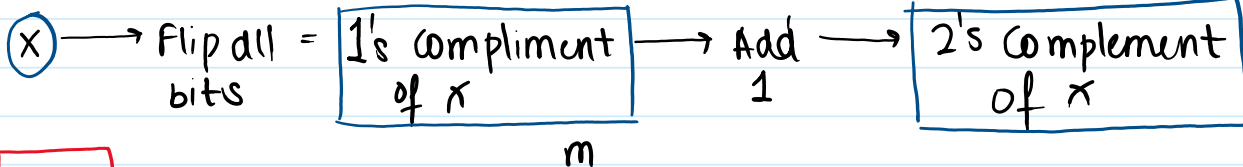
Python stores (int) in 32 bits

31 30 ... 0
↑ ↑
sign bit store actual no.
0/1

SHIFT

$$x \gg k = \frac{x}{2^k}$$

$$x \ll k = x \cdot 2^k$$



NOT

$$x = \sim x$$

① Flip bits

② Is negative?
 N → STOP
 Y → 2's complement

BIT MANIPULATION TRICKS

* Check if ith bit is set or not

$$x \& (1 \ll i) \rightarrow 0 = \text{unset}$$

$$\rightarrow 1 = \text{set}$$

* Set/unset ith bit

$$\text{SET} \rightarrow x | (1 \ll i)$$

$$\text{UNSET} \rightarrow x \& \sim (1 \ll i)$$

* Toggle ith bit

$$x \wedge (1 \ll i)$$

↑
XOR

$$\begin{array}{r} x \\ 001001 \\ \wedge 001000 \\ \hline 000001 \end{array} \quad \begin{array}{r} x \\ 000111 \\ \wedge 001000 \\ \hline 001000 \end{array}$$

* Even or Odd

→ check last bit set
 Y → odd
 N → even

$$(x \& 1) \rightarrow 0 - \text{EVEN}$$

$$\rightarrow 1 - \text{ODD}$$

* UNSET last/rightmost set bit

$$x \& x-1$$

IMP $x, x-1$

$$x = 16, x-1 = 15$$

$$x = 40, x-1 = 39$$

$$16 \rightarrow 10000$$

$$15 \rightarrow 01111$$

$$40 \rightarrow 10100$$

$$39 \rightarrow 10011$$

$x \rightarrow x-1 \Rightarrow$ ① last/rightmost bit becomes 0 (frm 1)

$x \rightarrow x-1 \Rightarrow$ (1) Last(rightmost) bit becomes 0 (from 1)
 (2) All other bits on its right become 1

$x \text{ AND } x-1$ (40, 39)

Remains same \leftarrow \rightarrow set to 1 (But unchanged when ANDed)

$$\begin{array}{r} 10100 \\ \& 10011 \\ \hline 10000 \end{array}$$

this is unset for sure ($x \text{ AND } 0$)

* Check if power of 2

power of 2 iff only 1 bit is set

$x \& (x-1) == 0 \rightarrow x \& (x-1)$ unsets the rightmost set bit and here only 1 bit is set

* Count set bits \rightarrow TC \rightarrow $O(\text{num_setbits})$

cnt=0

while ($x \& (x-1) != 0$) {

$x = x \& (x-1);$

cnt+=1;

\rightarrow unsets last bit each time

}