Bit Manipulation - 1

Decimal Number System → 10 digits (base) [0, 9]

7 3 4
2 1 0

$700 + 30 + 4$

$7 \times 10^2 + 3 \times 10^1 + 4 \times 10^0$

6 5 9 4
3 2 1 0

$6000 + 500 + 90 + 4$

$6 \times 10^3 + 5 \times 10^2 + 9 \times 10^1 + 4 \times 10^0$

1) Next → 17 Nov next Friday

Solve all assgn

2) 22 Nov 9PM – 10:30 PM

other systems → Octal [0, 7] Base = 8
→ Hexadecimal Base = 16
→ Binary Base = 2 [0, 1]

Binary → Base is 2
→ every digit is 0 or 1

1) $(10110)_2$
4 3 2 1 0

$1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 22$

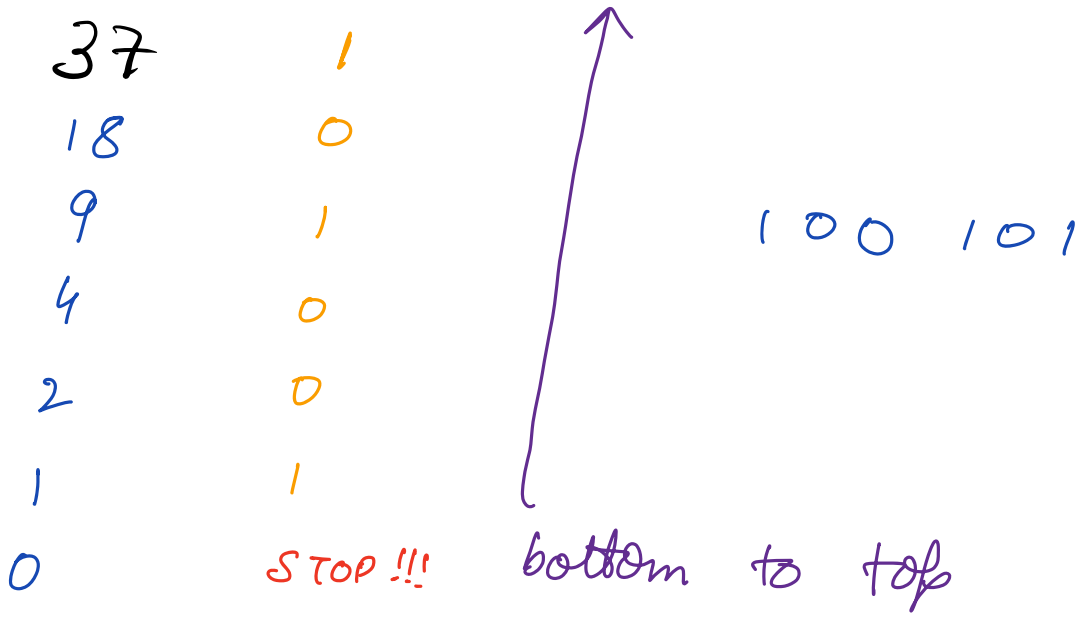
2) $(1011010)_2$
6 5 4 3 2 1 0

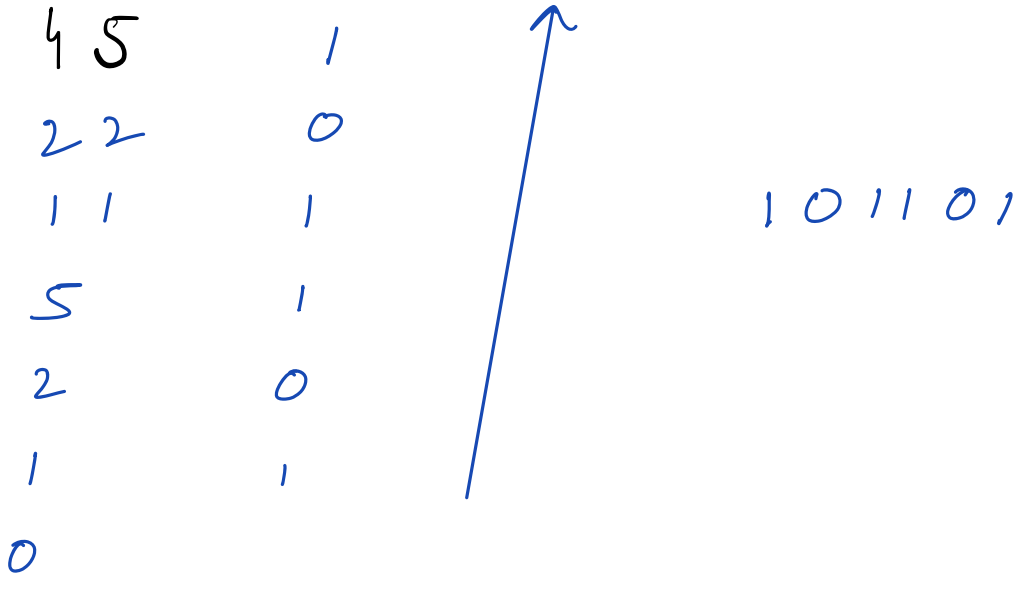
$1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$

$= 64 + 16 + 8 + 2 = 90$

Convert decimal to binary.

{Repeated division}





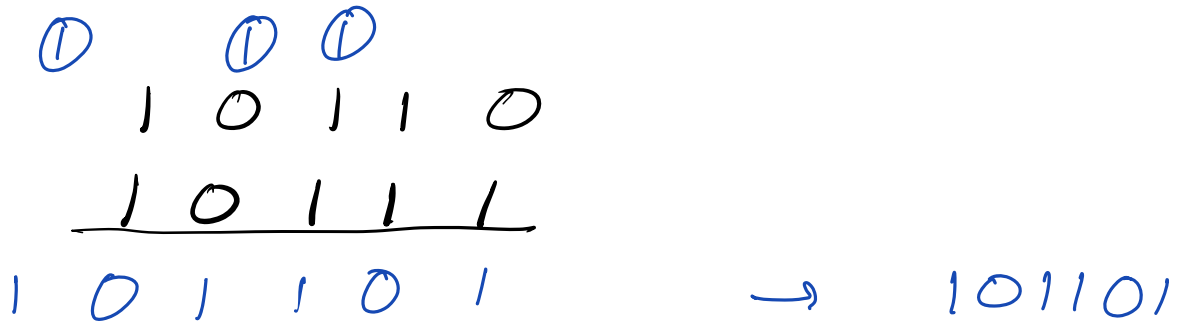
Addition of 2 decimal no.s.

```
  (1)  (1)
   7    8    9
   1    4    2
  ---------------
   9    3    1
  ---------------
```

```
  (1)  (1)
   6    5    8
   1    8    6
  ---------------
   8    4    4
  ---------------
```

Add 2 binary numbers.

```
      (1)  (1)
   1   0   1   1   0        22          2 → 1 0
   0   0   1   1   1         7          3 → 1 1
  ---------------------    ----
   1   1   1   0   1        29
```



~ 0 → 1

~ 1 → 0

Bitwise operators.

&	|	^	~	<<	>>
AND	OR	XOR	NOT	left shift	right shift
			toggle		

0 → false
1 → true

same same pubby thame

a	b	a&b	a|b	a^b	~a	~b
0	0	0	0	0	1	1
0	1	0	1	1	1	0
1	0	0	1	1	0	1
1	1	1	1	0	0	0

Basic problems

29 & 19 = 17

a = 29 b = 19

4 3 2 1 0

a: 1 1 1 0 1
b: 1 0 0 1 1

a&b 1 0 0 0 1 → 17
a|b 1 1 1 1 1 → 31
a^b 0 1 1 1 0 → 14

a = 20 b = 45

a = 0 1 0 1 0 0
b = 1 0 1 1 0 1

a^b 1 1 1 0 0 1

→ 57

Negative numbers → 2's complement

$-x$

1) get binary of x

2) Take NOT of x

3) Do +1

-5

1) 0 0 0 0 0 1 0 1

2) 1 1 1 1 1 0 1 0 (1's complement)

3)
$$\begin{array}{r} 1\,1\,1\,1\,1\quad 0\,1\,0 \\ +\quad 0\,0\,0\,0\,0\quad 0\,0\,1 \\ \hline 1\,1\,1\,1\,1\quad 0\,1\,1 \end{array}$$

2's complement

-3

0 0 0 0 0 0 1 1

→ 1 1 1 1 1 1 0 0

+1 0 0 0 0 0 0 0 1

---

1 1 1 1 1 1 0 1

7 6 5 4 3 2 1 0

-2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0

-10

0 0 0 0 1 0 1 0

1 1 1 1 0 1 0 1

+1

---

1 1 1 1 0 1 1 0

signed unsigned (all +ve)

_ _ _ _ _ _ _ _

7 6 5 4 3 2 1 0

-2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0

_ _ _ _ _ _ _ _

$n-1$ $n-2$ 2 1 0

-2^{n-1} 2^{n-2} . . . . . 2^2 2^1 2^0

$2^{n-2} + 2^{n-3} + \dots + 2^2 + 2^1 + 2^0$

$= 2^{n-1} - 1$

Range

$[-2^{n-1}, \quad 2^{n-1}-1]$

int (32 bit)

$-2^{31}, \quad 2^{31}-1$

$\approx [-2\times10^{9}, \quad 2\times10^{9}-1]$

-2147483648

long (64 bit)

$-2^{63}, \quad 2^{63}-1$

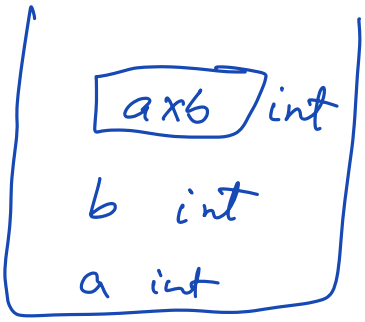
$\sim [-8\times10^{18}, \quad 8\times10^{18}-1]$

Constraints

int a = 10^5 int b = 10^6 = 10^{11}

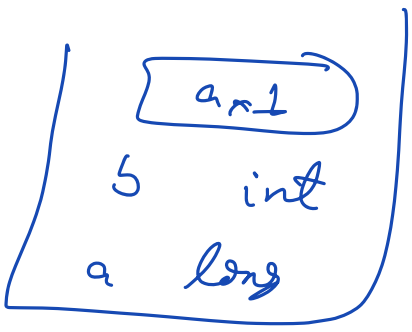
int c = a x b

long c = a x b



long c = long (a x b)

long c = long(a) x b



Q Sum of array

$1 \le n \le 10^5$

$1 \le a[i] \le 10^6$

} sum → 10^{11}

$\underbrace{10^6 \quad 10^6 \quad \ldots \quad 10^6}_{10^5}$

```
long sum = 0
for ( i=0 ; i<n ; i++)  {
|       sum += a[i]
}
return sum
```

long

long int

[done]

0 0 4 5 6

0 1 2 3 4

$\underbrace{17 \quad 17\,17\,17}_{11}$

17 × 11

less = 0

Pseudo code :

```
sort (arr)                    // ascending order
int ans = 0
int less = 0

if (a[0] == 0)                // check a[0]
    ans++
for(i=1 ; i<n ; i++) {
  if(a[i] == a[i-1]) {
    //
  else
    less = i

  if(a[i] == less)
    ans++;
}
return ans.
```

1 1 4 5 6

TC: O(nlogn) SC: O(1)