Day - 7

Saturday, 17 January 2026 11:04 AM

Bit- manipulatⁿ-1

Decimal NS ⇒ {0, 1 ... 9} ⇒ 10 Digits ⇒ Base (10) ✓

0 10 20
1 11 .
. 12 .
9 . .
19 29 ...

eg $(531)_{10}$ ⇒ 500 + 30 + 1

$5 \cdot 10^2 + 3 \cdot 10^1 + 1 \cdot 10^0$

eg 7845 ⇒ 7000 + 800 + 40 + 5

$7 \cdot 10^3 + 8 \cdot 10^2 + 4 \cdot 10^1 + 5 \cdot 10^0$

Binary NS ⇒ {0, 1}

base (2)

0 - 0   10 - 2   100 - 4
1 - 1   11 - 3   101 - 5
110 - 6 ✓
111 - 7.

eg $(110)_2 = 1 * 2^2 + 1 * 2^1 + 0 \cdot 2^0$

$= 4 + 2 + 0 \Rightarrow (6)_{10}$

$(1101)_2 = 1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0$

$= 8 + 4 + 0 + 1 \Rightarrow (13)_{10}$ ✓

$\begin{array}{ccccc} 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \\ 1 & 0 & 1 & 1 & 0 \end{array}$ $_2 = (22)_{10}$

16 8 4 2 1 ✓

$\begin{array}{ccccc} 16 & 8 & 4 & 2 & 1 \\ 1 & 0 & 0 & 1 & 0 \end{array}$ $_2 = (18)_{10}$

Decimal to Binary.

$$\begin{array}{r|l} 2 & 15 \\ \hline 2 & 7 \quad 1 \\ \hline 2 & 3 \quad 1 \\ \hline & 1 \quad 1 \end{array}$$

$(15)_{10} = (1111)_2$

$$\begin{array}{r|l} 2 & 22 \\ \hline 2 & 11 \quad 0 \\ \hline 2 & 5 \quad 1 \\ \hline 2 & 2 \quad 1 \\ \hline & 1 \quad 0 \end{array}$$

$(10110)_2$

2 ⇒ (10) ✓

Addⁿ

eg

1 1
1 7 8

1
0 1 0 1 ⇒ (5)

$$\begin{array}{r} + \ 237 \\ \hline 415 \end{array}$$ ✓

$0110 \Rightarrow 6$

$1011 \Rightarrow 11$ ✓

8 4 2 1

Operator

- Uni: ~5
- Binary: +, −, *, /, %, &, |, ^ …
- Ternary (?:): ( ) ? ___ : ___ (T / F)

Bitwise Operator

~, &, |, ^, <<, >>

- ~ → NOT
- & → AND
- | → OR
- ^ → EXOR
- << → Left shift
- >> → Right shift

NOT (~/!) ⇒ 1 → 0

0 → 1

eg $\sim(5)_{10} \Rightarrow \sim(0101)_2$

$(\sim 5)_{10} \Rightarrow (1010)_2$ ✓

AND ⇒ (&)

a = 5 ⇒ 0101

b = 6 ⇒ & 0110

0100 ⇒ 4 ✓

OR (|)

a = 5 ⇒ 0101

b = 6 ⇒ | 0110

0111 ⇒ 7 ✓

EXOR

a = 5 ⇒ 0101

b = 6 ⇒ ^ 0110

0011 ⇒ 3 ✓

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

Properties.

(i) A & 1 = ?

eg. A = 5 (0101)

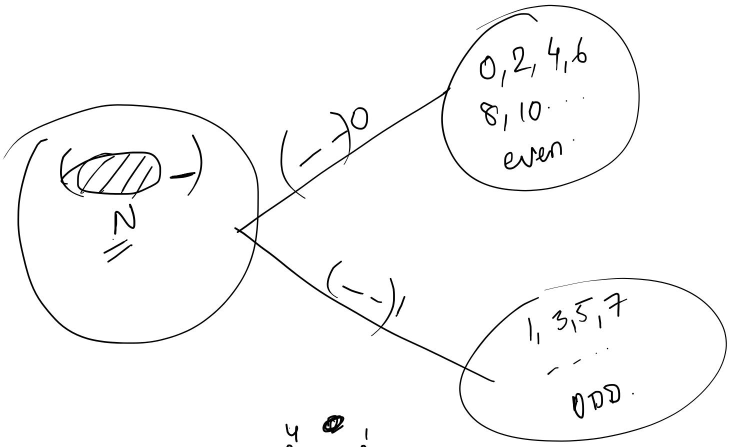
```
  0101
& 0001
------
  0001 ✓
```

A = 6 (0110)

```
  0110
& 0001
------
  0000
```

= 1 ⇒ if last bit is set bit in A

= 0 ⇒ —— " —— unset bit in A.



$\underbrace{1001}\underbrace{0}$

Even + Even = even.

$\underbrace{1001}\underbrace{1}$

Even. + ODD. = ODD.

(ii) A & 0 = 0

```
  0101
& 0000
------
  0000
```

(iii) A & A = A

```
  0101
& 0101
------
  0101
```

(iv) A | 0 = A

```
  0101
| 0000
------
  0101 ⇒ A ✓
```

(v) A & A = A

```
  0101
& 0101
------
  0101
```

(vi) $A \wedge 0 = A$ ✓

$$\begin{array}{r} 0101 \\ \wedge\ 0000 \\ \hline 0101 \end{array} \Rightarrow A$$

(v) $A \wedge A = 0$

$$\begin{array}{r} 0101 \\ \wedge\ 0101 \\ \hline 0000 \end{array}$$

Commutative Prop

$(a \,\&\, b) = (b \,\&\, a)$ ✓

$(a \mid b) = (b \mid a)$ ✓

$(a \wedge b) = (b \wedge a)$ ✓

Associativity

$\boxed{a \,\&\, b \,\&\, c} = \boxed{(c \,\&\, b) \,\&\, a}$?

$(b \,\&\, (c) \,\&\, a)$

$b \,\&\, a \,\&\, c$

$(a \,\&\, b \,\&\, c)$

$\boxed{a \wedge b \wedge c} = (c \wedge a) \wedge b$

$(a \wedge c) \wedge b$

$\boxed{a \wedge b \wedge c}$

eg $a \wedge b \wedge c \wedge b \wedge a = ?$ → c ✓

$a \wedge a \wedge b \wedge b \wedge c =$ → c ✓

$0 \wedge 0 \wedge c$

$0 \wedge c = c$ ✓

eg $1 \wedge 1 \wedge 3 \wedge 5 \wedge 2 \wedge 5 \wedge 3$

o/p ⇒ 2

$\underbrace{1 \wedge 1}_{0} \wedge \underbrace{3 \wedge 3}_{0} \wedge \underbrace{5 \wedge 5}_{0} \wedge 2$

$0 \wedge 0 \wedge 0 \wedge 2$

$0 \wedge 0 \wedge 2$

$0 \wedge 2$

2 ✓

Q Given an int arr of size "N".

Q. all ele appears twice except for '1' ele which appear once.
Find the unique ele.

$[1, 3, 5] \Rightarrow 9$

eg arr[] = {6, 2, 1, 6, 2} o/p ⇒ 1

$[3, 1, 5] = 9$

eg arr[] = {2, 3, 5, 6, 3, 6, 2} o/p ⇒ 5 ✓

M-1

```
ans = 0
for (i = 0 ; i < n ; i++)
    ans = ans ^ arr[i]
rt ans;
```

TC = O(N)
SC = O(1)

M-2 (Brute Force)

```
for (i = 0; i < n; i++) {      —— N
    curEle = arr[i]
    count = 0;
    for ( j = 0 ; j < n ; j++ ) {
        if ( arr[j] == curEle)         ⇒ O(N)
            count++
    }
    if (count == 1)
        rt arr[i] // rt curEle
}
```

TC = O(N²)
SC = O(1)

M-3.

map ⇒

2 ⇒ ~~2~~
3 ⇒ ~~2~~
5 ⇒ 1
6 ⇒ ~~2~~

{2, 3, 5, 6, 3, 6, 2}

TC = O(N) + O(N) ⇒ O(N)

SC = O(N/2) ≈ O(N)

for i ← 0 ... N-1

if arr[i] in map

map[arr[i]] ++

else

map (arr[i]) = 1

O(N)

for k, v in map

if (val == 1)

rt key ✓

O(N)

[Searching]

M-4

(1, 1, 2, 2, 3, 4, 4, 7, 7, 9, 9) ✓

0 1 2 3 4 5 6 7 8 9 10

O(Nlogn) ✓

arr[sorted]

Left shift (<<)

int ⇒ 4B ⇒ 32 bit

8 bit ✓

a = 25 $(0\,0\,0\,1\,1\,0\,0\,1)_2$

(25 << 1) ⇒ 0 0 0 1 1 0 0 1 0

0 0 1 1 0 0 1 0

$(0\,0\,1\,1\,0\,0\,1\,0)_2$

32 16 50 2

$\cancel{16}$ 50

$$a = (0\ 0\ 0\ 0\ \overset{2^4}{1}\ 0\ 0\ \overset{2^0}{1})_2 \Rightarrow (9)_{10}$$

$$a \ll 1 = (0\ 0\ 0\ \overset{2^5}{1}\ 0\ 0\ \overset{2^1}{1}\ 0)_2 \Rightarrow (18)_{10}$$

$$N = (a_1 \cdot 2^x + a_2 \cdot 2^y)$$

$$N \ll 1 = a_1\, 2^{x+1} + a_2 \cdot 2^{y+1}$$

$$= 2 \cdot (a_1 2^x) + 2(a_2\, 2^y)$$

$$= 2\,[\underbrace{a_1\, 2^x + a_2 2^y}_{N}]$$

$$= 2(N)$$

$$N \ll 2 \Rightarrow a_1 \cdot 2^{x+2} + a_2 \cdot 2^{y+2}$$

$$2^2[a_1 2^x + a_2 2^y]$$

$$2^2[N] \Rightarrow 4N$$

$$N \ll 3 \Rightarrow a_1 \cdot 2^{x+3} + a_2 \cdot 2^{y+3}.$$

$$\Rightarrow 2^3[a_1 2^x + a_2 \cdot 2^y]$$

$$\Rightarrow 8[N]$$

$1 \ll 0 \qquad 1 = (0000\ 0001)$

$1 \ll 1 \Rightarrow 2 \qquad (0\ 000\ 0010) = 2$

$1 \ll 2 \Rightarrow 4 \qquad (0000\ 0100) = 4$

$\boxed{1 \ll 3} \Rightarrow 8 \qquad (0000\ 1000) = 8$

Right shift $\Rightarrow$

$$(0\ 0\ 0\ 1\ 0\ 0\ 1\ 0) \Rightarrow (18)_{10}$$

$18 \gg 1 \qquad \Rightarrow (0\ 0\ 0\ 0\ 1\ 0\ 0\ 1) \Rightarrow (9)_{10}$

$$(0\ 0\ 0\ 1\ 1\ 0\ 1\ 1) \Rightarrow (27)_{10}$$

$27 \gg 1 \qquad \Rightarrow (0\ 0\ 0\ 0\ 1\ 1\ 0\ 1) \Rightarrow (13)$

$$\left\lfloor \frac{27}{2} \right\rfloor = 13$$

log 1

$O(N)$ ✓ $O(N \log_{10} N)$

$N=3$ ✓

$\Rightarrow 3$

$3 * \underbrace{(\leq 1)}_{< 3} \Rightarrow 7, 1$

10^{5}

$\log_{10}(\ ) \Rightarrow \log_{10}$

$\log_{10}(2)$

$\vdots$

$\log_{10}(9)$

< 1

$\log_{10} 10 = 1$

$\log_{10}(11) \Rightarrow > 1$

$O(N)$