

Announcement: 23rd June → Bit manipulation, sorting,
maths and modular

[0-9] Decimal num system

7 3 4 : Seven hundred thirty four : $700 + 30 + 4 : 7 \times 10^2 + 3 \times 10^1 + 4 \times 10^0$

6 9 7 4 : $6 \times 10^3 + 9 \times 10^2 + 7 \times 10^1 + 4 \times 10^0$

Bits: 0 & 1s

AMA (Just send a whatsapp)

8510955377

Octal numbers [0-7] base is 8

$$\begin{array}{rcll} (331)_8 & \longrightarrow & \begin{array}{ccc} 3 & 3 & 1 \\ \downarrow & \downarrow & \downarrow \\ 8^2 & 8^1 & 8^0 \end{array} & = 3 \times 64 + 3 \times 8 + 1 \\ & & & = (217)_{10} \\ (971)_8 & \times & & \end{array}$$

Halloween = Christmas?

OCT 31

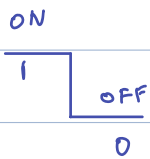
DEC 25

$$(31)_8 = (25)_{10}$$

Decimal

$$\begin{array}{rcll} (111)_8 & \longrightarrow & \begin{array}{ccc} 1 & 1 & 1 \\ \downarrow & \downarrow & \downarrow \\ 8^2 & 8^1 & 8^0 \end{array} & = 64 + 8 + 1 = 73 \end{array}$$

Binary [0 1] Base 2 [0, 1]



$$\begin{aligned}
 (1011010)_2 &= 2^6 + 2^4 + 2^3 + 2 \\
 &= 64 + 16 + 8 + 2 \\
 &= \underline{90}
 \end{aligned}$$

Diagram showing the binary number 1011010 with arrows pointing to the corresponding powers of 2: 2⁶, 2⁵, 2⁴, 2³, 2², 2¹, and 2⁰.

$$\begin{aligned}
 (1011)_2 &= 8 + 2 + 1 = 11
 \end{aligned}$$

Diagram showing the binary number 1011 with arrows pointing to the corresponding powers of 2: 2³, 2², 2¹, and 2⁰.



MSB (Most Significant Bit) and LSB (Least Significant Bit) are indicated for the decimal number (379)₁₀.

$$(379)_{10} \longrightarrow [3, 7, 9]$$

$$\begin{aligned}
 &\downarrow \div 10 \longrightarrow 9 \\
 &10 \overline{) 37} \\
 &\quad \downarrow \div 10 \longrightarrow 7 \\
 &\quad 10 \overline{) 3} \\
 &\quad \quad \downarrow \div 10 \longrightarrow 3 \\
 &\quad \quad 10 \overline{) 0}
 \end{aligned}$$

Decimal No.

Decimal to binary

$$(20)_{10} = (10100)_2$$

$$\begin{array}{r} 0 \\ 2 \sqrt{1} \\ 0 \\ \hline 1 \end{array}$$

2	20	→ %2 = 0
2	10	→ %2 = 0
2	5	→ %2 = 1
2	2	→ %2 = 0
2	1	→ %2 = 1

0

$$(45)_{10}$$

2	45	%2 → 1
2	22	%2 → 0
2	11	%2 → 1
2	5	%2 → 1
2	2	%2 → 0
	1	%2 → 1

$$(101101)_2$$

$$(25)_{10}$$

2	25	%2 → 1
2	12	%2 → 0
2	6	%2 → 0
2	3	%2 → 1
	1	%2 → 1

$$(11001)_2$$

(Decimal to Binary)

Octal \rightarrow Binary
 \hookrightarrow Decimal \nearrow

Add two Decimal numbers

Sum	$17 \times 10 = 7$
Carry	$17 / 10 = 1$

$$\begin{array}{rcccc} & 3 & 4 & 9 & 7 \\ + & 4 & 8 & 7 & 4 \\ \hline 8 & 3 & 7 & 1 & \end{array}$$

Num / 10

Carry

	1	1	1	1	
	5	6	7	7	
+	8	8	2	8	
	<hr/>				
Nums	1	14	15	10	15
	<hr/>				
Num:10	1	4	5	0	5
	<hr/>				

✓

Num/2

Carry :

0	1	1	0	
1	0	1	1	0
0	0	1	1	1

Num

1	1	3	2	1
---	---	---	---	---

Num/2

1	1	1	0	1
---	---	---	---	---

$$\text{Num}/2$$

Carry: 0 0 1 1

1 0 0 1 | → 19

0 | 0 0 | → 9

Num 1 1 1 2 2

Num/2 1 1 1 0 0 → 28

Addition of binary numbers

0 → False / Unset / off
1 → True / Set / on

Strict parents

Clean your room and complete HW



TOY



Lenient parents: Clean your room OR complete HW

XOX: Same same puppy shem

Tenth table operators

Bit Manipulation (& | ^ ~ >> <<)

↓ ↓ ↓ ↓ ↓ ↓

and or XOR NOT Rightshift Leftshift

a	b	$a \& b$	$a \vee b$	$a \wedge b$	$\sim a$
0	0	0	0	0	1
0	1	0	1	1	1
1	0	0	1	1	0
1	1	1	1	0	0

XOR: Addition without carry

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

$a \& b = a \times b$	absolutely not
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print (5 & 6) → 4

VI

$$\begin{array}{r} 5 \rightarrow 101 \\ 6 \rightarrow 110 \\ \hline 100 \rightarrow 4 \end{array}$$

print (20 & 45) → 4

$$\begin{array}{r} 20 \rightarrow 010100 \\ 45 \rightarrow 101101 \\ \hline 000100 \rightarrow 4 \end{array}$$

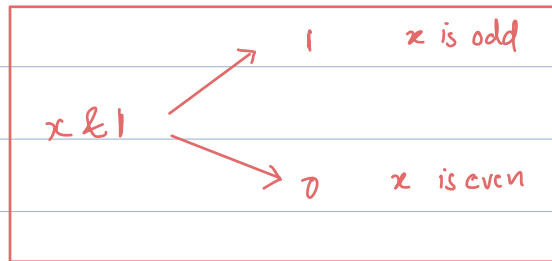
$$\begin{array}{r} 20 \rightarrow 010100 \\ \text{xor } 45 \rightarrow 101101 \\ \hline 111001 \rightarrow 57 \end{array}$$

$$\begin{array}{r} 5 \& 1 = 1 \quad 101 \\ \& 001 \\ \hline 001 \end{array}$$

$$\begin{array}{r} 6 \& 1 = 0 \quad 110 \\ 001 \\ \hline 000 \end{array}$$

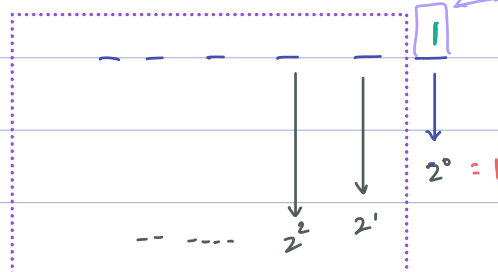
00001

Property 1)



why?

Even numbers



← set Has to be a odd num.

property 2:

$$\begin{aligned} A \& 0 &= 0 \\ A \& A &= A \end{aligned}$$

$$\begin{array}{r} S: 101 \\ S: 101 \\ \hline 101 \end{array}$$

$$\alpha \alpha \alpha \boxed{A \mid A = A + A} \alpha \alpha \alpha \alpha$$

$$\begin{array}{r} S: 101 \\ 0: 000 \\ \hline 101 \end{array}$$

property 3

$$\begin{aligned} A \mid 0 &= A \\ A \mid A &= A \end{aligned}$$

$$\begin{array}{r} S: 101 \\ \alpha S: 101 \\ \hline 101 \end{array}$$

property 4

$$A \wedge A = 0$$

$$A \wedge 0 = A$$

$$A: 101010$$

$$A: 101010$$

$$\underline{\hspace{1cm}} \\ 000000$$

$$1 \wedge 0 = 1$$

$$0 \wedge 0 = 0$$

$$A: 1001$$

$$0: 0000$$

$$\underline{\hspace{1cm}} \\ 1001$$

optional HOTS:

$$A \wedge 1 =$$

even $A+1$

odd $A-1$

Toggles the 0th bit

$$A | 1 \longrightarrow$$

$$5: 101$$

$$001$$

$$\underline{\hspace{1cm}} \\ 100 = 4$$

$$6: 110$$

$$1: 001$$

$$\underline{\hspace{1cm}} \\ 111 = 7$$

Back (10:36 - 10:46)

Commutative property: ✓

$$A+B = B+A$$

$$\begin{array}{r} A=5 \quad 101 \\ B=6 \quad \& 110 \\ \hline 100 \end{array}$$

$$A \& B = B \& A$$

$$A | B = B | A$$

$$A \wedge B = B \wedge A$$

✓

$$\begin{array}{r} 110 \\ \& 101 \\ \hline 100 \end{array}$$

Associative property ✓

$$(A+B)+C = (A+C)+B = A+(B+C)$$

$$(A \& B) \& C = (A \& C) \& B = A \& (B \& C)$$

$$(A | B) | C = (A | C) | B = A | (B | C)$$

$$(A \wedge B) \wedge C = (A \wedge C) \wedge B = A \wedge (B \wedge C)$$

$$\begin{aligned} 1 \& 3 \& 5 &= (1 \& 3) \& 5 = (1 \& 5) \& 3 \\ &= (5 \& 3) \& 1 \end{aligned}$$

$$a^n b^n c^n b^n c^n d^n d =$$

↓

$$a^n \cancel{b^n b^n c^n c^n d^n d} = a$$

$$\underbrace{0 \quad 0 \quad 0}_{0}$$

0

✓

$$1^n 3^n \cancel{5^n 3^n} 2^n 1^n = 3^n 2^n = 1$$

$$\begin{array}{r} 11 \\ 10 \\ \hline 01 \end{array}$$

Q1) Given an array of size N . All elements are repeating even no. of times. Except one $\rightarrow 2$ (Advance) element which is occurring odd no. of times. Find element occurring odd times.

$A = \{ 2, 2, 3, 4, 3, 7, 3, 3, 7, 4, 6 \}$

output: 6

2 : 2

3 : 4

4 : 2

7 : 2

6 : 1

1) Count occurrence of all elements:

$O(N^2)$

$$A \wedge A = 0$$

$$A \wedge A \wedge A \wedge A = 0$$

$$A \wedge A \wedge A = A$$

unique = 2

0	3	3^4	4	4^7	4^7^3	4^7	4	0	6	
{ 2	, 2	, 3	, 4	, 3	, 7	, 3	, 3	, 7	, 4	, 6 }

unique = 0

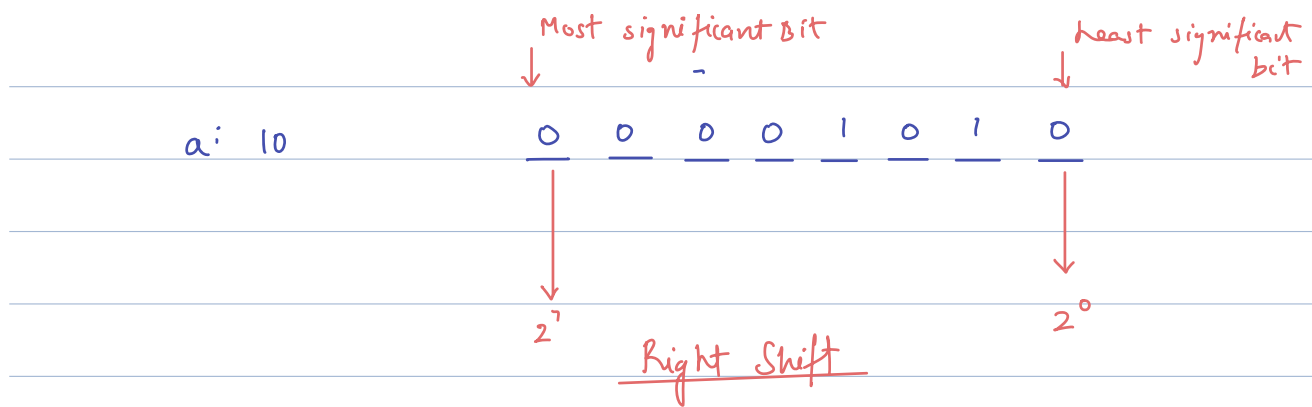
for (i=0; i<N; i++) {

 unique = unique ^ A[i]

}
return unique

TC: $O(N)$

SC: $O(1)$



$$a \gg 1 = a/2$$

$$a \gg 2 = a/4$$

$$a \gg k \Rightarrow a/2^k$$

*r Left shift

$$N/3$$

Majority element $> N/3$ times

[5 3 3 3 3 8 9 8 8 8 3 8 8]

$$N = 13$$

$$> \frac{13}{3} = > 4 \text{ times}$$

Majority elem: 3, 8
 \downarrow \downarrow
 5 6

2 why?



12

2 majority elements

[5 3 3 3 3 8 9 8 8 8 3 8 8]

↑

m1 = 5 9 8

m2 = 3

dummy

c1 = 1 0 1 0 2 5 4

c2 = 4 3 2 3

m1 = 8

m2 = 3

check m1 is majority or not

check m2 is majority or not

Code