

$\&, |, ^, \sim, \ll, \gg$

left shift (\ll)

Most significant

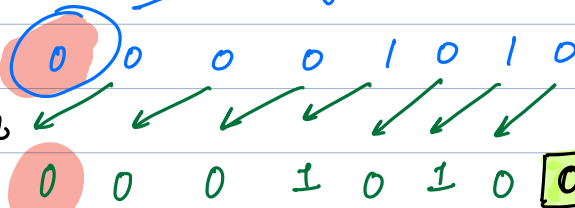
8 bits

$a = 10$

$$= 10 = 10 \times 2^0$$

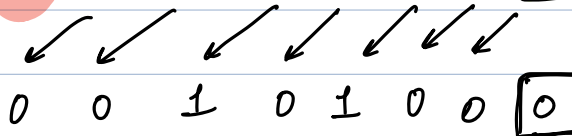
$a \ll 1$

discarded



$$= 20 = 10 \times 2$$

$a \ll 2$



$$= 40 = 10 \times 2^2$$

$a \ll 3$



$$= 80 = 10 \times 2^3$$

$a \ll 4$



$$= 160 = 10 \times 2^4$$

$a \ll 5$

overflow



$$= 64$$

$$a \ll i = a \times 2^i$$

$a = 11$

$a \ll 3$

$$= 11 \times 2^3 = 88$$

Right shift (>>)

$a = 40$

$a >> 1$
 $\uparrow \quad \downarrow$

$a >> 2$

$a >> 3$

$a >> 4$

$a >> 5$

$a >> 6$

0 0 1 0 1 0 0 0

↓ ↓ ↓ ↓ ↓ ↓ ↓

0 0 0 1 0 1 0 0

↓ ↓ ↓ ↓ ↓ ↓ ↓

0 0 0 0 1 0 1 0

0 0 0 0 0 1 0 1

0 0 0 0 0 0 1 0

0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0

$= 40$

$= 20 = 40/2$

$= 10 = 40/2^2$

$= 5 = 40/2^3$

$= 2 = 40/2^4$

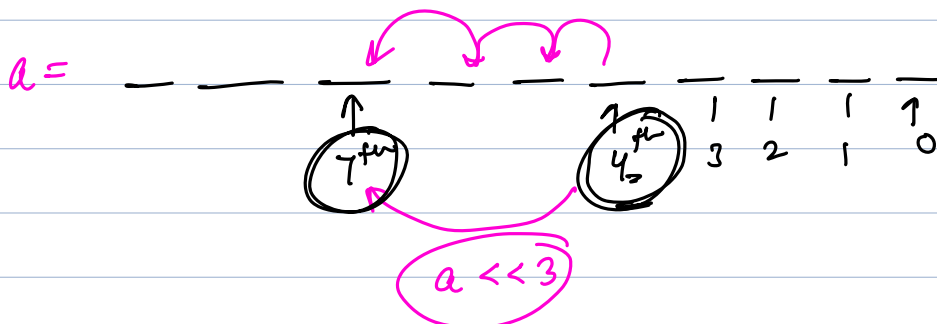
$= 1 = 40/2^5$

$= 0 = 40/2^6$

$a >> i = a / 2^i$

$15 << 2 = 15 \times 2^2 = 60$

$29 >> 2 = 29 / 2^2 = 7$

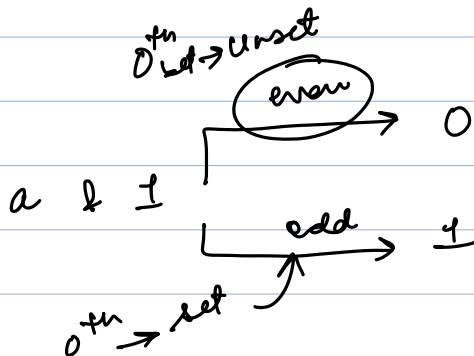


Q

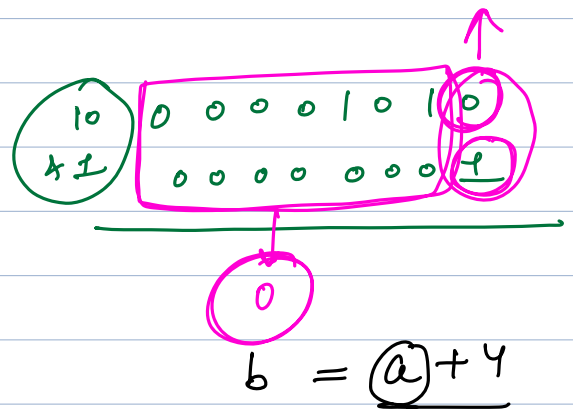
number N , check if i^{th} bit is set or unset

$N=13$
 $i=5$

0 0 0 0 1 1 0 1
 ↑
 unset



0th bit is set?



$N=27$
 $i=4$

4 3 2 1 0th

0 0 0 1 1 0 1 1

$a \gg 4$

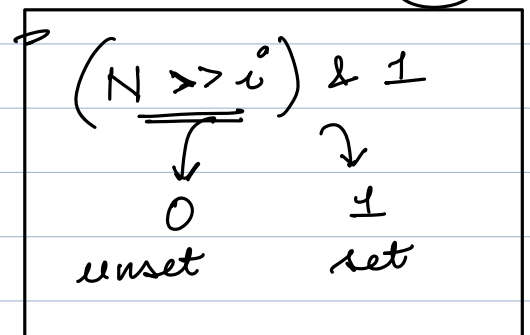
0 0 0 0 0 0 0 1

$\& 1$ 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 1

i^{th}

$(a \& 1)$



39

0 0 1 0 0 1 1 1

$39 \gg 2$

0 0 0 0 1 0 0 1

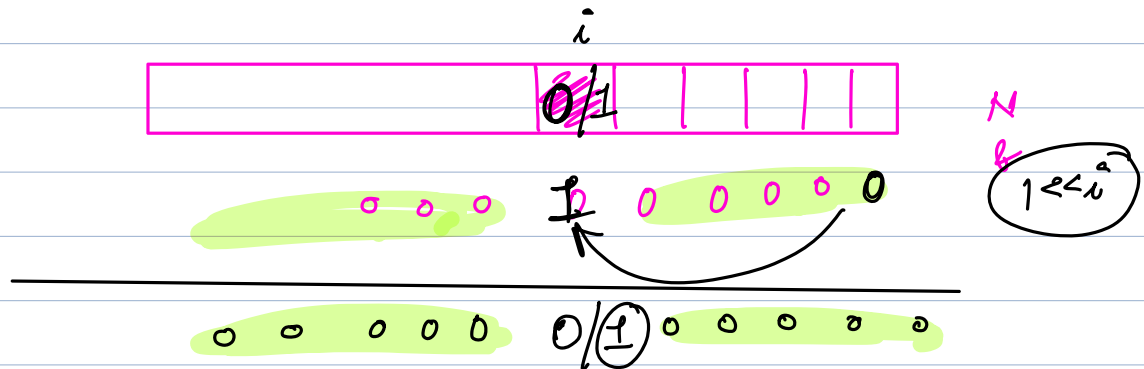
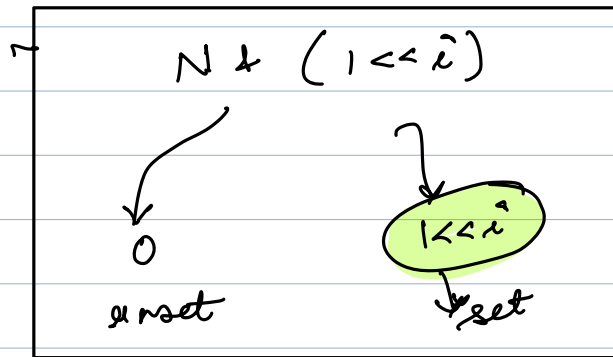
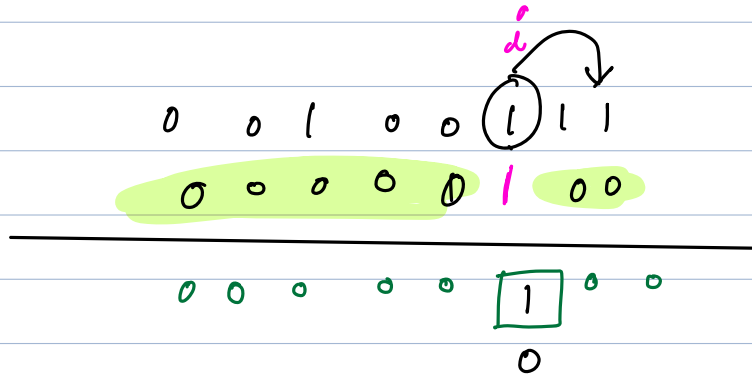
$\& 1$ 0 0 0 0 0 0 0 1

0

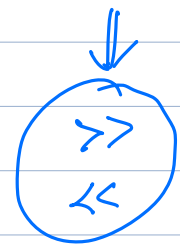
1

2nd bit

N = 39



if (N & (1 << i) == (1 << i))



if (N & (1 << i) > 0)

Q

given a Number N . set the i^{th} bit.

$N = 27$

	0	0	0		1	0	1	1
	0	0	0		0	0	1	0
ans	0	0	0		1	1	1	1

$= (31)$

00

$$a \& 0 = 0$$

$$a | 0 = a$$

$$a \wedge 0 = a$$

$$N | (1 \ll i)$$

Q

Toggle the i^{th} bit

$$0 \rightarrow 1$$

$$1 \rightarrow 0$$

$N = 27$

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

$$a \wedge 0 = a$$

$$a | 0 = a$$

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

$$0 \wedge 1 = 1$$

$$1 \wedge 1 = 0$$

$N \& (1 \ll i)$	set / unset
$N (1 \ll i)$	set the i^{th} bit
$N \wedge (1 \ll i)$	Toggle

10:25

Recording - available
 session - optional
 no attendance =

PS session
 Sunday - 11 am

2-3 weeks
 2-3 hrs
 optional/
 Archi

Q
 number N. Toggle all the bits starting from the last set bit (rightmost)

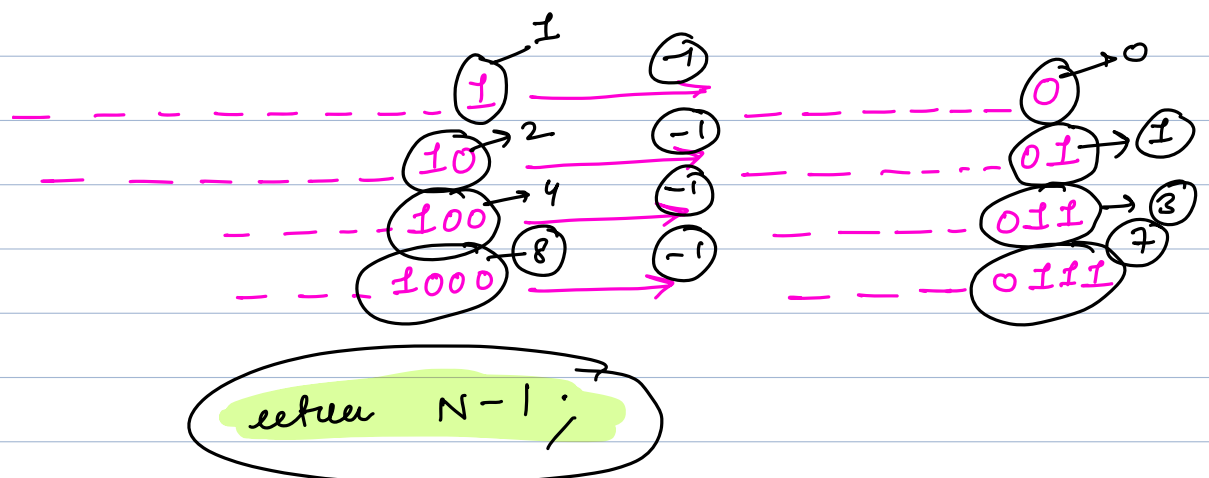
N =

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

```

i = 0;
while (N & (1 << i) == 0)
{
    N = N ^ (1 << i);
    i++;
}
N = N ^ (1 << i);
  
```

$O(\text{number of bits})$



$$\begin{array}{r} N \\ \& \\ N-1 \end{array}$$

—	—	—	—	—	—	1	0	0	0	0	0
—	—	—	—	—	—	0	1	1	1	1	1

$\frac{a(r^n - 1)}{r - 1}$

$2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0$

$$a \& a = a$$

$$\frac{2^0 (2^5 - 1)}{2 - 1} = 2^5 - 1$$

$$\underline{N \& (N-1)} \rightarrow \text{unset the right most set bit}$$

$$\begin{array}{r} N = \\ \& \\ N-1 \end{array}$$

—	—	—	—	—	1	0	0	0
—	—	—	—	—	0	1	1	1

$a \& a = a$

$0 \quad 0 \quad 0 \quad 0$

$$\begin{array}{r} 1 \quad 0 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 1 = N \\ 1 \quad 0 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad N-1 \\ \hline 1 \quad 0 \quad 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \end{array}$$

check if a number is power of 2

32 ✓
14 X

only 1 bit is set

$$N \& (N-1) = 0$$

N = 00010000
N-1 = 00001111

00000000

00001 - 2⁰
00000

00000

0 count total no of set bits

27 000011011 (4)
56 01110000 (3)
 32 16 8

00011011 ⇒ N & N-1

```
while( N > 0)
{
    N = N & (N-1)
    cnt++;
}
```

T.C: no of set bits

0	0	0	1	1	0	1	1	27	cnt++
0	0	0	0	1	1	0	1	27 >> 1	cnt++
								= 13	
0	0	0	0	1	1	0	0	13 >> 1	

```

while (N > 0)
{
    if (N & 1 != 0)
        cnt++;
    N = N >> 1;
}

```

no. of iterations
will be
= no. of bits