

$N | (1 \ll i) :-$ sets the i^{th} bit in N
 $N \& (1 \ll i) :-$ check if i^{th} bit is set
 $N \wedge (1 \ll i) :-$ Toggles the i^{th} bit in N
 $N \& (N-1) :-$ unset the last set bit

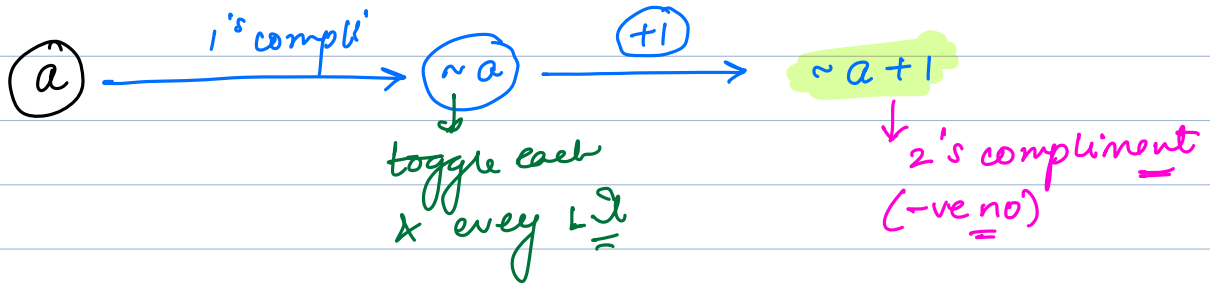
signed
 8 bit
 10: 0 0 0 0 1 0 1 0
 -10: 1 0 0 0 1 0 1 0
 -10

8 bits
 -4: 1 0 0 0 0 1 0 0
 10: 0 0 0 0 1 0 1 0
 +
 1 0 0 0 1 1 1 0 \rightarrow -14
 0 \rightarrow 14

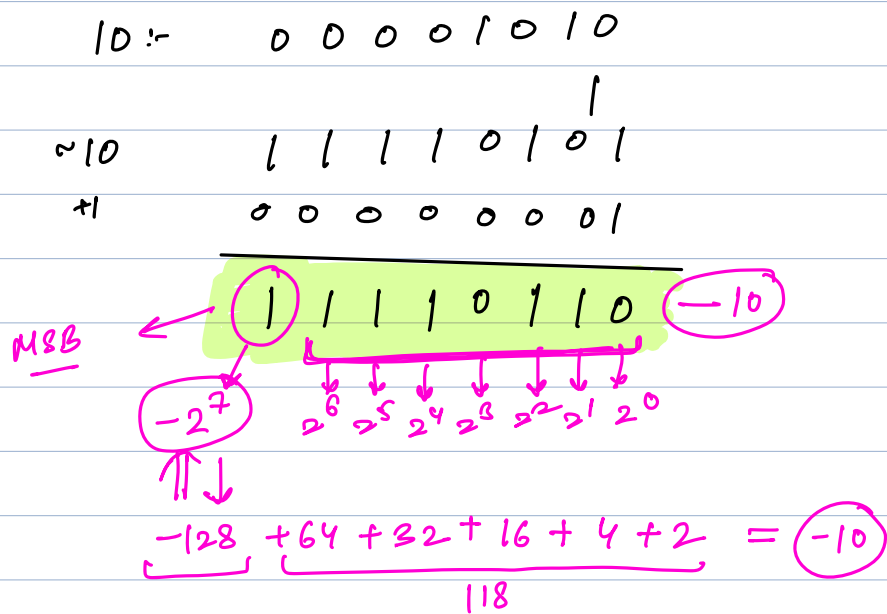
signed bit
 0 0 0 0 0 0 0 0 \rightarrow 0
 1 0 0 0 0 0 0 0 \rightarrow -0?

-ve number \Rightarrow 2's complement of its positive number

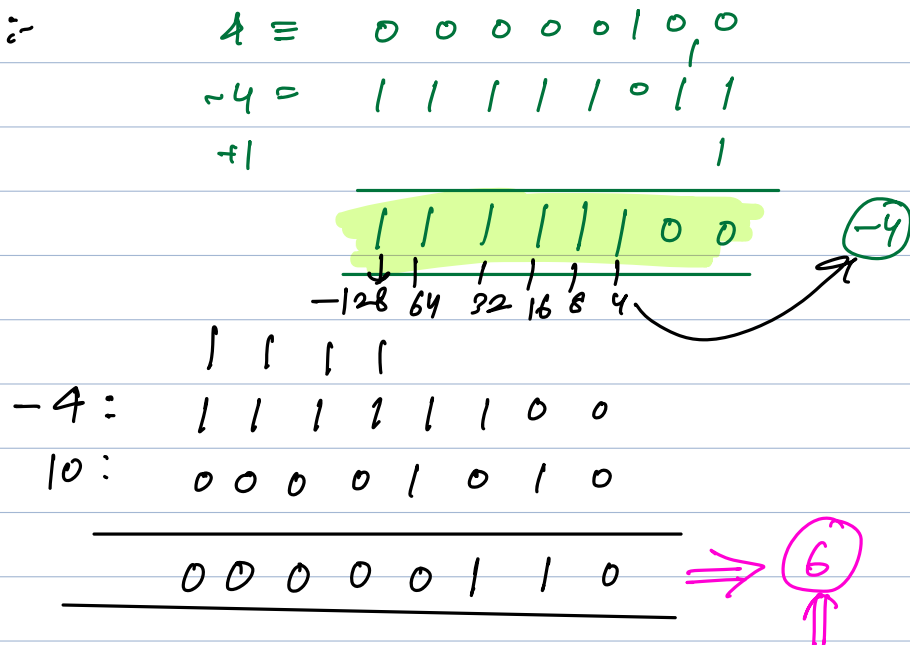
$-a$



-10



-4



-ve \rightarrow decimal

MSB $\Rightarrow -2^{\text{---}}$

all $\Rightarrow +2^{\text{---}}$

-ve \rightarrow decimal

MSB $\Rightarrow -2^{\text{---}}$

all $\Rightarrow +2^{\text{---}}$

-ve \rightarrow decimal

MSB $\Rightarrow -2^{\text{---}}$

all $\Rightarrow +2^{\text{---}}$

-34 :-

$$\begin{array}{r} -34 :- \\ \hline \end{array} \qquad \begin{array}{r} 34 :- \\ \hline \end{array}$$

$$\begin{array}{r} \underline{-34} :- \\ 34 :- \\ \sim 34 \end{array} \quad \begin{array}{r} 36+2 \\ 0 \ 0 \ 1 \ 0 \ 0 \ 0 \ 1 \ 0 \\ 1 \ 1 \ 0 \ 1 \ 1 \ 1 \ 0 \ 1 \end{array}$$

$$\begin{array}{r} 1 \\ \hline 1 \ 1 \ 0 \ 1 \ 1 \ 1 \ 1 \ 0 \\ \hline -128 \end{array} = -34$$

4 bul's

$$-2^2 \quad 2^2 \quad 2^1 \quad 2^0$$
$$\begin{array}{cccc|c} \textcircled{-1} & 1: & 0 & 0 & 0 & \underline{1} \\ & 2: & 1 & 1 & 1 & 0 \\ & 3: & & & & 1 \end{array}$$

$$\begin{array}{cccc}
 & 1 & 1 & 1 & 1 \\
 & \downarrow & \downarrow & \downarrow & \downarrow \\
 -2^3 & 2^2 & 2^1 & 2^0 \\
 -8 & +4 & +2 & +1 & = -1
 \end{array}$$

①

$$-x$$

n bits

$$\begin{array}{c} \downarrow \\ 0 \\ \hline \downarrow \\ n-1 \\ \swarrow \\ -2^{n-1} \end{array}$$

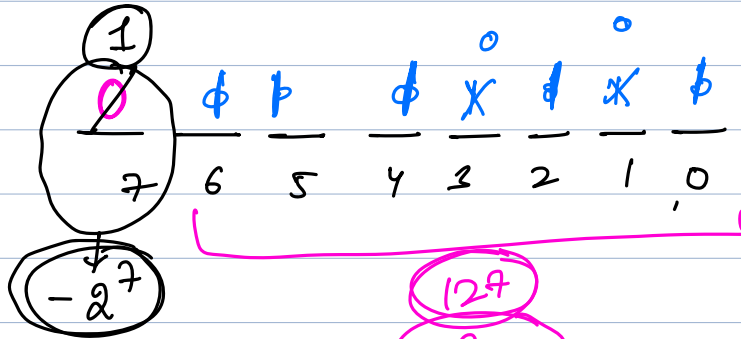
Diagram illustrating a stack structure with indices 0, 1, 2, 3, 4, 5. The index 5 is circled in blue. Below the stack, the expression $n-1$ is written above $2 - 1$, which is circled in green. A green arrow points from the green circle up to the index 3 in the stack.

$+127$
 10
 117

$$\begin{array}{c} \cancel{2^{n-1}} - 1 - x + \cancel{(-2^{n-1})} \\ \longrightarrow (-x) - 1 + 1 \end{array}$$

$(-x)$

x



8 bits

7 bits

$$\begin{array}{c} 127 \\ 2^7 - 1 \end{array}$$

$$2^0(2^7 - 1)$$

$$\begin{array}{c} \cancel{2^{n-1}} - 1 - x - \cancel{2^{n-1}} \\ \longrightarrow -1(-x) + 1 \end{array}$$

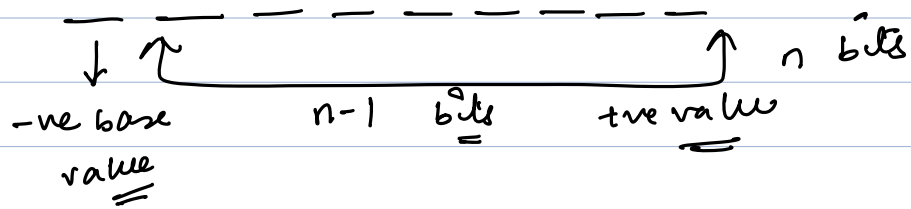
$$127 - 10 = 117$$

-ve num $\equiv 2^i$ complement

12

$$\begin{array}{c} 1 \quad 1 \quad 0 \quad 0 \\ \hline \downarrow \\ -2^3 \\ -8 \end{array} \Rightarrow -4$$

4 bits



2 bits available

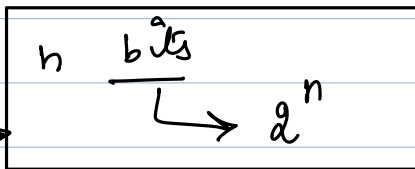
2 2
 ↓ ↓
 0/1 0/1

0	0
0	1
1	0
1	1

→ 4

2	2	2	3 bits
↓	↓	↓	
0/1	0/1	0/1	
0	0	0	= 0
0	0	1	= 1
0	1	0	= 2
0	1	1	= 3
1	0	0	= 4
1	0	1	= 5
1	1	0	= 6
1	1	1	= 7

different combinations



+ve numbers include 0

4 opt's

0 0 → 0
 0 1 → 1
 1 0 → 2
 1 1 → 3

0-3

8 opt's

0-7

$$n \text{ bits} \equiv 2^n$$

Range
(only +ve no)
index 0

=

$$0 \rightarrow 2^n - 1$$

include -ve numbers

$$\begin{array}{c} \textcircled{-2^1} \quad 2^0 \quad 2^1 \text{ bits} \\ \downarrow \\ \text{-ve here} \\ \text{value} \end{array} \quad \textcircled{4} = 2^2$$

$$\begin{array}{rcl} 0 & 0 & = 0 \\ 0 & 1 & = 1 \\ \textcircled{1} & 0 & = -2 \\ 1 & 1 & = -1 \end{array}$$

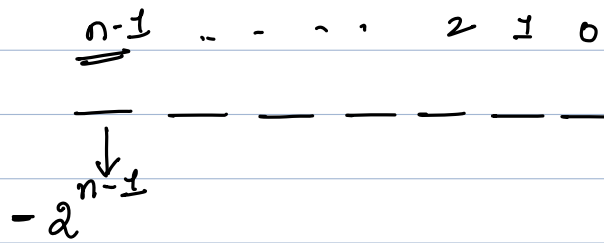
$$-2 \rightarrow 1$$

8 total

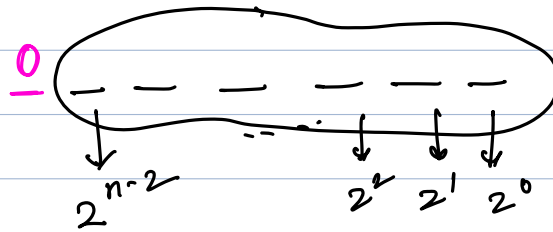
$$\overline{-2^2} \quad \overline{2^1} \quad \overline{2^0}$$

$$\begin{array}{rcl} 0 & 0 & 0 = 0 \\ 0 & 0 & 1 = 1 \\ 0 & 1 & 0 = 2 \\ 0 & 1 & 1 = 3 \\ \textcircled{1} & 0 & 0 = -4 \\ 1 & 0 & 1 = -3 \\ 1 & 1 & 0 = -2 \\ 1 & 1 & 1 = -1 \end{array}$$

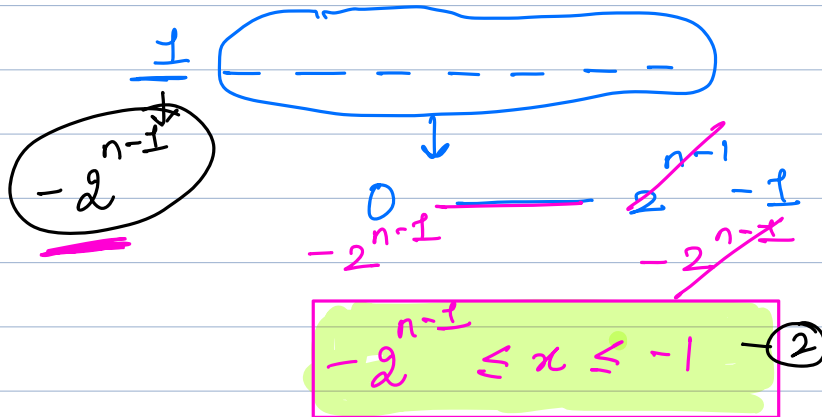
-4 to 3



for true 0



$$0 \leq x \leq 2^{n-1} - 1 \quad (1)$$



n bits

$$-(2^{n-1}) \leq x \leq 2^{n-1} - 1$$

n bits
 $0 \rightarrow 2^n - 1$
 if only +ve

n = 8 bits
 $2^8 = 256$
 +ve $\equiv 0 - 255$

+ve $\equiv 0 - 127$
 -ve $\equiv -128 \dots -1$
 $-128 \rightarrow +127$
 $-2^7 \rightarrow 2^7 - 1$

4 bits \Rightarrow

$-8 \rightarrow 7$

3 bits \rightarrow

$-4 \rightarrow 3$

$\text{int} \therefore 4 \text{ bytes} = 32 \text{ bits}$

$1 \text{ byte} = 8 \text{ bits}$

$-2^{31} \rightarrow 2^{31} - 1$

decimal value

2 1 4 7 4 8 3 6 4 8

$\text{long} \equiv 8 \text{ bytes} = 64 \text{ bits}$

$-2^{63} \rightarrow 2^{63} - 1$

$8 \text{ bits} \Rightarrow -128 \rightarrow 127$

$127 + 1$

overflow occurs

~~128~~

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

$+1$

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

-128

$1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1 \ 1$

-1

$0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0$

0

$2^{10} = 1024 \approx 10^3$

$2^{10} \approx 10^3$

$(2^{10})^2 \approx (10^3)^2$

$2^{20} \approx 10^6$

$2^{30} \approx 10^9$

$2^{31} \approx 2 \times 10^9$

$-2 \times 10^9 \leq x \leq 2 \times 10^9 - 1$

$2^{10} = 10^3$

$(2^{10})^6 = (10^3)^6$

$2^{60} \approx 10^{18}$

$2^3 \times 2^6 \approx 2^3 \times 10^{18}$

$2^{62} \approx 4 \times 10^{18}$

//

$$1 \leq n \leq 10^5$$

$$1 \leq arr[i] \leq 10^6$$

$$10^5 \times 10^6 = 10^{11}$$

~~long~~ ~~int~~ 2×10^9
~~int~~ total = 0;
 for (int i = 0; i < n; i++)
 total += arr[i];

int a, b;

int prod = a * b;

long prod = a * b;

long(a) * b;

long(a * b);

$$1 \leq a \leq 10^6$$

$$1 \leq b \leq 10^6$$

