

Bit manipulation

17 September 2022 13:07

Bitwise operators

AND	\wedge
OR	\vee
XOR	$\wedge\text{N}$
NOT	\sim

OR gate

$1 \mid 1 = 1$
$1 \mid 0 = 1$
$0 \mid 1 = 1$
$0 \mid 0 = 0$
$0 \quad 1 \quad 1 \quad 0$

0 1 1 0

0 1 0 0

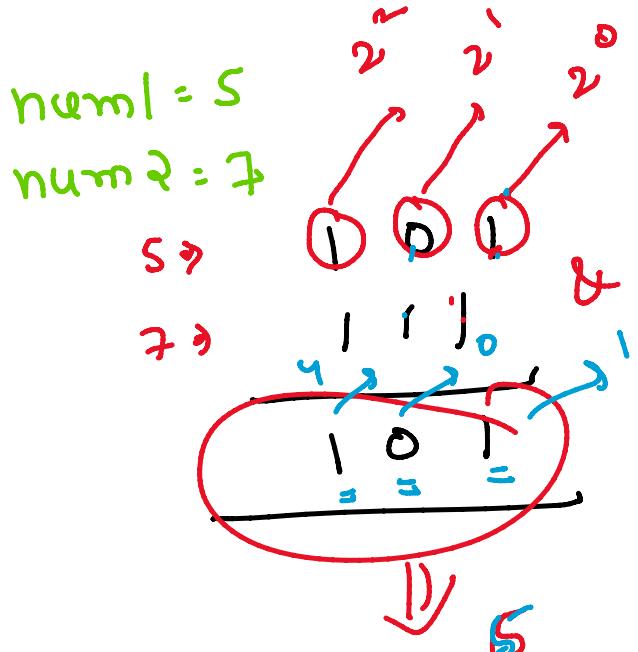
AND gate

$$1 \wedge 1 = 1 \quad 2^4 + 2^0$$

$$1 \wedge 0 = 0 \times 4 + 2 + 1$$

$$0 \wedge 1 = 0 \times 2^4 + 2^1 + 2^0$$

$$0 \wedge 0 = 0 \times 2^4 + 2^2 + 2^3 + 2^4$$



\Rightarrow

y

$$5 \rightarrow \begin{array}{r} 1 0 1 \\ 6 \rightarrow \begin{array}{r} 1 1 0 \\ \hline 1 0 0 \end{array} \end{array} \Rightarrow Y_1$$

$$5|6 = \begin{array}{r} 1 0 1 \\ 1 1 0 \\ \hline 1 1 1 \end{array} \text{ OR } \textcircled{7}$$

XOR
BIT one
if same then zero; else one.

Exactly one bit should 1

$$\underline{5} \underline{\wedge} \underline{5}$$

$$\underline{5} \wedge \underline{7}$$

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

$$\begin{array}{l} 1 \wedge 1 = 0 \\ 1 \wedge 0 = 1 \\ 0 \wedge 1 = 1 \\ 0 \wedge 0 = 0 \end{array}$$

$$5 \wedge 7 \wedge 5$$

$$\begin{array}{l} 5 \rightarrow \begin{array}{r} 1 0 1 \\ 7 \rightarrow \begin{array}{r} 1 1 \\ \hline 1 1 \end{array} \end{array} \end{array}$$

$$5 \wedge 7 \wedge 5$$

$$6 \wedge 6 \Rightarrow 0$$

$$\begin{array}{r} z \rightarrow \\ \hline 1 & 1 & 1 \\ 0 & 1 & 0 \\ \hline 1 & 0 & 1 \\ \textcircled{z} \quad \hline 1 & 1 & 1 \end{array}$$

NOT
negation.

flip the bits $\sim 1 = 0$

$$\sim 0 = 1$$

4, 1, 2, 1, 2

$$\text{XOR} = 4$$

Shift operators

17 September 2022 13:26

\ll left shift
 \gg right shift

1. left shift

multiply by 2.

$$5 \ll 1 = 10$$

$$5 \ll 2 = 20$$

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

$$5 \ll 2 = 5 \times 2^2 = 5 \times 4 = 20$$

$$5 \ll 3 = 5 \times 2^3 = 40$$

$$5 \ll 1 = 5 \times 2^1 = 10$$

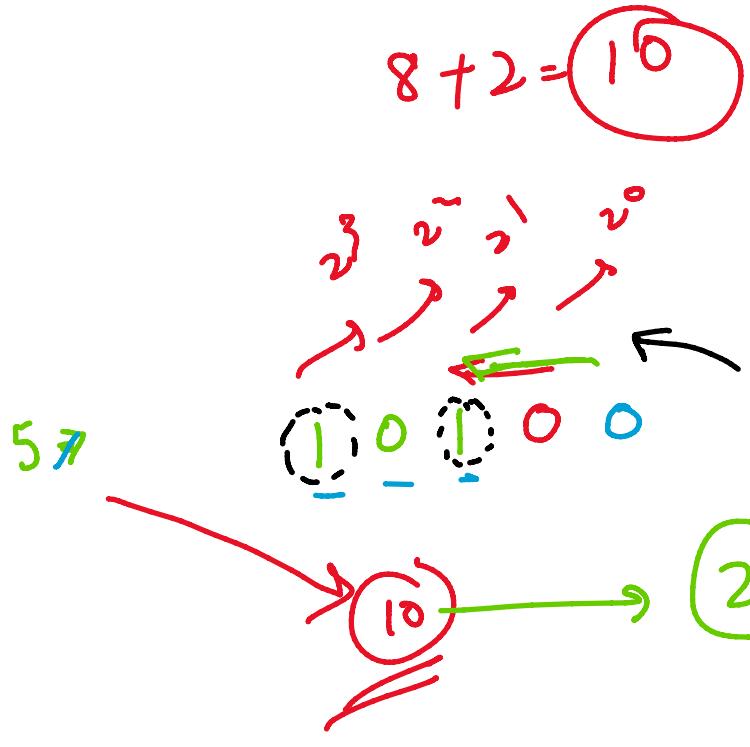
2. right shift

divide by 2.

$$a \gg b = a / 2^b$$

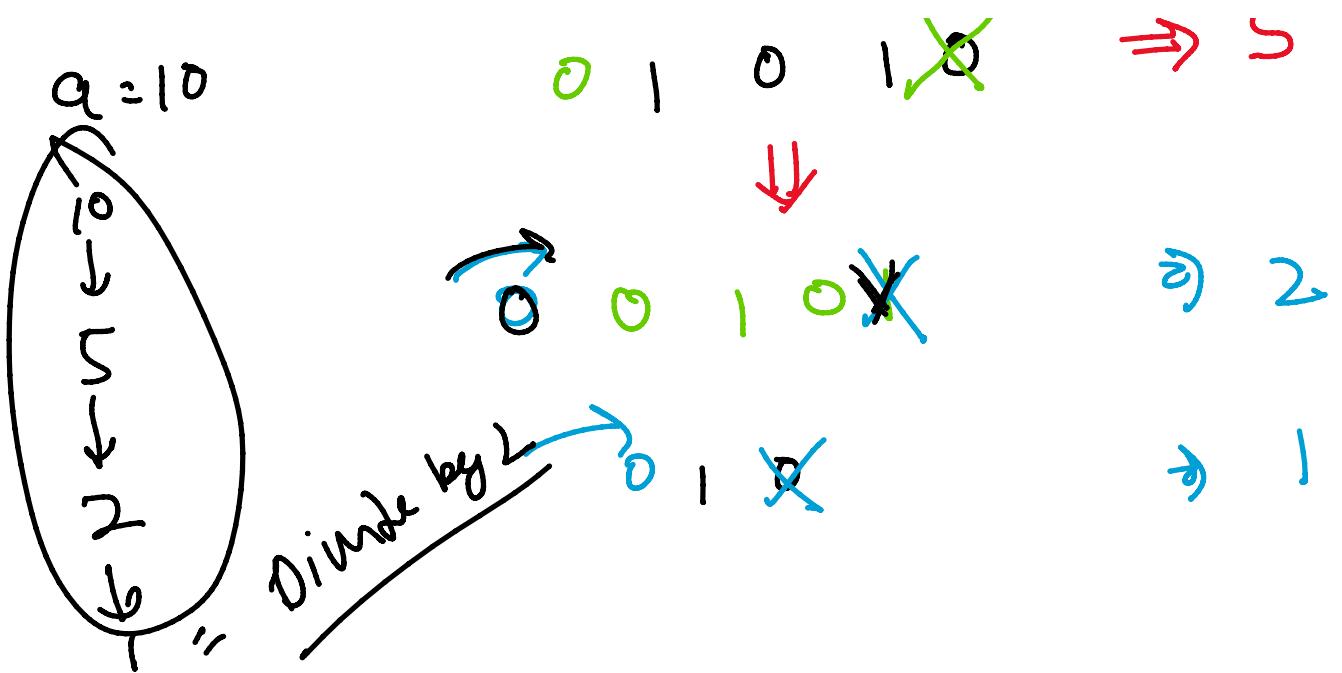
$$a = 10$$

$$0 \ 1 \ 0 \ 1 \cancel{0} \Rightarrow 5$$

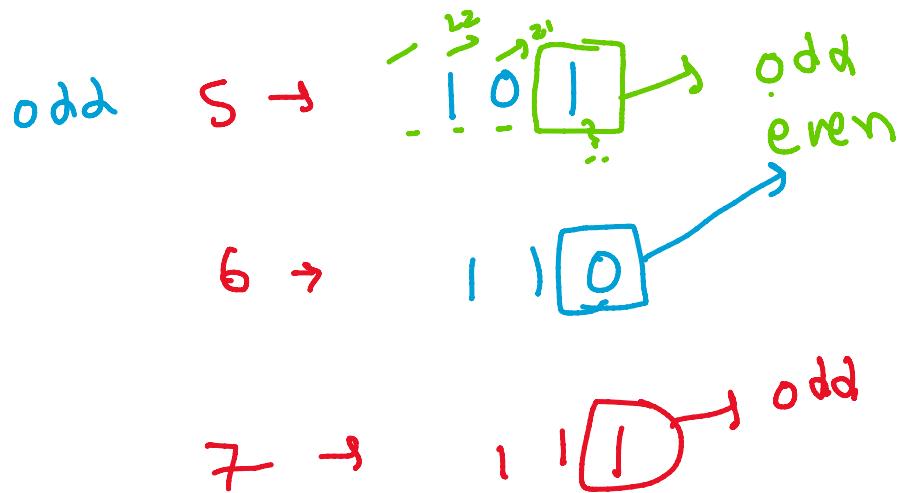


$$5 \times 4 = 20$$

-
=



1. odd or even
x [modules by 2]



1 or 0

2. get bit

$$n = 5$$

$$j = 2$$

1 << j
left shift

int n, int i

1 & 0

$$\begin{array}{r} \text{(n)} \\ \text{mask} \\ \hline \end{array} \quad \begin{array}{r} 2. \quad 1 \quad 0 \\ \times \quad ; \quad ; \\ 0 \quad | \\ \hline 1 \quad 0 \quad 0 \\ \hline \end{array}$$

✓ 1 <<

$$n = 8$$

$$j = 3$$

$$\begin{array}{r} \text{(n)} \\ \text{(mask)} \\ \hline \end{array} \quad \begin{array}{r} 2. \quad 1 \quad 0 \quad 0 \\ \times \quad ; \quad ; \quad ; \\ 0 \quad 1 \quad 0 \\ \hline 0 \quad 0 \\ \hline \end{array}$$

(1 << j)

<<

$$\frac{8}{i}$$

1000

$$\begin{array}{r} -11 \quad 2 \quad 1 \quad 0 \\ \times \quad ; \quad ; \quad ; \\ -11 \quad 2 \quad 1 \quad 0 \\ \hline \end{array}$$

卷一

1. get bit

三

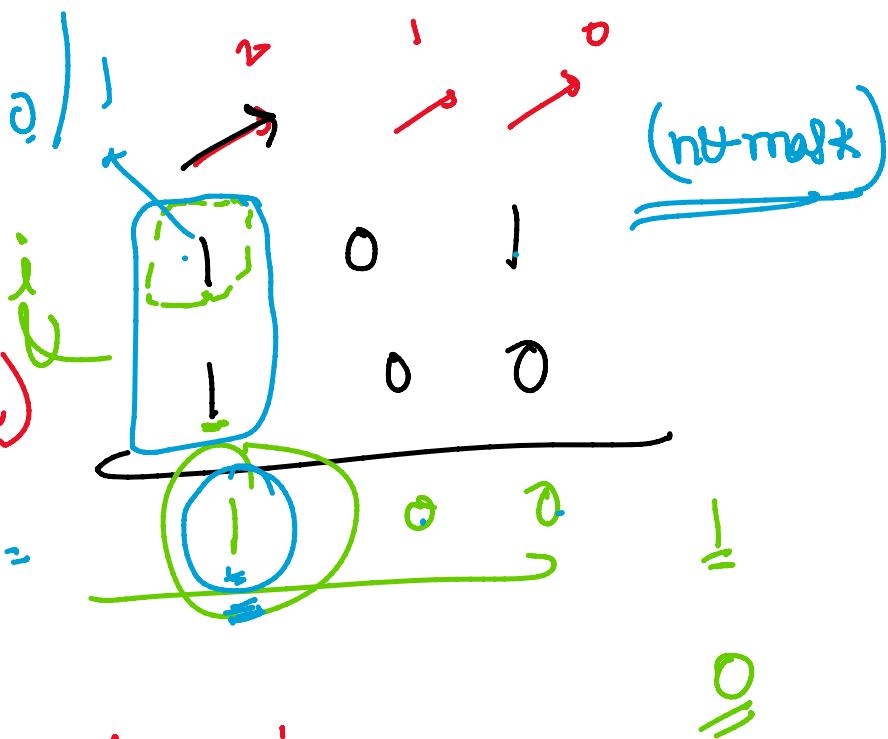
$$j = 2$$

۱۲۲

(n)

(mask)

$$\text{ans} =$$



mask = $\langle \rangle^{\times i}$

2. set bit

5

$$n=5$$

$$j = \frac{1}{z}$$

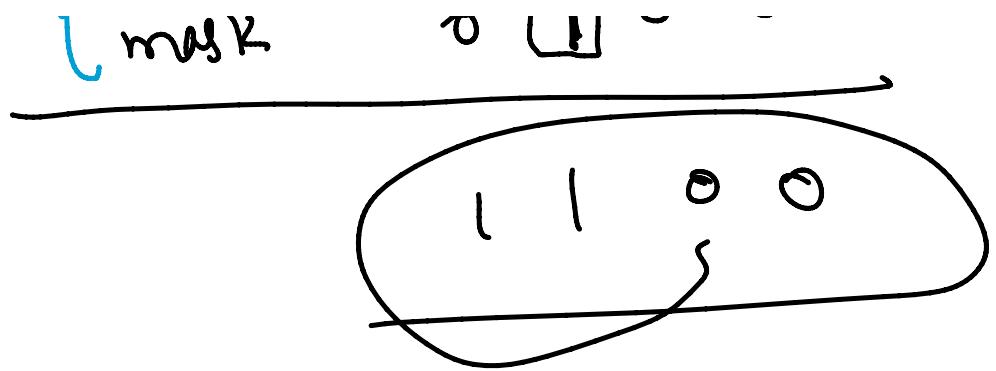
$$m \neq k = 1 \cancel{+} i$$

i = 2

०८

{ 82 mask }

$L \leq L_2$

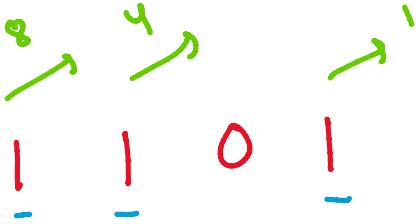


$$\begin{aligned} ! \int x &= 1 \\ \text{If } x &= \underline{\phi} \end{aligned}$$

Count set bits

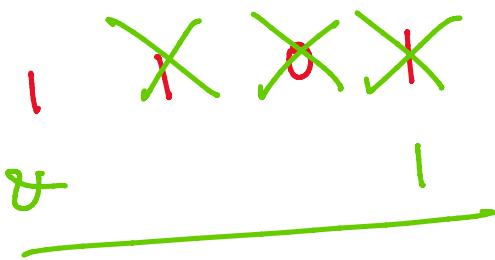
17 September 2022 14:08

$$n = 13$$



ans = 3
while (
{
} =

right shift the number



while ($k > 0$)

~~+6 -8 +4~~

$$\begin{aligned} \text{count} &= 0 \\ &+ 1 + 1 + 1 \\ &= 3 \end{aligned}$$

1 1 0 1

1 (1)

1 1 0
1 0 0

(2)
(3)

1 0 0 0

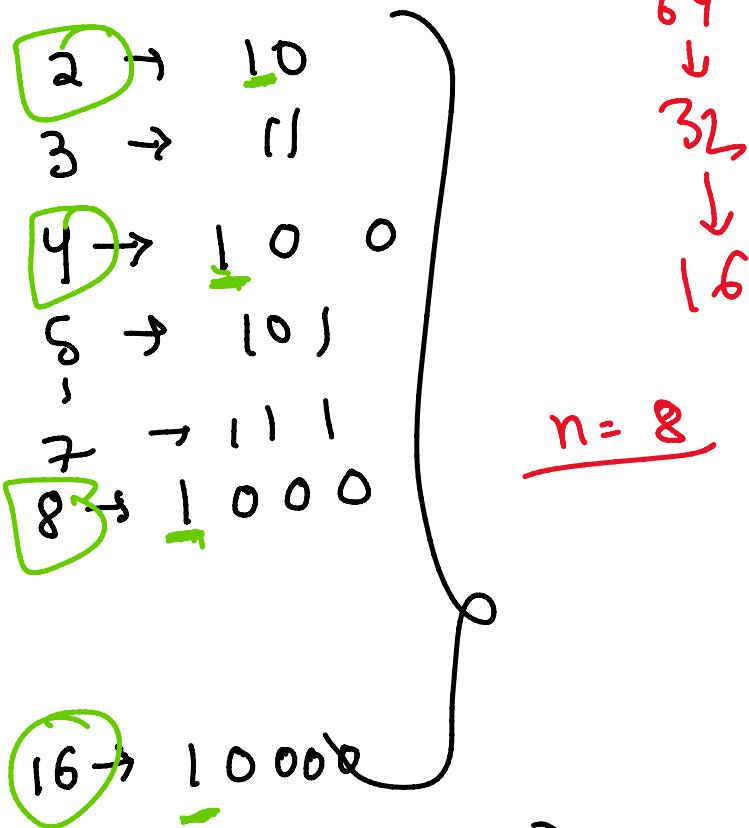
44

$\underline{\underline{16}} \sim \underline{\underline{\log N}}$

1 1 1 1

Power of 2

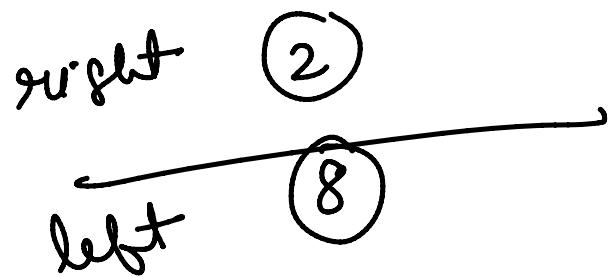
17 September 2022 14:15



while ()

$$\log N$$

O(1)



0 → power of 2
1 → not power.

power of 2

$$(n) \& (n-1) \Rightarrow 0$$

$$\begin{array}{r} 7 \rightarrow 111 \\ 8 \rightarrow 1000 \\ \hline 0000 \end{array}$$

$$15 \rightarrow \overline{111}$$

$$6 \rightarrow 110$$

$15 \rightarrow -1111$
 $16 \rightarrow \cancel{10000}$

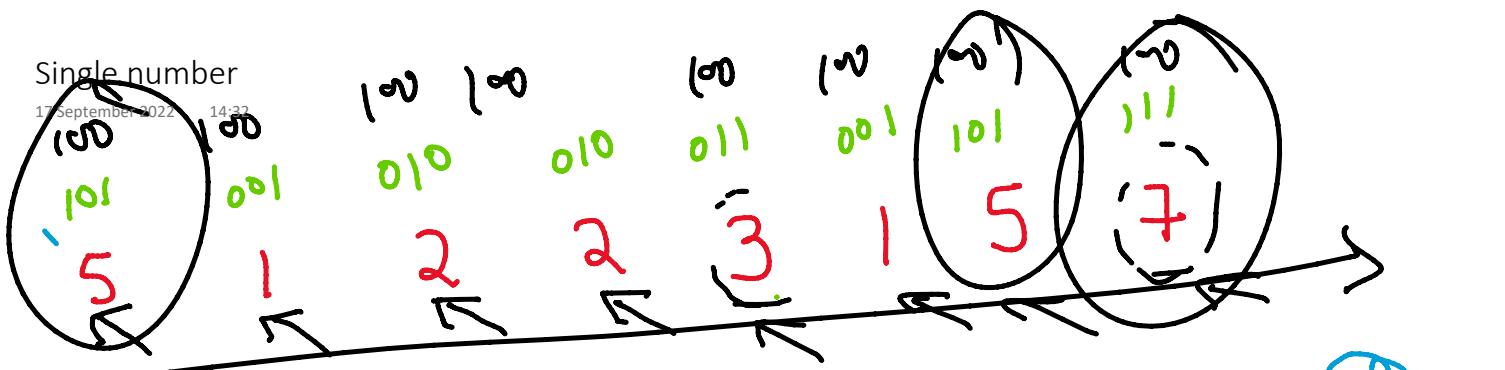
$2 \rightarrow 1^0$

$3 \rightarrow 11$

$\overline{10} \quad \times$

$6 \rightarrow 110$
 $5 \rightarrow 10 \}$

~~100~~



$K \leftarrow pos$
 $1 \leftarrow 2 = 100$

$XOR = 4$

~~$0 \wedge 1 =$~~
 ~~$(3 \wedge 2) \wedge 7$~~

~~num1 = 2~~

~~temp = 7~~

~~either 2 or 4~~

~~never be zero~~

$0 \wedge 1 =$
 $ans = 4$

$(3 \wedge 2) \wedge 7$

$num1 = 2$

$temp = 7$

XOR

$(post)$

$num2 = 3$

$O(N)$ $O(1)$

- when a function calls itself.
- when solution of a problem depends on smaller of same nature.

$$4! = 4 \times 3 \times 2 \times 1 = 24$$

$$5! = 120$$

~~for (i=n; i>=1; i--)~~

$$\frac{5!}{N!} = 5 \times (N-1)!$$

Recursive
 $n! = n \times i(n-1)!$

$$5! = 5 \times 4! \xrightarrow{24} 120$$

$$4 \times 3! \xrightarrow{6} 24$$

$$3 \times 2! \xrightarrow{2} 6$$

$$2 \times 1! \xrightarrow{1} 2$$

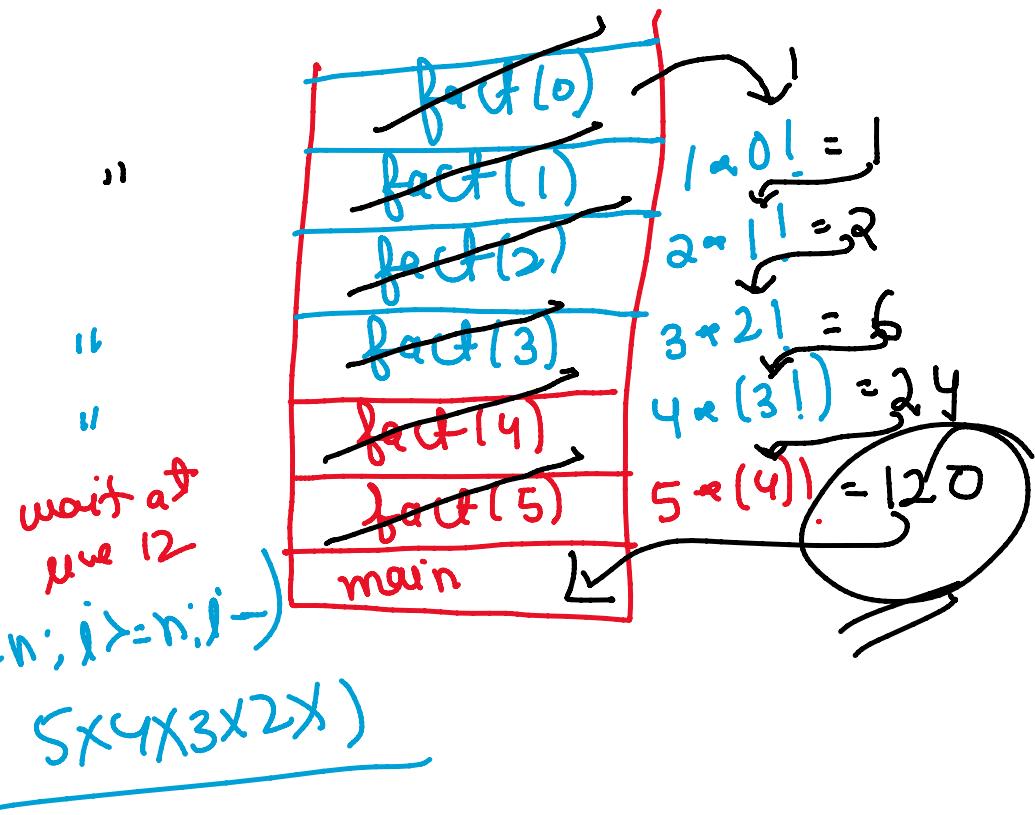
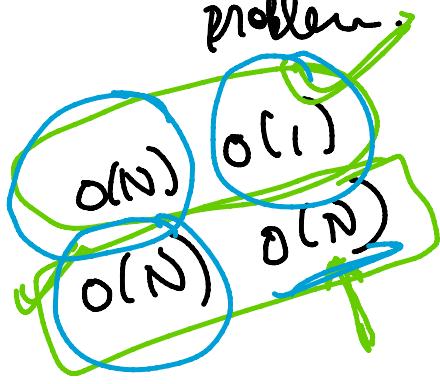
$$1 \times 0! \xrightarrow{1} 1$$

base: if ($n == 0$)
 return

2 cases:-

- (i) base case
- (ii) recursive case

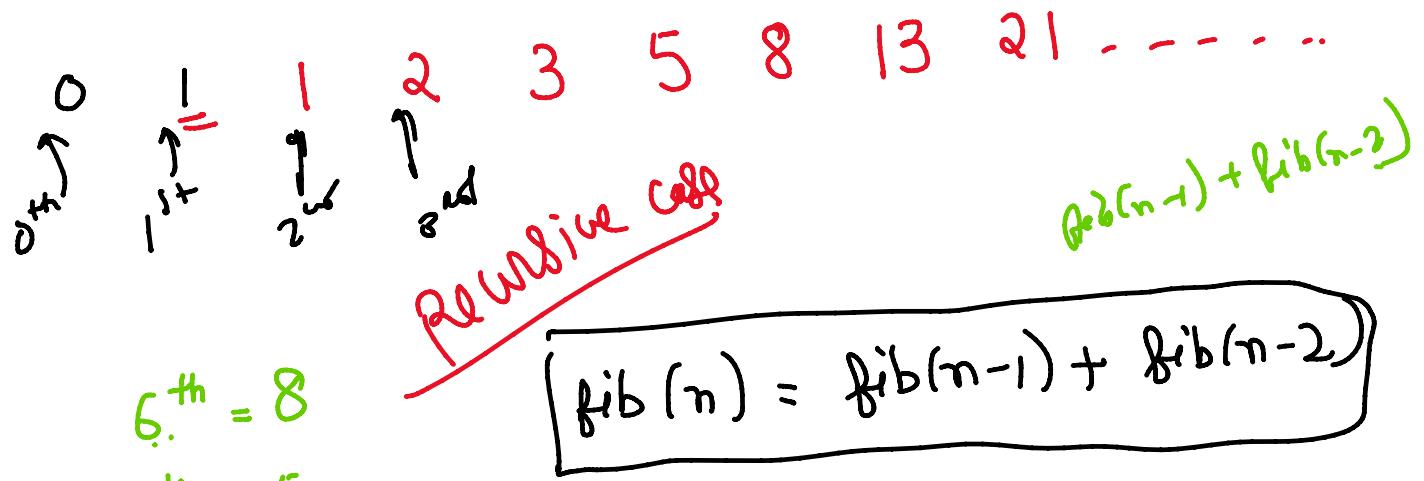
1. figure out the base case -
2. Assume subproblems will be solved automatically.
3. Using subproblems write ans for current problem.



Fibonacci series

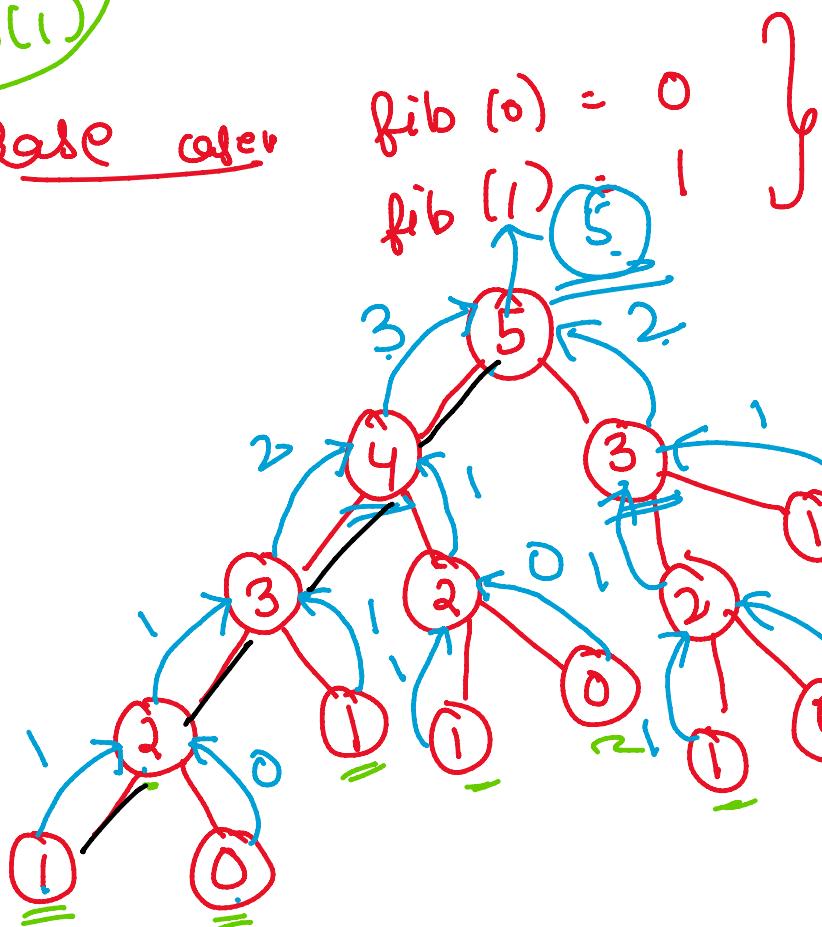
17 September 2022 15:35

find $\underline{n^{\text{th}}}$ fibonacci number.



$O(N)$
 $O(1)$

base case



$$\text{fib}(n) = \text{fib}(n-1) + \text{fib}(n-2)$$

= 5

space - $O(N)$
time - (2^n)

left to right direction

~~left to right writing~~

~~swung, bubble,
recursion, merge~~

$\pm 1.5 \text{ hrs}$

Inc and dec order

17 September 2022 15:47

$n = 5$

<u>in c:</u>	1, 2, 3, 4, 5
<u>dec t</u>	5, 4, 3, 2, 1

~~for~~
 \downarrow
 $\underline{0}$
 \downarrow
 ret

dec:
~~5, 4, 3, 2, 1, *~~

$\swarrow \searrow \swarrow \searrow \swarrow \searrow$
 $\downarrow * 8 8 8 \frac{1}{*} ?$

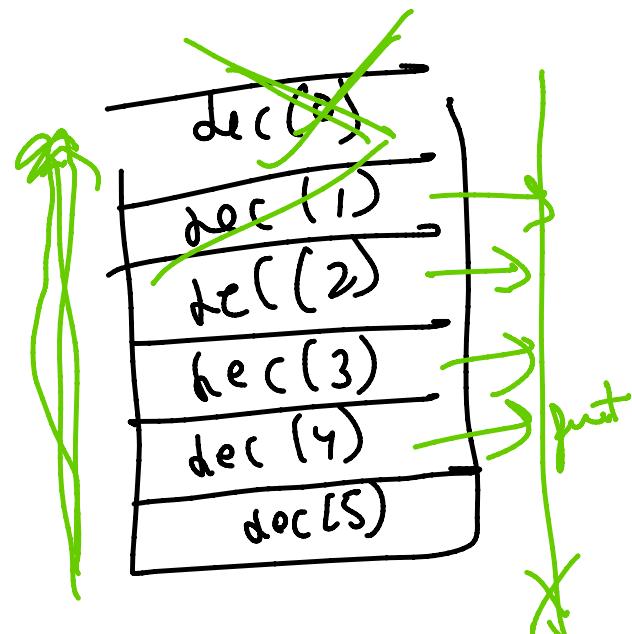
dec (n)
 $\text{if } (n == 0)$
 $\quad \quad \quad \text{return } n$
 $\text{print}(n)$
 $\text{dec}(n-1)$

inc t

inc(n)
 $\text{if } (n == 0)$
 $\quad \quad \quad \text{return } n$
 inc(n-1)
 $\text{print}(n)$

~~5, 4, 3, 2, 1, *~~
 $\downarrow, 2, 3, 4, 5,$

Rec



Power

17 September 2022 15:55

$$a^b$$

$$5^3 = 5 \times 5 \times 5 = 125$$

$$2^4 = 16$$

$$a^0 = 1$$

① if $\underline{\underline{b = 0}}$ return 1

② recursive call

$$\underline{\underline{a^b = a \times a^{b-1}}}$$

$$f(a, b) = a \times f(a, b-1)$$

$$\begin{aligned} 5^3 &= 5 \times 5^2 \\ &\downarrow \\ 5 \times 5^1 &= 25 \\ &\downarrow \\ 5 \times 5^0 &= 5 \\ &\downarrow \\ 1 & \end{aligned}$$