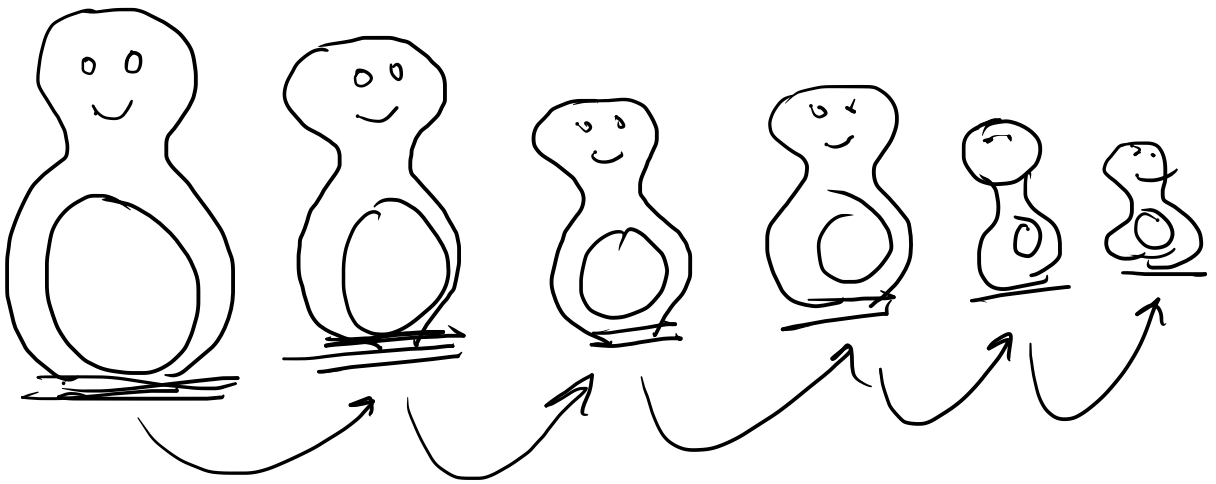
Recursion

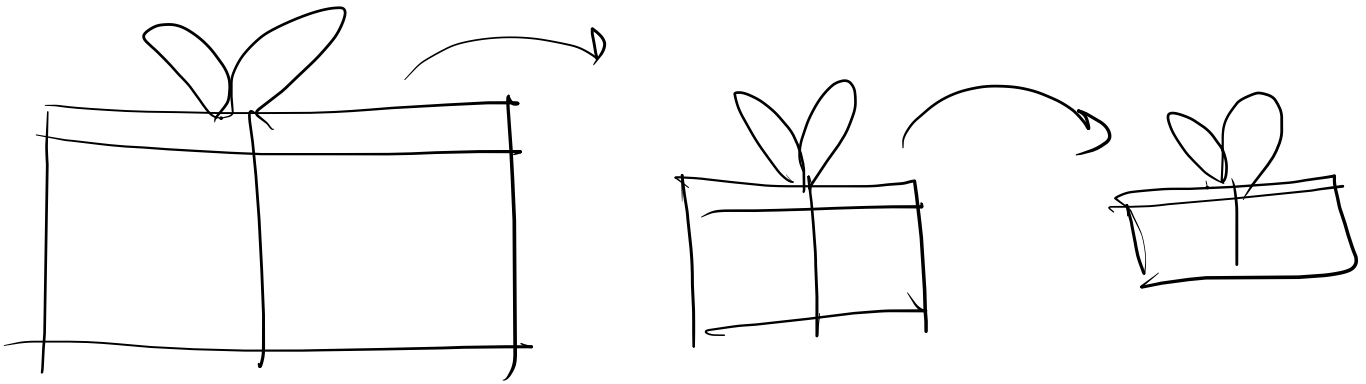
↳ process of func calling itself

↳ recursive function

function that calls itself

Recursion





Solve bigger problem

Solve smaller sub-problems

Q) Sum of numbers from n to 1

$n = 5$

Sum = $5 + 4 + 3 + 2 + 1 = 15$

Sum of 1 to n

$$\text{formula} = \frac{n(n+1)}{2}$$

$n = 5$

$$\text{sum} = \frac{5 \times 6}{2} = 15$$

sumof (5 to 1)

↳ = 5 + sumof (4 to 1)

↳ 4 + sumof (3 to 1)

↳ 3 + sumof (2 to 1)

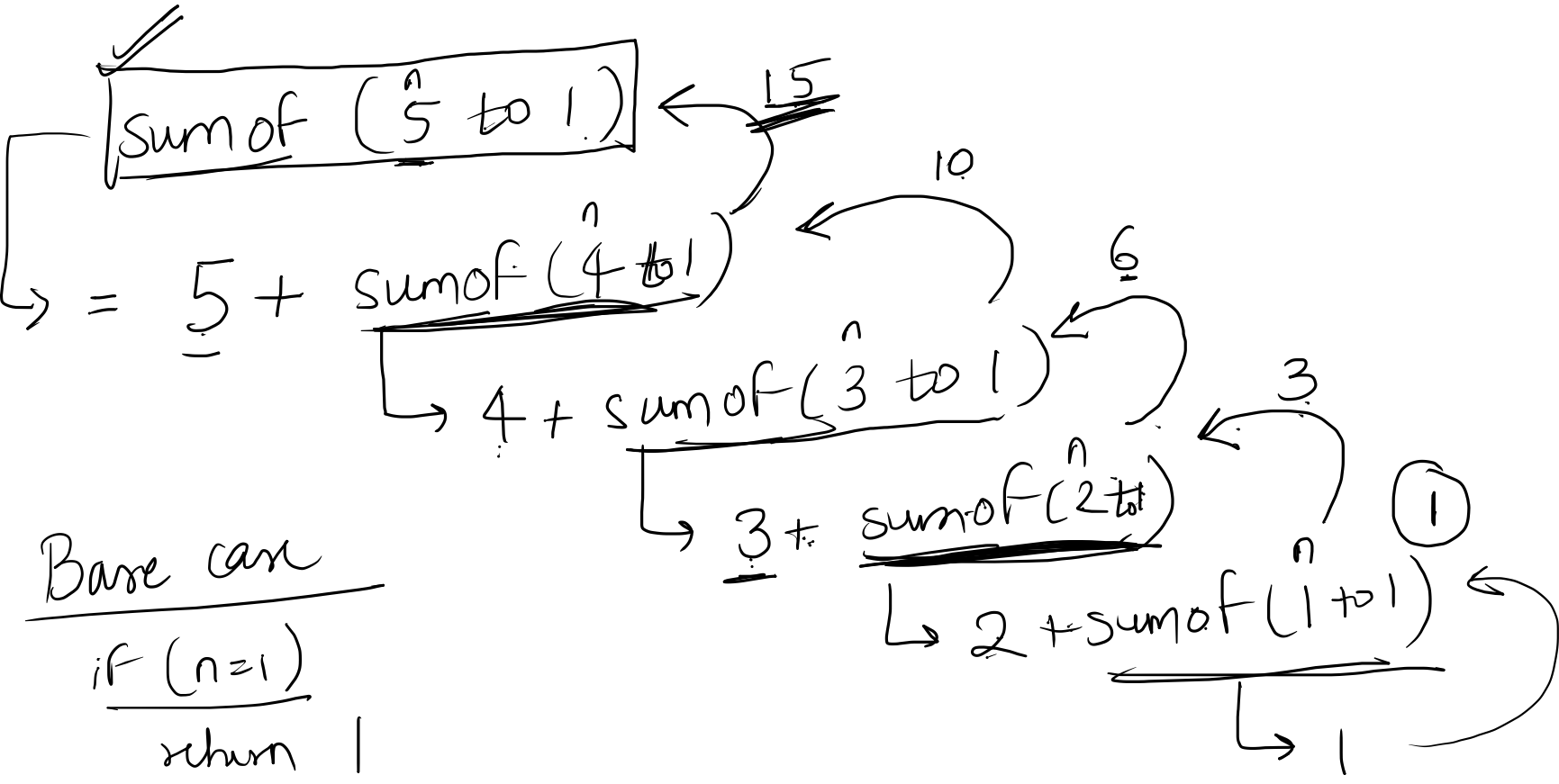
↳ 2 + sumof (1 to 1)

↳ 1

Base case

if (n=1)

return 1



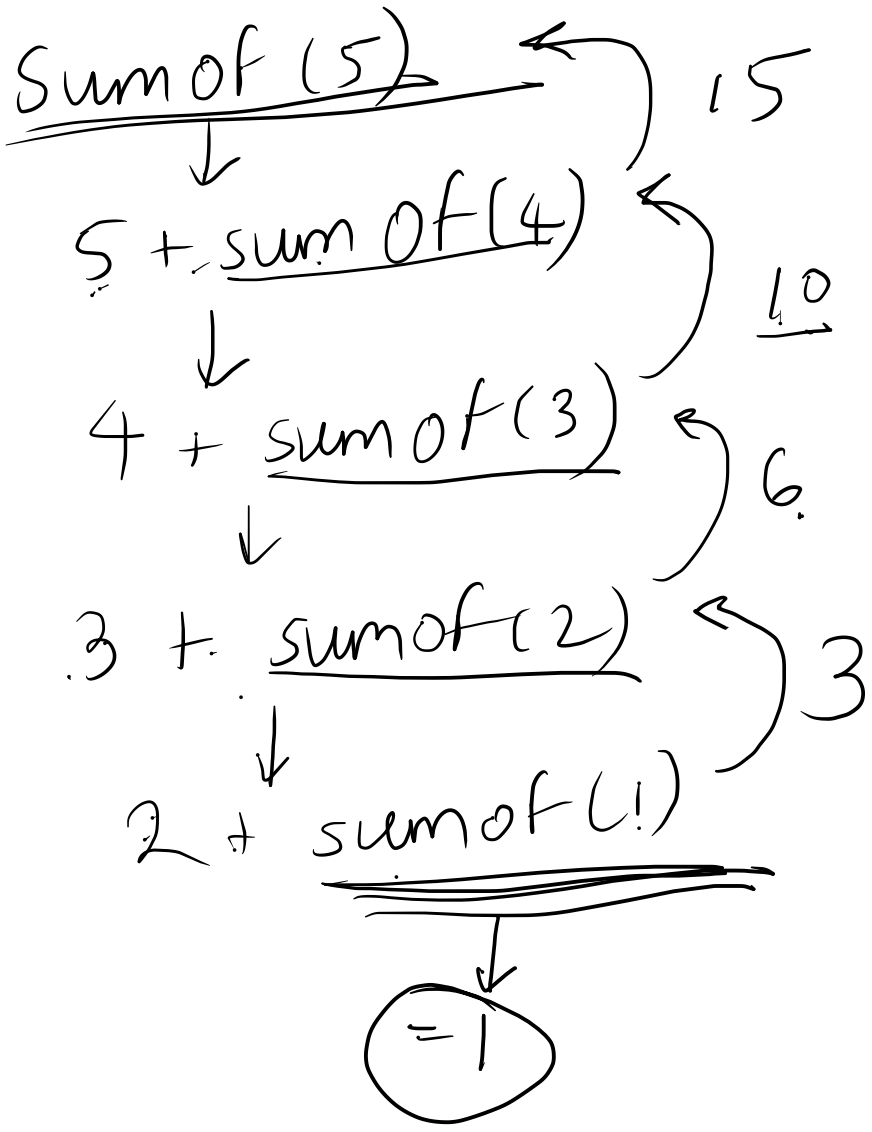
Base case

if (n=1)

return 1

$$sumof(n) = n + sumof(n-1)$$

$$sumof(5) = 5 + sumof(4)$$


sumof(5)
15
5 + sumof(4)
10
4 + sumof(3)
6
3 + sumof(2)
3
2 + sumof(1)
=1

Fibonacci Series

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55

seed values

$F(0) = 0$

$F(1) = 1$

n

$F(0) = 0$

$F(1) = 1$

$F(2) = 1$

$F(3) = 2$

$F(4) = 3$

$F(5) = 5$

$F(6) = 8$

$f(25)$

n

$F(0) = 0$

$F(1) = 1$

$F(2) = 1$

$F(3) = 2$

$F(4) = 3$

$F(5) = 5$

$F(6) = 8$

$f(25)$

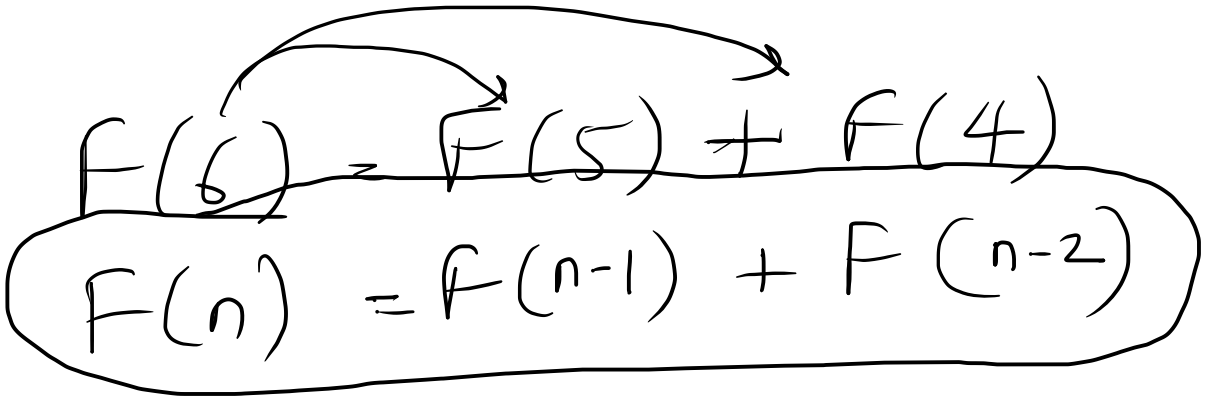
~~$f(3) = 1 + 2$~~

$f(3) = f(1) + f(2)$

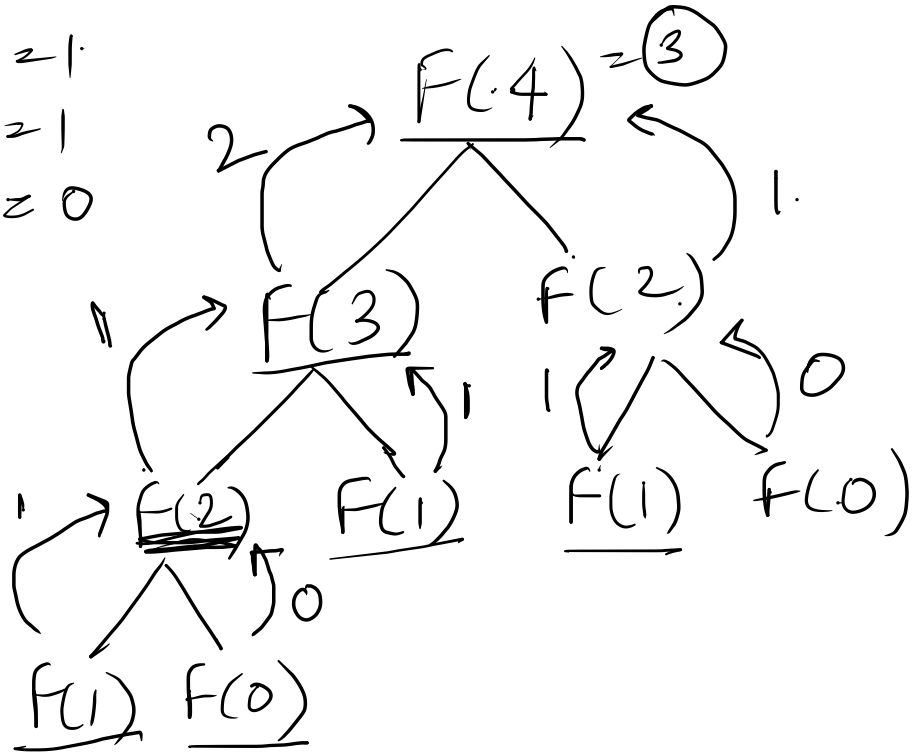
Sum of previous two fibo numbers

X $f(6) = 5 + 4$ X

✓ $f(6) = f(5) + f(4)$ ✓


F(6) = F(5) + F(4)
F(n) = F(n-1) + F(n-2)

F(2) = 1
F(1) = 1
F(0) = 0

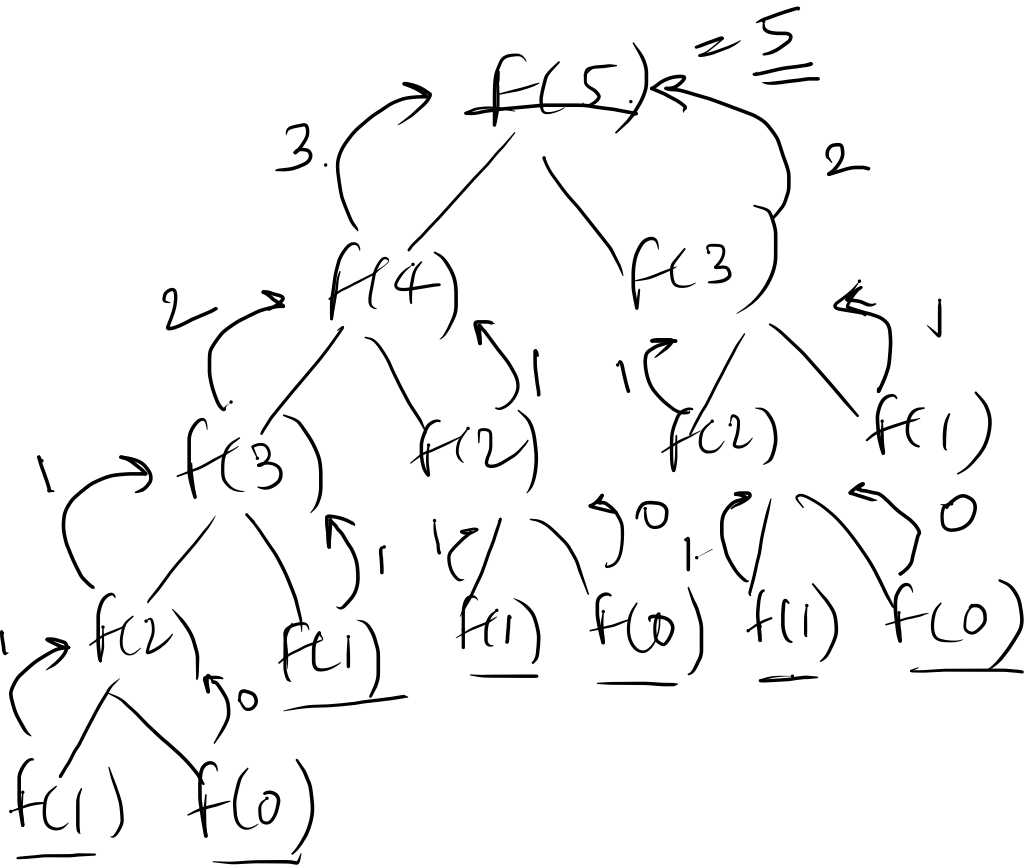


Base case

$F(1) = 1$

$F(0) = 0$

n	0	1	2	3	4
F(n)	0	1	1	2	3



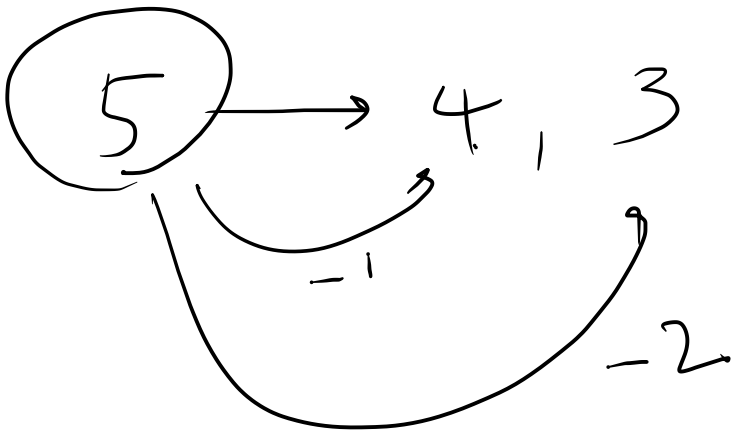
$f(0) = 0$

$f(1) = 1$

$$f(n) = f(n-1) + f(n-2)$$

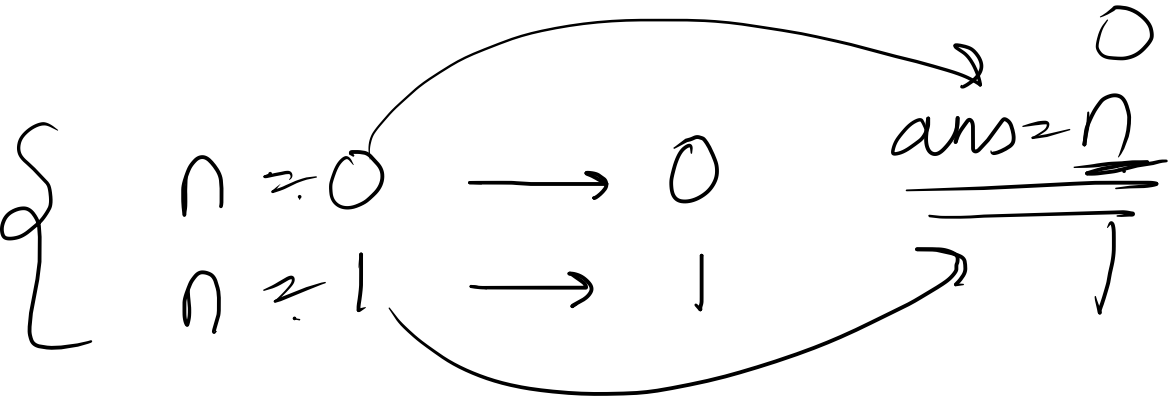
$$f(5) = f(4) + f(3)$$

$5-1$ $\qquad$ $5-2$



$$\begin{cases} f(10) = f(9) + f(8) \\ f(15) = f(14) + f(13) \\ f(7) = f(6) + f(5) \end{cases}$$

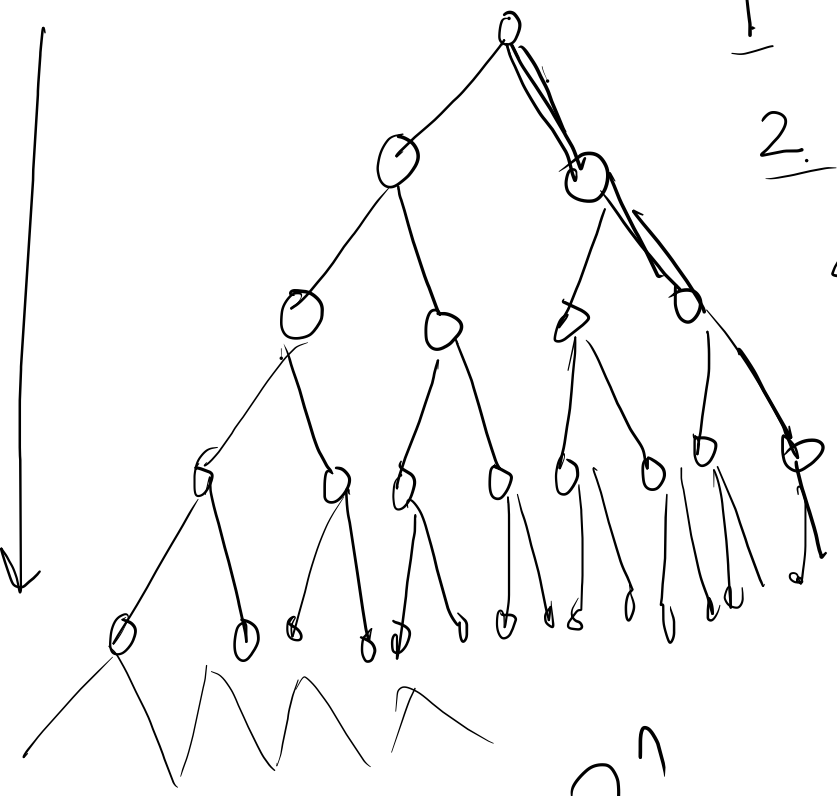
$$f(n) = f(n-1) + f(n-2)$$



ans = n

f(0) = 0

f(1) = 1



1

2 $= 2^1$

4 $= 2^2$

8 $= 2^3$

16 $= 2^4$

32

2^n

Factorial

Power of 4

$4^3 = 64$ ✓

$4^2 = 16$ ✓

$4^0 = 1$

$4^1 = 4$

$4^0 = 1$

$4^1 = 4 = 4$

$4^2 = 16 = 4 \times 4$

$4^3 = 64 = 4 \times 4 \times 4$

$4^4 = 256 = 4 \times 4 \times 4 \times 4$

$4^5 = 4 \times 4 \times 4 \times 4 \times 4 = \underline{1024}$

$4^0 = 1$

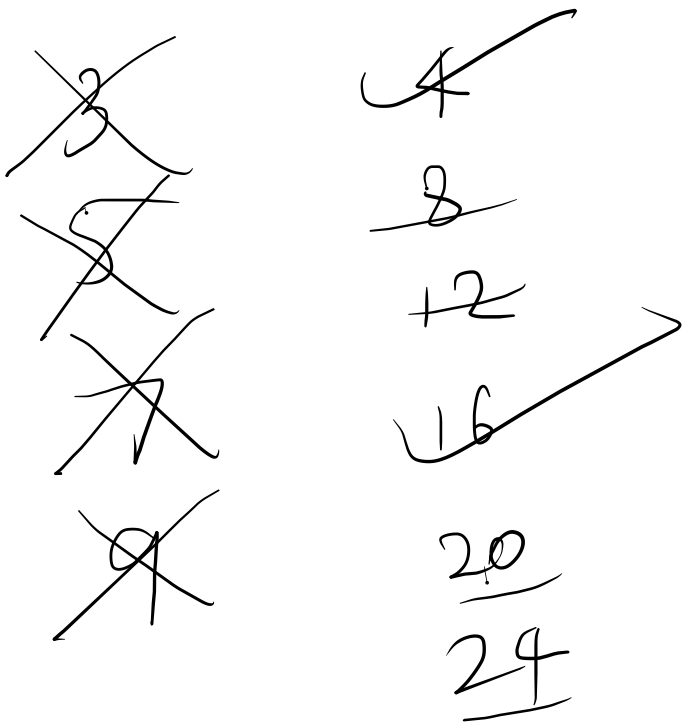
```
if (n <= 0)
    return false

if (n == 1)
    return true
```

n
4
16
64
256

$n \% 4 = 0$

8 → $8 \% 4 = 0$

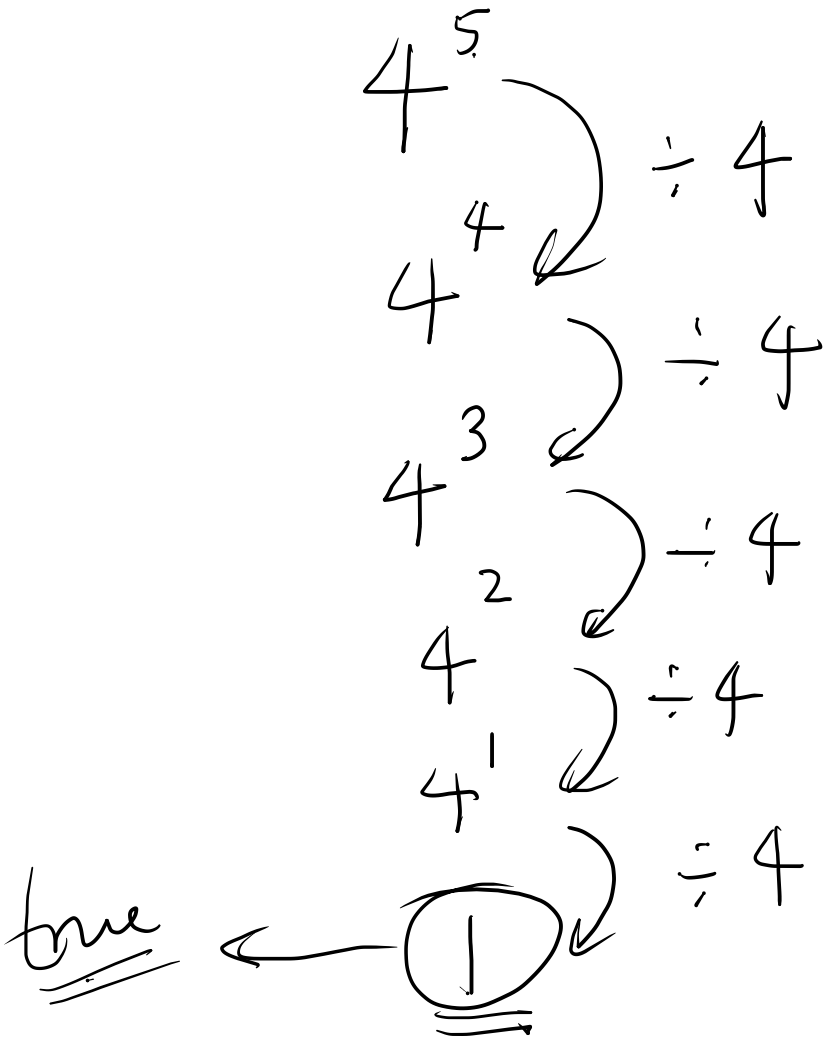


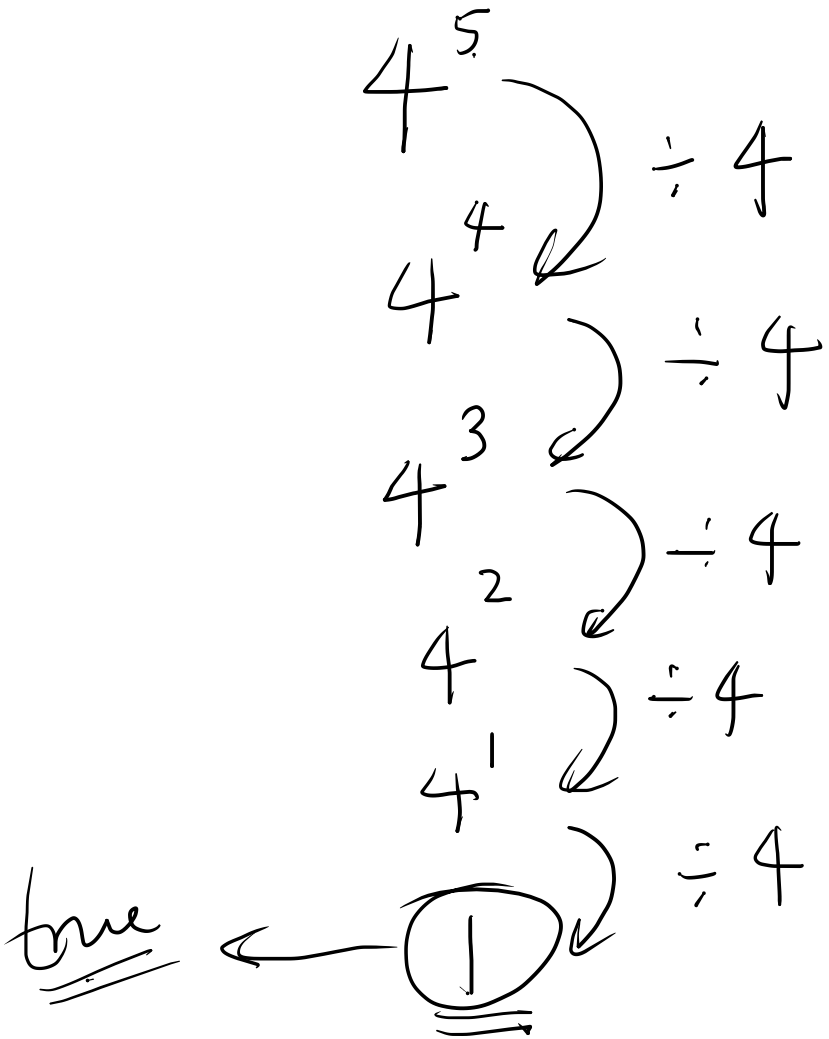
$4^3 = 64$

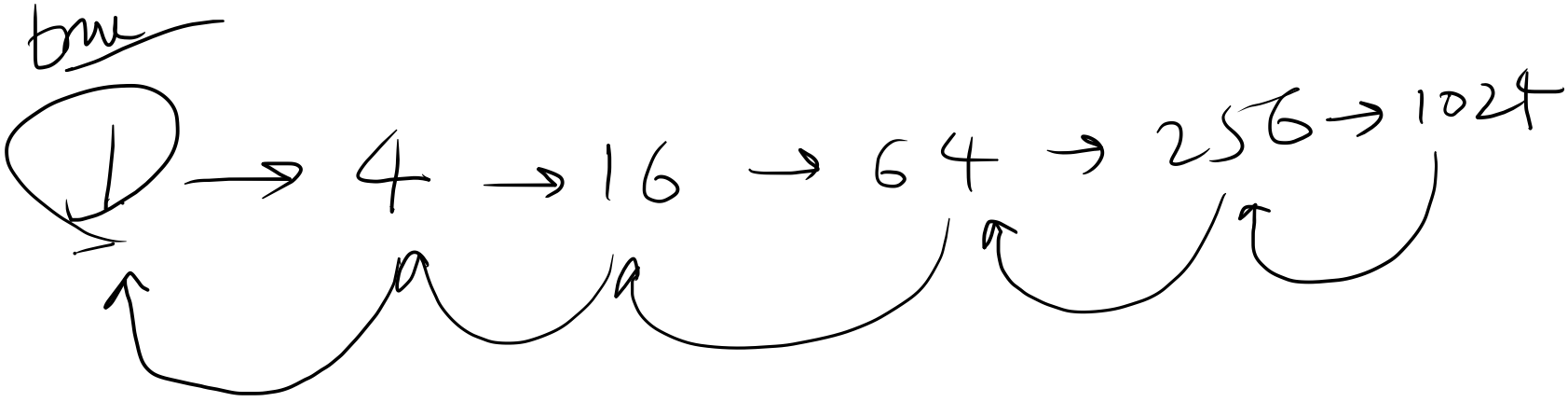
$64/4 = 16 = 4^2$

$16/4 = 4 = 4^1$

$4/4 = 1 = 4^0$


4^5
÷ 4
4^4
÷ 4
4^3
÷ 4
4^2
÷ 4
4^1
÷ 4
1
true


4^5
÷ 4
4^4
÷ 4
4^3
÷ 4
4^2
÷ 4
4^1
÷ 4
1
true

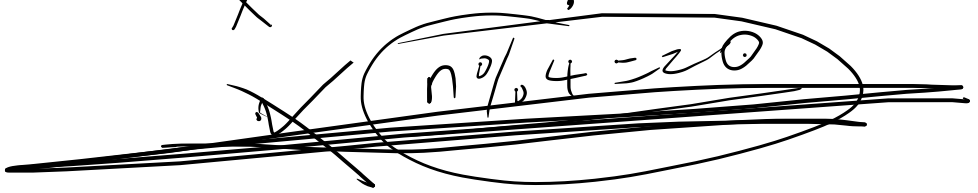

bw
1
4
16
64
256
1024

2.4

6

X not zero or negative

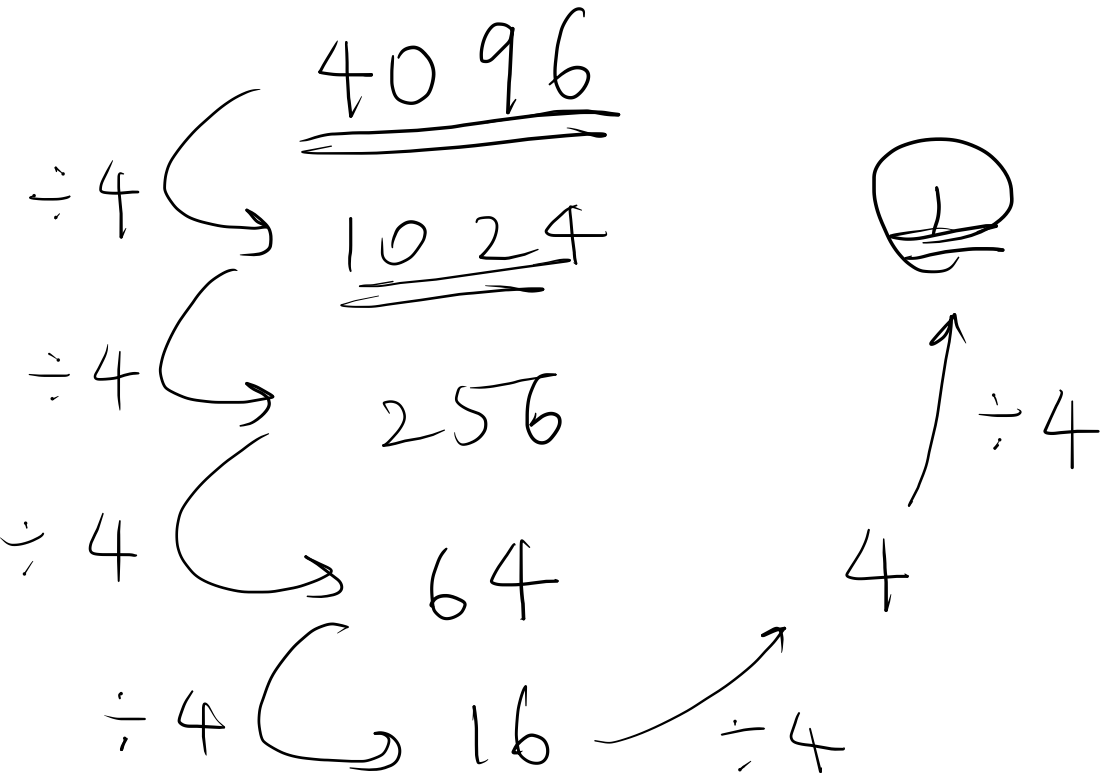
x = 21?

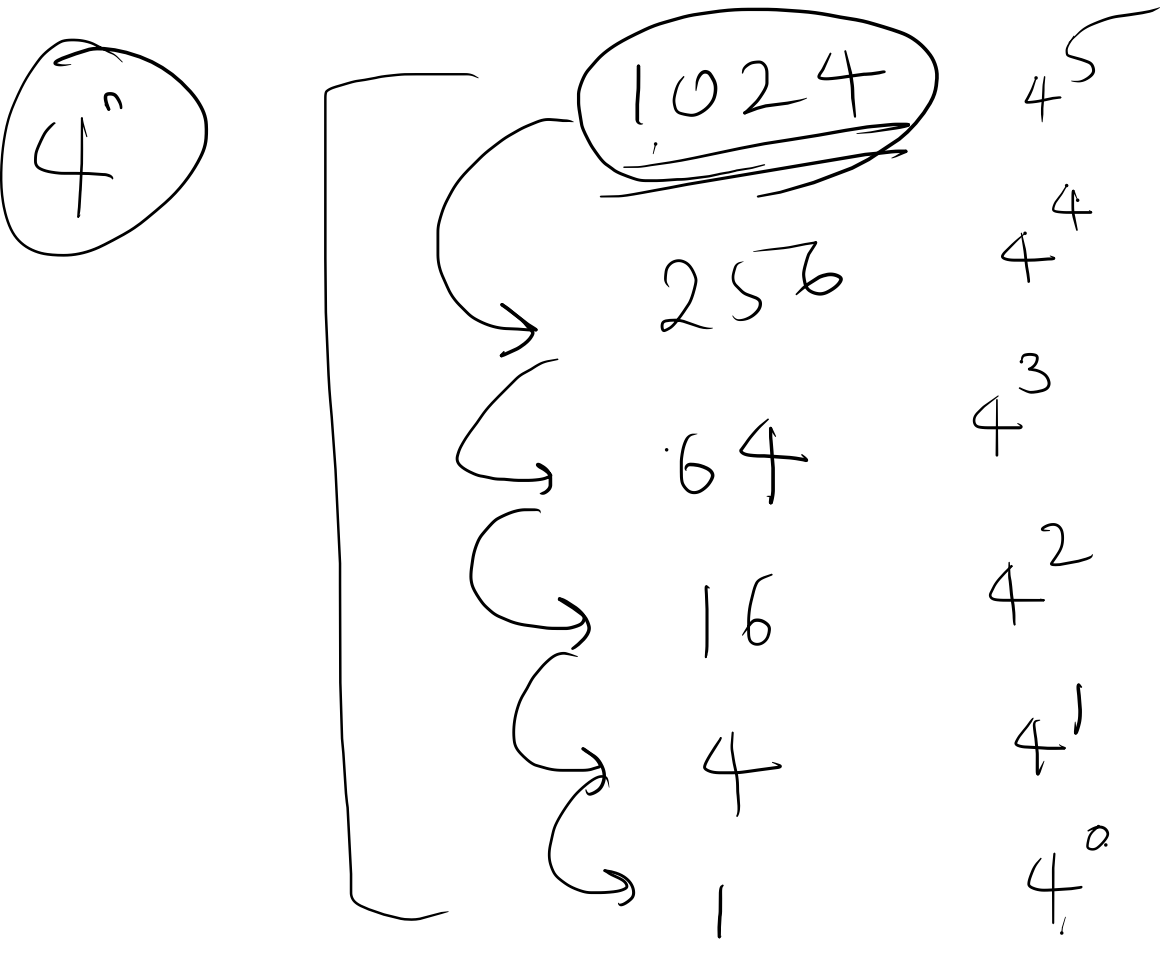


f(n/4)

```
if (n<=0)
    return false
if (n==1)
    return true
isPowerOfFour(n/4)
```

```
if (n%4 !=0)
    return false
```


4096
÷4
1024
÷4
256
÷4
64
÷4
16
÷4
4
÷4
1


4^n
1024
4^5
256
4^4
64
4^3
16
4^2
4
4^1
1
4^0

1024 → 5

256 → 4

64 → 3

16 → 2

4 → 1

1 → 0

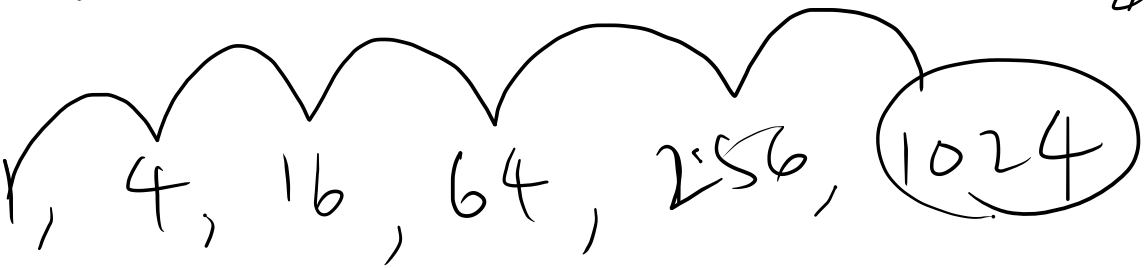
O(1)

$\log_4 n$

$\log_4 1024 = 5$

$1024 = 4^{?}$

$4^5 = 1024$



$$\frac{\log 1024}{\log 4} = 5$$