Recursion in Python

→ DSA (Data Structure & Algorithms)

Base case condition → if n == 1 → return 1;

Recursion → function is calling itself in the method definition

Recursive function call

factorial of any given number

$5! = 5 \times 4 \times 3 \times 2 \times 1$

$= 120$

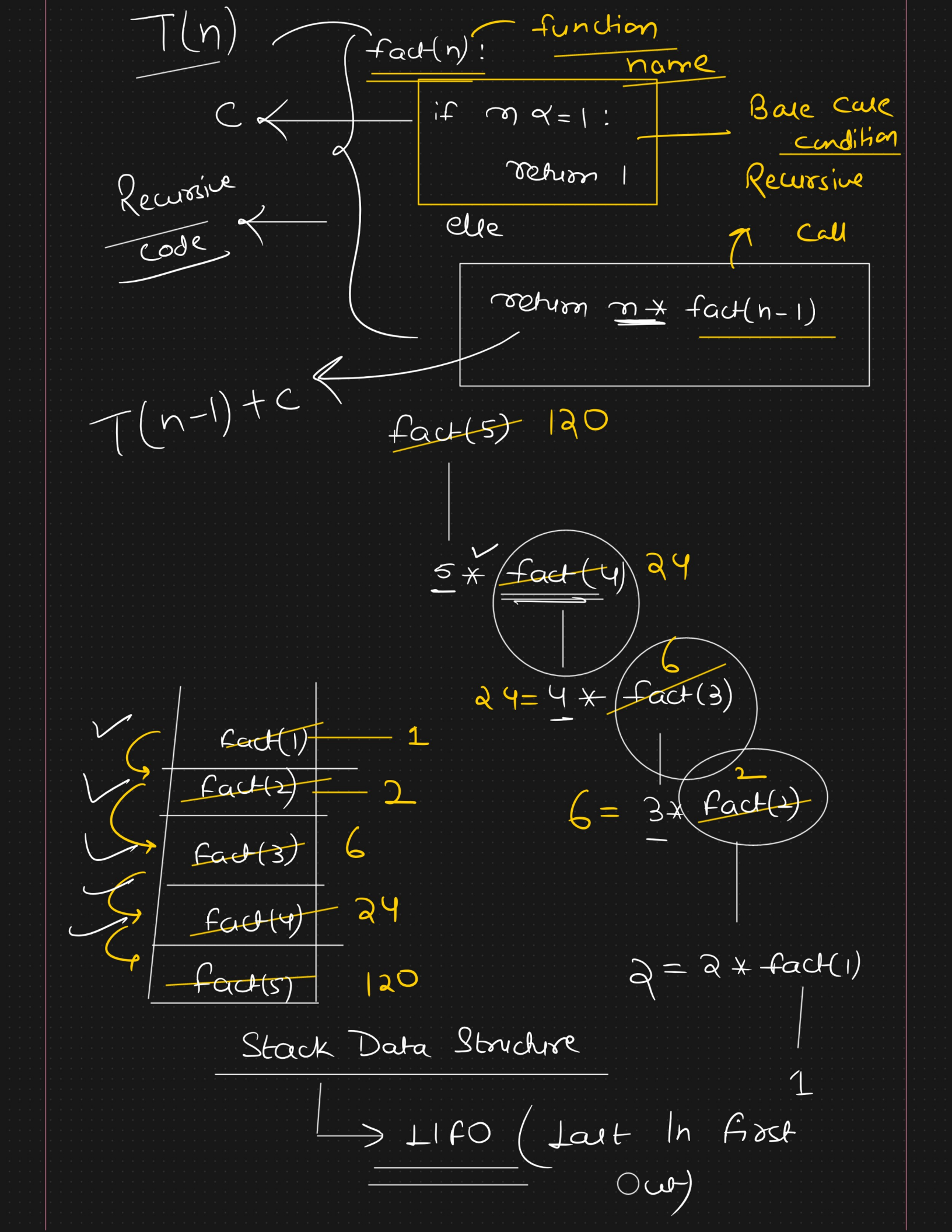
$0! = 1$

$1! = 1$

$5! = 5 * 4!$

$4 \times 3!$

$3 \times 2!$


T(n)
fact(n) :
function name
C
if n == 1 :
return 1
Base case condition
Recursive code
else
Recursive Call
return n * fact(n-1)
T(n-1) + C
fact(5) 120
5 * fact(4) 24
24 = 4 * fact(3) 6
6 = 3 * fact(2) 2
2 = 2 * fact(1) 1
fact(1) 1
fact(2) 2
fact(3) 6
fact(4) 24
fact(5) 120
Stack Data Structure
LIFO (Last In First Out)

Note:

→ Every Recursive code requires extra Stack Space to store the function calls.

Recursion code

↓

Recurrence Relation

- Substitution
- Master's Theorem
- Recursive Tree

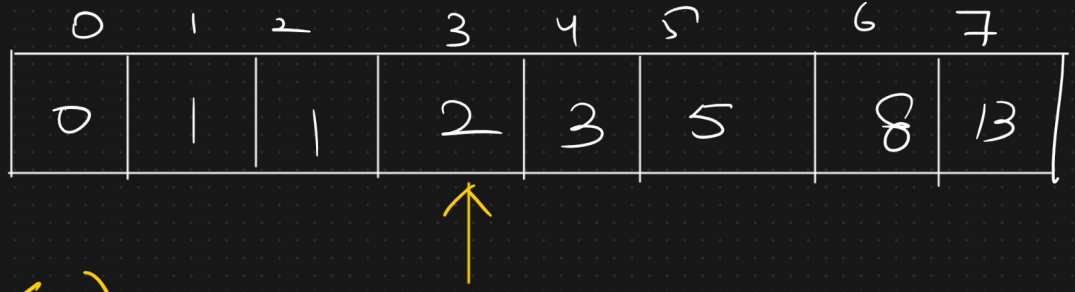
$$T(n) = T(n-1) + c$$

$$T(n) = O(n)$$ → Linear Time Complexity

Stack Space

→ Space complexity = O(n)

fibonacci Series



T(n) fib(n):

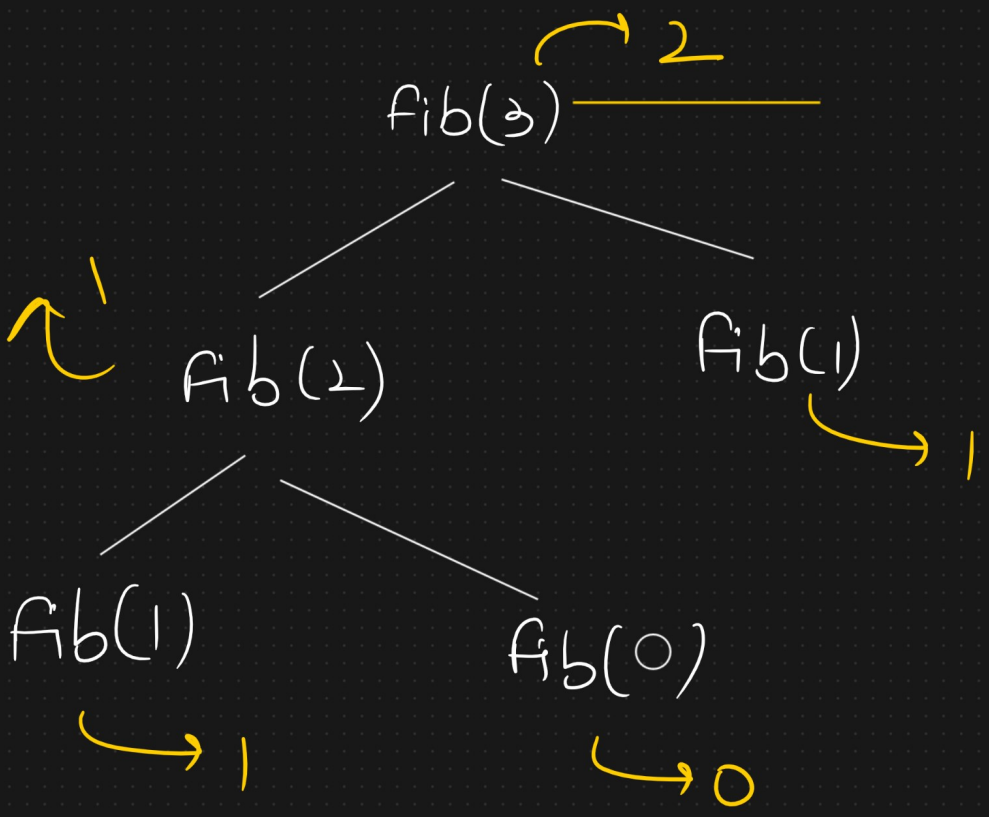
if n <= 1 ← Base case condition

c ← return n

else ← Recursive function call

return fib(n-1) + fib(n-2)

T(n-1) + T(n-2)

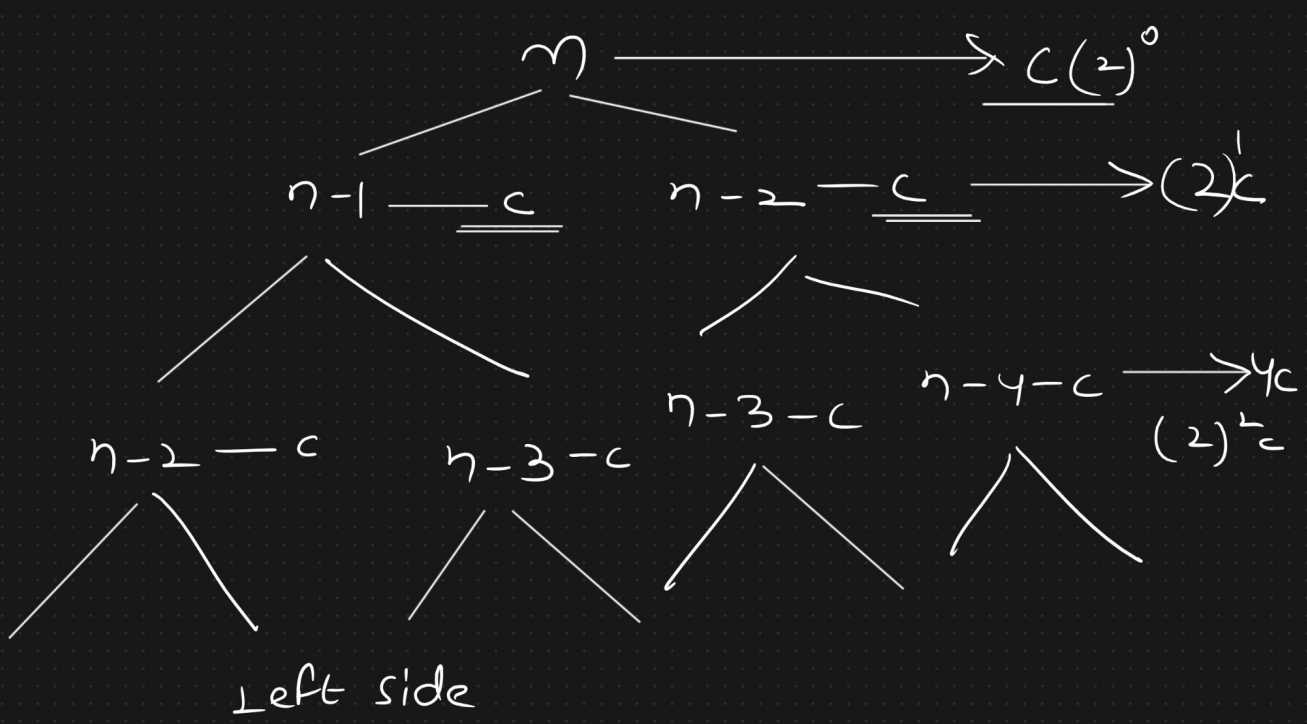


$$T(n) = T(n-1) + T(n-2) + c$$

→ Recursive tree approach

Dynamic Programming → $O(2^n)$

Drawback of using recursion ← Exponential time complexity



$n - k = 1$

$k = (n+1)$

Levels

$$c\left[2^0 + 2^1 + 2^2 + 2^3 + \_\_ + 2^k\right]$$

↳ GP series

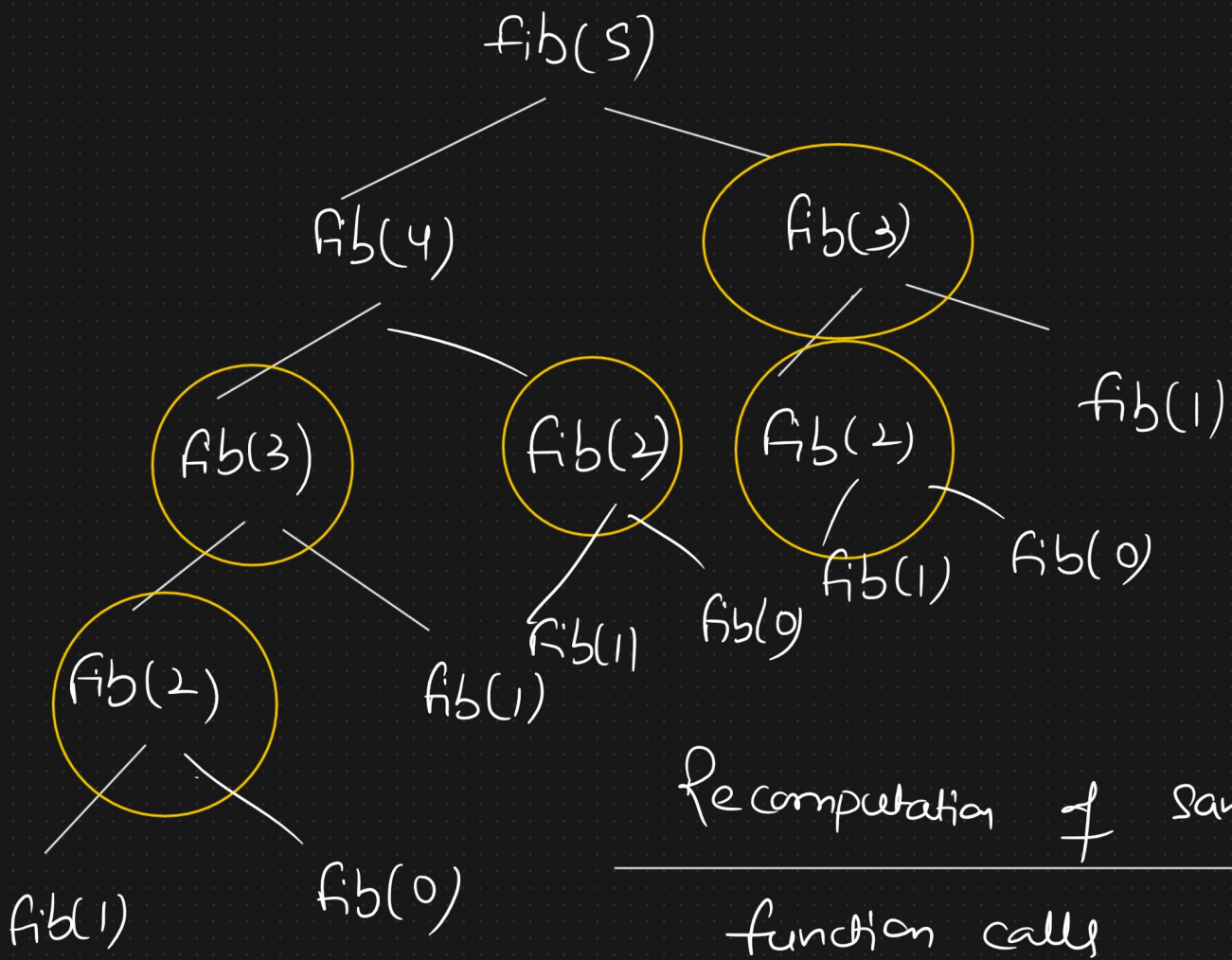
$a = 1$

$r = 2$

$r = 2$

$r > 1 \longrightarrow \dfrac{a(r^n - 1)}{r - 1}$

$$\frac{1(2^n - 1)}{1} = O(2^n)$$



Recomputation of same function calls

↓

$O(2^n)$

(Overlapping Subproblems)

Recursion

→ Divide & conquer

↳ MergeSort

① QuickSort

↳ Dynamic Programming

Sum of given number

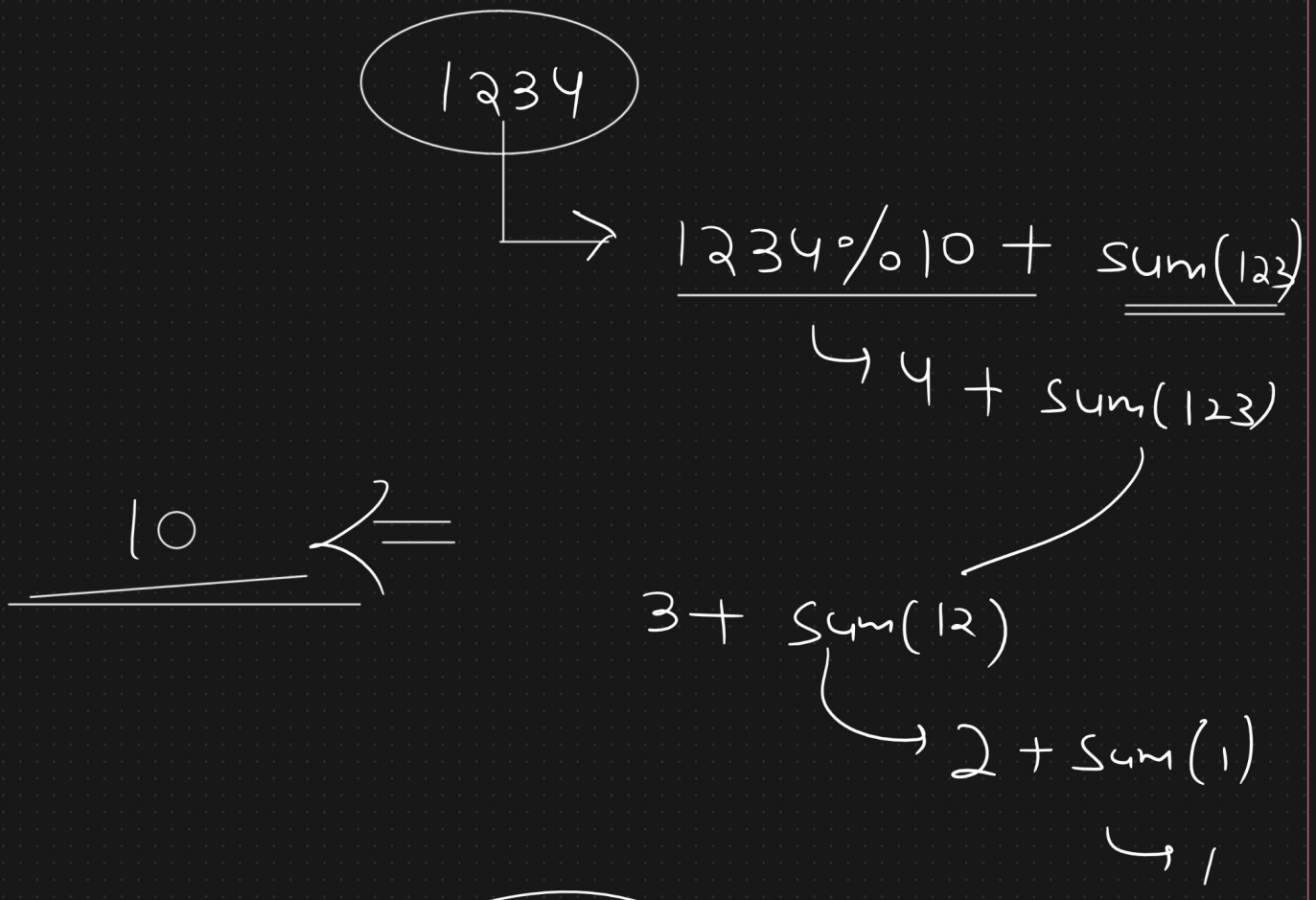
↳ num = 1234

↳ 1+2+3+4=10

① Base case condition

```
sum(n):
    if n < 10:
        return n
    else:
        n%10 + sum(n/10)
```

↳ remainder



Recursive	Iterative
① Base case condition	① for, while
Recursive function call	
② Lesser lines of code ↳ clarity	Higher num of lines of code

③	Stack space is required	No need of extra stack space