

Recursion

$n = 5$

dp

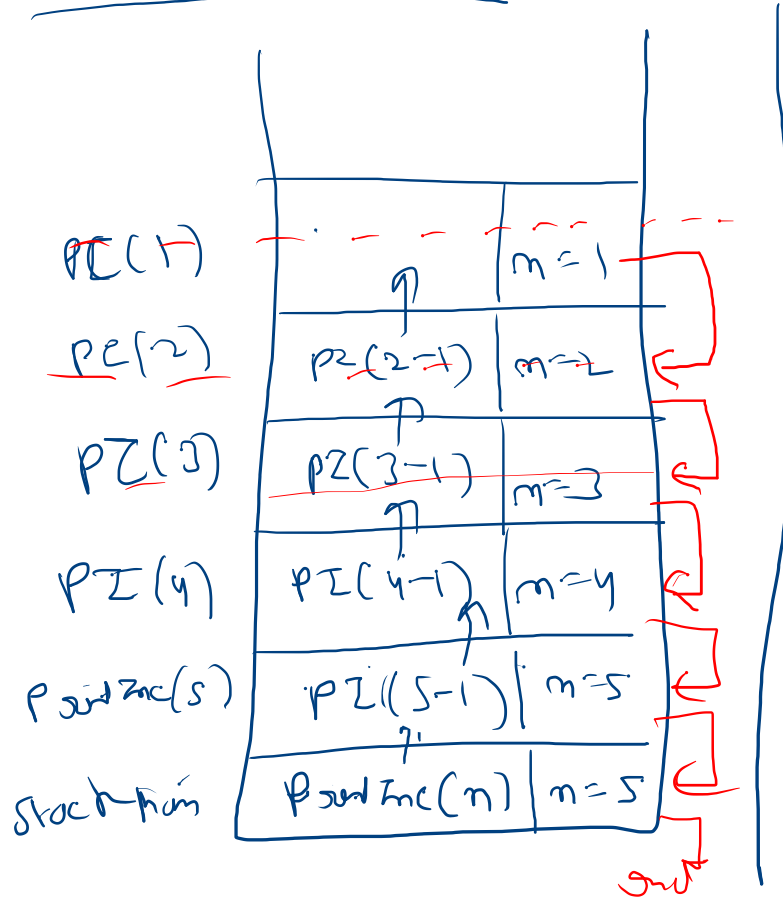
1

2

3

4

5



leaf

1
2
3
4
5

0/1

1

2

3

4

5

$sol(1) \rightarrow 1$

↑

$sol(2) \rightarrow 1, 2, 3$

↑

$sol(3) \rightarrow 1, 2, 3$

↑

$sol(4) \rightarrow 1, 2, 3$

↑

$sol(5) \rightarrow 1, 2, 3$

main method

```
2 usages
public static void solution(int n) {
    // base condition
    if (n == 1) {
        System.out.println(n);
        return;
    }
    2 solution(n - 1);
    3 System.out.println(n);
}
```

Phase of Recursion

5
4
3
2
1

Pre
phase

PO R (1)
↑
PO R (2)
↑
PO R (3)
↑
PO R (4)
↑
PO R (5)

Post phase

```
public static void phaseOfRecursion(int n) {  
    // pre recursion phase  
    phaseOfRecursion(n - 1);  
    // post recursion phase  
}
```

Factorial (Day 23)

$$n = 5$$

$$O/P = n! = 5! = 120$$

$$5 \times 4 \times 3 \times 2 \times 1 = 120$$

Fact(n)

$$0! = 1$$

$$n! = n \times n-1 \times n-2 \times n-3 \times \dots \times 3 \times 2 \times 1$$

$$\begin{aligned} \text{Fact}(n) &= n \times (n-1)! \\ &\hookrightarrow n \times [(n-1) \times (n-1-1) \times (n-1-2) \times (n-1-3) \times \dots] \\ &\rightarrow n \times [(n-1) \times (n-2) \times (n-3) \times (n-4) \times \dots] \end{aligned}$$

$$\text{Fact}(n) = n \times \text{Fact}(n-1)$$

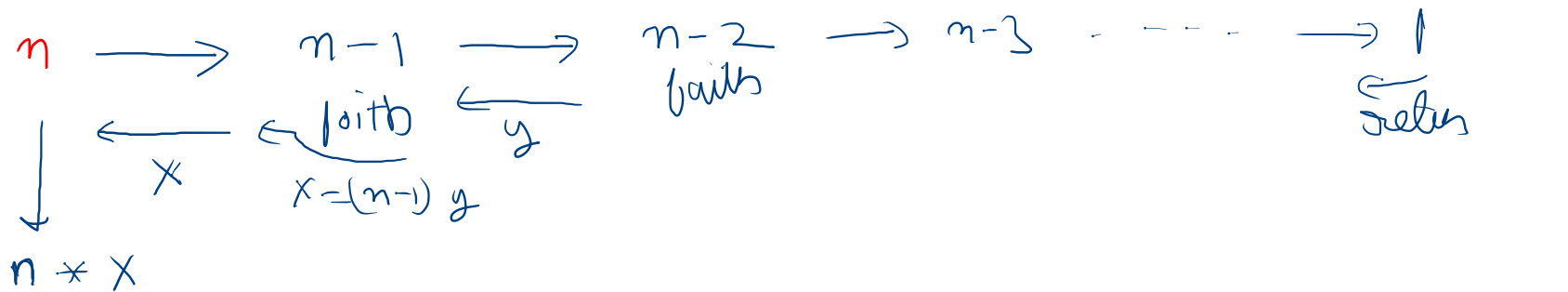
\Rightarrow recursive relation

Thumb Rule \rightarrow For get Logic & Code

Faith \rightarrow have some trust

Recursion \rightarrow faith over smaller Problems

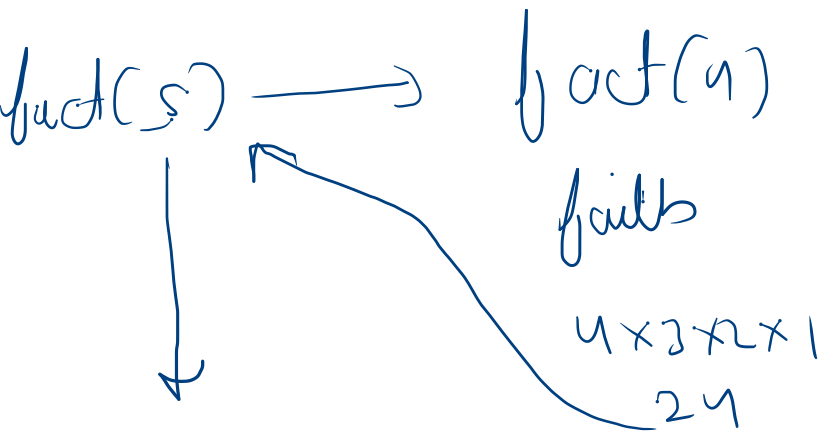
Bigger Problem (we want to solve)



Step 1 Identify
Big & Small Problems

Step 2 → Solve from Big → Small
 & have some faith

Step 3 → Calculate your answer by having faith on
 small problem



$$5 \times 24$$
$$= \underline{\underline{120}} \text{ ans}$$

$\text{fact}(1) \rightarrow 1$
 \uparrow
 $\text{fact}(2) \rightarrow 1, 2, 3 \leftarrow 1$
 \uparrow
 $2 \times 1 = 2$
 $\text{fact}(3) \rightarrow 1, 2, 3 \leftarrow 2$
 \uparrow
 $3 \times 2 = 6$
 $\text{fact}(4) \rightarrow 1, 2, 3 \leftarrow 6$
 \uparrow
 $4 \times 6 = 24$
 $\text{fact}(5) \rightarrow 1, 2, 3 \leftarrow 24$
 \uparrow
 $5 \times 24 = 120$

$5 \times 24 = 120 \rightarrow \text{main}$

```

public static int factorial(int n) {
    // base case
    if (n == 1) {
        return n;
    }
    int factorialNminusOne = factorial(n - 1); // faith on n - 1
    return n * factorialNminusOne; // cal my ans
}

```

Power-linear (Day 23)

$n \geq 0$

$$X^n$$

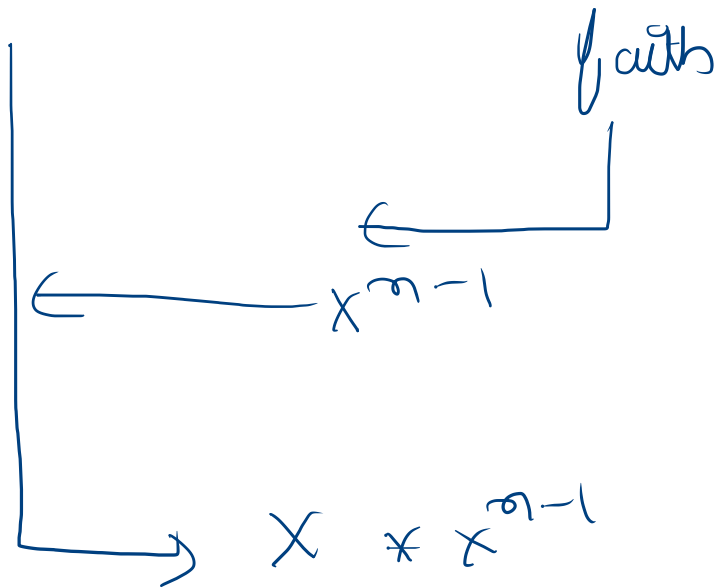
$$2^5 \Rightarrow 2 \times 2 \times 2 \times 2 \times 2$$

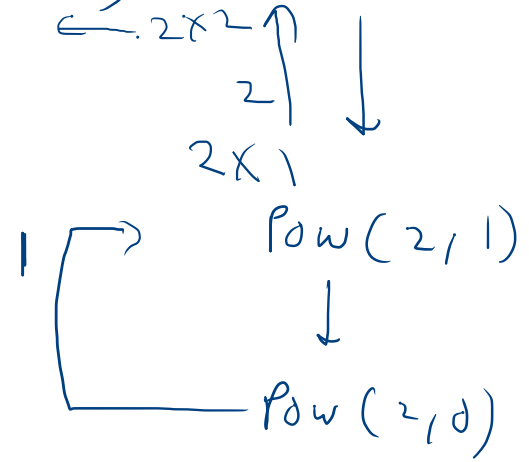
$$2^5 = 2 \times 2^4$$

$$X^n = X * X^{n-1}$$

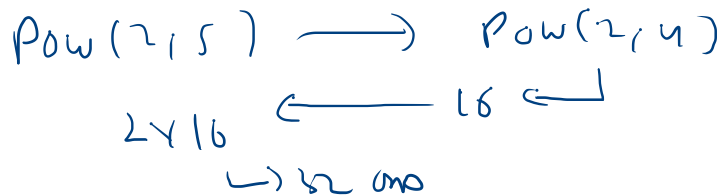
$$\text{Pow}(X, n) = X * \text{Pow}(X, n-1) \rightarrow \text{Recursive Relation}$$

$\text{Pow}(x, n) \longrightarrow \text{Pow}(x, n-1)$





$$2^0 = 1$$



$$\underline{\underline{n < 0}}$$

$$2^{-5} = \frac{1}{2^5}$$

$$\frac{1}{2^5} = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$$

$$= \frac{1}{32}$$

Analysis

height of call stack \rightarrow stack

Space Comp of recursion

\hookrightarrow recursion stack space

