



PREFIX SUM & DIFFERENCE ARRAY 1

--by HARSH GUPTA

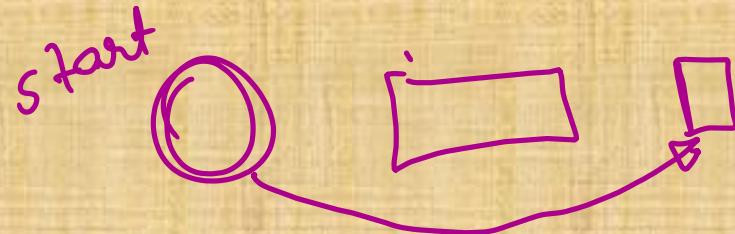
GOAL

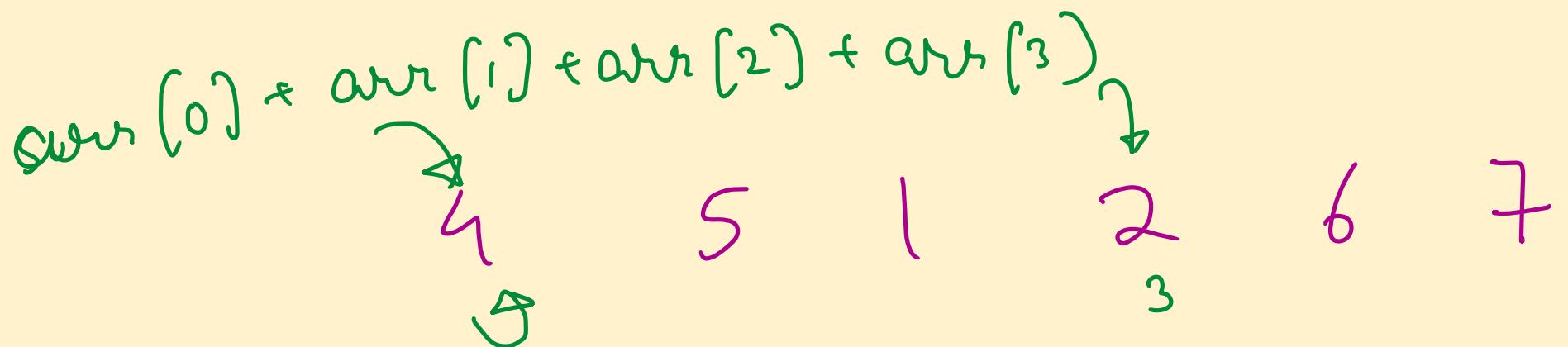
ID PREFIX SUM

2D PREFIX SUM

DIFFERENCE ARRAY

WHAT IS PREFIX SUM ?





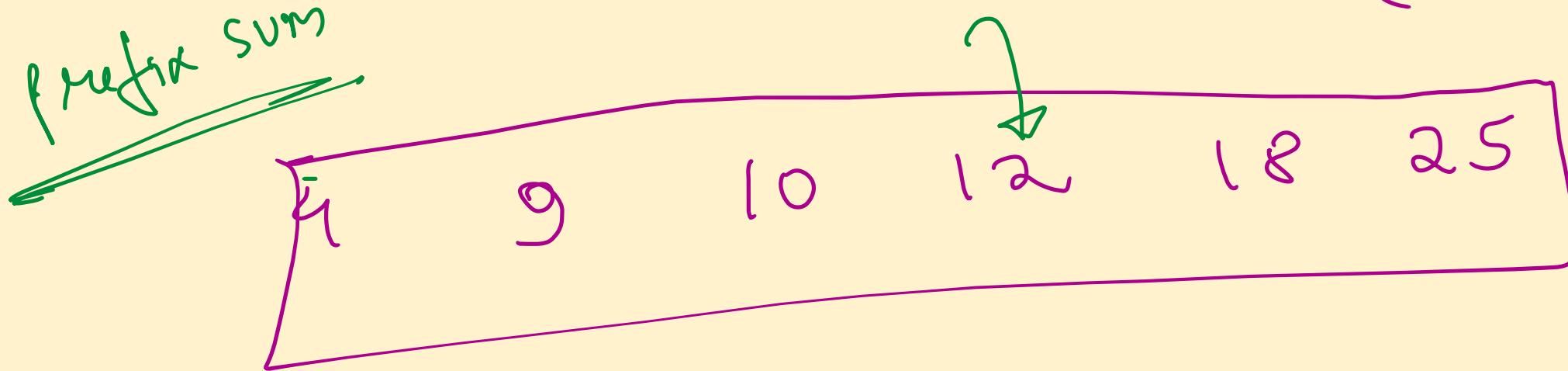
prefix sum

$$4 \quad (u+s) \quad (u+s+1) \quad (u+s+1+2) \quad (u+s+1+2+6)$$

$$(u+s+1+2+6+7)$$

Diagram illustrating the calculation of the prefix sum of an array. The array values are 4, 5, 1, 2, and 7 respectively. The prefix sum is calculated as follows:

- Step 1: $(u+s)$ (grouping 4 and 5)
- Step 2: $(u+s+1)$ (adding 1)
- Step 3: $(u+s+1+2)$ (adding 2)
- Step 4: $(u+s+1+2+6)$ (adding 7)
- Step 5: $(u+s+1+2+6+7)$ (adding 4)



$$\text{arr}[i] = \text{arr}[0] + \text{arr}[1] + \dots + \text{arr}[i]$$

WHY PREFIX SUM ???



$\lceil q \text{ queries} \rceil$

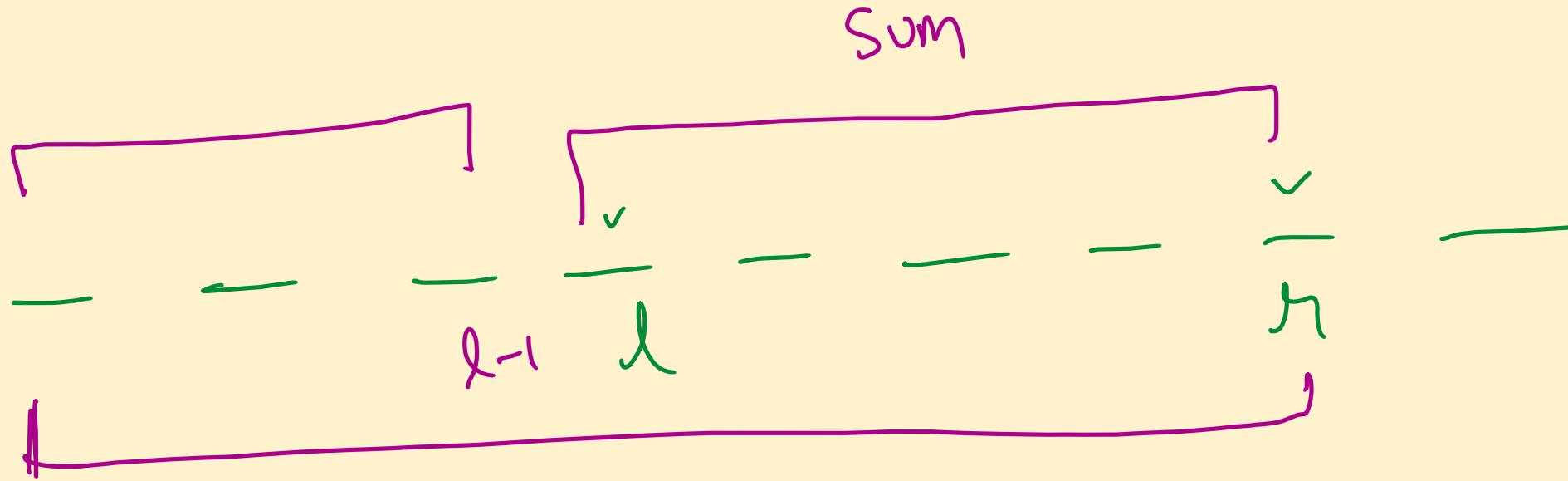
$a \leq 1e5$

$n \rightarrow arr$

$n \leq 1e5$

Every query

Sum of element from index l to
index n .



$$\text{sum 1} = (0, n)$$

$$\text{sum 2} = (0, l-1)$$

$$\boxed{\text{sum} = \text{sum 1} - \text{sum 2}}$$

(nq)

n^2

$(n^2 + q)$

$(n + q)$

$$\text{pre}[1] = \cancel{\text{arr}[0] + \text{arr}[1]}$$

$$\text{pre}[2] = \cancel{\text{arr}[0] + \cancel{\text{arr}[1]} + \text{arr}[2]}$$

$$\text{pre}[3] = \cancel{\text{arr}[0] + \cancel{\text{arr}[1]} + \text{arr}[2]} + \text{arr}[3]$$

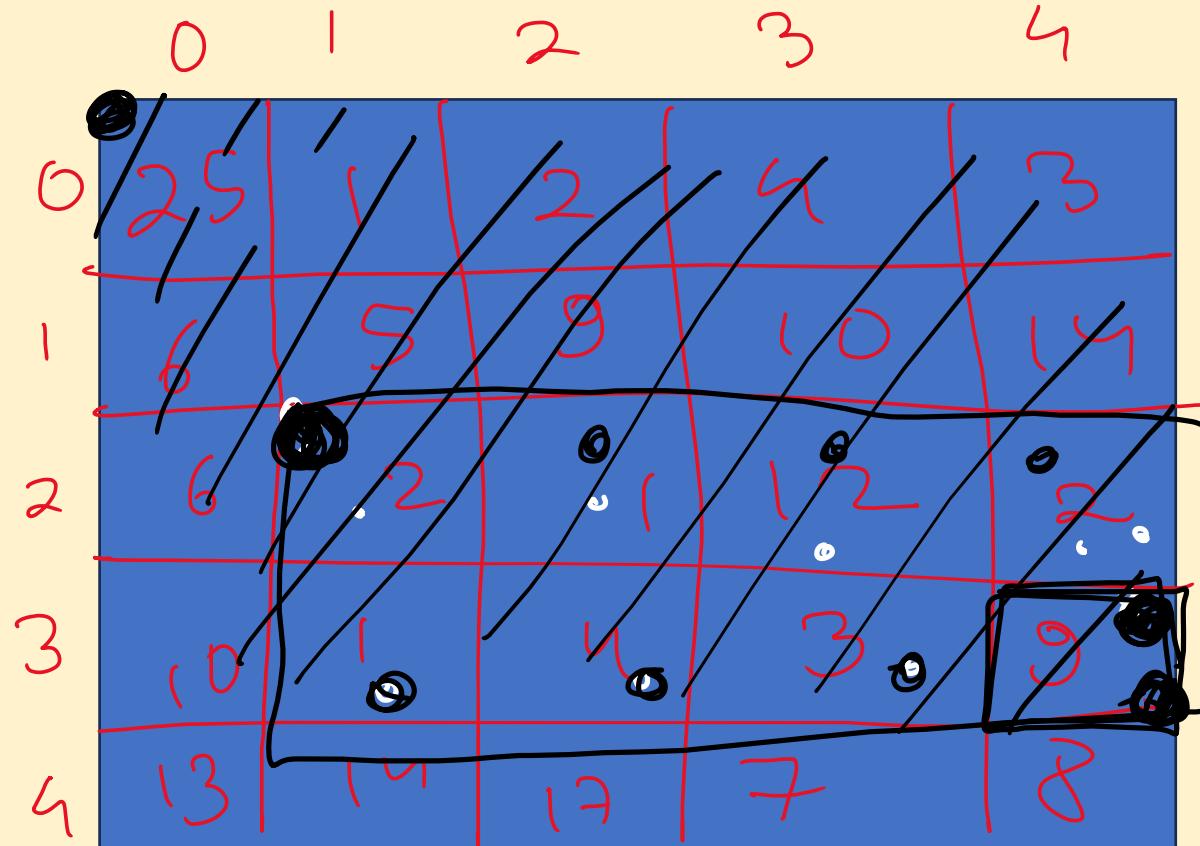
$$\text{pre}[2] = \text{pre}[1] + \text{arr}[2]$$

$$\text{pre}[3] = -\text{pre}[2] + \text{arr}[3]$$

$$\text{pre}[i] = \text{pre}[i-1] + \text{arr}[i]$$

$$n+q$$

2D PREFIX SUM



$$(x_1, y_1)$$

$$(x_2, y_2)$$

$\text{pre}[x][y]$

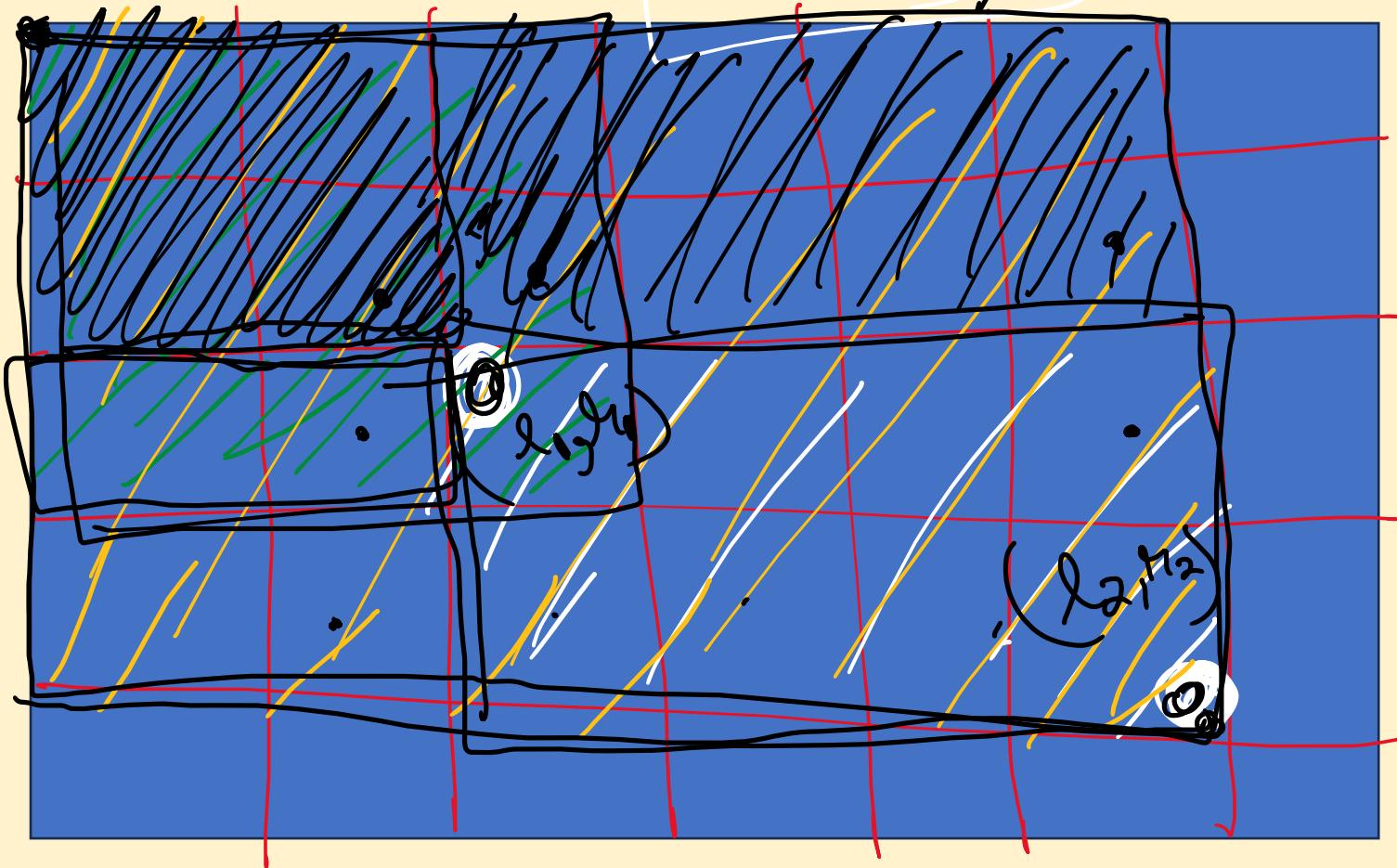
$$(2, 2)$$

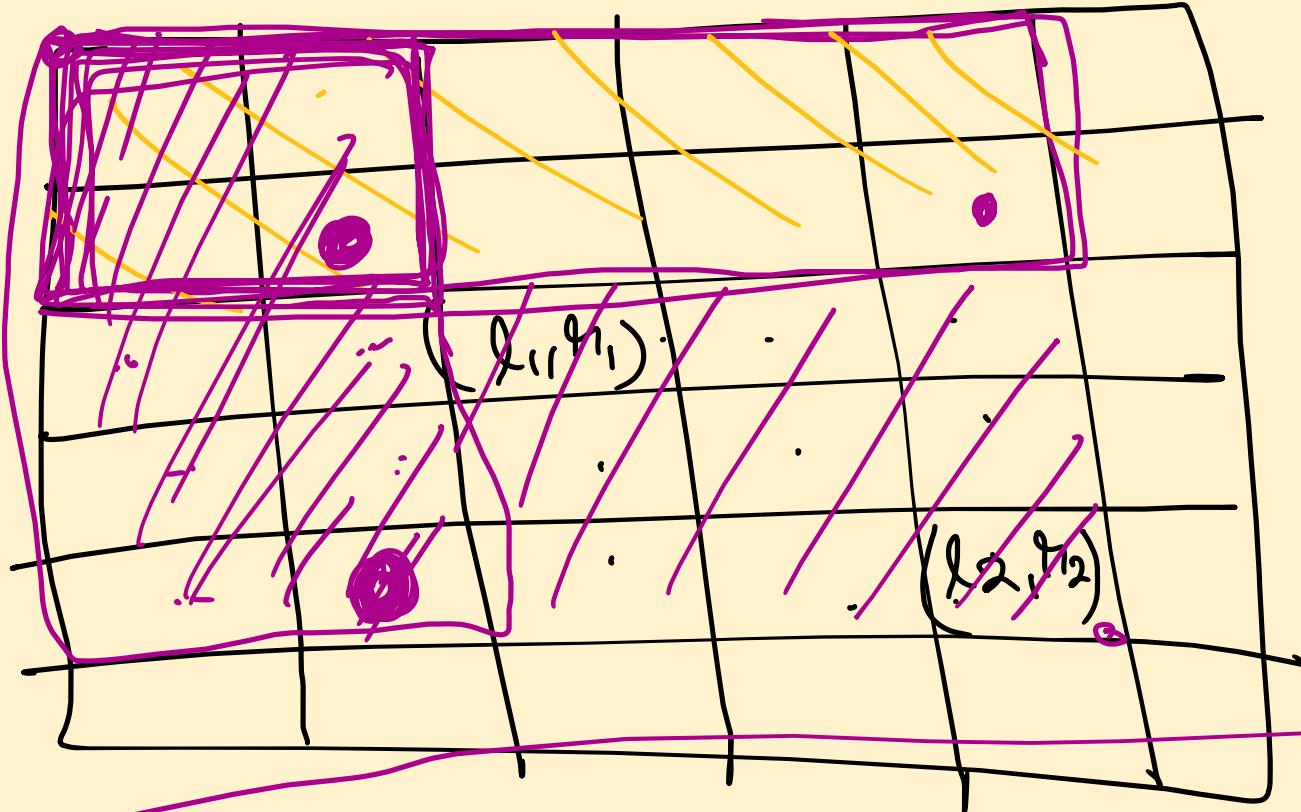
$$(3, u)$$

$(\bullet, 0) \rightarrow (n, y)$

$\text{pre}([n])(y) = (0, 0) \text{ till } (n, y)$

| O () ?

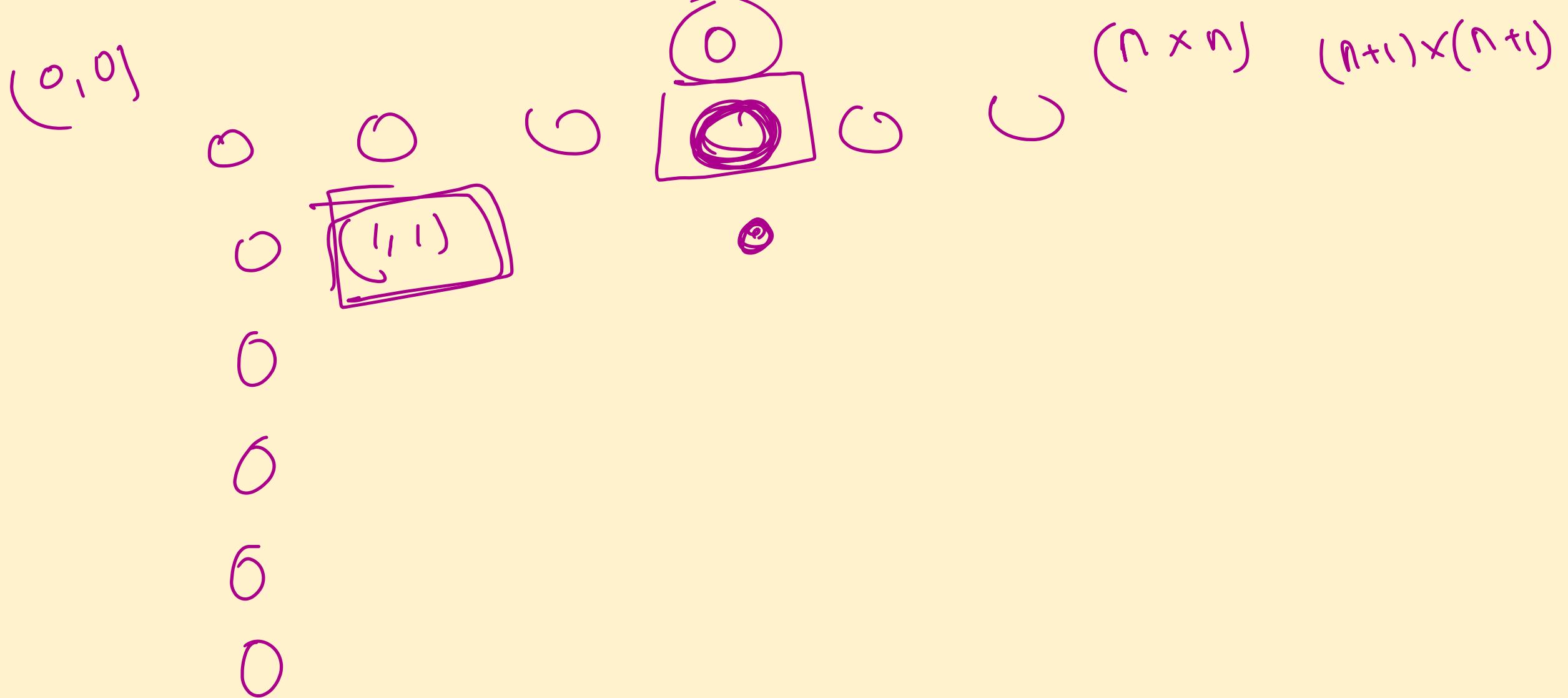




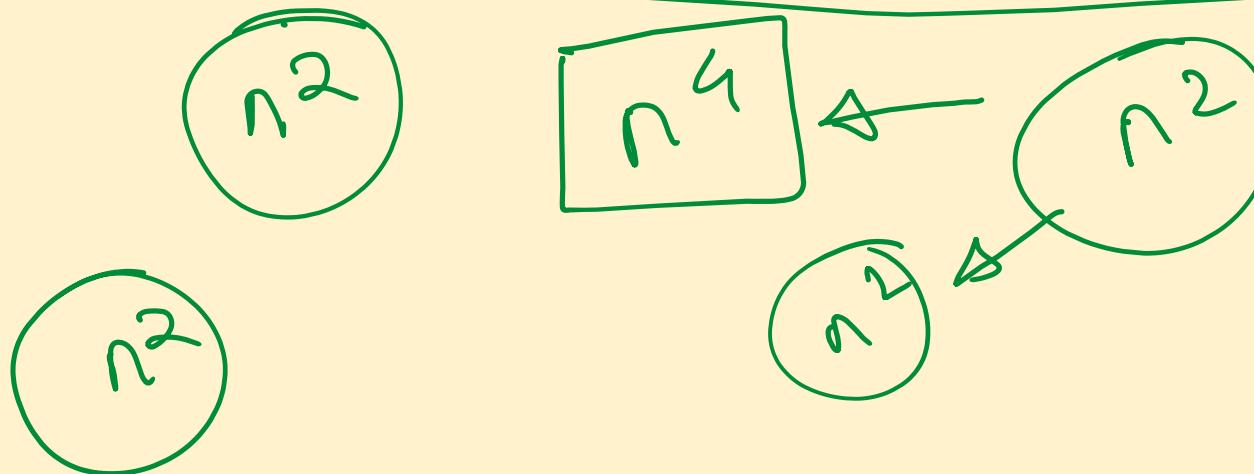
$l_1 - 1$
 $r_1 - 1$

$$\text{pre}[l_2][r_2] - \text{pre}[l_1 - 1][r_2]$$

$$- \text{pre}[l_2][r_1 - 1] + \text{pre}[l_1 - 1][r_1 - 1]$$



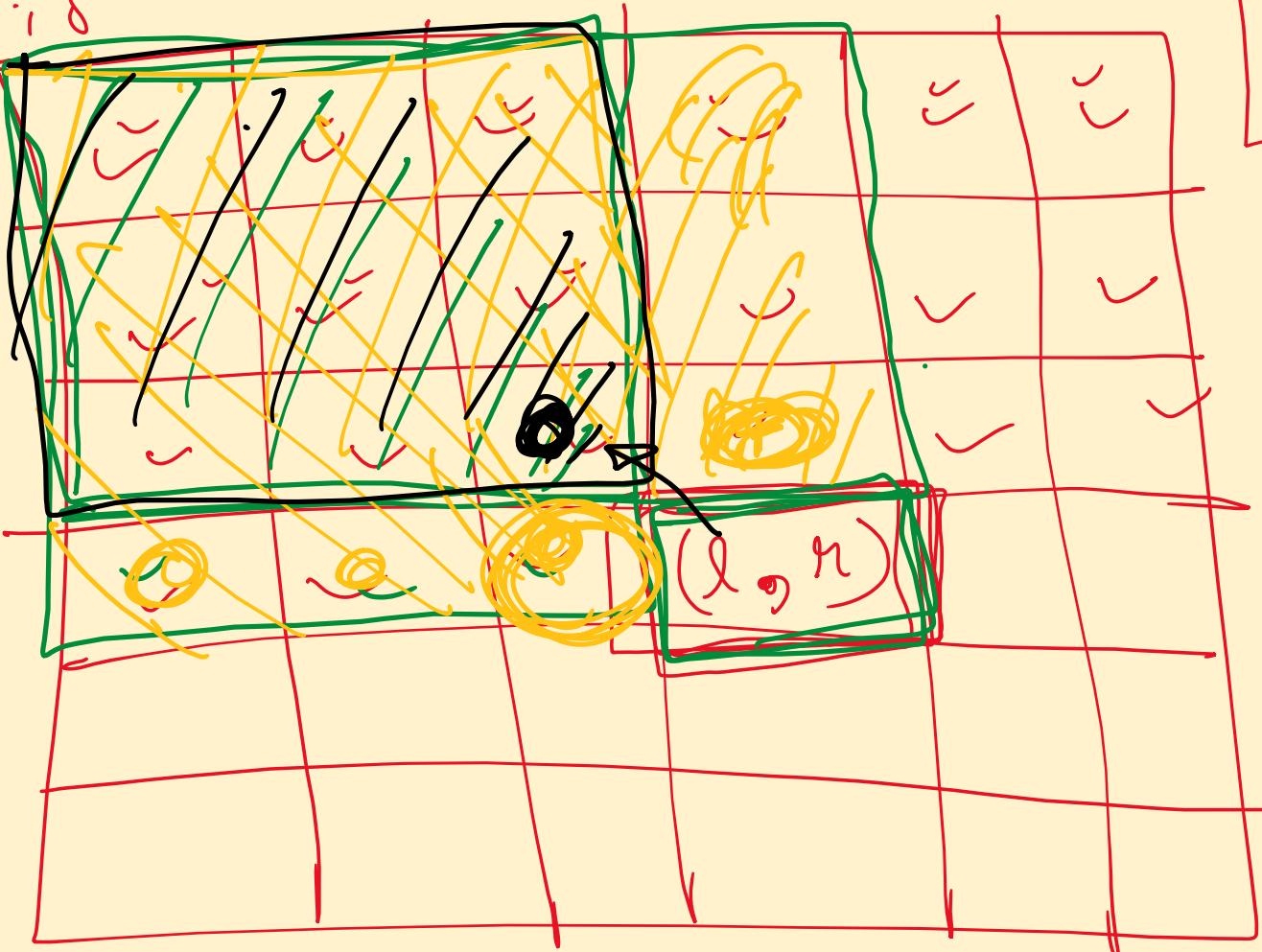
$$(x, y) \rightarrow [0, 0] \rightarrow (n, y)$$



$i = 0; i < n; i++$
 $j = 0; j < n; j++$

\sim

$O(n)$

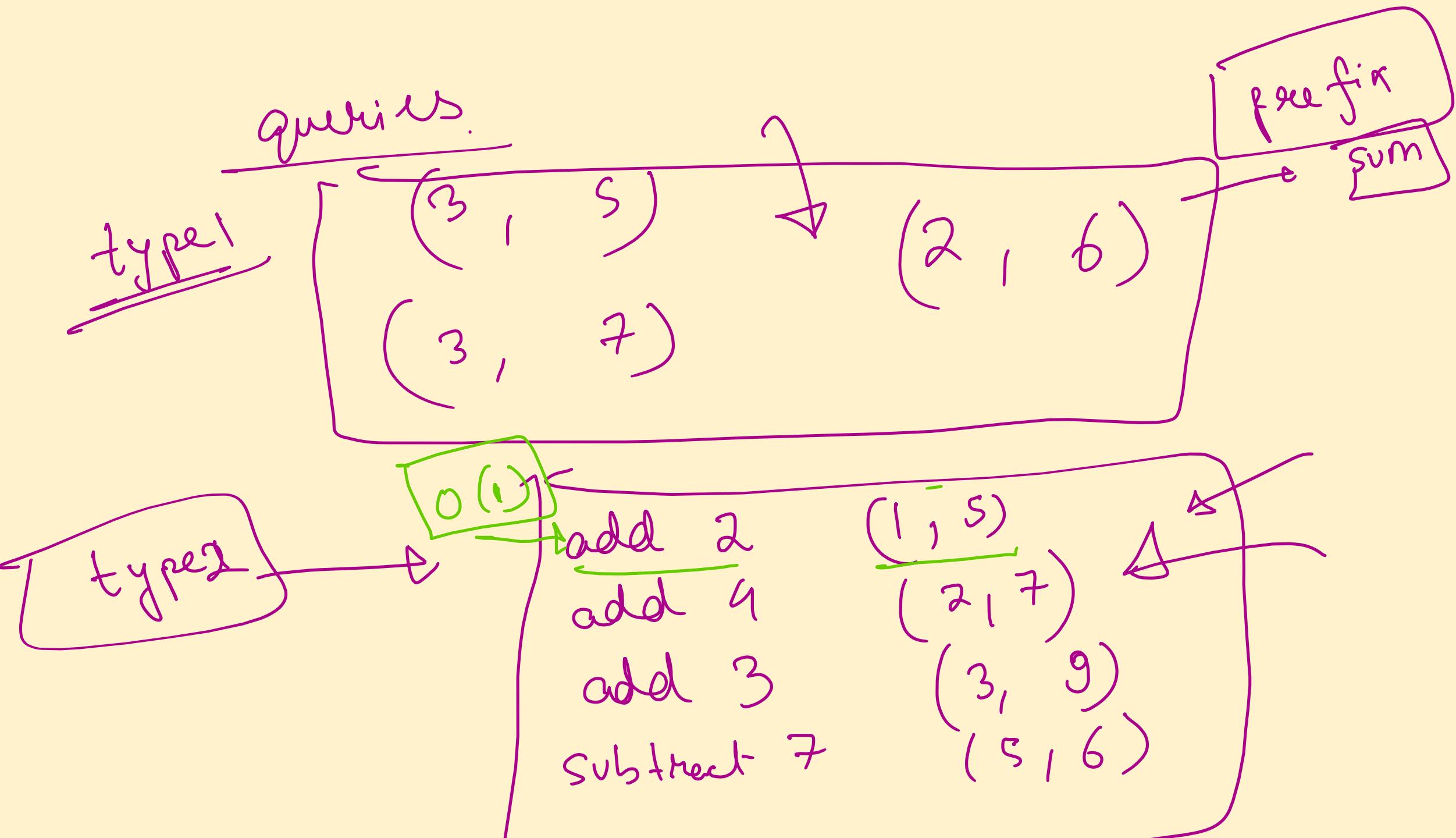


$O(\cdot)$

$$pre[l][r] = arr[l][r] + \frac{pre[l-1][r]}{pre[l-1][r-1]} + pre[l][r-1]$$

FOREST QUERIES

DIFFERENCE ARRAY



for(3 → 6)
add → 5

~~58~~ ~~69~~

2 3 ~ 5 6
9 27 15 38 16

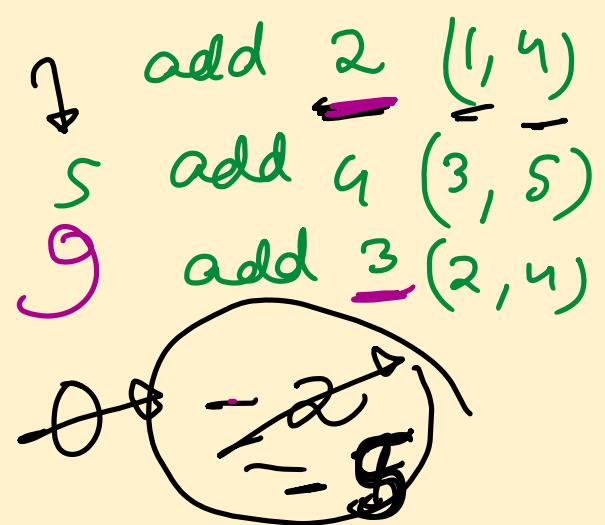
add 0 5. (3, 6)
add 0 3 (0, 1)

1e5

8 9 9 7 9 8 6

0(1)

0(a)

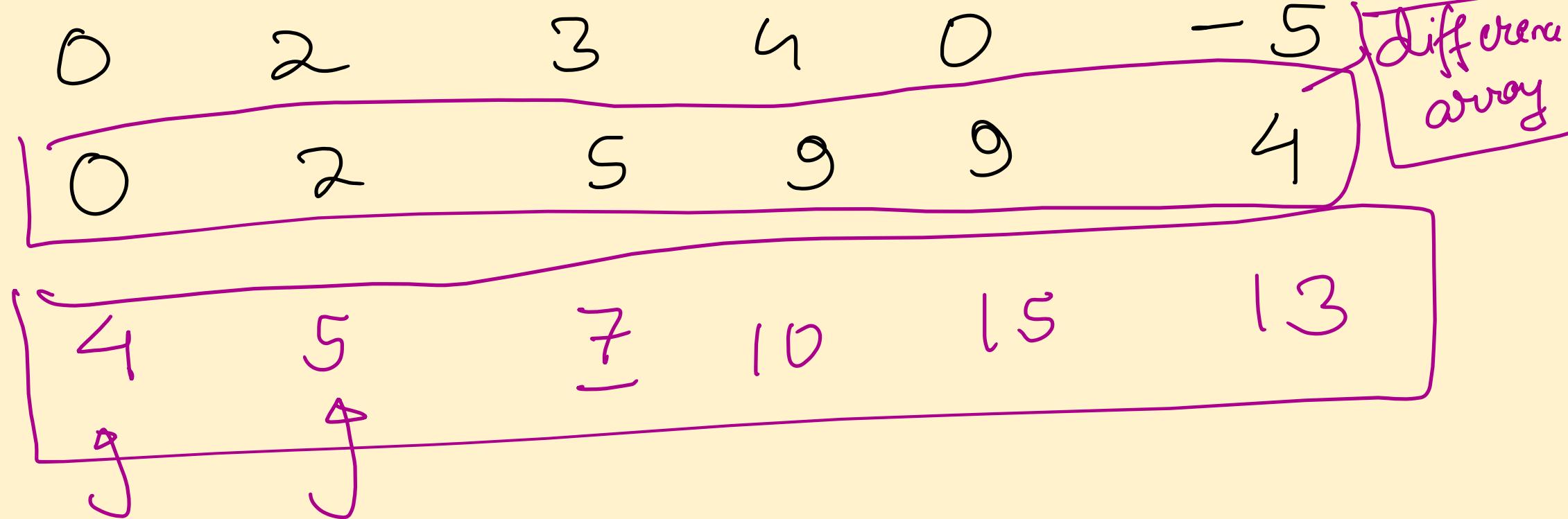


pre

pre

pre

new
arr =



add x (l, m)

{ add x $\rightarrow l$
sub x $\rightarrow (m+1)$

At the end get the prefix sum

NOTE :- $L, R \leq 1e6$

THANK YOU 😊