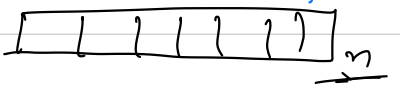
Multidimensional Arrays

1-D array → that stores element in linear fashion or one dimension



N-D arrays → It will store elements in N-dimension

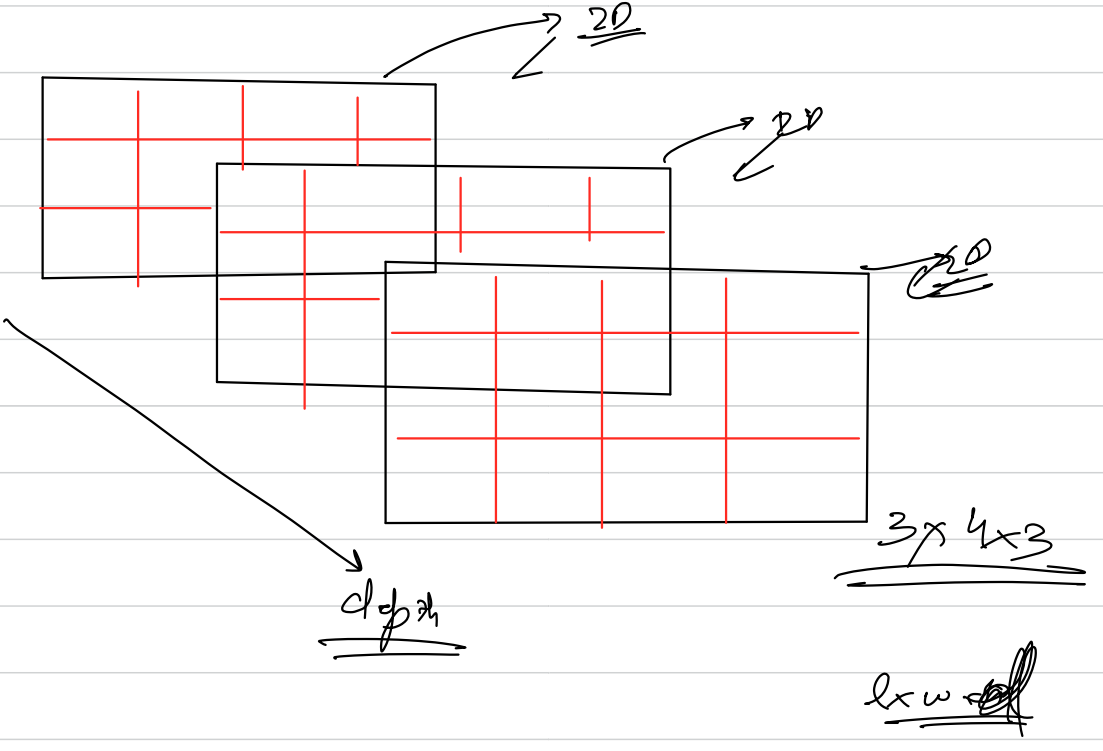
Eg 2D array → Represented in the form of a grid & stores elements in 2 dimension.

→ homogenous data

1	2	3	4
5	6	7	8
9	10	11	12

3×4

3d array → cuboidal shape → homogenous



2D arrays ← Data Structure

↳ How to initialize a 2D arrays ??

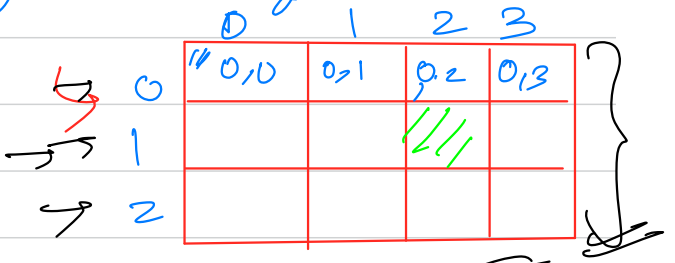
int arr[M][N]; → one way to initialize 2D array

M → no. of rows

N → no of cols

How can we access elements of 2d arrays.

↳ 2D array are 0-based-indexed

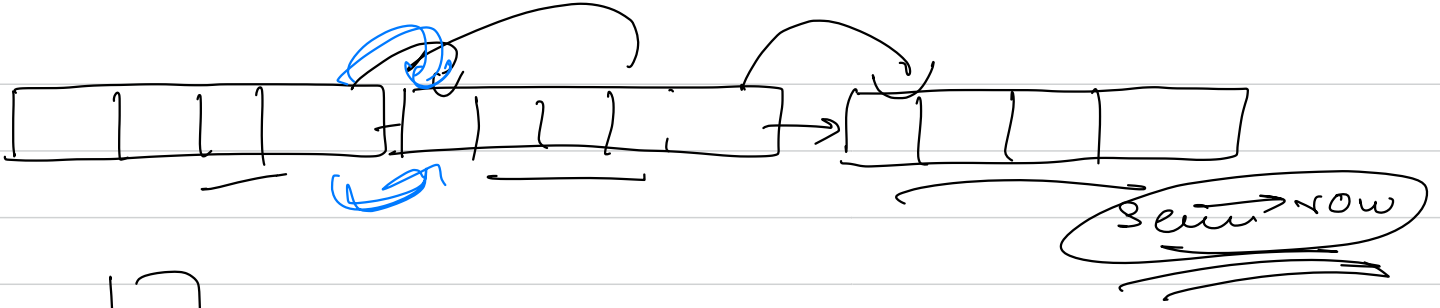


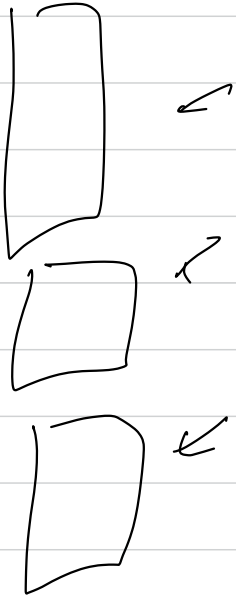
arr[r][c]

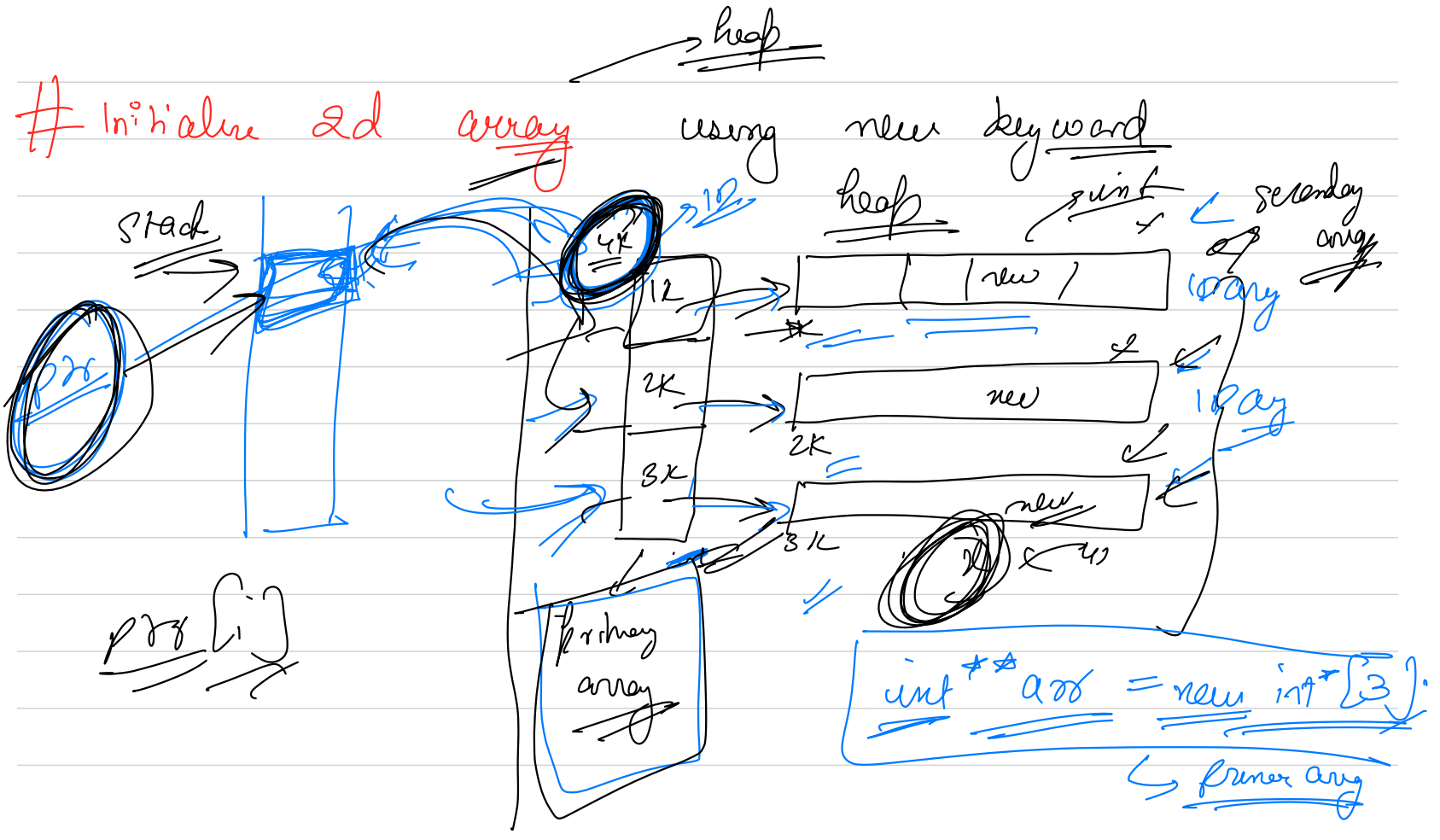
[row major / col major]

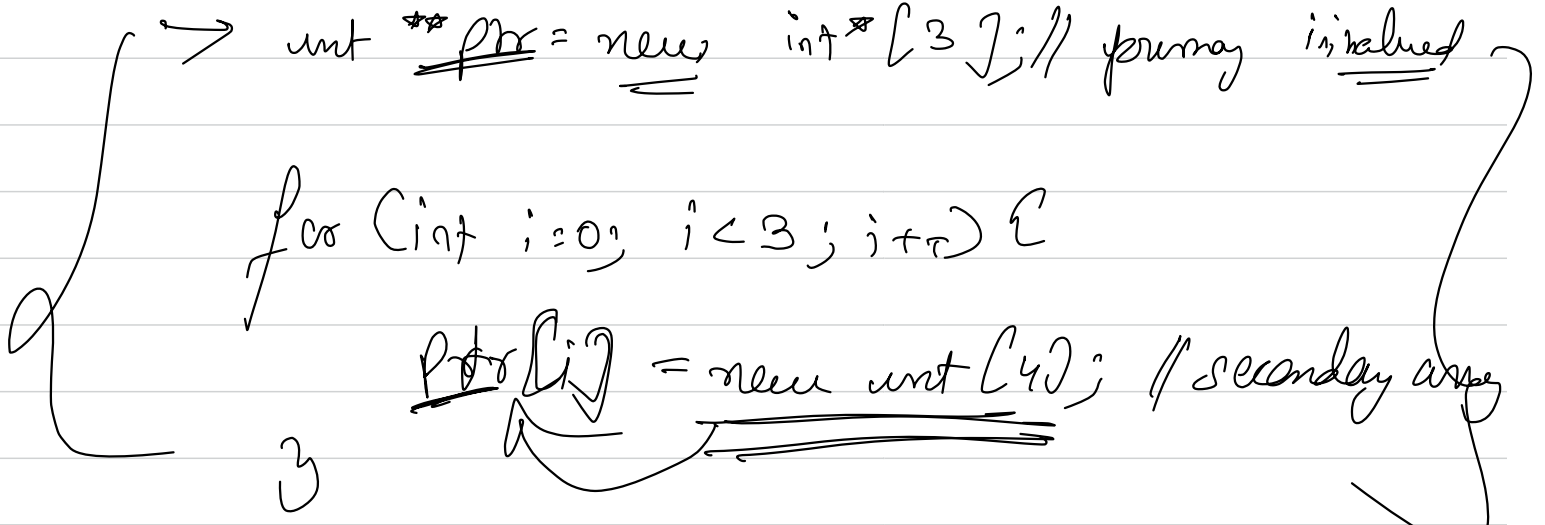
arr[1][2] ← access (1,2) cell

Class??


Seq->row




heap
Initialize 2d array using new keyword
stack
arr
4K
12
2K
3K
arr[1]
primary array
heap
new
new
new
2K
3K
int
secondary array
int** arr = new int*[3];
primary array


int ** ptr = new int*[3]; // primary is initialized
for (int i=0; i<3; i++) {
ptr[i] = new int[4]; // secondary array
}

Q⇒ You are given a 2D array (matrix) of integers. Find the sum of all sub matrices of the given matrix.

→ $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ → 1+1+1+1+2+2+2+2+4

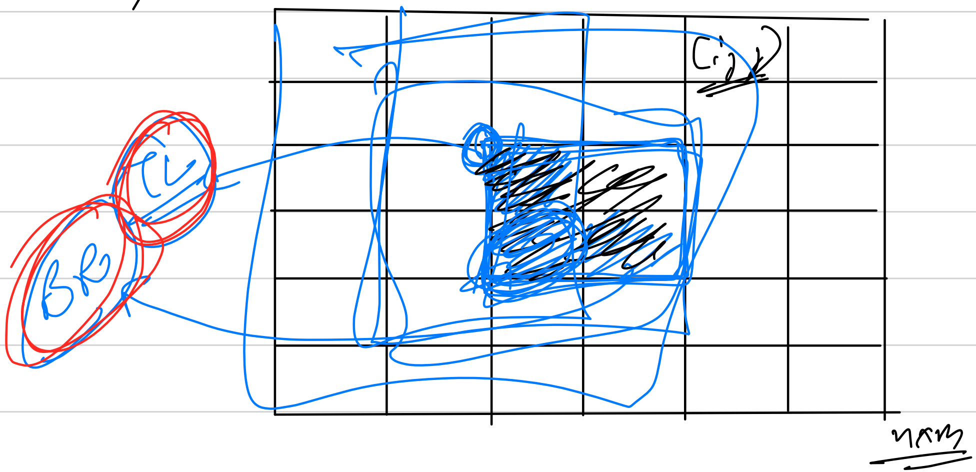
⇒ 4 + 4 + 4 + 4

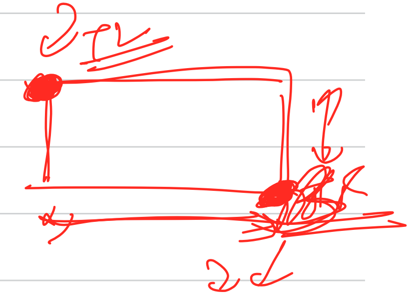
⇒ 16 ans

$N, M \leq 10^3$

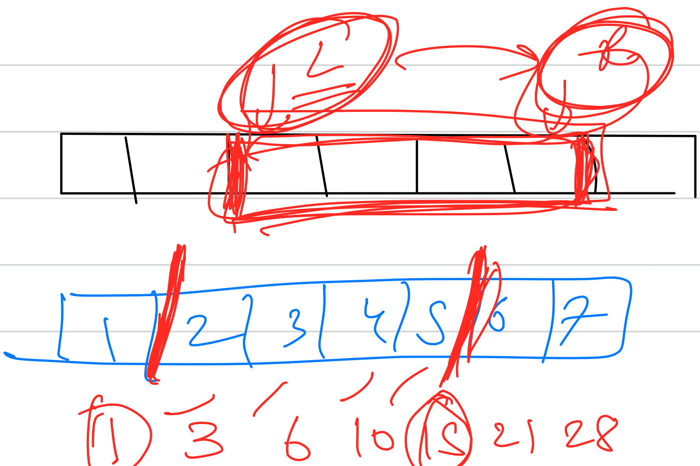
Think in terms of 1D arrays & brute force

Brutforce



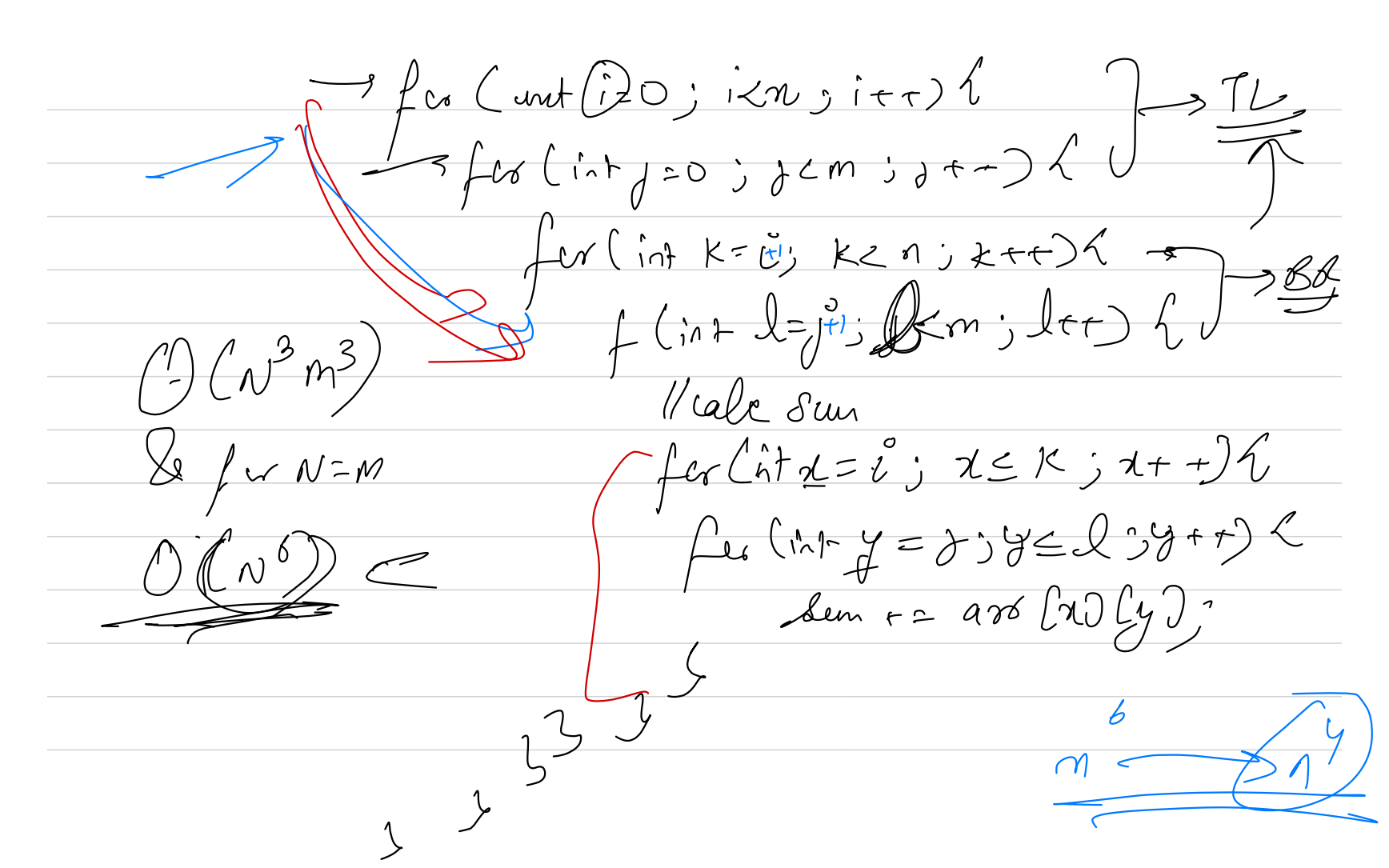


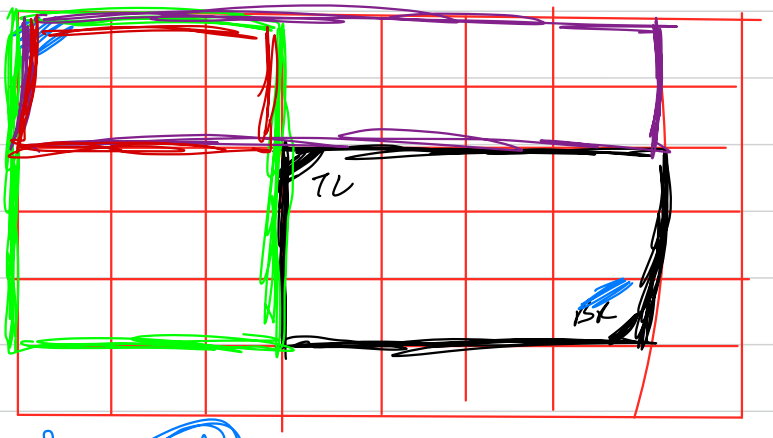
How to define submatrix of a matrix



subarray of 1D array

1 operation


for (int i=0; i<n; i++) {
for (int j=0; j<m; j++) {
TL
for (int k=i+1; k<n; k++) {
for (int l=j+1; l<m; l++) {
BOF
// calc sum
for (int x=i; x<=k; x++) {
for (int y=j; y<=l; y++) {
sum += arr[x][y];
O(N^3 M^3)
& for N=M
O(N^6)
n
6
1
4



n^2

n^2

1	3	6
8	12	21
12	27	45

pre

1	2	3
4	5	6
7	8	9

1	3	6
4	9	15
12	15	24

$n^2 + n^2 + (n-2)^2$

$n \times m$

Sum (0,0, BR) → A → A − B − C + D

Sum (0, 0, BR.x, TL.y − 1) → B

Sum (0, 0, TL.x − 1, BR.y) → C

Sum (0, 0, TL.x − 1, TL.y − 1) → D

O(1)

How to optimize more??

Calculate for a cell that how many submatrix it is a part of ?? → y

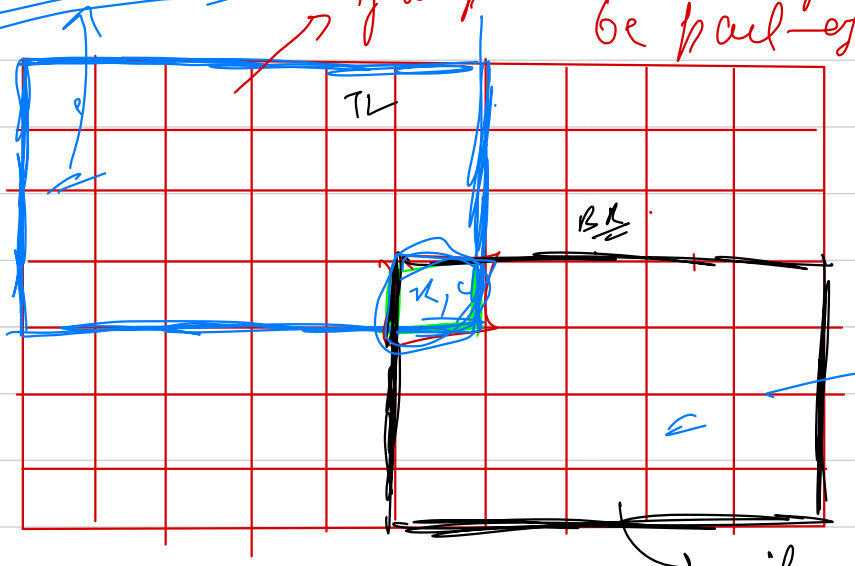
Sum += value of cell × y

O(n×m)

n == m

n^2

How many submatrices my cell is part of.



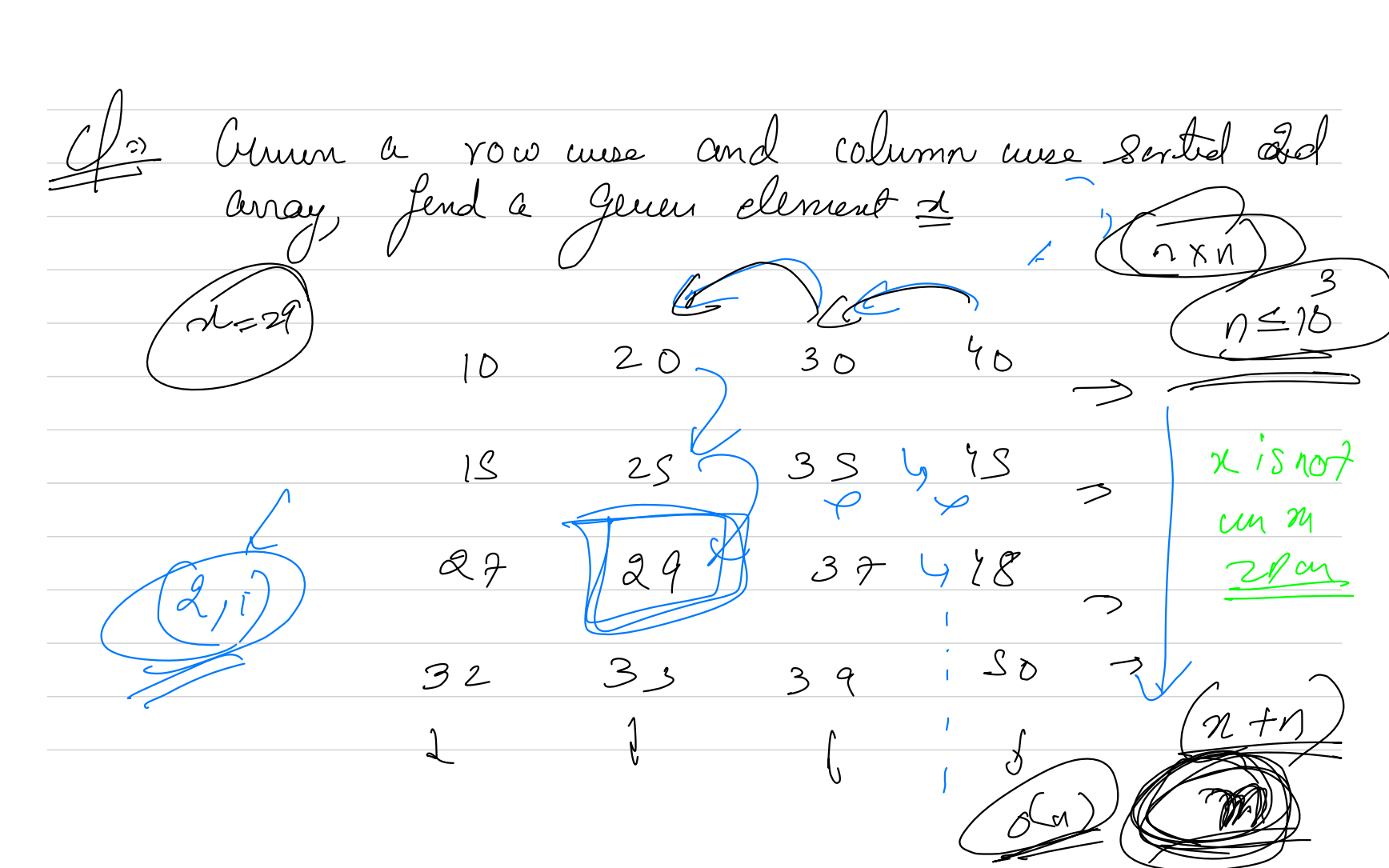
$x C_1 \times y C_1$

$x' = (x+1) * (y+1)$

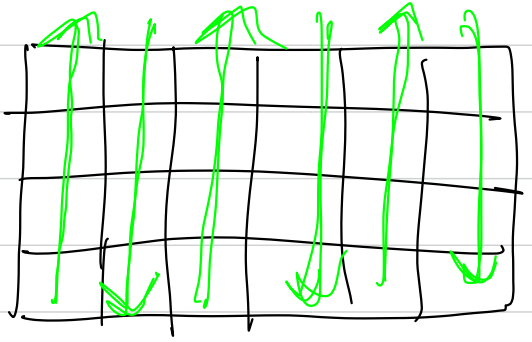
$y' = (n-x)(m-y)$

$O(1)$

Q:) Given a row wise and column wise sorted 2d array, find a given element x



Q-n 1 Wave front



Q-n 2 Spherical front