

Today's Content

1. Make terp

## Make Zero

Problem 3 Row to Column zero.

You are given a 2D integer matrix A.

if  $A[i][j] = 0$ : Make all the elements in a  $i^{\text{th}}$  row &  $j^{\text{th}}$  column zero

Constraints:  $0 \leq A[i][j] \leq 10^9$

Ex1:

Input mat[3][4]

—————→ Output

0 1 2 3  
0  $\begin{bmatrix} 5 & 3 & 2 & 9 \end{bmatrix}$  Rows: 1 2  
1  $\begin{bmatrix} 2 & 1 & 2 & 0 \end{bmatrix}$  Cols: 3 2  
2  $\begin{bmatrix} 9 & 2 & 0 & 4 \end{bmatrix}$

0 1 2 3  
0  $\begin{bmatrix} 5 & 3 & 0 & 0 \end{bmatrix}$   
1  $\begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$   
2  $\begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$

Ex2:

Input mat[3][4]

—————→ Output

0 1 2 3  
0  $\begin{bmatrix} 5 & 0 & 2 & 9 \end{bmatrix}$  Rows: 0 2  
1  $\begin{bmatrix} 3 & 2 & 2 & 1 \end{bmatrix}$  Cols: 1 2  
2  $\begin{bmatrix} 9 & 2 & 0 & 4 \end{bmatrix}$

0 1 2 3  
0  $\begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$   
1  $\begin{bmatrix} 3 & 0 & 0 & 1 \end{bmatrix}$   
2  $\begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$

Idea1: Iterate m mat[i][j] \*

if  $\text{mat}[i][j] == 0$ :

Iterate m  $i^{\text{th}}$  row & make all elements 0

Iterate m  $j^{\text{th}}$  col & make all elements 0

Issue: We cannot differentiate between input 0 & updated 0,  
because of that every element becomes = 0.

Dry Run:

0 1 2 3  
0  $\begin{bmatrix} 5 & 0 & 2 & 9 \end{bmatrix}$   
1  $\begin{bmatrix} 3 & 2 & 2 & 1 \end{bmatrix}$   
2  $\begin{bmatrix} 9 & 2 & 0 & 4 \end{bmatrix}$

After  
Modifying

0 1 2 3  
0  $\begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$   
1  $\begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$   
2  $\begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix}$

Idea:

1. Iterate m mat[i][j]  $T(n) O(\underline{N^2} M (\underline{M+N})) = N^2 M + N M^2$

if mat[i][j] == 0:

$\uparrow$  Iterate m  $i^{th}$  row & make all elements -1; } We can diff between  
 $\uparrow$  Iterate m  $j^{th}$  col & make all elements -1; } update 0 & input 0.

Note: While updating elements as -1, if mat[i][j] is already 0 skip it.

2. Iterate m mat[i][j] all -1, make it 0

	0	1	2	3	4	5		0	1	2	3	4	5		0	1	2	3	4	5
0	5	0	2	9	0	3	$\rightarrow$	0	-1	0	-1	-1	0	-1	0	0	0	0	0	0
1	3	2	2	1	6	2		1	3	-1	-1	1	-1	2	3	0	0	1	0	2
2	9	2	0	4	2	7		2	-1	-1	0	-1	-1	-	0	0	0	0	0	0
3	7	3	2	9	0	6		3	-1	-1	-1	-1	0	-1	0	0	0	0	0	0
4	4	7	8	10	11	9		4	4	-1	-1	10	-1	9	4	0	0	10	0	9
									$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$	$\rightarrow$

vector<vector<int>> mul (vector<vector<int>> A) { TODO

Update Constraints:

Constraints:  $-10^9 \leq A[i][j] \leq 10^9$

Issue:  $\text{mat}[3][3]$

$$\begin{array}{c} 0 \\ 1 \\ 2 \end{array} \begin{bmatrix} -1 & 6 & 3 \\ 2 & 0 & 4 \\ 3 & 9 & -1 \end{bmatrix} \xrightarrow[\text{appr}]{\text{Abre}} \begin{array}{c} 0 \\ 1 \\ 2 \end{array} \begin{bmatrix} -1 & -1 & 3 \\ -1 & 0 & -1 \\ 3 & -1 & -1 \end{bmatrix} \xrightarrow[\text{Make 0}]{\text{Add -1}} \begin{array}{c} 0 \\ 1 \\ 2 \end{array} \begin{bmatrix} 0 & 0 & 3 \\ 0 & 0 & 0 \\ 3 & 0 & 0 \end{bmatrix}$$

\*Wrong

Idea2:

$$\begin{array}{c} 0 & 1 & 2 & 3 & 4 & 5 \\ w) & \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \end{bmatrix} \end{array}$$

$$\begin{array}{c} \text{row} \\ 0 \\ 1 \\ 2 \\ 3 \\ 4 \end{array} \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \\ 1 \end{bmatrix} \quad \begin{array}{c} 0 & 1 & 2 & 3 & 4 & 5 \\ 0 & \begin{bmatrix} 5 & 0 & 2 & 9 & 7 & 3 \\ 3 & 2 & 2 & 1 & 6 & 2 \\ 9 & 2 & 0 & 4 & 2 & 7 \\ 7 & 3 & 2 & 9 & 0 & 6 \\ 4 & 7 & 8 & 10 & 11 & 9 \end{bmatrix} \\ 1 & \begin{bmatrix} 5 & 0 & 2 & 9 & 7 & 3 \\ 3 & 2 & 2 & 1 & 6 & 2 \\ 9 & 2 & 0 & 4 & 2 & 7 \\ 7 & 3 & 2 & 9 & 0 & 6 \\ 4 & 7 & 8 & 10 & 11 & 9 \end{bmatrix} \\ 2 & \begin{bmatrix} 5 & 0 & 2 & 9 & 7 & 3 \\ 3 & 2 & 2 & 1 & 6 & 2 \\ 9 & 2 & 0 & 4 & 2 & 7 \\ 7 & 3 & 2 & 9 & 0 & 6 \\ 4 & 7 & 8 & 10 & 11 & 9 \end{bmatrix} \\ 3 & \begin{bmatrix} 5 & 0 & 2 & 9 & 7 & 3 \\ 3 & 2 & 2 & 1 & 6 & 2 \\ 9 & 2 & 0 & 4 & 2 & 7 \\ 7 & 3 & 2 & 9 & 0 & 6 \\ 4 & 7 & 8 & 10 & 11 & 9 \end{bmatrix} \\ 4 & \begin{bmatrix} 5 & 0 & 2 & 9 & 7 & 3 \\ 3 & 2 & 2 & 1 & 6 & 2 \\ 9 & 2 & 0 & 4 & 2 & 7 \\ 7 & 3 & 2 & 9 & 0 & 6 \\ 4 & 7 & 8 & 10 & 11 & 9 \end{bmatrix} \end{array} \rightarrow \begin{array}{c} 0 & 1 & 2 & 3 & 4 & 5 \\ 0 & \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 10 & 0 & 9 \end{bmatrix} \\ 1 & \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 10 & 0 & 9 \end{bmatrix} \\ 2 & \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 10 & 0 & 9 \end{bmatrix} \\ 3 & \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 10 & 0 & 9 \end{bmatrix} \\ 4 & \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 10 & 0 & 9 \end{bmatrix} \end{array}$$

Idea:

$\text{int mat}[N][M];$

Step: 0 {  $\text{vector<int> row}(N, 0);$   
           $\text{vector<int> col}(M, 0);$

TC:  $O(N*M)$  SC:  $O(N+M)$

Step: 1 Iterate n  $\text{mat}[0][0]$   
          if  $(\text{mat}[i][j] == 0)$  {  
               $\text{row}[i] = 0$   
               $\text{col}[j] = 0$   
          }

Step: 2 Iterate n  $\text{mat}[0][0]$   
          if  $(\text{row}[i] == 0 \parallel \text{col}[j] == 0)$  {  
               $\text{mat}[i][j] = 0;$   
          }

Update Constraints: No Extra Space

Idea:

Step1:

Trace1:

	0	1	2	3	4
0	5	2	<del>0</del>	2	<del>0</del>
1	<del>0</del>	2	0	1	6
2	<del>0</del>	2	2	4	0
3	6	3	2	9	2

	0	1	2	3	4
0	5	2	0	2	0
1	0	2	0	1	6
2	0	2	2	4	0
3	6	3	2	9	2

$mat[0][j] = 0 \Rightarrow j^{th} col = 0$

$mat[i][0] = 0 \Rightarrow i^{th} row = 0$

Trace2:

	5	2	9	8	7	3
0	<del>0</del>	2	<del>0</del>	8	<del>0</del>	3
1	3	2	2	1	6	2
2	<del>0</del>	2	0	4	2	7
3	<del>0</del>	3	2	9	0	6
4	6	7	8	10	11	9

Issue: Not sure  $mat[0][0]$  representing  $0^{th}$  row or  $0^{th}$  col.

	0	1	2	3	4	5
0	0	2	0	8	0	3
1	3	2	2	1	6	2
2	0	2	0	4	2	7
3	0	3	2	9	0	6
4	6	7	8	10	11	9

To avoid above Issue:

Assume  $mat[0][0]$  is representing  $0^{th}$  row.

We will take flag variable: To indicate if  $0^{th} col = 0$

Trace3:

flag = 1  $\Rightarrow 0^{th} col$ .

flag = 0 =  $0^{th} col$

	0	1	2	3	4	5
0	<del>0</del>	2	<del>0</del>	<del>0</del>	<del>0</del>	3
1	3	2	2	1	6	2
2	<del>0</del>	2	0	4	2	7
3	<del>0</del>	3	2	9	0	6
4	6	7	8	10	11	9

	0	1	2	3	4	5
0	0	2	0	0	0	3
1	3	2	2	1	6	2
2	0	2	0	4	2	7
3	0	3	2	9	0	6
4	6	7	8	10	11	9

Step 2:

Trace 1: Skip 0th row & 0th col & update everything else

flag = 0 = 0th Col

	0	1	2	3	4	5
0	0	2	0	0	7	3
1	3	2	2	1	6	2
2	0	2	0	4	2	7
3	0	3	2	9	0	6
4	6	7	8	10	11	9

	0	1	2	3	4	5
0	0	2	0	0	7	3
1	3	2	0	0	6	2
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	6	7	0	0	11	9

Step 3: update 0th row & 0th col in that row

0th Row: if  $mat[i][0] == 0$ : Iterate in 0th Row

0th Col: if flag == 0: Iterate in 0th Col

	0	1	2	3	4	5
0	0	2	0	0	7	3
1	3	2	0	0	6	2
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	6	7	0	0	11	9

$\text{vector} \langle \text{vector} \langle \text{int} \rangle \rangle$  mul ( $\text{vector} \langle \text{vector} \langle \text{int} \rangle \rangle$  A) { TC:  $O(N^2M)$  SC:  $O(1)$  }

int N = A.size(), M = A[0].size();  
int flag = 1; # 0<sup>th</sup> col representation.

```
for (int i = 0; i < N; i++) {  
    for (int j = 0; j < M; j++) {  
        if (mat[i][j] == 0) {  
            if (j == 0) {  
                mat[i][0] = 0;  
            }  
            flag = 0;  
        }  
        else {  
            mat[i][0] = 0;  
            mat[0][j] = 0;  
        }  
    }  
}
```

```
for (int i = 1; i < N; i++) {  
    for (int j = 1; j < M; j++) {  
        # mat[i][j] = 0  
        if (mat[i][0] == 0 || mat[0][j] == 0) {  
            mat[i][j] = 0;  
        }  
    }  
}
```

if (mat[0][0] == 0) { # Iterate m 0<sup>th</sup> row of mat = 0 }  
if (flag == 0) { # Iterate m 0<sup>th</sup> col of mat = 0 }