



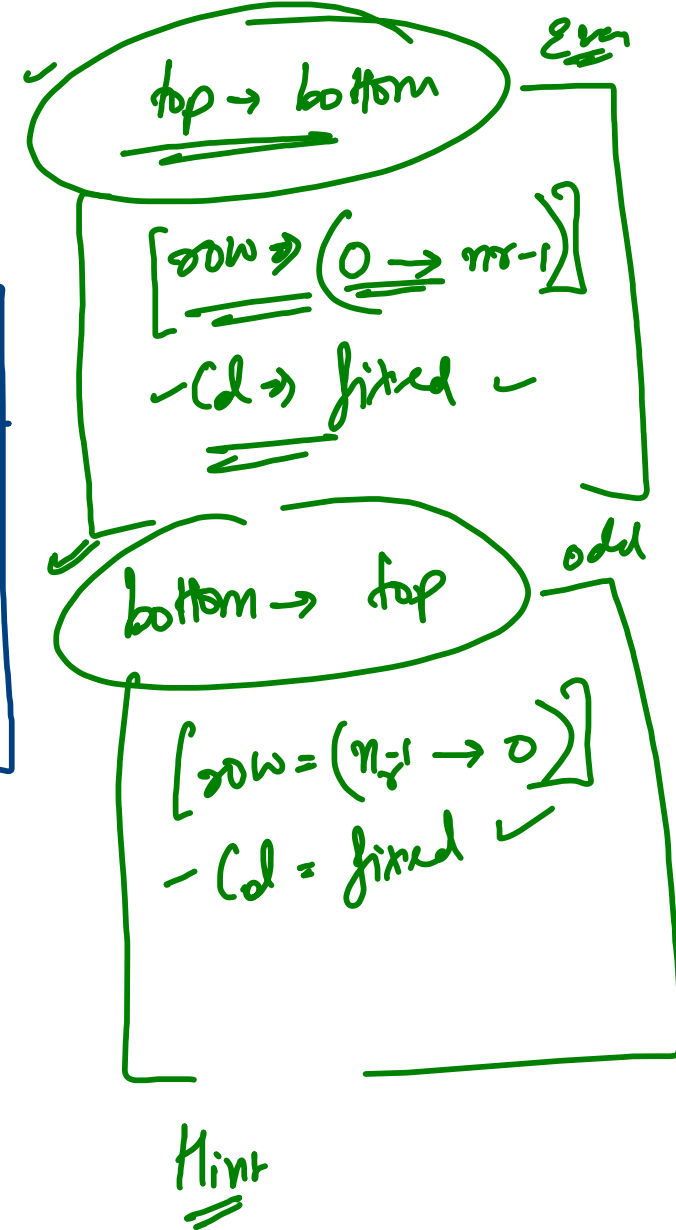
3  
4  
11 12 13 14  
21 22 23 24  
31 32 33 34

→ 0

1

→ 2

	0	1	2	3
	↙	↖	↙	↖
11		12		13
21		22		23
31		32		33
	↓	↓	↓	↓



nr=3

	0	1	2	3
0	11 ✓	12 ✓	13 ✓	14 ✓
1	21 ✓	22 ✓	23 ✓	24 ✓
2	31 ✓	32 ✓	33 ✓	34 ✓

```
for(int c = 0 ; c < nc ; c++){
    if(c % 2 == 0){
        // even : top -> bottom
        for(int r = 0 ; r <= nr-1 ; r++){
            System.out.println(mat[r][c]);
        }
    }else{
        // odd : bottom -> top
        for(int r = nr-1 ; r >= 0 ; r--){
            System.out.println(mat[r][c]);
        }
    }
}
```

$c=0, r=0,1,2$

$c=1, r=2,1,0$

$c=2, r=0,1,2$

$[0][0] \rightarrow 11$

$[1][0] \rightarrow 21$

$[2][0] \rightarrow 31$

$[2][1] \rightarrow 32$

$[1][1] \rightarrow 22$

$[0][1] \rightarrow 12$

$\left[ \begin{array}{l} 2 \rightarrow nc \\ 4 \rightarrow nc \end{array} \right.$   
 11 ✓  
 12 ✓  
 13 ✓  
 14 ✓  
 ✓ 21  
 ✓ 22  
 ✓ 23  
 ✓ 24

$i(row)$   
 $i(col)$

	0	1	2	3
0	11	12	13	14
1	21	22	23	24

✓ 2  
✓ 4  
✓ 11  
✓ 12  
✓ 13  
✓ 14  
✓ 21  
✓ 22  
✓ 23  
✓ 24

nr = 2

nc = 4

→

	0	1	2	3
0	11	12	13	14
1	21	22	23	24

i 2

;

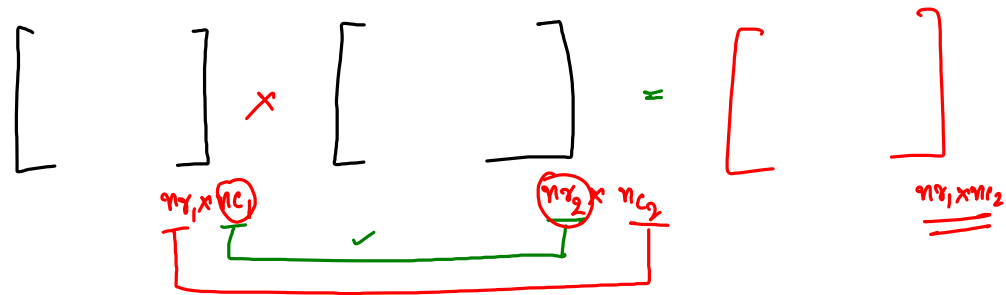
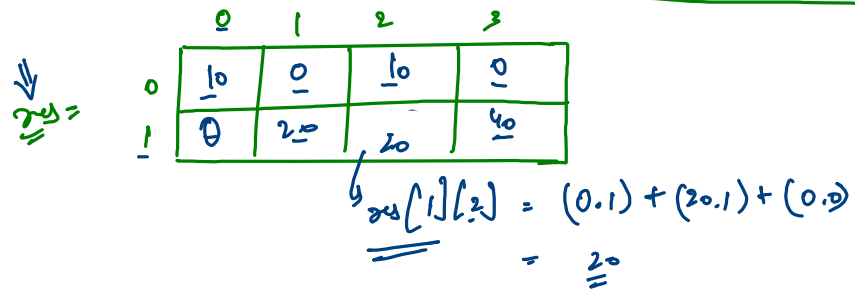
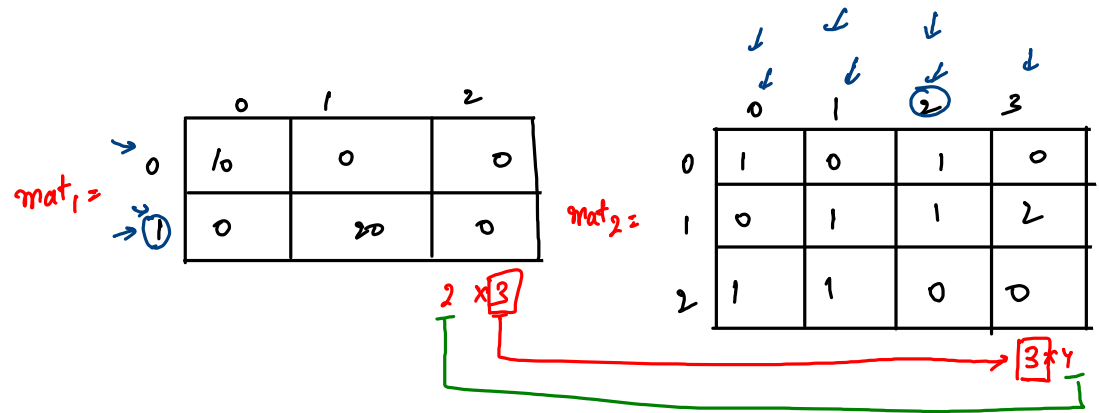
```
int nr = scn.nextInt();  
int nc = scn.nextInt();
```

→ `int mat[][] = new int[nr][nc];`

```
for(int i = 0 ; i < nr ; i++){  
    for(int j = 0 ; j < nc ; j++){  
        mat[i][j] = scn.nextInt();  
    }  
}
```

row col

2  
3  
0  
0  
0  
20  
0  
3  
4  
1  
0  
1  
0  
0  
1  
1  
2  
1  
1  
0  
0



mat<sub>1</sub> =

→ 0  
1

	0	1	2
0	10	0	0
1	0	20	0

mat<sub>2</sub> =

	0	1	2	3
0	1	0	1	0
1	0	1	1	2
2	1	1	0	0

0  
1

	0	1	2	3
0			10	
1				

i=0, j=2, k=0, 1, 2

$$res[0][2] = \left( \frac{10}{10} \cdot \frac{1}{1} \right) + \left( \frac{0}{0} \cdot \frac{1}{1} \right) + \left( \frac{0}{10} \cdot \frac{0}{0} \right)$$

```
int res[][] = new int[nr1][nc2];
```

```
// matrix multiplication
```

```
for(int i = 0 ; i < res.length ; i++){
    for(int j = 0 ; j < res[0].length ; j++){
        for(int k = 0 ; k < nc1 ; k++){
            res[i][j] = res[i][j] + (mat1[i][k] * mat2[k][j]);
        }
    }
}
```

Handwritten diagram illustrating a 3x5 grid with row and column indices, and various annotations.

**Grid Structure:**

	$C_{min}$ 0	1	2	3	$C_{max}$ 4
$R_{min}$ 0	11	12	13	14	15
1	21	22	23	24	25
2 <u><math>R_{max}</math></u>	31	32	33	34	35

**Annotations:**

- $C_{min}$  (Column Minimum) points to column 0.
- $C_{max}$  (Column Maximum) points to column 4.
- $R_{min}$  (Row Minimum) points to row 0.
- $R_{max}$  (Row Maximum) points to row 2.
- Green arrows indicate paths:
  - From (0,0) to (0,2) vertically.
  - From (0,0) to (1,0) horizontally.
  - From (1,0) to (4,0) horizontally.
  - From (4,0) to (4,1) vertically.
  - From (1,2) to (4,2) horizontally.





5 7

11	12	13	14	15	16	17
21	22	23	24	25	26	27
31	32	33	34	35	36	37
41	42	43	44	45	46	47
51	52	53	54	55	56	57

5 7

11	12	13	14	15	16	17
21	22	23	24	25	26	27
31	32	33	34	35	36	37
41	42	43	44	45	46	47
51	52	53	54	55	56	57

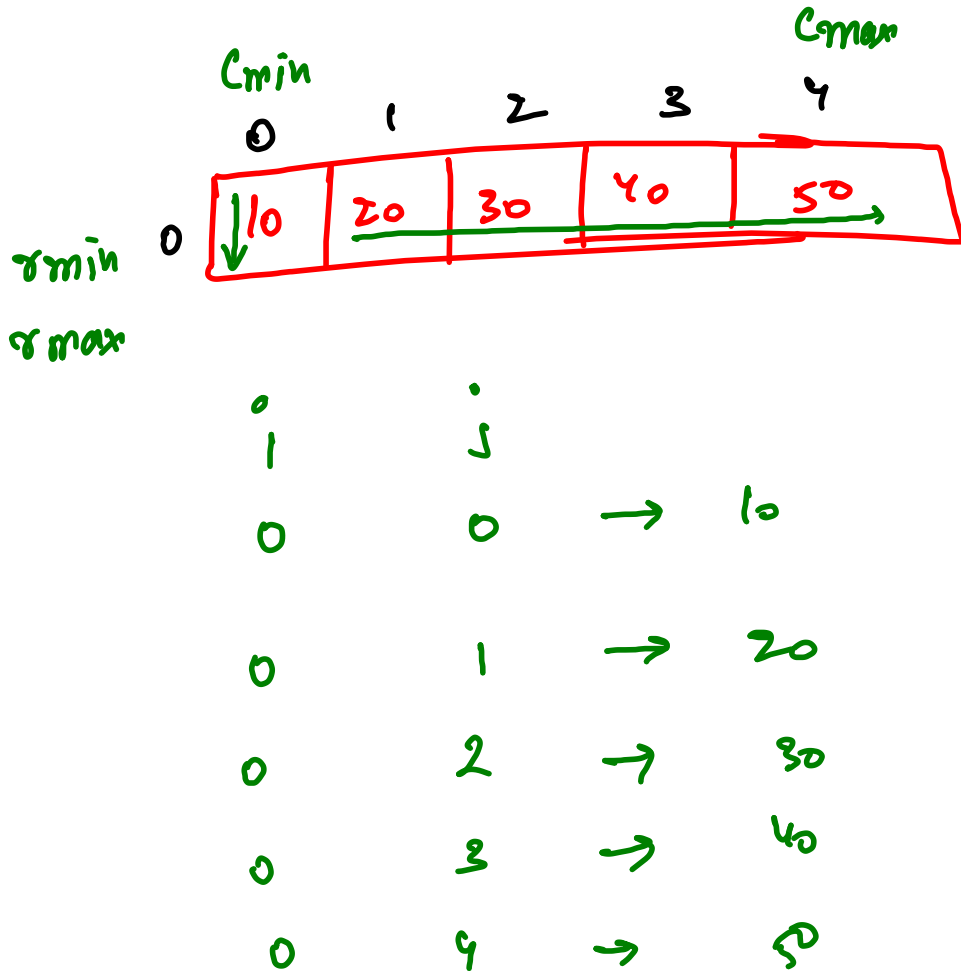
✓ 11  
✓ 21  
✓ 31  
✓ 41  
✓ 51  
✓ 52  
✓ 53  
✓ 54  
✓ 55  
✓ 56  
✓ 57  
✓ 47  
✓ 37  
✓ 27  
✓ 17  
✓ 16  
✓ 15  
✓ 14  
✓ 13  
✓ 12  
✓ 22  
✓ 32  
✓ 42  
✓ 43  
✓ 44  
✓ 45  
✓ 46  
✓ 36  
✓ 26  
✓ 25  
✓ 24  
✓ 23  
✓ 33  
✓ 34  
✓ 35

5	7						
11	12	13	14	15	16	17	
21	22	23	24	25	26	27	
31	32	33	34	35	36	37	
41	42	43	44	45	46	47	
51	52	53	54	55	56	57	

11 ✓  
 21 ✓  
 31 ✓  
 41 ✓  
 51 ✓  
 52 ✓  
 53 ✓  
 54 ✓  
 55 ✓  
 56 ✓  
 57 ✓  
 47 ✓  
 37 ✓  
 27 ✓  
 17 ✓  
 16 ✓  
 15 ✓  
 14 ✓  
 13 ✓  
 12 ✓  
 22 ✓  
 32 ✓  
 42 ✓  
 43 ✓  
 44 ✓  
 45 ✓  
 46 ✓  
 36 ✓  
 26 ✓  
 25 ✓  
 24 ✓  
 23 ✓  
 33 ✓  
 34 ✓  
 35 ✓



Count = 0, 1, 2, 3, 4 total element = 5



```

int rmin = 0, cmin = 0, rmax = mat.length-1, cmax = mat[0].length-1;
int count = 0;
int totalEle = mat.length * mat[0].length;
while(count < totalEle){
    for(int i = rmin, j = cmin; i <= rmax && count < totalEle; i++){
        System.out.println(mat[i][j]);
        count++;
    }
    for(int i = rmax, j = cmin+1; j <= cmax && count < totalEle; j++){
        System.out.println(mat[i][j]);
        count++;
    }
    for(int i = rmax-1, j = cmax; i >= rmin && count < totalEle; i--){
        System.out.println(mat[i][j]);
        count++;
    }
    for(int i = rmin, j = cmax-1; j >= cmin+1 && count < totalEle; j--){
        System.out.println(mat[i][j]);
        count++;
    }
    rmin++;
    cmin++;
    rmax--;
    cmax--;
}

```

Handwritten annotations on the code:

- For the first loop:  $2 \leq 4$
- For the second loop:  $-1 \geq 0$
- For the third loop:  $3 \geq 1$