* Matrix Multiplication :

$$
\begin{array}{c|ccc}
 & 0 & 1 & 2 \\
\hline
0 & 1 & 2 & 3 \\
1 & 4 & 5 & 6
\end{array}
\quad * \quad
\begin{array}{c|cc}
 & 0 & 1 \\
\hline
0 & 10 & 11 \\
1 & 20 & 21 \\
2 & 30 & 31
\end{array}
$$

2×3 $m_1 \times n_1$

3×2 $m_2 \times n_2$

=

	0	1
0	$1\times10 + 2\times20 + 3\times30 = 140$	$1\times11 + 2\times21 + 3\times31 = 146$
1	$4\times10 + 5\times20 + 6\times30 = 320$	$4\times11 + 5\times21 + 6\times31 = 335$

2×2 $m_1 \times n_2$

	0	1
0	140	146
1	320	335

2×2

1. you can only multiply $m_1 \times n_1$ matrix and $m_2 \times n_2$ matrix if and only if $n_1 == m_2$ i.e; no. of cols in mat 1 = no. of rows in mat 2.

2. The resultant matrix will $m_1 \times n_2$

$$(2 \times 3) * (3 \times 2) = 2 \times 2$$

* TC : $O(m_1 * n_2 * n_1)$

: $O(N^3)$ If $(m_1 = n_1 = m_2 = n_2 = N)$

$$
\begin{array}{c|ccc}
 & 0 & 1 & 2 \\
\hline
0 & a_{00} & a_{01} & a_{02} \\
1 & a_{10} & a_{11} & a_{12}
\end{array}
\quad * \quad
\begin{array}{c|cccc}
 & 0 & 1 & 2 & 3 \\
\hline
0 & b_{00} & b_{01} & b_{02} & b_{03} \\
1 & b_{10} & b_{11} & b_{12} & b_{13} \\
2 & b_{20} & b_{21} & b_{22} & b_{23}
\end{array}
\quad = \quad
\begin{array}{c|cccc}
 & 0 & 1 & 2 & 3 \\
\hline
0 & c_{00} & c_{01} & c_{02} & c_{03} \\
1 & c_{10} & c_{11} & c_{12} & c_{13}
\end{array}
$$

2×3 3×4 2×4

$m_1 \times n_1$ $m_2 \times n_2$ $m_1 \times n_2$

$$c_{00} = \overbrace{a_{00} \cdot b_{00}}^{0} + \overbrace{a_{01} \cdot b_{10}}^{1} + \overbrace{a_{02} \cdot b_{20}}^{2}$$

r c   r c   r c   r c

$$c_{01} = \overbrace{a_{00} \cdot b_{01}}^{0} + \overbrace{a_{01} \cdot b_{11}}^{1} + \overbrace{a_{02} \cdot b_{21}}^{2}$$

r c   r c   r c   r c

$$c_{02} = \overbrace{a_{00} \cdot b_{02}}^{0} + \overbrace{a_{01} \cdot b_{12}}^{1} + \overbrace{a_{02} \cdot b_{22}}^{2}$$

r=0 c=2   r=0 c=2   r=0 c=2   r=0 c=2

$$c[r][c] = \text{Sum}\left(a[r][?] * b[?][c]\right)$$

$$= \sum_{k=0}^{k=(n_1 \text{ or } m_2)-1} \left(a[r][k] * b[k][c]\right)$$

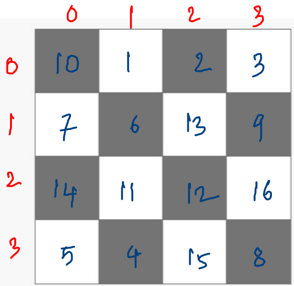
$$\star \quad c\overset{r}{[1]}\overset{c}{[2]}$$

$$= \sum_{k=0}^{k=3-1=2} \left(a[1]\overbrace{[k] * b[k]}^{0,1,2}[2]\right)$$

$$= a[1][0] \cdot b[0][2] + a[1][1] \cdot b[1][2]$$

$$+ a[1][2] \cdot b[2][2]$$

* Alternate Matrix Sum :



4 x 4 Chess Board

bsum = 10 + 2 + 6 + 9 + 14 + 12
+ 4 + 8
= 75

wsum = 1 + 3 + 7 + 13 + 11 + 16
+ 5 + 15
= 71

equal or not

black	white
(0, 0) = 0	(0, 1) = 1
(0, 2) = 2	(0, 3) = 3
(1, 1) = 2	(1, 0) = 1
(1, 3) = 4	(1, 2) = 3
(2, 0) = 2	(2, 1) = 3
(2, 2) = 4	(2, 3) = 5
(3, 1) = 4	(3, 0) = 3
(3, 3) = 6	(3, 2) = 5
even	odd

(r, c)
r + c
even → black
odd → white

* Diagonal Difference :

	0	1	2	3	4
0	1	5	9	13	21
1	2	6	10	14	22
2	3	7	11	15	23
3	4	8	12	16	24
4	17	18	19	20	25

anti diagonal

$N \times N = 5 \times 5$

diagonal

$diag = 1 + 6 + 11 + 16 + 25 = X$

$adiag = 21 + 14 + 11 + 8 + 17 = Y$

$abs(X - Y)$!

diag

(0,0)
(1,1)
(2,2)
(3,3)
(4,4)

given R
col = R

adiag

$(0,4) \Rightarrow (0, 5-0-1)$
$(1,3) \Rightarrow (1, 5-1-1)$
$(2,2) \Rightarrow (2, 5-2-1)$
$(3,1) \Rightarrow (3, 5-3-1)$
$(4,0) \Rightarrow (4, 5-4-1$

given R,
$col = n - R - 1$

$i = \cancel{0}\ \cancel{1}\ \cancel{2}\ \cancel{3}\ \cancel{4}\ \cancel{5}$
$j = \cancel{0}\ \cancel{1}\ \cancel{2}\ \cancel{3}\ \cancel{4}\ 5$

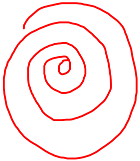
```
sum += mat[i][j]
i++;
j++;
```

$i = \cancel{0}\ \cancel{1}\ \cancel{2}\ \cancel{3}\ \cancel{4}\ \cancel{5}$
$j = \cancel{4}\ \cancel{3}\ \cancel{2}\ \cancel{1}\ \cancel{0}\ -1$

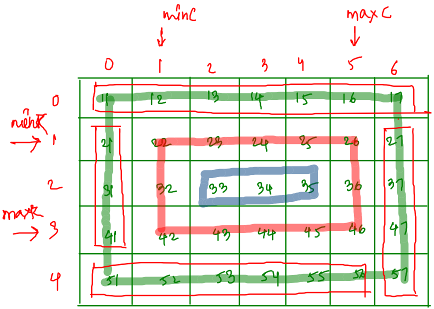
```
sum += mat[i][j]
i++;
j--;
```

* Spiral traversal :

	0	1	2	3	4	5	6
0	11	12	13	14	15	16	17
1	21	22	23	24	25	26	27
2	31	32	33	34	35	36	37
3	41	42	43	44	45	46	47
4	51	52	53	54	55	56	57



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



① top wall → minR ③ bottom wall → maxR

② right wall → maxC ④ left wall → minC

① Top wall (minR, minC to maxC)

```
for(let c = minC; c <= maxC; c++) {
    psw(mat[minR][c]);
}
minR++;
```

(once the job is completed move next topwall)

② right wall (maxC, minR to maxR)

```
for(let r = minR; r <= maxR; r++) {
    psw(mat[r][maxC]);
}
maxC--;
```

③ bottom wall (maxR, maxC to minC)

```
for(let c = maxC; c >= minC; c--) {
    psw(mat[maxR][c]);
}
maxR--;
```

④ leftwall (minC, maxR to minR)

```
for(let r = maxR; r >= minR; r--) {
    psw(mat[r][minC]);
}
minC++;
```

★ TC: how many times each ele is visited
⇒ 1 time
⇒ O(n×m)

★ until how long we need to keep on printing?

→ Count elements while printing

→ If cnt = total you can stop printing. i.e; you will print only if cnt < total.

Row
= 0 A

1 B C

2 C D E

3 D E F G

69 70 71 72 73

4 E F G H I

5 F G H I J K

6 G

7 H

8 I

⋮

24 Y

25 Z

26 A

27 B

28 C

r = 0 → alph = 'A' (65) 65+0

1 → alph = 'B' (66) 65+1

2 → alph = 'C' (67) 65+2

⋮

24 → alph = 'Y' (89) 65+24

25 → alph = 'Z' (90) 65+25

cont ascii = row + 65

= (row % 26) + 65

r = 26 → (26 % 26) + 65 ⇒ 65 ⇒ 'A'

27 → (27 % 26) + 65 ⇒ 66 ⇒ "B"

28 → (28 % 26) + 65 ⇒ 67 ⇒ 'C"

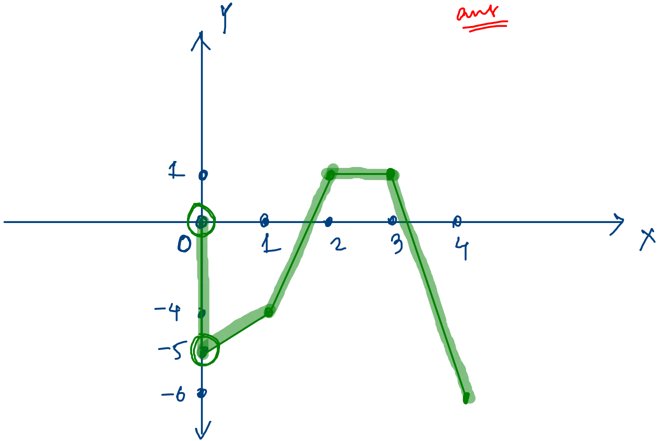
0 1 2 3 4

[-5, 1, 5, 0, -7]

+1 +5 +0

[0, -5, -4, 1, 1, -6]

ans



running

sum = ~~0~~, ~~-5~~, ~~-4~~, ~~1~~, ~~1~~, -6

maxAlt = ~~0~~ 1

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \xrightarrow{90^\circ} \begin{bmatrix} 7 & 4 & 1 \\ 8 & 5 & 2 \\ 9 & 6 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \xrightarrow{\text{transpose}} \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix} \xrightarrow{\text{reverse every row}} \begin{bmatrix} 7 & 4 & 1 \\ 8 & 5 & 2 \\ 9 & 6 & 3 \end{bmatrix} \xrightarrow{90^\circ} \begin{bmatrix} 7 & 4 & 1 \\ 8 & 5 & 2 \\ 9 & 6 & 3 \end{bmatrix}$$