

**National Institute of Technology, Calicut**  
**Department of Computer Science and Engineering**  
**CS2094 – Data Structures Lab**  
**Assignment 1 Advanced - Corrections**

Input specification in questions 1 and 2 of Assignment-1 for the advanced batch has the following corrections (marked in Bold letters) and revised questions are give below:

1. Implement an in-place algorithm that reads an  $n \times n$  matrix  $M$  as input and rotates  $M$  clockwise by  $90^\circ$ , that is,  $i^{\text{th}}$  row of  $M$ ,  $1 \leq i \leq n$  becomes  $(n - i + 1)^{\text{th}}$  column in the rotated matrix.

Input: The value  $n$  on the first line, followed by an  $n \times n$  matrix  $\mathbf{M}$ , with  $0 < n \leq 100$ , containing positive integers in the range  $0-2^{31}$ .

Output: Matrix  $\mathbf{M}$  rotated clockwise by  $90^\circ$ .

Example:

Input:

**4**

```
1  2  3  4
5  6  7  8
9 10 11 12
13 14 15 16
```

Output:

```
13  9  5  1
14 10  6  2
15 11  7  3
16 12  8  4
```

2. Write a menu driven program that reads an  $n \times m$  matrix  $\mathbf{M}$ , with  $0 < n, m \leq 100$  and prints the elements of  $\mathbf{M}$  by performing a spiral-order traversal as per the user's choice, given in the example. Spiral-order traversal intends to traverse the elements of  $\mathbf{M}$  in a spiral-like fashion and prints them in the order of traversal. We consider the following spiral-order traversals in this question:

a) *Clockwise spiral-order* traversal starts from the top, left-most position of a matrix and visits the remaining elements spirally inwards in the clockwise direction (see the example below).

b) *Anti-clockwise spiral-order* traversal starts from the top, left-most position of a matrix and visits the remaining elements spirally inwards in the anti-clockwise direction (see the example below).

*Note:* You should not use any additional array or matrix other than the input matrix to output the spiral-order traversal of the input matrix.

Input: The values  $n$  and  $m$  on the first line, separated by a space, followed by an  $n \times m$  matrix  $\mathbf{M}$ , with  $0 < n \leq 100$ ,  $0 < m \leq 100$ , containing posit integers in the range  $0-2^{31}$ , and a choice.

Output: Result of the chosen spiral-order traversal in  $\mathbf{M}$

**Example 1:**

Input:

Enter the elements of the matrix:

**5 4**  
1 2 3 4  
5 6 7 8  
9 10 11 12  
13 14 15 16  
17 18 19 20

Menu:

- a. Clockwise spiral-order traversal
- b. Anti-clockwise spiral-order traversal
- c. Exit

Enter your choice:

a

Output:

1 2 3 4 8 12 16 20 19 18 17 13 9 5 6 7 11 15 14 10

Menu:

- a. Clockwise spiral-order traversal
- b. Anti-clockwise spiral-order traversal
- c. Exit

Enter your choice:

b

Output:

1 5 9 13 17 18 19 20 16 12 8 4 3 2 6 10 14 15 11 7

### Example 2:

Input:

Enter the elements of the matrix:

**2 4**  
1 2 3 4  
5 6 7 8

Menu:

- a. Clockwise spiral-order traversal
- b. Anti-clockwise spiral-order traversal
- c. Exit

Enter your choice:

a

Output:

1 2 3 4 8 7 6 5

Menu:

- a. Clockwise spiral-order traversal
- b. Anti-clockwise spiral-order traversal
- c. Exit

Enter your choice:

b

Output:

1 5 6 7 8 4 3 2

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