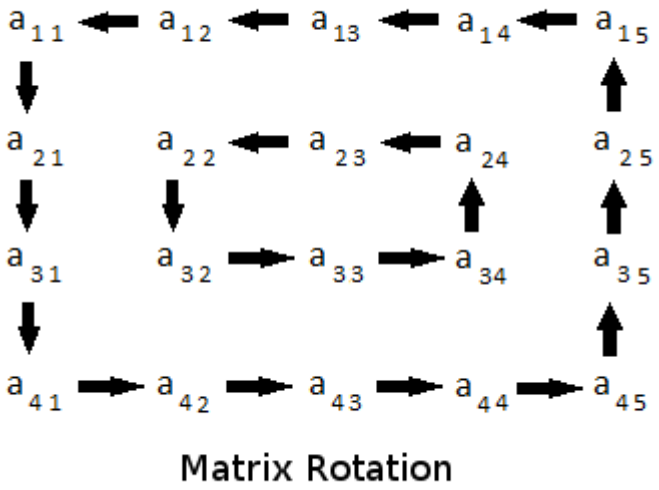
Difficulty: Hard Points: 80

Problem: Matrix Rotation Algo

You are given a 2D matrix, a, of dimension MxN and a positive integer R. You have to rotate the matrix R times and print the resultant matrix. Rotation should be in anti-clockwise direction.
Rotation of a $4x5$ matrix is represented by the following figure. Note that in one rotation, you have to shift elements by one step only (refer sample tests for more clarity).



Matrix Rotation

It is guaranteed that the minimum of M and N will be even.

Input Format

First line contains three space separated integers, M, N and R, where M is the number of rows, N is number of columns in matrix, and R is the number of times the matrix has to be rotated.
Then M lines follow, where each line contains N space separated positive integers. These M lines represent the matrix.

Constraints

2 <= M, N <= 300
1 <= R <= 10^9
min(M, N) % 2 == 0
1 <= a_{ij} <= 10^8, where $i \in [1..M]$ & $j \in [1..N]$

Output Format

Print the rotated matrix.

Sample Input #00

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

Sample Output #00

```
2 3 4 8
```

```
1 7 11 12
5 6 10 16
9 13 14 15
```

Sample Input #01

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

Sample Output #01

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

Sample Input #02

```
5 4 7
1 2 3 4
7 8 9 10
13 14 15 16
19 20 21 22
25 26 27 28
```

Sample Output #02

```
28 27 26 25
22 9 15 19
16 8 21 13
10 14 20 7
4 3 2 1
```

Sample Input #03

```
2 2 3
1 1
1 1
```

Sample Output #03

```
1 1
1 1
```

Explanation

Sample Case #00: Here is an illustration of what happens when the matrix is rotated once.

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

Sample Case #01: Here is what happens when to the matrix after two rotations.

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

Sample Case #02: Following are the intermediate states.

```
1  2  3  4      2  3  4 10    3  4 10 16    4 10 16 22
7  8  9 10      1  9 15 16    2 15 21 22    3 21 20 28
13 14 15 16 ->  7  8 21 22 -> 1  9 20 28 -> 2 15 14 27 ->
19 20 21 22    13 14 20 28    7  8 14 27    1  9  8 26
25 26 27 28    19 25 26 27    13 19 25 26   7 13 19 25
```

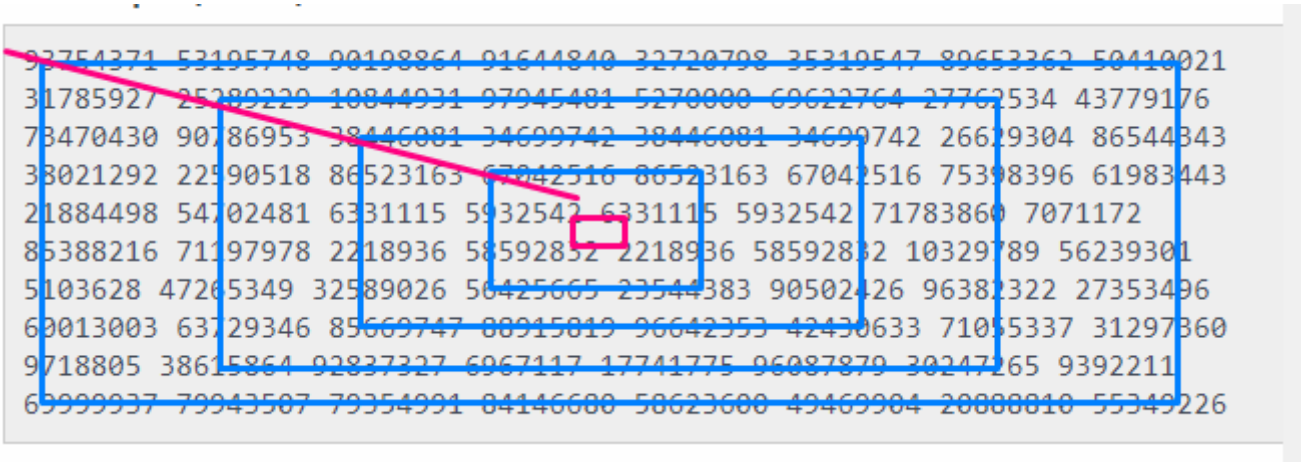
```
10 16 22 28    16 22 28 27    22 28 27 26    28 27 26 25
 4 20 14 27    10 14  8 26    16  8  9 25    22  9 15 19
 3 21  8 26 ->  4 20  9 25 -> 10 14 15 19 -> 16  8 21 13
 2 15  9 25     3 21 15 19     4 20 21 13    10 14 20  7
 1  7 13 19     2  1  7 13     3  2  1  7     4  3  2  1
```

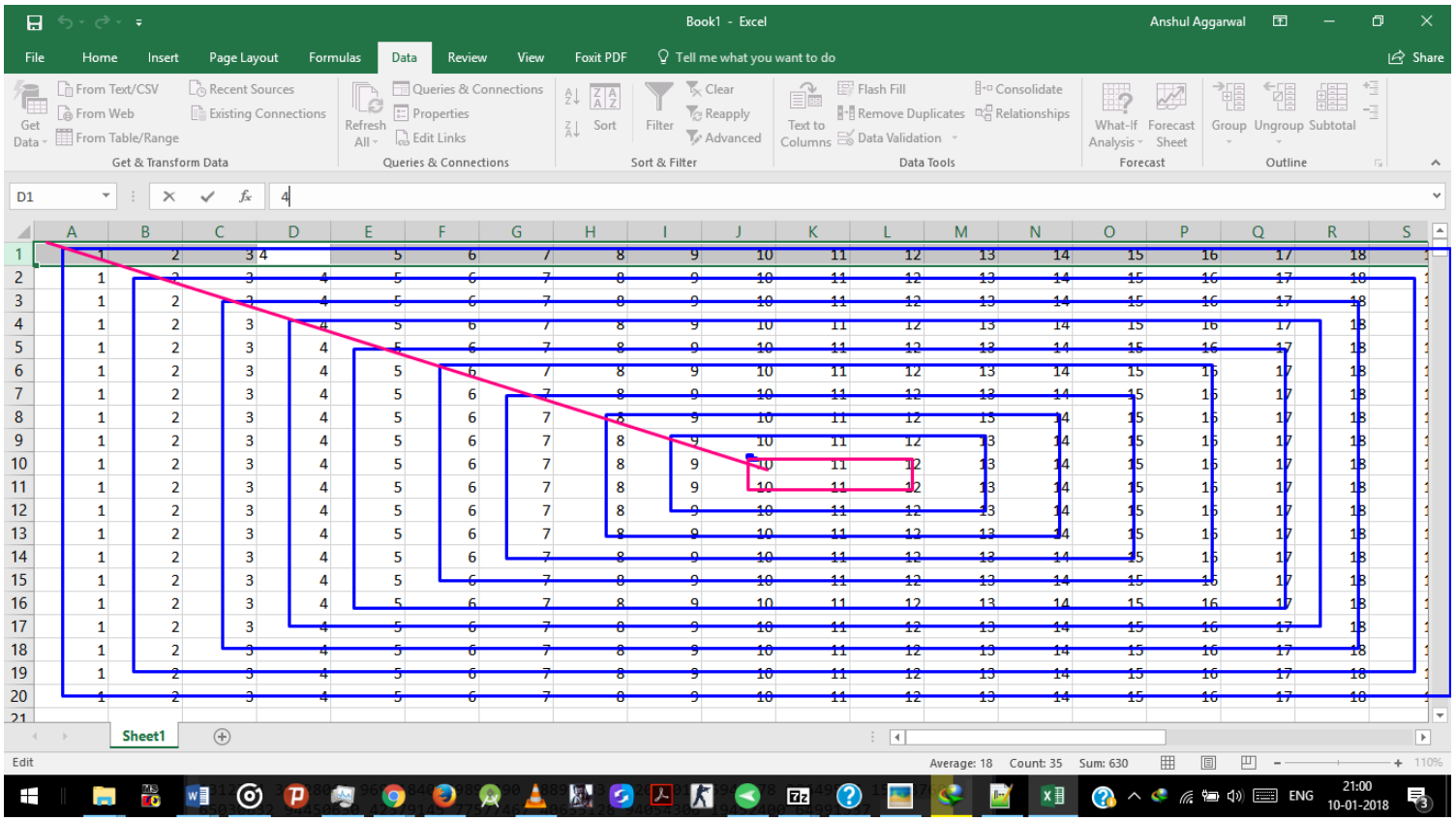
Sample Case #03: As all elements are same, any rotation will reflect the same matrix.

Adopted Approach

- Bifurcate the matrix into different layers each forming a rectangle
- Start from the upper right corner for each layer and read the matrix layer's elements into an array clockwise
- Process the array for left rotation to compensate for the clockwise rotations of the matrix
- Similar to 2 step follow the same loop and order but this time the processed left rotated array's elements are fed to the matrix layer
- Repeat until all the layers are processed.

Visual Aid:


93754371 53195748 90198864 91644840 32720798 35319547 89653362 50410021
31785927 25289229 10844931 97945481 5270000 69622764 27762534 43779176
78470430 90786953 38446081 34699742 38446081 34690742 26629304 86544343
38021292 22590518 86523163 67042516 86523163 67042516 75398396 61983443
21884498 54702481 6331115 5932542 6331115 5932542 71783860 7071172
85388216 71197978 2218936 58592852 2218936 58592852 10329789 56239301
5103628 47265349 32589026 50425665 23544383 90502426 96382322 27353496
60013003 63729346 85669747 88915819 96642353 42430633 71055337 31297360
9718805 38615864 92837327 6967117 17741775 96087879 30247265 9392211
69999937 79943507 79354991 84146680 58623600 49469904 20888810 55349226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Queries & Connections
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Data Tools
Forecast
Outline
D1
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Average: 18 Count: 35 Sum: 630
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Solution

```
#include <cmath>
#include <cstdio>
#include <vector>
#include <iostream>
#include <algorithm>
using namespace std;

int main()
    {
        /*Feeding the data*/
        int rows, cols;
        long i,j,k;
        long rotations;
        cin>>rows >>cols>>rotations;
        long array[rows][cols];
        for(long i=0; i<rows; i++)
            {for(long j=0; j<cols;j++)
                {cin>>array[i][j];}
            }

        /*------------ The MEAT -----------------*/
        long const fixrows=rows;
        long const fixcols=cols;
        vector <long> vec;
        rows+=2; cols+=2; //Equates the decrement during the first pass
        for(long k=0; k<min(fixcols/2,fixrows/2); k++)
                    //runs for each layer of the matrix
                    //min() formulates total layers to process
            {
                vec.erase(vec.begin(),vec.end()); //resets the vector for each layer
                nextr=0+k; long nextc=fixcols-1-k;
                  //nextr nextc ---> coordinates of the upper right corner of the layer
                long counter=0;    // ---- > the total elements in the layer of the matrix
                rows-=2; cols-=2;          //decrements per loop to move to next layer
                while(counter<=(rows*2+(cols-2)*2)-1)
                                    //while total elements of layer are not listed
                  {
                  //nextr and nextc are the index of next element of   matrix layer's
                    Element from the upper right corner in clockwise fashion
```

```
                    //based on counter value,  nextr and nextc calculated for each
                      element position in the matrix layer

                      counter++;
                      if(counter<=(rows-1))
                              {nextr+=1;  nextc+=0;}
                      else  if(counter>(rows-1)  &&  counter<=(rows+cols-2))
                              {nextr+=0;  nextc-=1;}
                      else  if(counter>(rows+cols-2)  &&  counter<=(2*rows+cols-3))
                              {nextr-=1;  nextc+=0;}
                      else  if(counter>(2*rows-3+cols)  &&  counter<=(2*rows-4+2*cols))
                              {nextr+=0;  nextc+=1;}
                      else  if(counter>2*rows-4+2*cols-1)
                              {nextr+=1;  nextc+=1;}
                      vec.push_back(array[nextr][nextc]);

                       //places the elements of the layer into vector vec
                      //starting from the right vertical column moving  clockwise

                      //        ^ ---> |
                     //         | <--- v


          }
     //vector feeding complete
   //---------repeat the upper loop now to feed the value to matrix layer's indexes from
              the array instead of feeding to array

            nextr=0+k;  nextc=fixcols-1-k;      //nextr nextc find the upper right
                                                  corner of the next matrix layer to process
            counter=0;  long  size=vec.size();
            while(counter<=(rows*2+(cols-2)*2)-1)    //while all the elements of the
                                                       matrix layer are not re fed.
                 {
                      counter++;
                      if(counter<=(rows-1))
                              {nextr+=1;  nextc+=0;}
                      else  if(counter>(rows-1)  &&  counter<=(rows+cols-2))
                              {nextr+=0;  nextc-=1;}
                      else  if(counter>(rows+cols-2)  &&  counter<=(2*rows+cols-3))
                              {nextr-=1;  nextc+=0;}
                      else  if(counter>(2*rows-3+cols)  &&  counter<=(2*rows-4+2*cols))
                              {nextr+=0;  nextc+=1;}
                      else  if(counter>2*rows-4+2*cols-1)
                              {nextr+=1;  nextc+=1;}
```

```
                    array[nextr][nextc]=vec[((counter-1)+(size+1)*rotations)%size];
                        //the elements are left rotated in the vector
                       //and then inserted to matrix layer's elements
                      //to compensate for the clockwise rotations

                }
            }

//Printing the final processed matrix
      for(i=0;  i<fixrows;  i++)
            {     for(j=0;  j<fixcols;  j++)
                        {cout<<array[i][j]<<" ";}
                  cout<<endl;
            }

}
```

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