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766. Toeplitz Matrix [☑] (/problems/toeplitz-matrix/)

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A matrix is Toeplitz if every diagonal from top-left to bottom-right has the same element.

Now given an M x N matrix, return True if and only if the matrix is Toeplitz.

Example 1:

```
Input: matrix = [[1,2,3,4],[5,1,2,3],[9,5,1,2]]
Output: True
Explanation:
1234
5123
9512
In the above grid, the diagonals are "[9]", "[5, 5]", "[1, 1, 1]", "[2, 2, 2]", "[3, 3]", "[4]",
```

Example 2:

```
Input: matrix = [[1,2],[2,2]]
Output: False
Explanation:
The diagonal "[1, 2]" has different elements.
```

Note:

- 1. matrix will be a 2D array of integers.
- 2. matrix will have a number of rows and columns in range [1, 20].
- 3. matrix[i][j] will be integers in range [0, 99].

Approach #1: Group by Category [Accepted]

Intuition and Algorithm

We ask what feature makes two coordinates (r1, c1) and (r2, c2) belong to the same diagonal?

It turns out two coordinates are on the same diagonal if and only if r1 - c1 == r2 - c2.

This leads to the following idea: remember the value of that diagonal as groups[r-c]. If we see a mismatch, the matrix is not Toeplitz; otherwise it is.

```
Java
       Python
                                                                                                  Сору
 1
    class Solution {
        public boolean isToeplitzMatrix(int[][] matrix) {
3
            Map<Integer, Integer> groups = new HashMap();
            for (int r = 0; r < matrix.length; ++r) {
4
 5
                for (int c = 0; c < matrix[0].length; ++c) {
 6
                    if (!groups.containsKey(r-c))
                        groups.put(r-c, matrix[r][c]);
8
                    else if (groups.get(r-c) != matrix[r][c])
9
                        return False:
10
11
12
            return True;
13
14
    }
```

Complexity Analysis

- Time Complexity: O(M*N). (Recall in the problem statement that M,N are the number of rows and columns in matrix.)
- Space Complexity: O(M * N).

Approach #2: Compare With Top-Left Neighbor [Accepted]

Intuition and Algorithm

For each diagonal with elements in order $a_1, a_2, a_3, \ldots, a_k$, we can check $a_1 = a_2, a_2 = a_3, \ldots, a_{k-1} = a_k$. The matrix is *Toeplitz* if and only if all of these conditions are true for all (top-left to bottom-right) diagonals.

Every element belongs to some diagonal, and it's previous element (if it exists) is it's top-left neighbor. Thus, for the square (r, c), we only need to check r == 0 OR c == 0 OR matrix[r-1][c-1] == matrix[r][c].

```
■ Copy
Java
      Python
1
  class Solution {
2
       public boolean isToeplitzMatrix(int[][] matrix) {
3
           for (int r = 0; r < matrix.length; ++r)
                for (int c = 0; c < matrix[0].length; ++c)
                    if (r > 0 \&\& c > 0 \&\& matrix[r-1][c-1] != matrix[r][c])
5
6
                        return false;
           return true;
8
       }
9
   }
```

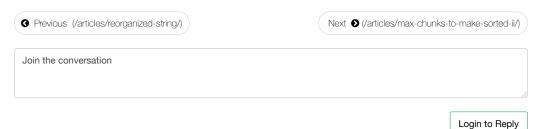
Complexity Analysis

- Time Complexity: O(M*N), as defined in the problem statement.
- Space Complexity: O(1).

Analysis written by: @awice (https://leetcode.com/awice).

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chairco commented 2 weeks ago

python (https://discuss.leetcode.com/user/chairco)

```
B boloutare commented last month
```

```
class Solution: def isToeplitzMatrix(self, matrix): """ :type matrix:
(https://discuss.leetcode.com/user/boloutare)
    List[List[int]] :rtype: bool """ for j in range(1, len(matrix)): if
    matrix[j-1][:len(matrix[j])-1] != matrix[j][1:]: return False return True
```



prakashmanwani commented last month

class Solution { (https://discuss.l s.leetcode.com/user/prakashmanwani) public boolean is loeplitzMatrix(int[][] matrix) { System.out.println(matrix.length);

```
int rows = matrix.length;
    int columns = matrix[0].length;
    for (int i=1;i<rows;i++){</pre>
         for (int j =1;j<columns;j++){</pre>
         if (matrix[i-1][j-1]!=matrix[i][j])return false;
    }
    return true;
}
}
```

SherMM commented last month

```
S
            def isToeplitzMatrix(self, matrix):
(https://discuss.leetcode.com/user/shermm)
                :type matrix: List[List[int]]
                :rtype: bool
                r, c = len(matrix), len(matrix[0])
                for i in range(r-1):
                    for j in range(c-1):
                        if matrix[i+1][j+1] != matrix[i][j]:
                            return False
                return True
```

You only need to iterate to next to last row and column, since single-value items will be Toeplitz.

Nevillealee commented 2 months ago

Javascript (https://discuss/leetcode.com/user/nevillealee)

@param {number[][]} matrix @return {boolean} */ var isToeplitzMatrix = function(matrix) { for(var r = 1; r < matrix.length; r++) { for(var c = 1; c < matrix[0].length; c++) { if(matrix[r][c] != matrix[r-1][c-1]) { return false; } } } return true;

Μ

marirod commented 2 months ago

};

@StefanPochmann (https://discuss.leetcode.com/uid/591) Indeed, thanks for the fast reply! (https://discuss.leetcode.com/user/marirod)

awice commented 2 months ago

@StefanPochmann (https://discuss.leetcode.com/uid/591) Thanks, corrected. Funny (https://discuss.leetcode.com/user/awice) because I write the problem statements ;(Though with that definition of N it was correct.

StefanPochmann commented 2 months ago

@marirod (https://discuss.leetcode.com/uid/389430) Should say neither O(N) nor O(N^2) (https://discuss.leetcode.com/user/stefangochmann) but O(MN), I guess @awice (https://discuss.leetcode.com/uid/71269) overlooked that M and N are already defined in the problem.

View original thread (https://discuss.leetcode.com/topic/117862)

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