

Documentation for Set Matrix Zeroes Solution

Problem Description

Problem Statement:

Given an $m \times n$ integer matrix, if an element is 0, set its entire row and column to 0. The operation must be done in place.

Examples:

1. Example 1:

- *Input:* matrix = [[1,1,1], [1,0,1], [1,1,1]]
- *Output:* [[1,0,1], [0,0,0], [1,0,1]]

2. Example 2:

- *Input:* matrix = [[0,1,2,0], [3,4,5,2], [1,3,1,5]]
- *Output:* [[0,0,0,0], [0,4,5,0], [0,3,1,0]]

Constraints:

- $m == \text{matrix.length}$
- $n == \text{matrix}[0].\text{length}$
- $1 \leq m, n \leq 200$
- $-2^{31} \leq \text{matrix}[i][j] \leq 2^{31} - 1$

Followup:

- Avoid using $O(mn)$ extra space.
- Aim for $O(1)$ space solution.

Solution Overview

The solution leverages the matrix itself to store the zero markers, thus achieving $O(1)$ additional space complexity.

Detailed Steps:

1. Determine Zeroes in First Row and Column:

- Check if the first row contains any zero.
- Check if the first column contains any zero.

2. Use First Row and Column as Markers:

- Traverse the matrix starting from the second row and column.
- For any cell that contains zero, mark its corresponding row and column by setting the first cell of that row and column to zero.

3. Set Zeroes Based on Markers:

- Traverse the matrix again starting from the second row and column.
- For any cell where its corresponding row or column marker is zero, set that cell to zero.

4. Set Zeroes in First Row and Column if Needed:

- If the first row initially contained a zero, set all cells in the first row to zero.
- If the first column initially contained a zero, set all cells in the first column to zero.

Explanation of the Code

1. Initial Checks and Setup:

- The solution begins by checking if the matrix is empty. If it is, the function returns immediately.
- It then calculates the number of rows (m) and columns (n) in the matrix.

2. Identify Zeroes in the First Row and Column:

- It uses generator expressions to determine if there are any zeroes in the first row and the first column.

3. Mark Rows and Columns:

- The solution iterates over the matrix starting from the second row and column. For each zero found, it marks the corresponding row and column by setting the first cell of that row and column to zero.

4. Set Zeroes Based on Marks:

- It then iterates again starting from the second row and column, setting cells to zero based on the markers in the first row and column.

5. Handle First Row and Column Separately:

- Finally, the solution zeroes out the first row and column if they were initially identified to contain any zeroes.

This approach ensures that the matrix is modified in place with a time complexity of $O(m * n)$ and a space complexity of $O(1)$, satisfying the problem constraints.