September 6, 2022 ▪ Graph

# Number of Enclaves

**Problem Statement:** You are given an N x M binary matrix grid, where 0 represents a sea cell and 1 represents a land cell. A move consists of walking from one land cell to another adjacent (4-directionally) land cell or walking off the boundary of the grid. Find the number of land cells in the grid for which we cannot walk off the boundary of the grid in any number of moves.

**Examples:**

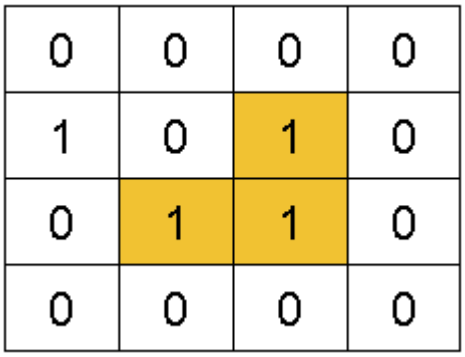
**Example 1:**

**Input:**

| | | | |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 |

**Output:** 3

**Explanation:** The highlighted cells represent the land cells.




**Example 2:**

**Input:**

**Output:** 4

**Explanation:** The highlighted cells represent the land cells.

## Solution

Count Subarray sum Equals K

Binary Tree Representation in Java

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***Disclaimer**: Don't jump directly to the solution, try it out yourself first.*

TCS NQT

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## Intuition:

The land cells present in the boundary cannot be counted in the answer as we will walk off the boundary of the grid. Also, land cells connected to the boundary land cell can never be the answer.

The intuition is that we need to figure out the boundary land cells, go through their connected land cells and mark them as visited. The sum of all the remaining land cells will be the answer.

## Approach:

We can follow either of the traversal techniques as long as we are starting with a boundary element and marking all those 1s connected to it. We will be solving it using BFS traversal, but you can apply DFS traversal as well, we have applied DFS traversal to solve a similar problem in the previous article.

Breadth First Search, BFS is a traversal technique where we visit the nodes level-wise, i.e., it visits the same level nodes simultaneously, and then moves to the next level.

**Initial configuration:**

- **Queue:** Define a queue and insert the coordinates of the cell <row, column> which are in the boundary and are marked as 1. The boundary cells will always have row i = 0 or row i = n-1 or col j = 0 or col j = m-1.
- **Visited array:** an array initialized to 0 indicating unvisited cells, apart from the ones in the boundary which are already in the queue ds.

**The algorithm steps are as follows:**

- For BFS traversal, we need a queue data structure and a visited array. Create a corresponding visited array.
- Push the coordinates of boundary nodes in the queue and mark them as visited.
- Start the BFS traversal, pop out an element from the queue every time and travel to all its ***unvisited neighboring land cells*** in the 4 directions. For every unvisited node, push it {row, col} into the Q and mark it as visited to avoid multiple traversals in the future.
- Repeat the steps until the queue becomes empty. When all the boundaries are traversed and corresponding sets of 1s are marked as visited, use a counter variable to count the number of remaining unvisited land cells.
- Return the value of the counter as it indicates the number of land cells that

cannot cross the boundary.

Consider the following illustration to understand how BFS traverses the matrix and finds the number of land cells in the grid for which we cannot walk off the boundary of the grid in any number of moves.

**How do set boundaries for 4 directions?**

The 4 neighbors will have the following indexes:

Now, either we can apply 4 conditions or follow the following method. From the above image, it is clear that the delta change in the row is -1, +0, +1, +0. Similarly, the delta change in the column is 0, +1, +0, -1. So we can apply the same logic to find the neighbors of a particular pixel (<row, column>).

**Code:**

## C++ Code

```
#include <bits/stdc++.h>
using namespace std;

class Solution {
  public:
    int numberOfEnclaves(vector<vect
        queue<pair<int,int>> q;
        int n = grid.size();
        int m = grid[0].size();
        int vis[n][m] = {0};
        // traverse boundary element
        for(int i = 0;i<n;i++) {
            for(int j = 0;j<m;j++) {
                // first row, first
```

```
                if(i == 0 || j == 0
                    // if it is a la
                    if(grid[i][j] ==
                        q.push({i, j
                        vis[i][j] =
                    }
                }
            }
        }

        int delrow[] = {-1, 0, +1, 0
        int delcol[] = {0, +1, +0, -

        while(!q.empty()) {
            int row = q.front().firs
            int col = q.front().seco
            q.pop();

            // traverses all 4 direc
            for(int i = 0;i<4;i++) {
                int nrow = row + del
                int ncol = col + del
                // check for valid c
                if(nrow >=0 && nrow
                && vis[nrow][ncol] =
                    q.push({nrow, nc
                    vis[nrow][ncol]
                }
            }

        }

        int cnt = 0;
        for(int i = 0;i<n;i++) {
            for(int j = 0;j<m;j++) {
                // check for unvisit
                if(grid[i][j] == 1 &
                    cnt++;
            }
        }
        return cnt;
    }
};

int main() {
```

```
    vector<vector<int>> grid{
        {0, 0, 0, 0},
        {1, 0, 1, 0},
        {0, 1, 1, 0},
        {0, 0, 0, 0}};

    Solution obj;
    cout << obj.numberOfEnclaves(gri

}
```

**Output:** 3

**Time Complexity:** O(NxMx4) ~ O(N x M), For the worst case, assuming all the pieces as land, the BFS function will be called for (N x M) nodes and for every node, we are traversing for 4 neighbors, so it will take O(N x M x 4) time.

**Space Complexity ~** O(N x M), O(N x M) for the visited array, and queue space takes up N x M locations at max.

## Java Code

```
import java.util.*;

class Solution {

    int numberOfEnclaves(int[][] gri
        Queue<Pair> q = new LinkedLi
        int n = grid.length;
        int m = grid[0].length;
        int vis[][] = new int[n][m];
        // traverse boundary element
        for(int i = 0;i<n;i++) {
            for(int j = 0;j<m;j++) {
                // first row, first
                if(i == 0 || j == 0
                    // if it is a la
```

```
                if(grid[i][j] ==
                    q.add(new Pa
                    vis[i][j] =
                }
            }
        }
    }

    int delrow[] = {-1, 0, +1, 0
    int delcol[] = {0, +1, +0, -

    while(!q.isEmpty()) {
        int row = q.peek().first
        int col = q.peek().secon
        q.remove();

        // traverses all 4 direc
        for(int i = 0;i<4;i++) {
            int nrow = row + del
            int ncol = col + del
            // check for valid c
            if(nrow >=0 && nrow
            && vis[nrow][ncol] =
                q.add(new Pair(n
                vis[nrow][ncol]
            }
        }

    }
    int cnt = 0;
    for(int i = 0;i<n;i++) {
        for(int j = 0;j<m;j++) {
            // check for unvisit
            if(grid[i][j] == 1 &
                cnt++;
        }
    }
    return cnt;

}
public static void main(String[]
{
    int grid[][] = {
    {0, 0, 0, 0},
    {1, 0, 1, 0},
    {0, 1, 1, 0},
```

```
            {0, 0, 0, 0}};

            Solution ob = new Solution()
            int ans = ob.numberOfEnclave
            System.out.println(ans);
        }

    }
    class Pair {
        int first;
        int second;
        public Pair(int first, int secon
            this.first = first;
            this.second = second;
        }
    }
```

**Output:** 3

**Time Complexity:** O(NxMx4) ~ O(N x M), For the worst case, assuming all the pieces as land, the BFS function will be called for (N x M) nodes and for every node, we are traversing for 4 neighbors, so it will take O(N x M x 4) time.

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