Find the number of islands | Set 1 (Using DFS)

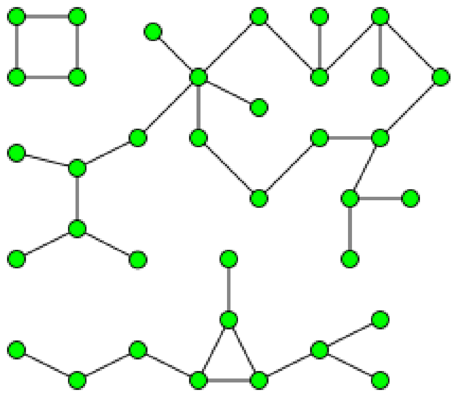
3.2

Given a boolean 2D matrix, find the number of islands. A group of connected 1s forms an island. For example, the below matrix contains 5 islands

```
Input : mat[][] = {{1, 1, 0, 0, 0},
                   {0, 1, 0, 0, 1},
                   {1, 0, 0, 1, 1},
                   {0, 0, 0, 0, 0},
                   {1, 0, 1, 0, 1}
Output : 5
```

This is an variation of the standard problem: "Counting number of connected components in a undirected graph".

Before we go to the problem, let us understand what is a connected component. A connected component of an undirected graph is a subgraph in which every two vertices are connected to each other by a path(s), and which is connected to no other vertices outside the subgraph.
For example, the graph shown below has three connected components.



Recommended: Please solve it on "*PRACTICE*" first, before moving on to the solution.

A graph where all vertices are connected with each other, has exactly one connected component, consisting of the whole graph. Such graph with only one connected component is called as St▲y Connected Graph.

The problem can be easily solved by applying DFS() on each component. In each DFS() call, a component or a sub-graph is visited. We will call DFS on the next un-visited component. The number of calls to DFS() gives the number of connected components. BFS can also be used.

What is an island?

A group of connected 1s forms an island. For example, the below matrix contains 5 islands

```
{1, 1, 0, 0, 0},
{0, 1, 0, 0, 1},
{1, 0, 0, 1, 1},
{0, 0, 0, 0, 0},
{1, 0, 1, 0, 1}
```

Recommended: Please solve it on “*PRACTICE*” first, before moving on to the solution.

A cell in 2D matrix can be connected to 8 neighbors. So, unlike standard DFS(), where we recursively call for all adjacent vertices, here we can recursive call for 8 neighbors only. We keep track of the visited 1s so that they are not visited again.

C/C++

```
// Program to count islands in boolean 2D matrix
#include <stdio.h>
#include <string.h>
#include <stdbool.h>

#define ROW 5
#define COL 5

// A function to check if a given cell (row, col) can be included in DFS
int isSafe(int M[][COL], int row, int col, bool visited[][COL])
{
    // row number is in range, column number is in range and value is 1
    // and not yet visited
    return (row >= 0) && (row < ROW) &&
           (col >= 0) && (col < COL) &&
           (M[row][col] && !visited[row][col]);
}

// A utility function to do DFS for a 2D boolean matrix. It only considers
// the 8 neighbours as adjacent vertices
void DFS(int M[][COL], int row, int col, bool visited[][COL])
{
    // These arrays are used to get row and column numbers of 8 neighbours
    // of a given cell
    static int rowNbr[] = {-1, -1, -1,  0, 0,  1, 1, 1};
    static int colNbr[] = {-1,  0,  1, -1, 1, -1, 0, 1};

    // Mark this cell as visited
    visited[row][col] = true;

    // Recur for all connected neighbours
    for (int k = 0; k < 8; ++k)
        if (isSafe(M, row + rowNbr[k], col + colNbr[k], visited) )
            DFS(M, row + rowNbr[k], col + colNbr[k], visited);
}

// The main function that returns count of islands in a given boolean
// 2D matrix
int countIslands(int M[][COL])
{
    // Make a bool array to mark visited cells.
    // Initially all cells are unvisited
    bool visited[ROW][COL];
    memset(visited, 0, sizeof(visited));

    // Initialize count as 0 and travese through the all cells of
    // given matrix
    int count = 0;
    for (int i = 0; i < ROW; ++i)
        for (int j = 0; j < COL; ++j)
            if (M[i][j] && !visited[i][j]) // If a cell with value 1 is not
            {                              // visited yet, then new island found
                DFS(M, i, j, visited);     // Visit all cells in this island.
                ++count;                   // and increment island count
            }

    return count;
}

// Driver program to test above function
int main()
{
    int M[][COL]= {  {1, 1, 0, 0, 0},
        {0, 1, 0, 0, 1},
        {1, 0, 0, 1, 1},
        {0, 0, 0, 0, 0},
        {1, 0, 1, 0, 1}
    };

    printf("Number of islands is: %d\n", countIslands(M));

    return 0;
}
```

Run on IDE

Java

```
// Java program to count islands in boolean 2D matrix
import java.util.*;
import java.lang.*;
import java.io.*;

class Islands
{
    //No of rows and columns
    static final int ROW = 5, COL = 5;

    // A function to check if a given cell (row, col) can
    // be included in DFS
    boolean isSafe(int M[][], int row, int col,
                   boolean visited[][])
    {
        // row number is in range, column number is in range
        // and value is 1 and not yet visited
        return (row >= 0) && (row < ROW) &&
               (col >= 0) && (col < COL) &&
               (M[row][col]==1 && !visited[row][col]);
    }

    // A utility function to do DFS for a 2D boolean matrix.
    // It only considers the 8 neighbors as adjacent vertices
    void DFS(int M[][], int row, int col, boolean visited[][])
    {
        // These arrays are used to get row and column numbers
        // of 8 neighbors of a given cell
        int rowNbr[] = new int[] {-1, -1, -1,  0, 0,  1, 1, 1};
        int colNbr[] = new int[] {-1,  0,  1, -1, 1, -1, 0, 1};

        // Mark this cell as visited
        visited[row][col] = true;

        // Recur for all connected neighbours
        for (int k = 0; k < 8; ++k)
            if (isSafe(M, row + rowNbr[k], col + colNbr[k], visited) )
                DFS(M, row + rowNbr[k], col + colNbr[k], visited);
    }

    // The main function that returns count of islands in a given
    //  boolean 2D matrix
    int countIslands(int M[][])
    {
        // Make a bool array to mark visited cells.
        // Initially all cells are unvisited
        boolean visited[][] = new boolean[ROW][COL];


        // Initialize count as 0 and travese through the all cells
        // of given matrix
        int count = 0;
        for (int i = 0; i < ROW; ++i)
            for (int j = 0; j < COL; ++j)
                if (M[i][j]==1 && !visited[i][j]) // If a cell with
                {                                 // value 1 is not
                    // visited yet, then new island found, Visit all
                    // cells in this island and increment island count
                    DFS(M, i, j, visited);
                    ++count;
                }

        return count;
    }

    // Driver method
    public static void main (String[] args) throws java.lang.Exception
    {
        int M[][]=  new int[][] {{1, 1, 0, 0, 0},
                                 {0, 1, 0, 0, 1},
                                 {1, 0, 0, 1, 1},
                                 {0, 0, 0, 0, 0},
                                 {1, 0, 1, 0, 1}
                                };
        Islands I = new Islands();
        System.out.println("Number of islands is: "+ I.countIslands(M));
    }
} //Contributed by Aakash Hasija
```

Run on IDE

Python

```
# Program to count islands in boolean 2D matrix
class Graph:

    def __init__(self, row, col, g):
        self.ROW = row
        self.COL = col
        self.graph = g

    # A function to check if a given cell
    # (row, col) can be included in DFS
    def isSafe(self, i, j, visited):
        # row number is in range, column number
        # is in range and value is 1
        # and not yet visited
        return (i >= 0 and i < self.ROW and
                j >= 0 and j < self.COL and
                not visited[i][j] and self.graph[i][j])


    # A utility function to do DFS for a 2D
    # boolean matrix. It only considers
    # the 8 neighbours as adjacent vertices
    def DFS(self, i, j, visited):

        # These arrays are used to get row and
        # column numbers of 8 neighbours
        # of a given cell
        rowNbr = [-1, -1, -1,  0, 0,  1, 1, 1];
        colNbr = [-1,  0,  1, -1, 1, -1, 0, 1];

        # Mark this cell as visited
        visited[i][j] = True

        # Recur for all connected neighbours
        for k in range(8):
            if self.isSafe(i + rowNbr[k], j + colNbr[k], visited):
                self.DFS(i + rowNbr[k], j + colNbr[k], visited)


    # The main function that returns
    # count of islands in a given boolean
    # 2D matrix
    def countIslands(self):
        # Make a bool array to mark visited cells.
        # Initially all cells are unvisited
        visited = [[False for j in range(self.COL)]for i in range(self.ROW)]

        # Initialize count as 0 and travese
        # through the all cells of
        # given matrix
        count = 0
        for i in range(self.ROW):
            for j in range(self.COL):
                # If a cell with value 1 is not visited yet,
                # then new island found
                if visited[i][j] == False and self.graph[i][j] ==1:
                    # Visit all cells in this island
                    # and increment island count
                    self.DFS(i, j, visited)
                    count += 1

        return count


graph = [[1, 1, 0, 0, 0],
        [0, 1, 0, 0, 1],
        [1, 0, 0, 1, 1],
        [0, 0, 0, 0, 0],
        [1, 0, 1, 0, 1]]


row = len(graph)
col = len(graph[0])

g= Graph(row, col, graph)

print "Number of islands is :"
print g.countIslands()

#This code is contributed by Neelam Yadav
```

Run on IDE

Output:

```
Number of islands is: 5
```

Time complexity: O(ROW x COL)

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Reference:
http://en.wikipedia.org/wiki/Connected_component_%28graph_theory%29

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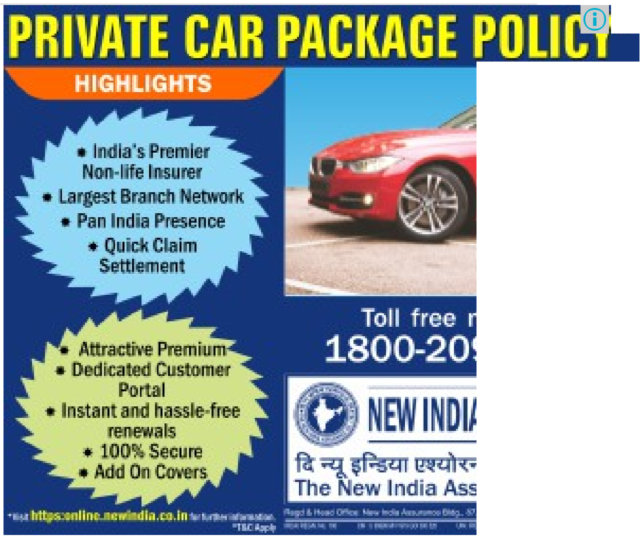

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