

## Graph-02 Solutions

Solution 1:

Time Complexity :  $O(V+E)$

Space Complexity:  $O(V+E)$

```
import java.util.*;

class Solution{

    static void addEdge(int u, int v,
        ArrayList<ArrayList<Integer>> adj){
        adj.get(u).add(v);
    }

    static void DFSUtil(ArrayList<ArrayList<Integer>> g,
        int v, boolean[] visited){
        visited[v] = true;

        for(int x : g.get(v)){
            if (!visited[x]){
                DFSUtil(g, x, visited);
            }
        }
    }

    static int motherVertex(ArrayList<ArrayList<Integer>>g,
        int V){

        boolean[] visited = new boolean[V];
        int v = -1;

        for(int i = 0; i < V; i++){
            if (!visited[i]){
                DFSUtil(g, i, visited);
                v = i;
            }
        }

        boolean[] check = new boolean[V];
        DFSUtil(g, v, check);
```

```
for(boolean val : check){
    if (!val){
        return -1;
    }
}
return v;
}

public static void main(String[] args){
    int V = 7;
    int E = 8;

    ArrayList<
    ArrayList<Integer>> adj = new ArrayList<
        ArrayList<Integer>>();
    for(int i = 0; i < V; i++){
        adj.add(new ArrayList<Integer>());
    }
    addEdge(0, 1,adj);
    addEdge(0, 2,adj);
    addEdge(1, 3,adj);
    addEdge(4, 1,adj);
    addEdge(6, 4,adj);
    addEdge(5, 6,adj);
    addEdge(5, 2,adj);
    addEdge(6, 0,adj);

    System.out.println("The mother vertex is " +
        motherVertex(adj, V));
}
}
```

## Solution 2:

Time Complexity :  $O(V+E)$

Space Complexity:  $O(1)$

```
import java.io.*;
import java.lang.*;
import java.util.*;
```

```
class Solution {
    int V, E;
```

```
Edge edge[];
```

```
class Edge {  
    int src, dest;  
};
```

```
Solution(int v, int e){  
    V = v;  
    E = e;  
    edge = new Edge[E];  
    for (int i = 0; i < e; ++i)  
        edge[i] = new Edge();  
}
```

```
int find(int parent[], int i){  
    if (parent[i] == i)  
        return i;  
    return find(parent, parent[i]);  
}
```

```
void Union(int parent[], int x, int y){  
    parent[x] = y;  
}
```

```
int isCycle(Solution graph){  
    int parent[] = new int[graph.V];  
  
    for (int i = 0; i < graph.V; ++i)  
        parent[i] = i;  
  
    for (int i = 0; i < graph.E; ++i) {  
        int x = graph.find(parent, graph.edge[i].src);  
        int y = graph.find(parent, graph.edge[i].dest);  
  
        if (x == y)  
            return 1;  
  
        graph.Union(parent, x, y);  
    }  
    return 0;
```

```
}

public static void main(String[] args){
    int V = 3, E = 3;
    Solution graph = new Solution(V, E);
    graph.edge[0].src = 0;
    graph.edge[0].dest = 1;
    graph.edge[1].src = 1;
    graph.edge[1].dest = 2;
    graph.edge[2].src = 0;
    graph.edge[2].dest = 2;

    if (graph.isCycle(graph) == 1)
        System.out.println("Graph contains cycle");
    else
        System.out.println(
            "Graph doesn't contain cycle");
    }
}
```

### Solution 3 :

Time Complexity :  $O(n)$

Space Complexity:  $O(n)$

```
import java.util.*;
```

```
public class Solution {
```

```
    static class pair {
```

```
        int first, second;
```

```
        pair(int first, int second){
```

```
            this.first = first;
```

```
            this.second = second;
```

```
        }
```

```
    }
```

```
    static ArrayList<ArrayList<Integer> >
```

```

make_graph(int numTasks, Vector<pair> prerequisites){
    ArrayList<ArrayList<Integer> > graph
        = new ArrayList<ArrayList<Integer> >(numTasks);

    for (int i = 0; i < numTasks; i++) {
        graph.add(new ArrayList<Integer>());
    }

    for (pair pre : prerequisites)
        graph.get(pre.second).add(pre.first);

    return graph;
}

static int[] compute_indegree(
    ArrayList<ArrayList<Integer> > graph)
{
    int degrees[] = new int[graph.size()];

    for (ArrayList<Integer> neighbors : graph)
        for (int neigh : neighbors)
            degrees[neigh]++;

    return degrees;
}

static boolean canFinish(int numTasks,
                        Vector<pair> prerequisites){
    ArrayList<ArrayList<Integer> > graph
        = make_graph(numTasks, prerequisites);
    int degrees[] = compute_indegree(graph);

    for (int i = 0; i < numTasks; i++) {
        int j = 0;
        for (; j < numTasks; j++)
            if (degrees[j] == 0)
                break;

        if (j == numTasks)
            return false;
    }
}

```

```
        degrees[j] = -1;
        for (int neigh : graph.get(j))
            degrees[neigh]--;
    }

    return true;
}

public static void main(String args[]){
    int numTasks = 4;
    Vector<pair> prerequisites = new Vector<pair>();

    prerequisites.add(new pair(1, 0));
    prerequisites.add(new pair(2, 1));
    prerequisites.add(new pair(3, 2));

    if (canFinish(numTasks, prerequisites)) {
        System.out.println(
            "Possible to finish all tasks");
    }
    else {
        System.out.println(
            "Impossible to finish all tasks");
    }
}
}
```

#### Solution 4 :

Time Complexity :  $O(V+E)$

Space Complexity:  $O(V+E)$

```
class Solution {
    public String alienOrder(String[] words) {
        Map<Character, Set<Character>> map = new HashMap<>();
        Map<Character, Integer> degree = new HashMap<>();
        String result = "";
        if (words == null || words.length == 0) { return result; }
```

```
for (String s: words) {
    for (char c: s.toCharArray()) {
        degree.put(c, 0);
    }
}

for (int i = 0; i < words.length - 1; i++) {
    String curr = words[i];
    String next = words[i + 1];
    int min = Math.min(curr.length(), next.length());
    for (int j = 0; j < min; j++) {
        char c1 = curr.charAt(j);
        char c2 = next.charAt(j);
        if (c1 != c2) {
            Set<Character> set = map.getDefault(c1, new HashSet<>());
            if (!set.contains(c2)) {
                set.add(c2);
                map.put(c1, set);
                degree.put(c2, degree.get(c2) + 1); // update c2, c1 < c2
            }
            break;
        }
    }
}

LinkedList<Character> q = new LinkedList<>();
for (char c: degree.keySet()) {
    if (degree.get(c) == 0) {
        q.add(c);
    }
}

while (!q.isEmpty()) {
    char c = q.poll();
    result += c;
    if (map.containsKey(c)) {
        for (char next: map.get(c)) {
            degree.put(next, degree.get(next) - 1);
            if (degree.get(next) == 0) {
                q.offer(next);
            }
        }
    }
}
```

```
        }  
    }  
}  
  
return result.length() == degree.size() ? result : "";  
}  
}
```

### Solution 5 :

Time Complexity :  $O(n*m)$

Space Complexity:  $O(n*m)$

```
import java.util.*;
```

```
class Solution{
```

```
    static void dfs(int[][] matrix, boolean[][] visited,  
        int x, int y, int n, int m,  
        boolean hasCornerCell){
```

```
        if (x < 0 || y < 0 || x >= n || y >= m ||  
            visited[x][y] == true || matrix[x][y] == 0)  
            return;
```

```
        if (x == 0 || y == 0 ||  
            x == n - 1 || y == m - 1){  
            if (matrix[x][y] == 1)  
                hasCornerCell = true;  
        }
```

```
        visited[x][y] = true;
```

```
        dfs(matrix, visited, x + 1, y, n, m,  
            hasCornerCell);
```

```
        dfs(matrix, visited, x, y + 1, n, m,
```



```
        hasCornerCell);
dfs(matrix, visited, x - 1, y, n, m,
    hasCornerCell);
dfs(matrix, visited, x, y - 1, n, m,
    hasCornerCell);
}
```

```
static int countClosedIsland(int[][] matrix, int n,
    int m){
```

```
    boolean[][] visited = new boolean[n][m];
    int result = 0;
```

```
    for(int i = 0; i < n; ++i) {
        for(int j = 0; j < m; ++j){
            if ((i != 0 && j != 0 &&
                i != n - 1 && j != m - 1) &&
                matrix[i][j] == 1 &&
                visited[i][j] == false) {
```

```
                boolean hasCornerCell = false;
                dfs(matrix, visited, i, j, n, m,
                    hasCornerCell);
                if (!hasCornerCell)
                    result = result + 1;
```

```
            }
        }
    }
    return result;
}
```

```
public static void main(String[] args){
    int N = 5, M = 8;
```

```
    int[][] matrix = { { 0, 0, 0, 0, 0, 0, 0, 1 },
        { 0, 1, 1, 1, 1, 0, 0, 1 },
        { 0, 1, 0, 1, 0, 0, 0, 1 },
        { 0, 1, 1, 1, 1, 0, 1, 0 },
        { 0, 0, 0, 0, 0, 0, 0, 1 } };
```

```
    System.out.print(countClosedIsland(matrix, N, M));
```

}

}

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