DOMAIN WINTER CAMP

(Department of Computer Science and Engineering)

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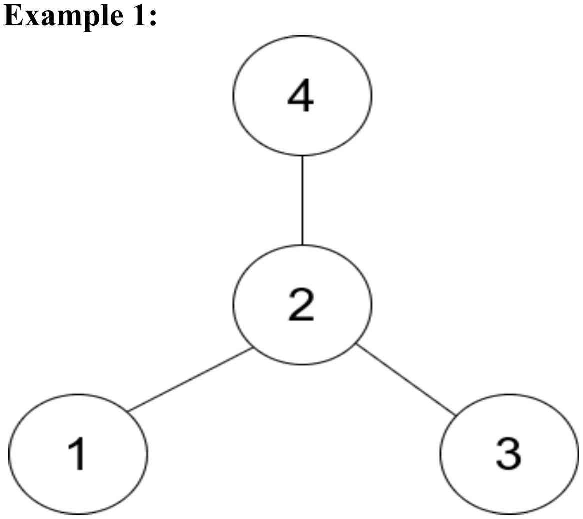
DAY-7

Q1. Find center of the graph

There is an undirected star graph consisting of n nodes labeled from 1 to n. A star graph is a graph where there is one center node and exactly n - 1 edges that connect the center node with every other node.

You are given a 2D integer array edges where each edges[i] = [ui, vi] indicates that there is an edge between the nodes ui and vi. Return the center of the given star graph.

Example 1:



Input: edges = [[1,2],[2,3],[4,2]]
Output: 2
Explanation: As shown in the figure above, node 2 is connected to every other node, so 2 is the center.

Example 2:
Input: edges = [[1,2],[5,1],[1,3],[1,4]]
Output: 1

Constraints:

- 3 <= n <= 1e5
- edges.length == n - 1
- edges[i].length == 2
- 1 <= ui, vi <= n
- ui != vi
- The given edges represent a valid star graph.

Program code:

```
#include <iostream>
#include <vector>
using namespace std;

int findCenter(vector<vector<int>>& edges) {     return (edges[0][0] ==
edges[1][0] || edges[0][0] == edges[1][1]) ? edges[0][0] :
edges[0][1];
}

int main() {     vector<vector<int>> edges1 = {{1, 2}, {2, 3},
{4, 2}};     vector<vector<int>> edges2 = {{1, 2}, {5, 1}, {1,
3}, {1, 4}};

    cout << "Center of edges1: " << findCenter(edges1) << endl;
cout << "Center of edges2: " << findCenter(edges2) << endl;

    return 0;
}
```

Output:

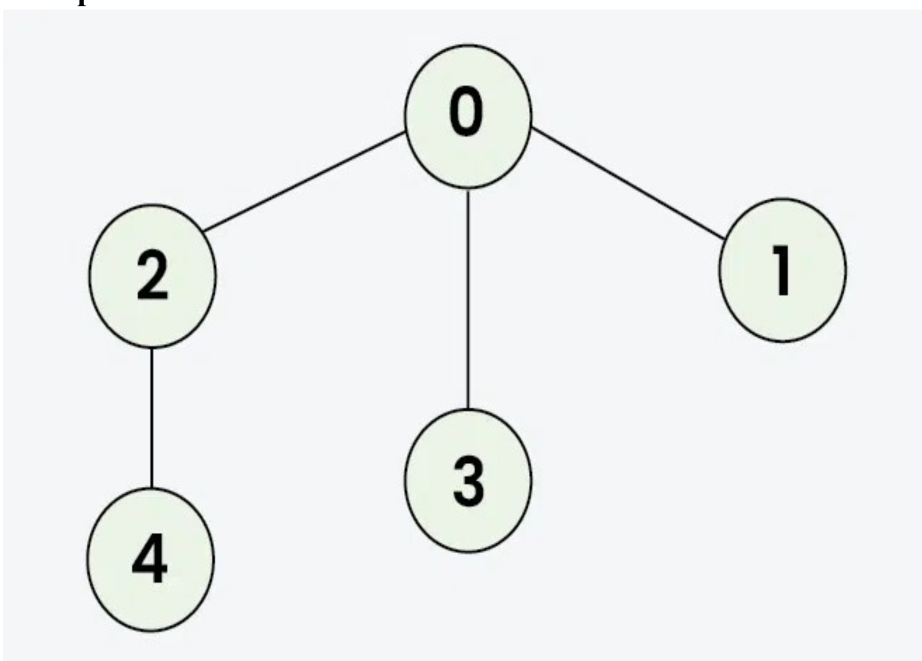
```
ankitvashisth@Ankits-MacBook-Pro ~ % g++ sorting.cpp -o
 sorting && ./sorting
Center of edges1: 2
Center of edges2: 1
```

Q 2. BFS of graph

Given a connected undirected graph represented by an adjacency list adj, which is a vector of vectors where each adj[i] represents the list of vertices connected to vertex i. Perform a Breadth First Traversal (BFS) starting from vertex 0, visiting vertices from left to right according to the adjacency list, and return a list containing the BFS traversal of the graph.

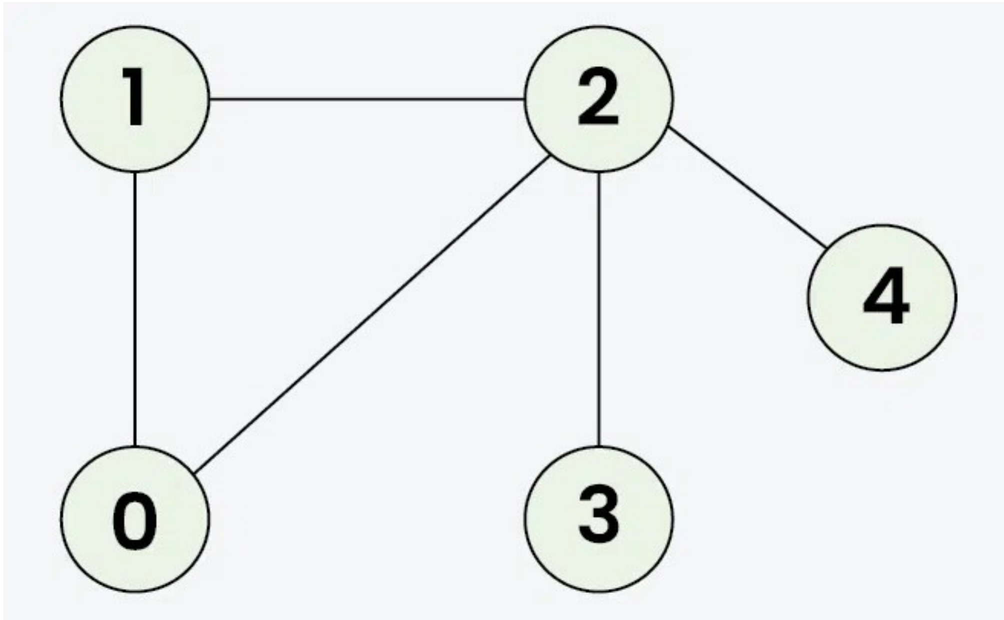
Note: Do traverse in the same order as they are in the adjacency list.

Example 1:



Input: adj = [[2,3,1], [0], [0,4], [0], [2]]
Output: [0, 2, 3, 1, 4]
Explanation: Starting from 0, the BFS traversal will follow these steps:
Visit 0 → Output: 0
Visit 2 (first neighbor of 0) → Output: 0, 2
Visit 3 (next neighbor of 0) → Output: 0, 2, 3
Visit 1 (next neighbor of 0) → Output: 0, 2, 3,
Visit 4 (neighbor of 2) → Final Output: 0, 2, 3, 1, 4

Example 2



Input: adj = [[1, 2], [0, 2], [0, 1, 3, 4], [2], [2]]
Output: [0, 1, 2, 3, 4]
Explanation: Starting from 0, the BFS traversal proceeds as follows:
Visit 0 → Output: 0
Visit 1 (the first neighbor of 0) → Output: 0, 1
Visit 2 (the next neighbor of 0) → Output: 0, 1, 2
Visit 3 (the first neighbor of 2 that hasn't been visited yet) → Output: 0, 1, 2, 3
Visit 4 (the next neighbor of 2) → Final Output: 0, 1, 2, 3, 4
Input: adj = [[1], [0, 2, 3], [1], [1, 4], [3]]
Output: [0, 1, 2, 3, 4]
Explanation: Starting the BFS from vertex 0:
Visit vertex 0 → Output: [0]
Visit vertex 1 (first neighbor of 0) → Output: [0, 1]
Visit vertex 2 (first unvisited neighbor of 1) → Output: [0, 1, 2]
Visit vertex 3 (next neighbor of 1) → Output: [0, 1, 2, 3] Visit vertex 4 (neighbor of 3) → Final Output: [0, 1, 2, 3, 4]
Constraints:

- 1 ≤ adj.size() ≤ 1e4
- 1 ≤ adj[i][j] ≤ 1e4

Program code:

```
#include <iostream>
#include <vector>
#include <queue>
using namespace std;

vector<int> bfsTraversal(int V, vector<vector<int>>& adj) {
```

```
    vector<int> bfs;
vector<bool> visited(V, false);
queue<int> q;     q.push(0);
    visited[0] = true;

    while (!q.empty()) {
int node = q.front();
q.pop();
        bfs.push_back(node);

        for (int neighbor : adj[node]) {
if (!visited[neighbor]) {
visited[neighbor] = true;
q.push(neighbor);
            }
        }     }
return bfs;
}

int main() {     vector<vector<int>> adj1 = {{2, 3, 1}, {0}, {0, 4},
{0}, {2}};     vector<vector<int>> adj2 = {{1, 2}, {0, 2}, {0, 1, 3,
4}, {2}, {2}};     vector<vector<int>> adj3 = {{1}, {0, 2, 3}, {1},
{1, 4}, {3}};

    vector<int> result1 = bfsTraversal(5, adj1);
vector<int> result2 = bfsTraversal(5, adj2);
vector<int> result3 = bfsTraversal(5, adj3);

    cout << "BFS Traversal of adj1: ";     for
(int node : result1) cout << node << " ";
cout << endl;

    cout << "BFS Traversal of adj2: ";     for
(int node : result2) cout << node << " ";
cout << endl;

    cout << "BFS Traversal of adj3: ";     for
(int node : result3) cout << node << " ";
cout << endl;

    return 0;
```

```
}
```

Output:

```
ankitvashisth@Ankits-MacBook-Pro ~ % g++ sorting2.cpp -o
 sorting2 && ./sorting2
BFS Traversal of adj1: 0 2 3 1 4
BFS Traversal of adj2: 0 1 2 3 4
BFS Traversal of adj3: 0 1 2 3 4
```

Q 3. Minimum height trees

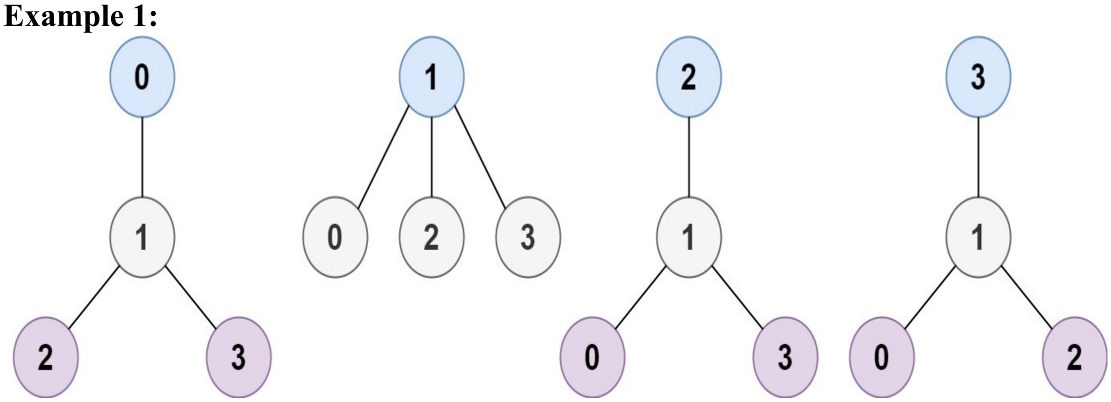
A tree is an undirected graph in which any two vertices are connected by exactly one path. In other words, any connected graph without simple cycles is a tree.

Given a tree of n nodes labelled from 0 to n - 1, and an array of n - 1 edges where edges[i] = [ai, bi] indicates that there is an undirected edge between the two nodes ai and bi in the tree, you can choose any node of the tree as the root. When you select a node x as the root, the result tree has height h. Among all possible rooted trees, those with minimum height (i.e. min(h)) are called minimum height trees (MHTs).

Return a list of all MHTs' root labels. You can return the answer in any order.

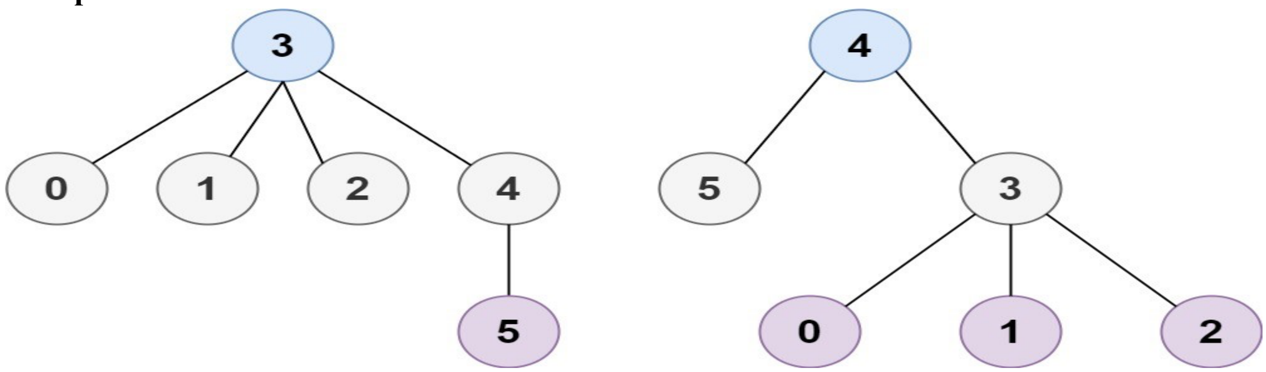
The height of a rooted tree is the number of edges on the longest downward path between the root and a leaf.

Example 1:



Input: n = 4, edges = [[1,0],[1,2],[1,3]]
Output: [1]
Explanation: As shown, the height of the tree is 1 when the root is the node with label 1 which is the only MHT.

Example 2:



Input: n = 6, edges = [[3,0],[3,1],[3,2],[3,4],[5,4]]
Output: [3,4]

Constraints:

- 1 <= n <= 2 * 1e4
- edges.length == n - 1
- 0 <= ai, bi < n
- ai != bi
- All the pairs (ai, bi) are distinct.
- The given input is guaranteed to be a tree and there will be no repeated edges.

Program Code:

```
#include <vector>
#include <queue>
#include <iostream>
using namespace std;

vector<int> findMinHeightTrees(int n, vector<vector<int>>& edges)
{     if (n == 1) return {0};     vector<int> degree(n, 0);
vector<vector<int>> adj(n);     for (auto& edge : edges) {
adj[edge[0]].push_back(edge[1]);
adj[edge[1]].push_back(edge[0]);
        degree[edge[0]]++;
degree[edge[1]]++;
    }
    queue<int> leaves;     for (int i = 0;
i < n; i++) {         if (degree[i] == 1)
leaves.push(i);
    }
```

```
    int remainingNodes = n;      while
(remainingNodes > 2) {          int
leafCount = leaves.size();
remainingNodes -= leafCount;          for
(int i = 0; i < leafCount; i++) {
int leaf = leaves.front();
leaves.pop();              for (int neighbor :
adj[leaf]) {
degree[neighbor]--;
                if (degree[neighbor] == 1) leaves.push(neighbor);
            }
        }
    }
    vector<int> result;      while
(!leaves.empty()) {
result.push_back(leaves.front());
        leaves.pop();
    }
    return result;
}

int main() {
    vector<vector<int>> edges1 = {{1, 0}, {1, 2}, {1, 3}};
    vector<vector<int>> edges2 = {{3, 0}, {3, 1}, {3, 2}, {3, 4}, {5, 4}};

    vector<int> result1 = findMinHeightTrees(4, edges1);
vector<int> result2 = findMinHeightTrees(6, edges2);

    cout << "MHT Roots for edges1: ";
    for (int root : result1) {
cout << root << " ";
    }
    cout << endl;

    cout << "MHT Roots for edges2: ";
    for (int root : result2) {
        cout << root << " ";
    }
    cout << endl;

    return 0;
```

}

Output:

```
ankitvashisth@Ankits-MacBook-Pro ~ % g++ sorting3.cpp -o
 sorting3 && ./sorting3
MHT Roots for edges1: 1
MHT Roots for edges2: 3 4
```

Q 4 Max area of island

You are given an m x n binary matrix grid. An island is a group of 1's (representing land) connected 4-directionally (horizontal or vertical.) You may assume all four edges of the grid are surrounded by water.

The area of an island is the number of cells with a value 1 in the island.

Return the maximum area of an island in grid. If there is no island, return 0.

Example 1:

0	0	1	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	1	1	1	0	0	0
0	1	1	0	1	0	0	0	0	0	0	0	0
0	1	0	0	1	1	0	0	1	0	1	0	0
0	1	0	0	1	1	0	0	1	1	1	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	1	1	1	0	0	0
0	0	0	0	0	0	0	1	1	0	0	0	0

Input: grid = [[0,0,1,0,0,0,0,1,0,0,0,0,0],[0,0,0,0,0,0,0,1,1,1,0,0,0],[0,1,1,0,1,0,0,0,0,0,0,0,0],[0,1,0,0,1,1,0,0,1,0,1,0,0],[0,1,0,0,1,1,0,0,1,1,1,0,0],[0,0,0,0,0,0,0,0,0,0,1,0,0],[0,0,0,0,0,0,0,1,1,1,0,0,0],[0,0,0,0,0,0,0,1,1,0,0,0,0]]
Output: 6
Explanation: The answer is not 11, because the island must be connected 4-directionally.
Example 2:

Input: grid = [[0,0,0,0,0,0,0,0]]

Output: 0

Constraints:

- m == grid.length
- n == grid[i].length ● 1 <= m, n <= 50
- grid[i][j] is either 0 or 1.

Program Code:

```
#include <iostream>
#include <vector> #include
<algorithm>
using namespace std;

int dfs(vector<vector<int>>& grid, int i, int j) {
   if (i < 0 || j < 0 || i >= grid.size() || j >= grid[0].size() || grid[i][j] == 0)
return 0;     grid[i][j] = 0;
   return 1 + dfs(grid, i + 1, j) + dfs(grid, i - 1, j) + dfs(grid, i, j + 1) + dfs(grid, i, j - 1); }

int maxAreaOfIsland(vector<vector<int>>& grid) {
int maxArea = 0;
   for (int i = 0; i < grid.size(); i++) {
for (int j = 0; j < grid[0].size(); j++) {
         if (grid[i][j] == 1) {
            maxArea = max(maxArea, dfs(grid, i, j));
         }
      }
   }
   return maxArea;
}

int main() {
vector<vector<int>> grid = {
{0,0,1,0,0,0,0,1,0,0,0,0,0},
      {0,0,0,0,0,0,0,1,1,1,0,0,0},
      {0,1,1,0,1,0,0,0,0,0,0,0,0},
      {0,1,0,0,1,1,0,0,1,0,1,0,0},
      {0,1,0,0,1,1,0,0,1,1,1,0,0},
      {0,0,0,0,0,0,0,0,0,0,1,0,0},
      {0,0,0,0,0,0,0,1,1,1,0,0,0},
```

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

    int result = maxAreaOfIsland(grid);

    // Output the result for the single grid
cout << result << endl;

    return 0;
}
```

Output:

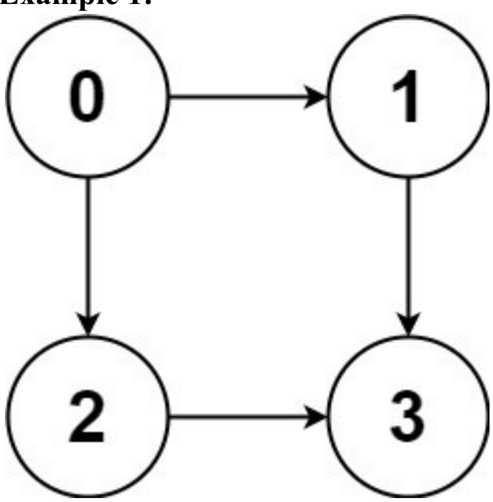
```
ankitvashisth@Ankits-MacBook-Pro ~ % g++ sorting4.cpp -o
 sorting4 && ./sorting4
6
```

Q 5. All path from source to target

Given a directed acyclic graph (DAG) of n nodes labeled from 0 to n - 1, find all possible paths from node 0 to node n - 1 and return them in any order.

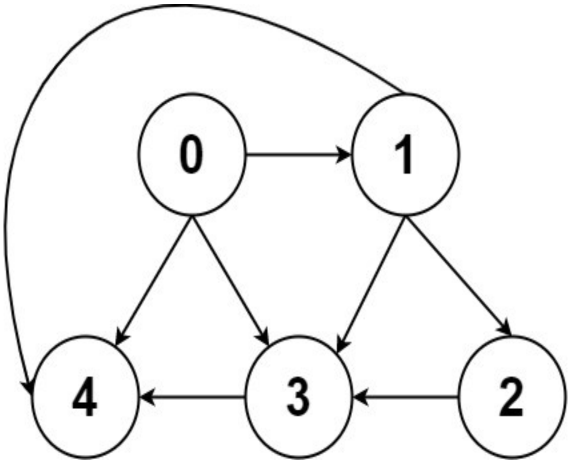
The graph is given as follows: graph[i] is a list of all nodes you can visit from node i (i.e., there is a directed edge from node i to node graph[i][j]).

Example 1:



Input: graph = [[1,2],[3],[3],[]]
Output: [[0,1,3],[0,2,3]]

Explanation: There are two paths: 0 -> 1 -> 3 and 0 -> 2 -> 3. **Example 2:**



Input: graph = [[4,3,1],[3,2,4],[3],[4],[]]
Output: [[0,4],[0,3,4],[0,1,3,4],[0,1,2,3,4],[0,1,4]]

Constraints:

- n == graph.length
- 2 <= n <= 15
- 0 <= graph[i][j] < n
- graph[i][j] != i (i.e., there will be no self-loops).
- All the elements of graph[i] are unique.
- The input graph is guaranteed to be a DAG.

Program Code:

```
#include <iostream> #include
<vector>
using namespace std;

void dfs(int node, vector<vector<int>>& graph, vector<int>& path,
vector<vector<int>>& result) {     path.push_back(node);     if
(node == graph.size() - 1) {         result.push_back(path);
    } else {         for (int neighbor :
graph[node]) {
            dfs(neighbor, graph, path, result);
        }
    }
    path.pop_back();
}
```

```
vector<vector<int>> allPathsSourceTarget(vector<vector<int>>& graph) {
vector<vector<int>> result;     vector<int> path;     dfs(0, graph, path,
result);     return result;
}

int main() {
    vector<vector<int>> graph1 = {{1,2},{3},{3},{}};
vector<vector<int>> graph2 = {{4,3,1},{3,2,4},{3},{4},{}};

    vector<vector<int>> result1 = allPathsSourceTarget(graph1);
vector<vector<int>> result2 = allPathsSourceTarget(graph2);

    for (const auto& path : result1) {
for (int node : path) {
            cout << node << " ";
        }
        cout << endl;
    }
    cout << endl;
    for (const auto& path : result2) {
for (int node : path) {            cout
<< node << " ";
        }
        cout << endl;
    }

    return 0;
}
```

Output:

```
ankitvashisth@Ankits-MacBook-Pro ~ % g++ sorting5.cpp -o
 sorting5 && ./sorting5
0 1 3
0 2 3

0 4
0 3 4
0 1 3 4
0 1 2 3 4
0 1 4
```