Breadth First Search (BFS): Level Order Traversal

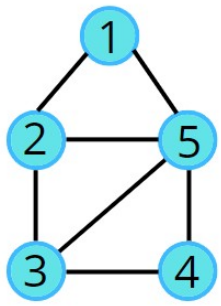
Problem Statement: Given an undirected graph, return a vector of all nodes by traversing the graph using breadth-first search (BFS).

Pre-req: Graph Representation, Queue STL

Examples:

Example 1:

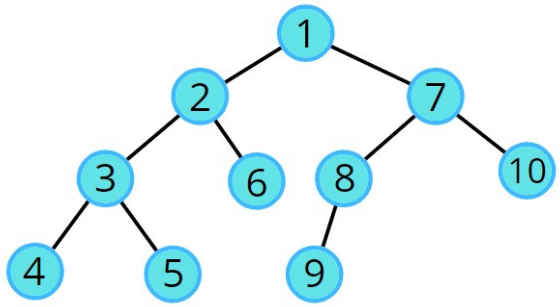
Input:



Output: 1 2 5 3 4

Example 2:

Input:



Output: 1 2 7 3 6 8 10 4 5 9

Solution

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

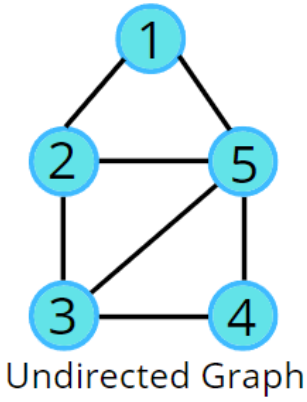
Approach:

Initial Configuration:

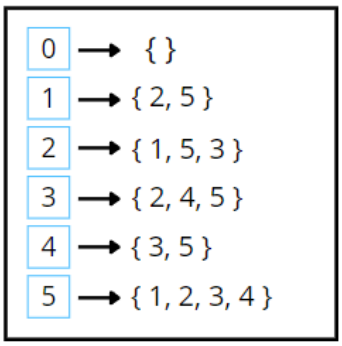
- Queue data structure: follows FIFO, and will always contain the starting.
- Visited array: an array initialized to 0

1. In BFS, we start with a "starting" node, mark it as visited, and push it into the queue data structure.
2. In every iteration, we pop out the node 'v' and put it in the solution vector, as we are traversing this node.
3. All the unvisited adjacent nodes from 'v' are visited next and are pushed into the queue. The list of adjacent neighbors of the node can be accessed from the adjacency list.
4. Repeat steps 2 and 3 until the queue becomes empty, and this way you can easily traverse all the nodes in the graph.

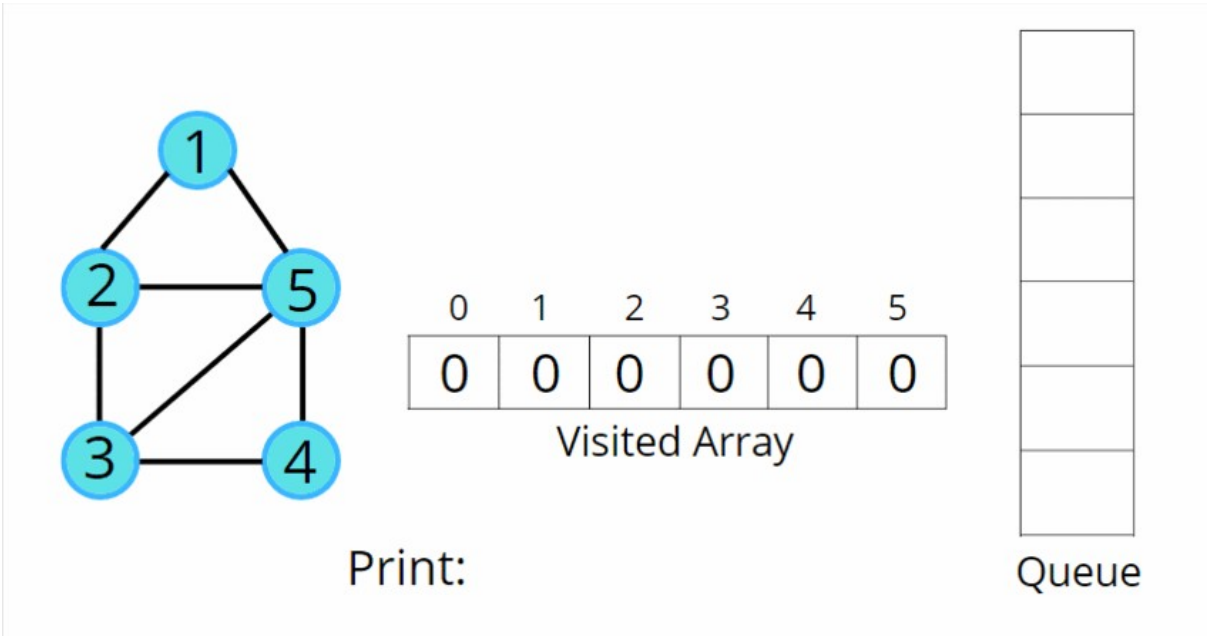
In this way, all the nodes are traversed in a breadthwise manner.



Undirected Graph



Adjacency List



Code:

- C++ Code
- Java Code

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

class Solution {
  public:
    // Function to return Breadth First Traversal of given graph.
    vector<int> bfsOfGraph(int V, vector<int> adj[]) {
        int vis[V] = {0};
        vis[0] = 1;
        queue<int> q;
        // push the initial starting node
        q.push(0);
        vector<int> bfs;
        // iterate till the queue is empty
        while(!q.empty()) {
            // get the topmost element in the queue
            int node = q.front();
            q.pop();
            bfs.push_back(node);
            // traverse for all its neighbours
            for(auto it : adj[node]) {
                // if the neighbour has previously not been visited,
                // store in Q and mark as visited
                if(!vis[it]) {
                    vis[it] = 1;
                    q.push(it);
                }
            }
        }
        return bfs;
    }
};

void addEdge(vector <int> adj[], int u, int v) {
    adj[u].push_back(v);
    adj[v].push_back(u);
}

void printAns(vector <int> &ans) {
    for (int i = 0; i < ans.size(); i++) {
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            cout << ans[i] << " ";
        }
}

int main()
{
    vector <int> adj[6];

    addEdge(adj, 0, 1);
    addEdge(adj, 1, 2);
    addEdge(adj, 1, 3);
    addEdge(adj, 0, 4);

    Solution obj;
    vector <int> ans = obj.bfsOfGraph(5, adj);
    printAns(ans);

    return 0;
}
```

Output: 0 1 4 2 3

Time Complexity: O(N) + O(2E), Where N = Nodes, 2E is for total degrees as we traverse all adjacent nodes.