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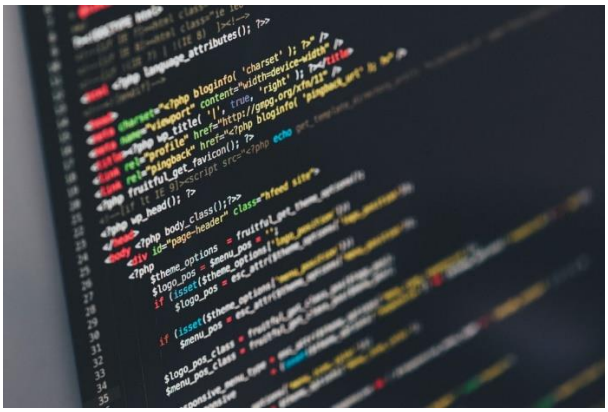
LAB REPORT

CSE2011 – DATA STRUCTURES AND ALGORITHMS LAB



(B.Tech. CSE Specialisation in Bioinformatics)

WINTER SEMESTER 2020-2021

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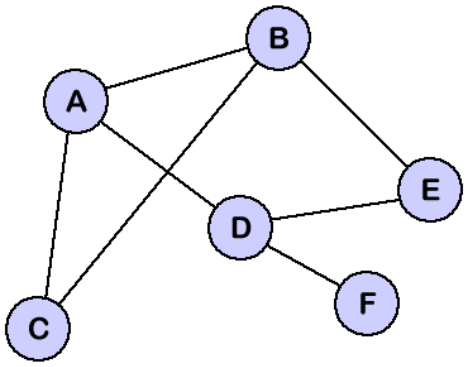
VIT – A Place to Learn; A Chance to Grow

ASSIGNMENT 6

1. Construct the given graph using Adjacency Matrix and Perform breadth first search on it.



CODE

```c
#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>
#define MAX 6
struct Vertex
{
    char label;
    bool visited;
};
int queue[MAX];
int rear = -1;
int front = 0;
int queueItemCount = 0;
struct Vertex *lstVertices[MAX];
int adjMatrix[MAX][MAX];
int vertexCount = 0;
void insert(int data)
{
    queue[++rear] = data;
    queueItemCount++;
}
int removeData()
{
```

```
    queueItemCount--;
    return queue[front++];
}
bool isQueueEmpty()
{
    return queueItemCount == 0;
}
void addVertex(char label)
{
    struct Vertex *vertex = (struct Vertex *)malloc(sizeof(struct Ve
rtex));
    vertex->label = label;
    vertex->visited = false;
    lstVertices[vertexCount++] = vertex;
}
void addEdge(int start, int end)
{
    adjMatrix[start][end] = 1;
    adjMatrix[end][start] = 1;
}
void displayVertex(int vertexIndex)
{
    printf("%c ", lstVertices[vertexIndex]->label);
}
int getAdjUnvisitedVertex(int vertexIndex)
{
    int i;
    for (i = 0; i < vertexCount; i++)
    {
        if (adjMatrix[vertexIndex][i] == 1 && lstVertices[i]-
>visited == false)
            return i;
    }
    return -1;
}
void breadthFirstSearch()
{
    int i;
    lstVertices[0]->visited = true;
    displayVertex(0);
    insert(0);
    int unvisitedVertex;
```

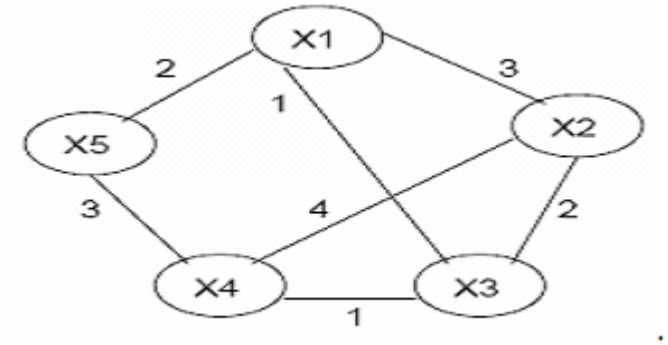
```
    while (!isQueueEmpty())
    {
        int tempVertex = removeData();
        while ((unvisitedVertex = getAdjUnvisitedVertex(tempVertex))
 != -1)
        {
            lstVertices[unvisitedVertex]->visited = true;
            displayVertex(unvisitedVertex);
            insert(unvisitedVertex);
        }
    }
    for (i = 0; i < vertexCount; i++)
    {
        lstVertices[i]->visited = false;
    }
}
int main()
{
    int i, j;
    for (i = 0; i < MAX; i++)
    {
        for (j = 0; j < MAX; j++)
            adjMatrix[i][j] = 0;
    }
    addVertex('A');
    addVertex('B');
    addVertex('C');
    addVertex('D');
    addVertex('E');
    addVertex('F');
    addEdge(0, 1);
    addEdge(0, 2);
    addEdge(0, 3);
    addEdge(1, 2);
    addEdge(1, 4);
    addEdge(3, 4);
    addEdge(3, 5);
    printf("\nBFS ");
    breadthFirstSearch();
    return 0;
}
```

OUTPUT

```
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assi
nswers\" ; if ($?) { g++ q1.cpp -o q1 } ; if ($?) { .\q1 }

BFS A B C D E F
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assi
```

2. Write a program to implement Kruskal's Algorithm and find the Minimum Spanning Tree for the following graph.



CODE

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <iostream>
using namespace std;
struct Edge
{
    int src, dest, weight;
};
struct Graph
{
    int V, E;
    struct Edge *edge;
};
struct Graph *createGraph(int V, int E)
{
    struct Graph *graph = (struct Graph *)malloc(sizeof(struct Graph
));
    graph->V = V;
    graph->E = E;
    graph->edge = (struct Edge *)malloc(graph-
>E * sizeof(struct Edge));
    return graph;
}
struct subset
{
    int parent;
```

```
    int rank;
};
int find(struct subset subsets[], int i)
{
    if (subsets[i].parent != i)
        subsets[i].parent = find(subsets, subsets[i].parent);
    return subsets[i].parent;
}
void Union(struct subset subsets[], int x, int y)
{
    int xroot = find(subsets, x);
    int yroot = find(subsets, y);
    if (subsets[xroot].rank < subsets[yroot].rank)
        subsets[xroot].parent = yroot;
    else if (subsets[xroot].rank > subsets[yroot].rank)
        subsets[yroot].parent = xroot;
    else
    {
        subsets[yroot].parent = xroot;
        subsets[xroot].rank++;
    }
}
int myComp(const void *a, const void *b)
{
    struct Edge *a1 = (struct Edge *)a;
    struct Edge *b1 = (struct Edge *)b;
    return a1->weight > b1->weight;
}
void KruskalMST(struct Graph *graph)
{
    int V = graph->V;
    struct Edge result[V];
    int e = 0;
    int i = 0;
    qsort(graph->edge, graph->E, sizeof(graph->edge[0]), myComp);
    struct subset *subsets = (struct subset *)malloc(V * sizeof(stru
ct subset));
    for (int v = 0; v < V; ++v)
    {
        subsets[v].parent = v;
        subsets[v].rank = 0;
    }
```

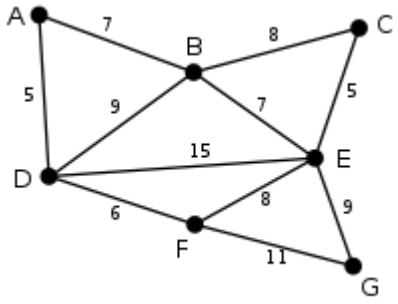
```
    while (e < V - 1)
    {
        struct Edge next_edge = graph->edge[i++];
        int x = find(subsets, next_edge.src);
        int y = find(subsets, next_edge.dest);
        if (x != y)
        {
            result[e++] = next_edge;
            Union(subsets, x, y);
        }
    }
    cout << "These are the edges in the constructed MST\n";
    for (i = 0; i < e; ++i)
        printf("%d -- %d == %d\n", result[i].src, result[i].dest,
                result[i].weight);
    return;
}
int main()
{
    int V = 5;
    int E = 7;
    struct Graph *graph = createGraph(V, E);
    //X1-X2
    graph->edge[0].src = 0;
    graph->edge[0].dest = 1;
    graph->edge[0].weight = 3;
    //X2-X3
    graph->edge[1].src = 1;
    graph->edge[1].dest = 2;
    graph->edge[1].weight = 2;
    //X3-X4
    graph->edge[2].src = 2;
    graph->edge[2].dest = 3;
    graph->edge[2].weight = 1;
    //X4-X5
    graph->edge[3].src = 3;
    graph->edge[3].dest = 4;
    graph->edge[3].weight = 3;
    //X5-X1
    graph->edge[4].src = 4;
    graph->edge[4].dest = 0;
    graph->edge[4].weight = 2;
```

```
    //X1-X3
    graph->edge[5].src = 0;
    graph->edge[5].dest = 2;
    graph->edge[5].weight = 1;
    //X2-X4
    graph->edge[6].src = 1;
    graph->edge[6].dest = 3;
    graph->edge[6].weight = 4;
    KruskalMST(graph);
    return 1;
}
```

OUTPUT

```
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assi
nswers\" ; if ($?) { g++ q2.cpp -o q2 } ; if ($?) { .\q2 }
These are the edges in the constructed MST
2 -- 3 == 1
0 -- 2 == 1
4 -- 0 == 2
1 -- 2 == 2
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assi
```

3. Write a program to implement Prim's Algorithm and find the Minimum Spanning Tree for the following graph.



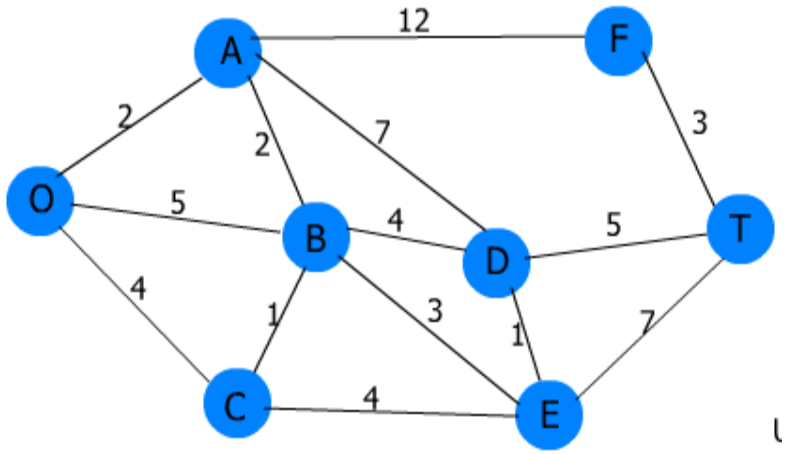
CODE

```
#include <stdio.h>
#include <limits.h>
#include <iostream>
using namespace std;
#define V 7
int minKey(int key[], bool mstSet[])
{
    int min = INT_MAX, min_index;
    for (int v = 0; v < V; v++)
        if (mstSet[v] == false && key[v] < min)
            min = key[v], min_index = v;
    return min_index;
}
int printMST(int parent[], int n, int graph[V][V])
{
    cout << "Edge Weight\n";
    for (int i = 1; i < V; i++)
        printf("%d - %d %d \n", parent[i], i, graph[i][parent[i]]);
}
void primMST(int graph[V][V])
{
    int parent[V];
    int key[V];
    bool mstSet[V];
```

```
    for (int i = 0; i < V; i++)
        key[i] = INT_MAX, mstSet[i] = false;
    key[0] = 0;
    parent[0] = -1;
    for (int count = 0; count < V - 1; count++)
    {
        int u = minKey(key, mstSet);
        mstSet[u] = true;
        for (int v = 0; v < V; v++)
            if (graph[u][v] && mstSet[v] == false && graph[u][v] < k
ey[v])
                parent[v] = u, key[v] = graph[u][v];
    }
    printMST(parent, V, graph);
}
int main()
{
    //0-A,1-B,2-C,3-D,4-E,5-F,6-G
    int graph[V][V] = {{0, 7, 0, 5, 0, 0, 0},
                       {7, 0, 8, 9, 7, 0, 0},
                       {0, 8, 0, 0, 5, 0, 0},
                       {5, 9, 0, 0, 15, 6, 0},
                       {0, 7, 5, 15, 0, 8, 9},
                       {0, 0, 0, 6, 8, 0, 11},
                       {0, 0, 0, 0, 9, 11, 0}};
    primMST(graph);
    return 0;
}
```

```
Edge Weight
0 - 1 7
4 - 2 5
0 - 3 5
1 - 4 7
3 - 5 6
4 - 6 9
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\A
```

4. Write a program that creates the following graph and finds the shortest path from the vertex O to all the other vertices using Dijikstra's Algorithm.



CODE

```
#include <iostream>
#include <stdio.h>
using namespace std;
#define INFINITY 9999
#define max 8
void dijkstra(int G[max][max], int n, int startnode);
void dijkstra(int G[max][max], int n, int startnode)
{
    int cost[max][max], distance[max], pred[max];
    int visited[max], count, mindistance, nextnode, i, j;
    for (i = 0; i < n; i++)
        for (j = 0; j < n; j++)
            if (G[i][j] == 0)
                cost[i][j] = INFINITY;
            else
                cost[i][j] = G[i][j];
    for (i = 0; i < n; i++)
    {
        distance[i] = cost[startnode][i];
        pred[i] = startnode;
        visited[i] = 0;
    }
```

```
    distance[startnode] = 0;
    visited[startnode] = 1;
    count = 1;
    while (count < n - 1)
    {
        mindistance = INFINITY;
        for (i = 0; i < n; i++)
            if (distance[i] < mindistance && !visited[i])
            {
                mindistance = distance[i];
                nextnode = i;
            }
        visited[nextnode] = 1;
        for (i = 0; i < n; i++)
            if (!visited[i])
                if (mindistance + cost[nextnode][i] < distance[i])
                {
                    distance[i] = mindistance + cost[nextnode][i];
                    pred[i] = nextnode;
                }
        count++;
    }
    for (i = 0; i < n; i++)
        if (i != startnode)
        {
            cout << "\nDistance of node " << i << " from node 0(O) =
 " << distance[i];
            cout << "\nPath Taken = " << i;
            j = i;
            do
            {
                j = pred[j];
                cout << " <- " << j;
            } while (j != startnode);
            cout << endl;
        }
}
int main()
{
    //O-0,A-1,B-2,C-3,D-4,E-5,F-6,T-7
    int G[max][max] = {
        {0, 2, 5, 4, 0, 0, 0, 0},
```

```
        {2, 0, 2, 0, 7, 0, 12, 0},
        {5, 2, 0, 1, 4, 3, 0, 0},
        {4, 0, 1, 0, 0, 4, 0, 0},
        {0, 7, 4, 0, 0, 1, 0, 5},
        {0, 0, 3, 4, 1, 0, 0, 7},
        {0, 12, 0, 0, 0, 0, 0, 3},
        {0, 0, 0, 0, 5, 7, 3, 0},
    };
    int n = 8;
    int u = 0;
    dijkstra(G, n, u);
    return 0;
}
```

OUTPUT

```
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assignment 6\Programs\All Answers> cd "e:\
nswers\" ; if ($?) { g++ q4.cpp -o q4 } ; if ($?) { .\q4 }

Dist of node 1 from node 0(O) = 2
Path Taken = 1 <- 0

Dist of node 2 from node 0(O) = 4
Path Taken = 2 <- 1 <- 0

Dist of node 3 from node 0(O) = 4
Path Taken = 3 <- 0

Dist of node 4 from node 0(O) = 8
Path Taken = 4 <- 2 <- 1 <- 0

Dist of node 5 from node 0(O) = 7
Path Taken = 5 <- 2 <- 1 <- 0

Dist of node 6 from node 0(O) = 14
Path Taken = 6 <- 1 <- 0

Dist of node 7 from node 0(O) = 13
Path Taken = 7 <- 4 <- 2 <- 1 <- 0
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assignment 6\Programs\All Answers>
```

5. Given an array of elements, construct a min Heap and perform in-place sorting (ascending order) using heap sort.

CODE

```
#include <iostream>
using namespace std;
void heapify(int arr[], int n, int i)
{
    int smallest = i;
    int l = 2 * i + 1;
    int r = 2 * i + 2;
    if (l < n && arr[l] < arr[smallest])
        smallest = l;
    if (r < n && arr[r] < arr[smallest])
        smallest = r;
    if (smallest != i)
    {
        swap(arr[i], arr[smallest]);
        heapify(arr, n, smallest);
    }
}
void heapSort(int arr[], int n)
{
    for (int i = n / 2 - 1; i >= 0; i--)
        heapify(arr, n, i);
    for (int i = n - 1; i >= 0; i--)
    {
        swap(arr[0], arr[i]);
        heapify(arr, i, 0);
    }
}
void printArray(int arr[], int n)
{
    for (int i = n - 1; i >= 0; i--)
        cout << arr[i] << " ";
    cout << endl;
}
int main()
{
    int arr[6] = {4, 25, 10, 1, 8, 3};
    int n = sizeof(arr) / sizeof(arr[0]);
```

```
    heapSort(arr, n);
    cout << "Sorted array is :" << endl;
    printArray(arr, n);
    return 1;
}
```

OUTPUT

```
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assignment
nswers\" ; if ($?) { g++ q5.cpp -o q5 } ; if ($?) { .\q5 }
Sorted array is :
1 3 4 8 10 25
PS E:\VIT Semester\Winter Semester 2020\DSA\Lab\Module 5\Assignment
```