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Data Structures and algorithms (CS09203)

Lab Report

Name: M.Usman Ali
Registration #: SEU-F16-135
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Submitted To: Mr. Usman Ahmed

The University of Lahore, Islamabad Campus
Department of Computer Science & Information Technology

Experiment # 11

Kruskal's algorithm

Objective

The objective of this session is to show the representation of trees using C++.

Software Tool

1. Code Blocks with GCC compiler.

1 Theory

Kruskal's algorithm is a minimum-spanning-tree algorithm which finds an edge of the least possible weight that connects any two trees in the forest.[1] It is a greedy algorithm in graph theory as it finds a minimum spanning tree for a connected weighted graph adding increasing cost arcs at each step.[1] This means it finds a subset of the edges that forms a tree that includes every vertex, where the total weight of all the edges in the tree is minimized. If the graph is not connected, then it finds a minimum spanning forest (a minimum spanning tree for each connected component).

2 Task

2.1 Task 1

Implement Kruskal's algorithm.

2.2 Procedure: Task 1

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

```

// Creating shortcut for an integer pair
typedef pair<int, int> iPair;

// Structure to represent a graph
struct Graph
{
    int V, E;
    vector< pair<int, iPair> > edges;

    // Constructor
    Graph(int V, int E)
    {
        this->V = V;
        this->E = E;
    }

    // Utility function to add an edge
    void addEdge(int u, int v, int w)
    {
        edges.push_back({w, {u, v}});
    }

    // Function to find MST using Kruskal's
    // MST algorithm
    int kruskalMST();
};

// To represent Disjoint Sets
struct DisjointSets
{
    int *parent, *rnk;
    int n;

    // Constructor.
    DisjointSets(int n)
    {
        // Allocate memory
        this->n = n;
        parent = new int[n+1];
        rnk = new int[n+1];
    }

```

```

    // Initially , all vertices are in
    // different sets and have rank 0.
    for (int i = 0; i <= n; i++)
    {
        rnk[i] = 0;

        //every element is parent of itself
        parent[i] = i;
    }
}

// Find the parent of a node 'u'
// Path Compression
int find(int u)
{
    /* Make the parent of the nodes in the path
       from u—> parent[u] point to parent[u] */
    if (u != parent[u])
        parent[u] = find(parent[u]);
    return parent[u];
}

// Union by rank
void merge(int x, int y)
{
    x = find(x), y = find(y);

    /* Make tree with smaller height
       a subtree of the other tree */
    if (rnk[x] > rnk[y])
        parent[y] = x;
    else // If rnk[x] <= rnk[y]
        parent[x] = y;

    if (rnk[x] == rnk[y])
        rnk[y]++;
}
};

```

```

/* Functions returns weight of the MST*/

int Graph::kruskalMST()
{
    int mst_wt = 0; // Initialize result

    // Sort edges in increasing order on basis of cost
    sort(edges.begin(), edges.end());

    // Create disjoint sets
    DisjointSets ds(V);

    // Iterate through all sorted edges
    vector< pair<int, iPair> >::iterator it;
    for (it=edges.begin(); it!=edges.end(); it++)
    {
        int u = it->second.first;
        int v = it->second.second;

        int set_u = ds.find(u);
        int set_v = ds.find(v);

        // Check if the selected edge is creating
        // a cycle or not (Cycle is created if u
        // and v belong to same set)
        if (set_u != set_v)
        {
            // Current edge will be in the MST
            // so print it
            cout << u << " - " << v << endl;

            // Update MST weight
            mst_wt += it->first;

            // Merge two sets
            ds.merge(set_u, set_v);
        }
    }

    return mst_wt;
}

```

```

}

// Driver program to test above functions
int main()
{
    /* Let us create above shown weighted
       and undirected graph */
    int V = 9, E = 14;
    Graph g(V, E);

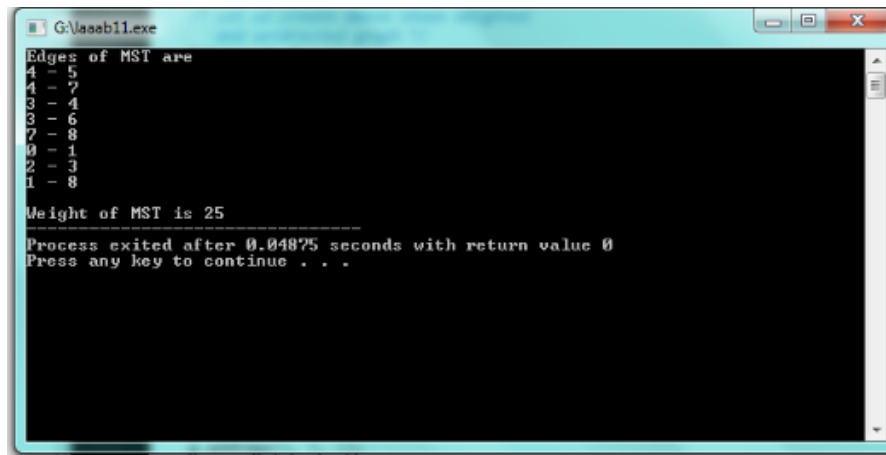
    // making above shown graph
    g.addEdge(0, 1, 4);
    g.addEdge(0, 7, 8);
    g.addEdge(1, 2, 8);
    g.addEdge(1, 8, 5);
    g.addEdge(1, 6, 10);
    g.addEdge(2, 6, 4);
    g.addEdge(2, 3, 4);
    g.addEdge(2, 8, 4);
    g.addEdge(2, 5, 4);
    g.addEdge(2, 1, 8);
    g.addEdge(3, 6, 3);
    g.addEdge(3, 2, 4);
    g.addEdge(3, 4, 3);
    g.addEdge(4, 3, 3);

    g.addEdge(4, 6, 6);
    g.addEdge(4, 5, 1);
    g.addEdge(4, 7, 2);
    g.addEdge(5, 2, 4);
    g.addEdge(5, 7, 3);
    g.addEdge(5, 4, 1);

    g.addEdge(6, 1, 10);
    g.addEdge(6, 2, 4);
    g.addEdge(6, 3, 3);
    g.addEdge(6, 4, 6);

    g.addEdge(7, 4, 2);
    g.addEdge(7, 5, 3);

```



```
G:\asab11.exe
Edges of MST are
4 - 5
4 - 7
3 - 4
3 - 6
7 - 8
0 - 1
2 - 3
1 - 8
Weight of MST is 25
-----
Process exited after 0.04875 seconds with return value 0
Press any key to continue . . .
```

Figure 1: output

```
g.addEdge(7, 8, 3);
g.addEdge(8, 1, 5);
g.addEdge(8, 2, 4);
g.addEdge(8, 5, 3);
cout << "Edges of MST are \n";
int mst_wt = g.kruskalMST();

cout << "\nWeight of MST is " << mst_wt;

return 0;
}
```