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| Experiment No. 7 |
| Kruskal's Algorithm |
| Date of Performance: |
| Date of Submission: |

# Experiment No. 7

**Title:** Kruskal's Algorithm.

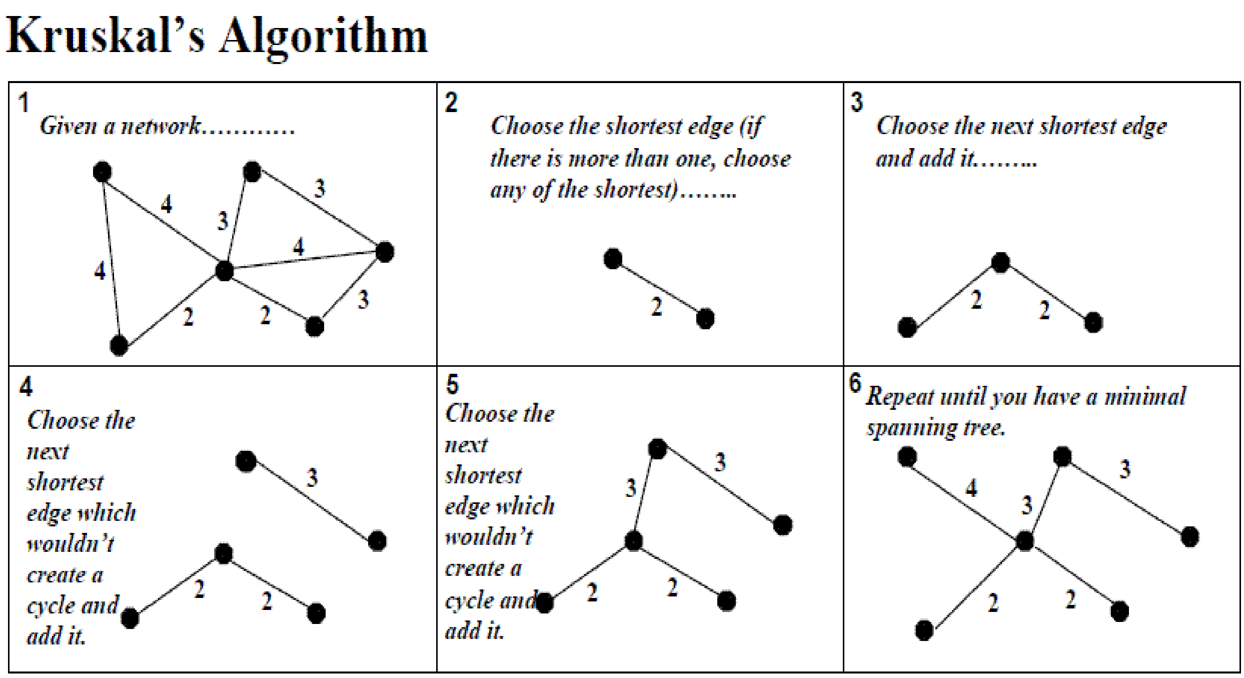
**Aim:** To study and implement Kruskal's Minimum Cost Spanning Tree Algorithm.

**Objective:** To introduce Greedy based algorithms

**Theory:**

Kruskal's algorithm finds a minimum spanning forest of an undirected edge-weighted graph. If the graph is connected, it finds a minimum spanning tree. (A minimum spanning tree of a connected graph is a subset of the edges that forms a tree that includes every vertex, where the sum of the weights of all the edges in the tree is minimized. For a disconnected graph, a minimum spanning forest is composed of a minimum spanning tree for each connected component.) It is a greedy algorithm in graph theory as in each step it adds the next lowest-weight edge that will not form a cycle to the minimum spanning forest.

**Example:**



**Algorithm and Complexity:**

```
Algorithm Kruskal(E, cost, n, t)
// E is the set of edges in G. G has n vertices. cost[u, v] is the
// cost of edge (u, v). t is the set of edges in the minimum-cost
// spanning tree. The final cost is returned.
{
    Construct a heap out of the edge costs using Heapify;
    for i := 1 to n do parent[i] := -1;
    // Each vertex is in a different set.
    i := 0; mincost := 0.0;
    while ((i < n - 1) and (heap not empty)) do
    {
        Delete a minimum cost edge (u, v) from the heap
        and reheapify using Adjust;
        j := Find(u); k := Find(v);
        if (j ≠ k) then
        {
            i := i + 1;
            t[i, 1] := u; t[i, 2] := v;
            mincost := mincost + cost[u, v];
            Union(j, k);
        }
    }
    if (i ≠ n - 1) then write ("No spanning tree");
    else return mincost;
}
```

Time Complexity is O(nlog n), Where, n = number of Edges

**Implementation:**

```
#include <stdio.h>
 #include <stdlib.h>
int comparator(const void* p1, const void* p2)
{
const int(*x)[3] = p1; const int(*y)[3] = p2; return (*x)[2] - (*y)[2];
}
void makeSet(int parent[], int rank[], int n)
{
for (int i = 0; i < n; i++) {
parent[i] = i; rank[i] = 0;
}
}
int findParent(int parent[], int component)
{
if (parent[component] == component) return component;
return parent[component]
= findParent(parent, parent[component]);
}
void unionSet(int u, int v, int parent[], int rank[], int n)
{
u = findParent(parent, u); v = findParent(parent, v); if (rank[u] < rank[v]) {
parent[u] = v;
}
else if (rank[u] > rank[v]) {
parent[v] = u;
}
else {
parent[v] = u; rank[u]++;
```

```
}
}
void kruskalAlgo(int n, int edge[n][3])
{
qsort(edge, n, sizeof(edge[0]), comparator);

int parent[n]; int rank[n];
makeSet(parent, rank, n); int minCost = 0;
printf(
"Following are the edges in the constructed MST\n"); for (int i = 0; i < n; i++) {
int v1 = findParent(parent, edge[i][0]);

int v2 = findParent(parent, edge[i][1]); int wt = edge[i][2];
if (v1 != v2) {
unionSet(v1, v2, parent, rank, n); minCost += wt;
printf("%d -- %d == %d\n", edge[i][0], edge[i][1], wt);
}}
printf("Minimum Cost Spanning Tree: %d\n", minCost);
}
int main()
{
int edge[5][3] = { { 0, 1, 10 },
{ 0, 2, 6 },
{ 0, 3, 5 },
{ 1, 3, 15 },
{ 2, 3, 4 } };
kruskalAlgo(5, edge);
return 0;
}
```

**Output:**

```
Output
/tmp/MndA9fPvSK.o
Following are the edges in the constructed MST
2 -- 3 == 4
0 -- 3 == 5
0 -- 1 == 10
Minimum Cost Spanning Tree: 19


=== Code Execution Successful ===
```

**Conclusion:** Implementing Kruskal's Algorithm requires managing sorted edges efficiently, using a disjoint set data structure for cycle detection, and maintaining the greedy property throughout the process. Its efficiency and optimality make it a popular choice for finding minimum spanning trees in graph-related problems.

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