Name:	Prerna Sunil Jadhav
Sap Id:	60004220127
Class:	S. Y. B.Tech (Computer Engineering)
Course:	Analysis of Algorithm Laboratory
Course Code:	DJ19CEL404
Experiment No.:	05

AIM: **IMPLEMENT MINIMUM SPANNING TREE (PRIM'S AND KRUSKAL)**

THEORY:

PRIM'S ALGORITHM

- Prim's algorithm is a Greedy algorithm.
- This algorithm always starts with a single node and moves through several adjacent nodes, in order to explore all of the connected edges along the way.
- The algorithm starts with an empty spanning tree.
- The idea is to maintain two sets of vertices.
- The first set contains the vertices already included in the MST, and the other set contains the vertices not yet included.
- At every step, it considers all the edges that connect the two sets and picks the minimum weight edge from these edges.
- After picking the edge, it moves the other endpoint of the edge to the set containing MST.
- **Pseudocode:**

```
T = ∅;
U = { 1 };
while (U ≠ V)
    let (u, v) be the lowest cost edge such that u ∈ U and v ∈ V - U;
    T = T ∪ {(u, v)}
    U = U ∪ {v}
```

CODE:

```
// Prim's Algorithm in C

#include<stdio.h>
#include<stdbool.h>

#define INF 9999999

// number of vertices in graph
#define V 5

// create a 2d array of size 5x5
//for adjacency matrix to represent graph
int G[V][V] = {
```

```
  {0, 9, 75, 0, 0},
  {9, 0, 95, 19, 42},
  {75, 95, 0, 51, 66},
  {0, 19, 51, 0, 31},
  {0, 42, 66, 31, 0}};

int main() {
  int no_edge;  // number of edge

  // create a array to track selected vertex
  // selected will become true otherwise false
  int selected[V];

  // set selected false initially
  memset(selected, false, sizeof(selected));

  // set number of edge to 0
  no_edge = 0;

  // the number of egde in minimum spanning tree will be
  // always less than (V -1), where V is number of vertices in
  //graph

  // choose 0th vertex and make it true
  selected[0] = true;

  int x;  //  row number
  int y;  //  col number

  // print for edge and weight
  printf("Edge : Weight\n");

  while (no_edge < V - 1) {
    //For every vertex in the set S, find the all adjacent vertices
    // , calculate the distance from the vertex selected at step 1.
    // if the vertex is already in the set S, discard it otherwise
    //choose another vertex nearest to selected vertex  at step 1.

    int min = INF;
    x = 0;
    y = 0;

    for (int i = 0; i < V; i++) {
      if (selected[i]) {
```

```
        for (int j = 0; j < V; j++) {
          if (!selected[j] && G[i][j]) {  // not in selected and there is an
edge
            if (min > G[i][j]) {
              min = G[i][j];
              x = i;
              y = j;
            }
          }
        }
      }
    }
    printf("%d - %d : %d\n", x, y, G[x][y]);
    selected[y] = true;
    no_edge++;
  }
  return 0;
}
```

OUTPUT:

```
swnujq.shi' '--dbgExe=C:\msys64\mingw64\bin\gdb.exe' '--interpreter=mi'
Edge : Weight
0 - 1 : 9
1 - 3 : 19
3 - 4 : 31
3 - 2 : 51
PS C:\Users\Jadhav\Desktop\BTech\4th sem\AOA\Prac\Code>
```

KRUSHKAL'S ALGORITHM

- Kruskal's algorithm is a minimum spanning tree algorithm that takes a graph as input and finds the subset of the edges of that graph which
  - form a tree that includes every vertex
  - has the minimum sum of weights among all the trees that can be formed from the graph
- Kruskal's algorithm working
  - It falls under a class of algorithms called greedy algorithms that find the local optimum in the hopes of finding a global optimum.
  - We start from the edges with the lowest weight and keep adding edges until we reach our goal.
  - The steps for implementing Kruskal's algorithm are as follows:
    - Sort all the edges from low weight to high
    - Take the edge with the lowest weight and add it to the spanning tree. If adding the edge created a cycle, then reject this edge.
    - Keep adding edges until we reach all vertices.

- Pseudocode

```
KRUSKAL(G):
A = ∅
For each vertex v ∈ G.V:
    MAKE-SET(v)
For each edge (u, v) ∈ G.E ordered by increasing order by weight(u, v):
    if FIND-SET(u) ≠ FIND-SET(v):
    A = A ∪ {(u, v)}
    UNION(u, v)
return A
```

CODE:

```
// Kruskal's algorithm in C

#include <stdio.h>

#define MAX 30

typedef struct edge {
  int u, v, w;
} edge;

typedef struct edge_list {
  edge data[MAX];
  int n;
} edge_list;

edge_list elist;

int Graph[MAX][MAX], n;
edge_list spanlist;

void kruskalAlgo();
int find(int belongs[], int vertexno);
void applyUnion(int belongs[], int c1, int c2);
void sort();
void print();

// Applying Krushkal Algo
void kruskalAlgo() {
  int belongs[MAX], i, j, cno1, cno2;
  elist.n = 0;

  for (i = 1; i < n; i++)
```

```
    for (j = 0; j < i; j++) {
      if (Graph[i][j] != 0) {
        elist.data[elist.n].u = i;
        elist.data[elist.n].v = j;
        elist.data[elist.n].w = Graph[i][j];
        elist.n++;
      }
    }

  sort();

  for (i = 0; i < n; i++)
    belongs[i] = i;

  spanlist.n = 0;

  for (i = 0; i < elist.n; i++) {
    cno1 = find(belongs, elist.data[i].u);
    cno2 = find(belongs, elist.data[i].v);

    if (cno1 != cno2) {
      spanlist.data[spanlist.n] = elist.data[i];
      spanlist.n = spanlist.n + 1;
      applyUnion(belongs, cno1, cno2);
    }
  }
}

int find(int belongs[], int vertexno) {
  return (belongs[vertexno]);
}

void applyUnion(int belongs[], int c1, int c2) {
  int i;

  for (i = 0; i < n; i++)
    if (belongs[i] == c2)
      belongs[i] = c1;
}

// Sorting algo
void sort() {
  int i, j;
  edge temp;
```

```
  for (i = 1; i < elist.n; i++)
    for (j = 0; j < elist.n - 1; j++)
      if (elist.data[j].w > elist.data[j + 1].w) {
        temp = elist.data[j];
        elist.data[j] = elist.data[j + 1];
        elist.data[j + 1] = temp;
      }
}

// Printing the result
void print() {
  int i, cost = 0;

  for (i = 0; i < spanlist.n; i++) {
    printf("\n%d - %d : %d", spanlist.data[i].u, spanlist.data[i].v,
spanlist.data[i].w);
    cost = cost + spanlist.data[i].w;
  }

  printf("\nSpanning tree cost: %d", cost);
}

int main() {
  int i, j, total_cost;

  n = 6;

  Graph[0][0] = 0;
  Graph[0][1] = 4;
  Graph[0][2] = 4;
  Graph[0][3] = 0;
  Graph[0][4] = 0;
  Graph[0][5] = 0;
  Graph[0][6] = 0;

  Graph[1][0] = 4;
  Graph[1][1] = 0;
  Graph[1][2] = 2;
  Graph[1][3] = 0;
  Graph[1][4] = 0;
  Graph[1][5] = 0;
  Graph[1][6] = 0;
```

```
  Graph[2][0] = 4;
  Graph[2][1] = 2;
  Graph[2][2] = 0;
  Graph[2][3] = 3;
  Graph[2][4] = 4;
  Graph[2][5] = 0;
  Graph[2][6] = 0;

  Graph[3][0] = 0;
  Graph[3][1] = 0;
  Graph[3][2] = 3;
  Graph[3][3] = 0;
  Graph[3][4] = 3;
  Graph[3][5] = 0;
  Graph[3][6] = 0;

  Graph[4][0] = 0;
  Graph[4][1] = 0;
  Graph[4][2] = 4;
  Graph[4][3] = 3;
  Graph[4][4] = 0;
  Graph[4][5] = 0;
  Graph[4][6] = 0;

  Graph[5][0] = 0;
  Graph[5][1] = 0;
  Graph[5][2] = 2;
  Graph[5][3] = 0;
  Graph[5][4] = 3;
  Graph[5][5] = 0;
  Graph[5][6] = 0;

  kruskalAlgo();
  print();
}
```

OUTPUT:

```
2 - 1 : 2
5 - 2 : 2
3 - 2 : 3
4 - 3 : 3
1 - 0 : 4
Spanning tree cost: 14
PS C:\Users\Jadhav\Desktop\BTech\4th sem\AOA\Prac\Code>
```

CONCLUSION:

- Kruskal's algorithm is another popular minimum spanning tree algorithm that uses a different logic to find the MST of a graph.
- Instead of starting from a vertex, Kruskal's algorithm sorts all the edges from low weight to high and keeps adding the lowest edges, ignoring those edges that create a cycle.
- The time complexity of Prim's algorithm is O(E log V).