Department of
Computer Science and Engineering

Title: Implement Prim’s Algorithm

Algorithms Lab

CSE 206

Submitted by : Shamim Ahmed

ID: 201902067

Green University of Bangladesh

1 Objective(s)

- To learn Prim’s algorithm to find MST of a graph.

2 Problem Analysis

2.1 Prim’s Algorithm

Prim’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.

2.2 How Prim’s algorithm works

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 one vertex and keep adding edges with the lowest weight until we reach our goal. The steps for implementing Prim’s algorithm are as follows:

- Initialize the minimum spanning tree with a vertex chosen at random.
- Find all the edges that connect the tree to new vertices, find the minimum and add it to the tree. •

Keep repeating step 2 until we get a minimum spanning tree.

2.3 Example of Prim’s algorithm

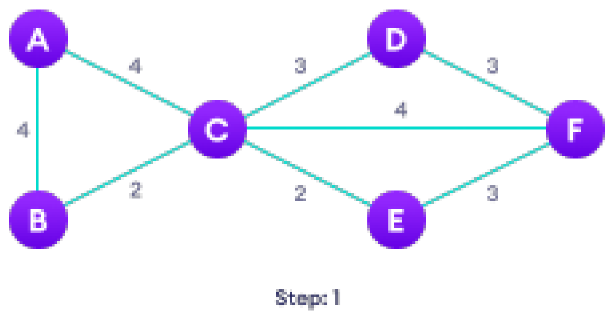
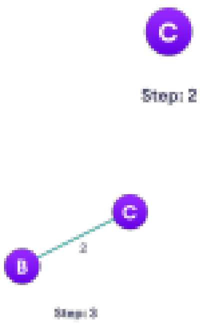
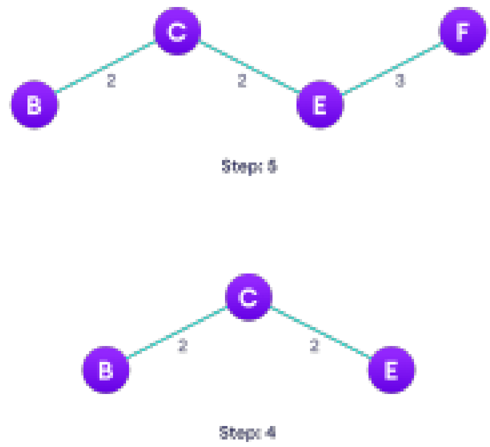


Figure 1: Start with a weighted graph



(a) Choose the edge with the least weight, if there are more than 1, choose anyone (b) Choose the next shortest edge and add it Figure 2: Step 2 and 3



(a) Choose the next shortest edge that doesn’t create a cycle and add it

(b) Choose the next shortest edge that doesn’t create a cycle and add it

Figure 3: Step 4 and 5

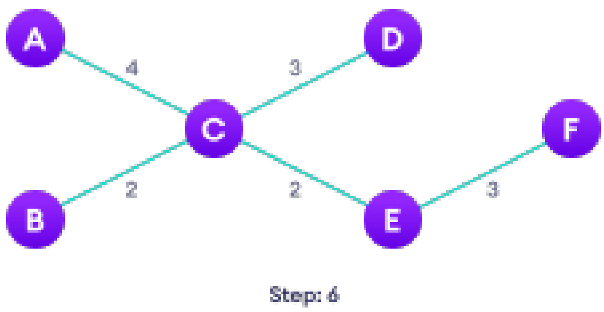


Figure 4: Repeat until you have a spanning tree

3 Algorithm

Algorithm 1: Prim’s Algorithm

```
T = ∅;
U = 1 ;
while (U 6= V) do
let (u, v) be the lowest cost edge such that u ∈ U and v ∈ V - U;
T = T ∪ (u, v)
U = U ∪ v
end
```

4 Implementation in C++

```
#include<bits/stdc++.h>

using namespace std;
```

```
#define V 5                //No of vertices


int selectMinVertex(vector<int>& value,vector<bool>& setMST)
{
    int minimum = INT_MAX;
    int vertex;
    for(int i=0;i<V;++i)
    {
            if(setMST[i]==false && value[i]<minimum)
            {
                    vertex = i;
                    minimum = value[i];
            }
    }
    return vertex;
}


void findMST(int graph[V][V])
{
    int parent[V];
```

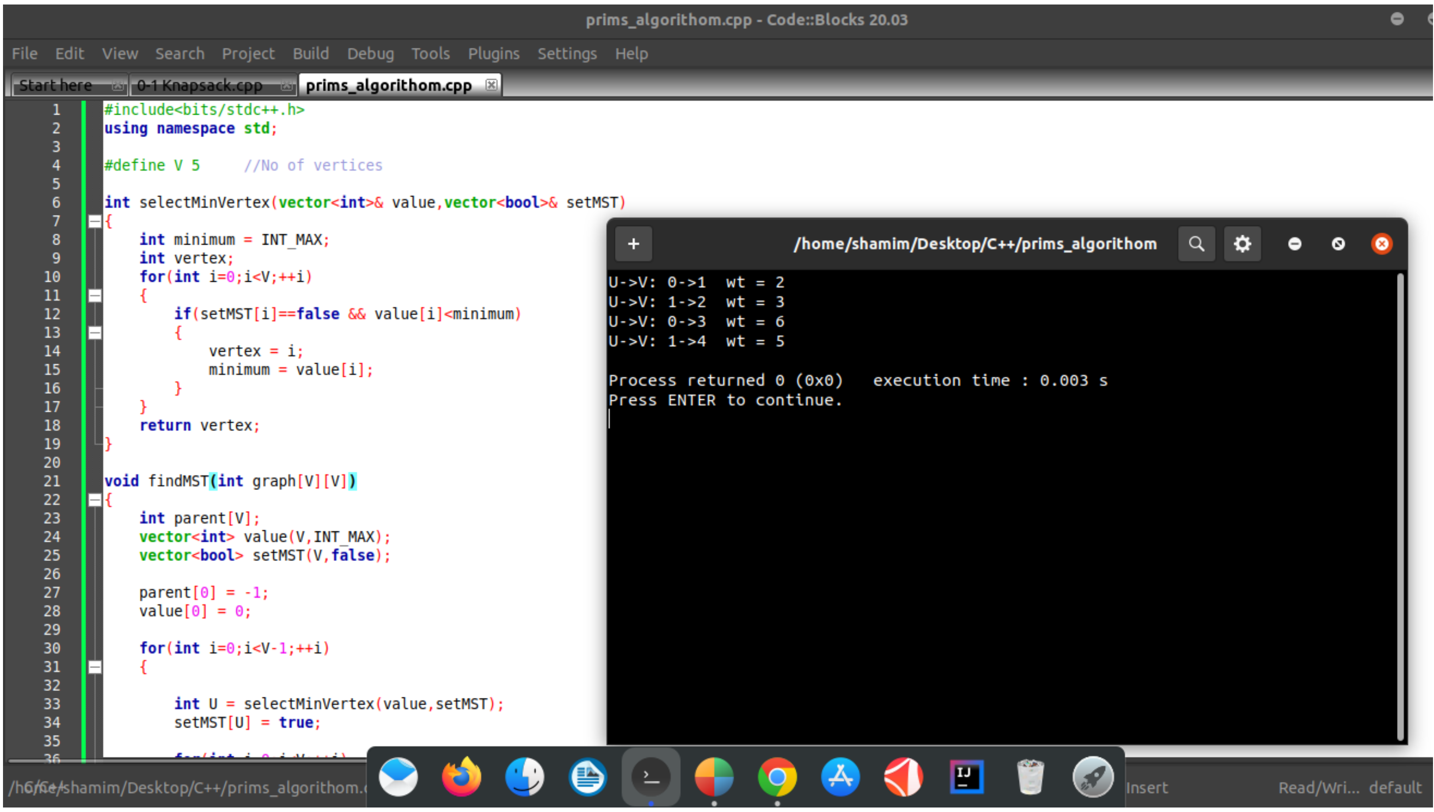
```
vector<int> value(V,INT_MAX);
vector<bool> setMST(V,false);

parent[0] = -1;
value[0] = 0;

for(int i=0;i<V-1;++i)
{

	int U = selectMinVertex(value,setMST);
	setMST[U] = true;

	for(int j=0;j<V;++j)
	{

		if(graph[U][j]!=0 && setMST[j]==false && graph[U][j]<value[j])
		{
			value[j] = graph[U][j];
			parent[j] = U;
		}
	}
```

```
    }

    //Print MST

    for(int i=1;i<V;++i)

            cout<<"U->V: "<<parent[i]<<"->"<<i<<"  wt = "<<graph[parent[i]][i]<<"\n";

}


int main()

{

    int graph[V][V] = { { 0, 2, 0, 6, 0 },{ 2, 0, 3, 8, 5 }, { 0, 3, 0, 0, 7 }, { 6, 8, 0, 0, 9 }, { 0, 5, 7, 9, 0 } };



    findMST(graph);

    return 0;

}
```

5 Sample Input/Output (Compilation, Debugging & Testing)

Edge Weight

0 - 1 => 2
1 - 2 => 3
0 - 3 => 6
1 - 4 => 5



7 Lab Task

```
#include<bits/stdc++.h>

using namespace std;

int rep[10000];
vector<int>va;
int edg;

struct edge
{
    int a, b , c;
}arr[100005];
```

```
bool cmp( edge x, edge y )
{
    return x.c < y.c;
}

void makeset(int n)
{
    for(int i=1;i<=n;i++) rep[i]=i;
}

int findr( int x )
{
    if( rep[x] == x ) return x;

    return rep[x] = findr( rep[x] );
}

int unio(int i,int sum)
{
    int x,y;
    x = findr( arr[i].a );
    y = findr( arr[i].b );
    if( x != y )
    {
        rep[x] = y;
        va.push_back(i);
        sum += arr[i].c;
```

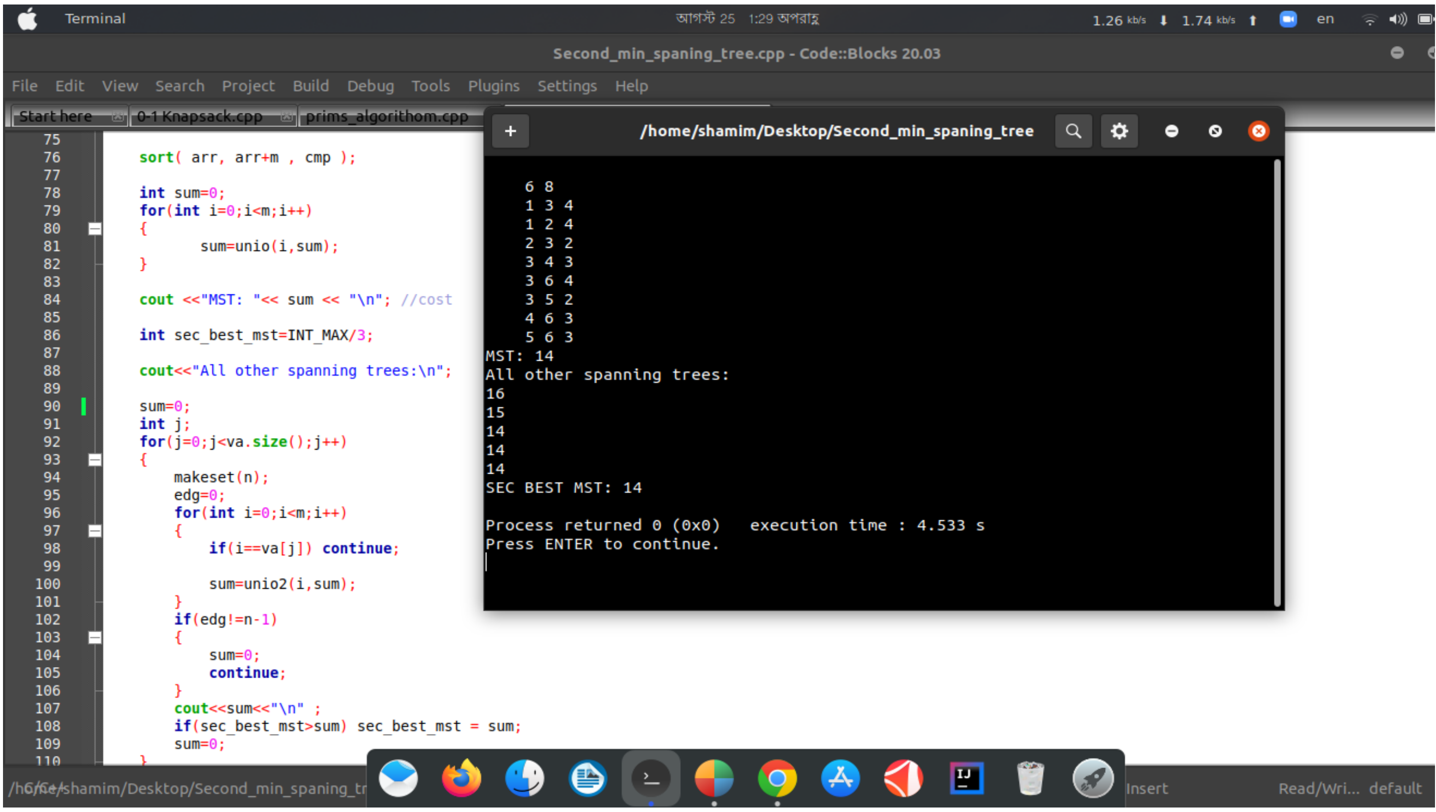
```
    }
    return sum;
}

int unio2(int i,int sum)
{
    int x,y;
    x = findr( arr[i].a );
    y = findr( arr[i].b );
    if( x != y )
    {
        rep[x] = y;
        sum += arr[i].c;
        edg++;
    }
    return sum;
}

int main()
{
    int n , m;
    cin >> n >> m;

    makeset(n);

    for( int i = 0; i < m; i++ )
    {
        int a, b, c ;
        cin >> a >> b >> c;
```

```
    arr[i].a = a;
    arr[i].b = b;
    arr[i].c = c;
}

sort( arr, arr+m , cmp );

int sum=0;
for(int i=0;i<m;i++)
{
       sum=unio(i,sum);
}

cout <<"MST: "<< sum << "\n"; //cost

int sec_best_mst=INT_MAX/3;

cout<<"All other spanning trees:\n";

sum=0;
int j;
for(j=0;j<va.size();j++)
{
    makeset(n);
    edg=0;
    for(int i=0;i<m;i++)
    {
        if(i==va[j]) continue;
```

```
        sum=unio2(i,sum);
      }
      if(edg!=n-1)
      {
        sum=0;
        continue;
      }
      cout<<sum<<"\n" ;
      if(sec_best_mst>sum) sec_best_mst = sum;
      sum=0;
    }

    cout<<"SEC BEST MST: "<<sec_best_mst<<"\n";

}


/*

    6 8
    1 3 4
    1 2 4
    2 3 2
    3 4 3
    3 6 4
    3 5 2
    4 6 3
    5 6 3
```

*/

8 Lab Tasks output



9. Discussion

The time complexity for second minimum spanning tree is : O(V^2). Here we use kruskal algorithm . It was much easier to implement kruskar than prims algorithm for second minimum spanning tree.