İ.T.Ü.

Bilgisayar ve Bilişim Fakültesi

Bilgisayar Mühendisliği Bölümü

ANALYSIS OF ALGORITHMS

HW2

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Description of how my program should be compiled and run:

I use Microsoft Visual C++ 2010 Express to develop the program. Program can be compiled and run on Linux/Unix using g++.

You should write a command like that for compile the Lightening a City solution Linux terminal.

```
g++ city.cpp graph.cpp –o city
```

You should give a command like that for run the Lightening a City solution after compilation.

```
./city
```

Description of homework

Economic crisis affected many countries. AOACountry is one of these countries. The government wants to make some savings. In the cities of AOACountry, street lights are turned on all night. The cost of a turned on street light is 1 AOALiras. The government decides to turn off some lights but they still want to establish a safe, peaceful environment. Therefore, the government wants to supply at least one lighted road from a crossroad to another crossroad even if the road is not the shortest path between the crossroads. Roads consist of one or more streets. Crossroads connect the streets to each other. Streets are dual carriageway; cars both go and come back from a street.

You are going to be given a city plan of some cities in AOACountry which holds crossroads and number of lights on the streets. By supplying the restriction of the government maximum how many AOALiras can be saved for a day?

City plan documentation format:

A city consists of m crossroads and n streets. You are going to be given an input file called “cityplan.txt”. The first line of the input file holds the numbers of m and n respectively. The following lines hold mi. and mj. crossroads and the number of the lights on the street between these crossroads (i != j).

As an output, print the lighted streets by representing them with crossroads that they connect. Give the total savings in AOALiras, and calculate and print the percentage of gain. In the last line, give the running time of the algorithm in milliseconds. You can run the algorithm for 1000 times in order to obtain a statistically significant value.

Input file format:

```
7 11
0 1 7
0 3 5
1 2 8
1 3 9
1 4 7
2 4 5
3 4 15
3 5 6
```

4 5 8
4 6 9
5 6 10

Output format:

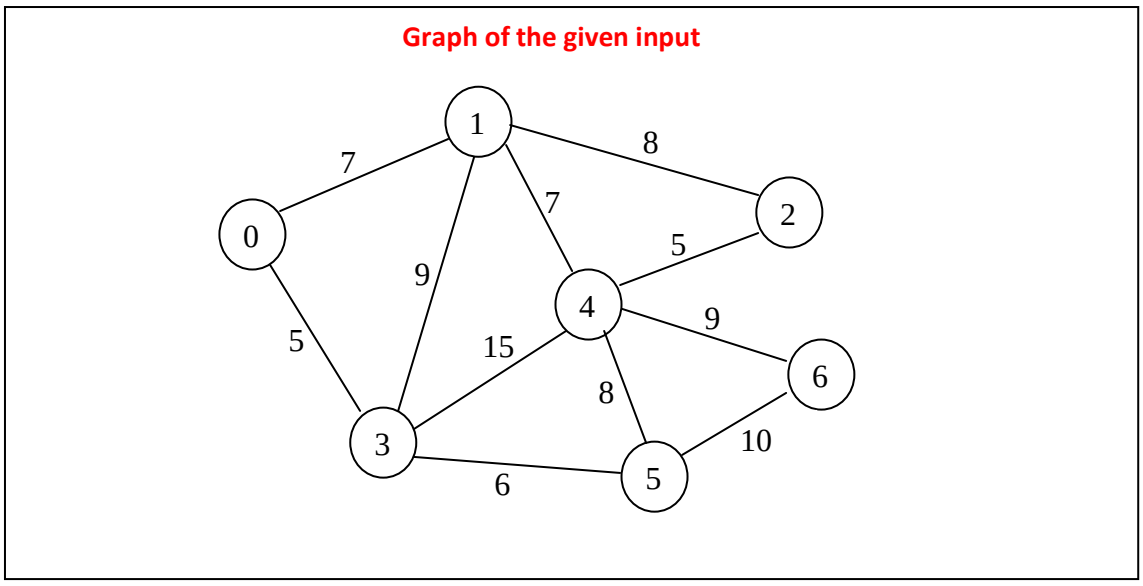
0 1
0 3
1 4
2 4
3 5
4 6
Total savings: 50 AOALiras

Total gain: (39 / 89) 43.82 %

Running time: 5 ms

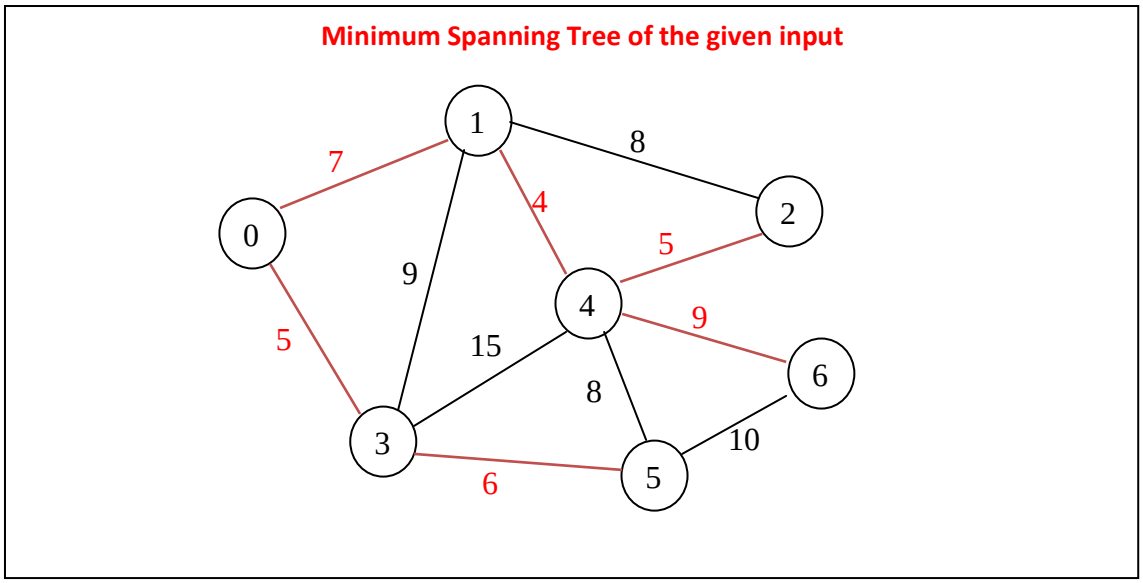
Solution of the problem

We can consider roads as a edges of graphs, crossroads as a nodes of graphs and street lights as a weight of an edge. Streets are dual carriageway; cars both go and come back from a street so graph is undirected.



The government wants to supply at least one lighted road from a crossroad to another crossroad. The government decides to turn off some lights but they still want to establish a safe, peaceful environment. If we think this situation on graphs, they want to cover every node. They also want to save maximum money from this operation. So if we make a tree which includes all nodes and if the tree has minimum weight we solve the problem.

We can use Minimum Spanning Tree algorithms to solve this problem. I choose Kruskal algorithm and solve this. You can see the solution below.



Kruskal algorithm in C++ code

```
void Graph::kruskal(){

	int *cycles = new int[m];

	vector<Edge*> edgescopy = edges; //not to loose original graph

	sort(edgescopy.begin(), edgescopy.end(), sortFunc);//sort edges according to
                                                           sortFunc function

	for(int i=0; i<m; i++)
		cycles[i] = i;

    while(mst.size()<(m-1) && edgescopy.size()){//if mst did not reach the maximum
                                                size and there is still edge in graph

	   if(cycles[edgescopy[0]->node1]!=cycles[edgescopy[0]->node2]){//if there is no cycle
		for(int i=0; i<m; i++){//for all nodes
			if(cycles[i]==cycles[edgescopy[0]->node2])
				cycles[i] = cycles[edgescopy[0]->node1];//rearrange cycles
                                                        (write the oldest connected edge)
		}
		mst.push_back(edgescopy[0]);//add to mst
	   }
		edgescopy.erase(edgescopy.begin(),edgescopy.begin()+1);//delete checked edge
    }
    for(int i=0;i<mst.size();i++)
		totalmst += mst[i]->weight;
}
```

Sorting = O(mlogm)

Make a set containing singleton u = O(n)

Look for u and v are different set = O(logn)

} So, algorithm runs O(mlogm) time.

My header files & explanations

This part of the report contains explanation about classes and necessary methods of the program.

_____edge.h_____

```
#ifndef __EDGE_H__
#define __EDGE_H__

#include <iostream>
#include <iomanip>
#include <cstdlib>
#include <fstream>
#include <string>

using namespace std;

class Edge{          //This class is a simple edge class.
                     //just include start node, finish
                     //node and weight of the edge
       public:
              int node1;
              int node2;
              int weight;
};

#endif
```

_____

_____graph.h_____

```
#ifndef __GRAPH_H__
#define __GRAPH_H__

#include "edge.h"
#include <vector>

using namespace std;

class Graph{         //This class is a graph class

              vector<Edge*> edges;       //Graph with contains edges
              vector<Edge*> mst;         //Minimum spanning tree of a graph

              int m;                     //node number
              int n;                     //edge number
              int totalmst;              //minimum weight
              int total;                 //weight

              void readData(string fileName);   //read data from txt file

       public:
              Graph(string fileName);    //constructor
              ~Graph();                  //destructor

              void kruskal();            //Kruskal algorithm which finds MST
              void writeData(int time);  //generate output file
              void clear();              //clears values for rerunning
};

#endif
```

_____