Assignment 4
Distributed Systems, Monsoon 2018
Deadline: 21st October 2018 at 9 PM

Q1) Minimum Spanning Tree

Implement a distributed algorithm in MPI to find the minimum spanning tree of an undirected graph.
You may refer the follow link to gain an approach to implement the algorithm parallely:
http://parallelcomp.uw.hu/ch10lev1sec2.html

Input Format:

First line of input contains two numbers : number of vertices (N) and number of edges (E), the following 'E' lines - v1 v2 w.
w corresponds to weight of the edge joining vertices v1 and v2.

Output Format:

The total weight of the MST constructed, the edges present in the MST with their corresponding weights.

Sample

Input:
5 5
0 1 2
0 3 6
1 3 8
1 2 3
1 4 5
2 4 7
3 4 9

Output:
16
0 1 2
1 2 3
0 3 6
1 4 5

Q2) Vertex Coloring

Given an undirected graph G, assign a color to every vertex such that no two adjacent vertices have the same color.

Total number of colors should not exceed d + 1 where d is the maximum degree of the graph.

Write an MPI program to find the optimal coloring to given graph G. The processes should communicate using **asynchronous message passing**.

Input Format :

First line of input contains two integers n and m. This is followed by m lines where each line is for an edge between 2 nodes in G.

Output Format:

Output the number of colors used in the first line followed by T (number of color) lines printing the color of nodes from 0 to T - 1.

Note: Your output may be different but ensure that it follows the mentioned constraints.

Sample:

Input:

```
6 7
0 1
0 2
1 3
2 3
3 4
3 5
4 5
```

Output:

```
3
0
1
1
0
1
2
```

Q3) Stable Marriage Problem

Let men and women each be array of *n* processes. Each man ranks the women from *0* to *n-1* and each woman ranks the men from *0* to *n-1.* A pairing is a one-to-one correspondence of men and women. A pairing is stable if, for two men m1 and m2 and their paired women w1 and w2, both of the following conditions are satisfied:

- m1 ranks w1 higher than w2 or w2 ranks m2 higher than m1; and
- m2 ranks w2 higher than w1 or w1 ranks m1 higher than m2.

Expressed differently, a pairing is unstable if a man and woman would both prefer each other to their current pair. A solution to the stable marriage problem is a set of n pairings, all of which are stable.

Write a distributed program to solve the stable marriage problem. The processes should communicate using **asynchronous message passing**. The men should send proposal and the women should listen. A woman has to accept the first proposal she gets, because a better one might not come along; however, she can dump the first man if she later gets a better proposal. Write the program using MPI. **Log the trace** of events (pairing, breaking), as they happen, in a text file named as *Log.txt*.

The number of slave processes will be 2n.

Input Format :

First line of input contains the integer n, denoting the number of men and women. The following 2n lines are the preferences of each person. The first n lines corresponds to the preferences of men and the second n lines corresponds to preferences of women.

Output Format:

Output n sorted lines (sorted wrt indices of men) with each line denoting the matched pair. The first element of the pair corresponds to the index of men and the second element to the matched women.

Sample:

Input:

4

3, 1, 2, 0

1, 0, 2, 3
0, 1, 2, 3
0, 1, 2, 3
0, 1, 2, 3
0, 1, 2, 3
0, 1, 2, 3
0, 1, 2, 3

Output (Men Women):
0 3
1 1
2 0
3 4

Q4) Walks in a graph
Given a directed graph, write a distributed MPI program to count all possible walks (both closed and open) of length k from every source and destination pairs.

Input Format:
First line contains three integers n, e, k, denoting the number of vertices, the number of edges and the required walk length.
Following ‘e’ lines contains 2 space separated integers A B, denoting a directed edge from A to B.

Output Format:
Output a single integer denoting the total number of walks in the graph.

Sample

Input:
4 5 2
1 2
1 3
1 4
3 4
2 4

Output:
2

Q5) 4-cycles in a Graph
Given an undirected graph G, write a distributed MPI program to calculate the total number of 4-vertex cycles in G.

Input Format:
First line contains two integers n, e, denoting the number of vertices, the number of edges in G..
Following ‘e’ lines contains 2 space separated integers A B, denoting an edge from A to B.

Output Format:
Output a single integer denoting the total number of 4-cycles in the graph.

Sample

Input
5 7
0 1
0 2
1 2
1 3
2 3
1 4
2 4

Output
3

Upload Format: Roll No.zip
Contents:
a. Q1.c/cpp
b. Q2.c/cpp
c. Q3.c/cpp
d. Q4.c/cpp
e. Q5.c/cpp

Note that plagiarism in any form will result in negative marks.