Chapter 5

TP Routing Algorithms

5.1 Subject

We model a computer network with a directed graph where we are only concerned whether there is at least one link from a data center to another data center. We use a binary matrix A (composed of 0 and 1) of size $n \times n$ where the indices of rows and columns correspond to different numbers of data centers encountered. A 1 at the location (i, j) of the matrix means that there is a link from data center i to the data center j. If there is no link between these two data centers, then $A(i, j) = 0$. Adjacency matrix A may be read in a file as given below :

0	1	1	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	0	0	0	0	0	0	0	0
0	1	0	1	0	0	0	1	0	0	0	0	0
1	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	1	0	0	0

Table 5.1: Adjacency Matrix

1. Imagine there are communication costs to transmit data from one data center to another one. Our first objective is to construct a routing table for each data center such that the transmission costs between any pair of centers is minimized. Costs are given by a cost matrix C as given below. Program and apply an algorithm (which one?) to find (if exists) shortest path between any pairs of data centers.

2. Imagine that you need to install cable between data centers to transmit data from on center to another one (do not consider the direction of the transmission for this question). The installation cost (if cable installation is possible) between any data centers is given

0	1	5	0	0	0	0	0	0	0	0	0	0
0	0	0	1	4	0	0	0	0	0	0	0	0
0	1	0	2	0	0	0	1	0	0	0	0	0
1	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	4	0	0	0	0	0	0
0	0	0	0	2	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	3	0	3	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0	6	0
0	0	0	0	0	0	0	0	0	0	0	0	7
0	0	0	0	0	0	0	0	0	8	0	0	0

Table 5.2: Cost Matrix

by a specific matrix. Find a solution (which cable should be installed?) that allow to link all data centers at minimum cost. Program and apply an appropriate algorithm (which one? Justify your choice)

3. Our third objective is to identify many clusters (or groups) of data centers. In each cluster, any data providing by a data center inside this cluster may be routed to another data center inside the same cluster. Program and apply an algorithm (which one?) to determine clusters.

4. Once the clusters have been identified, you are asked to provide a graph of clusters (a cluster is modeled by a node, communication links between two clusters are modeled by the edges of the graph). You should give a square matrix N. $N(x, y) = k$ if there is k links (possibly $k = 0$) from cluster x to level y. We obtain a weighted directed acyclic graph where the weight on each link represents the numbers of possible passageway between two clusters. For the given example, there are four clusters: {1,2,3,4}, {5,6,7}, {8,9}, {10,11,12,13}).

5. Write a brief report (2 pages) which gives : resume of the project, choice of data structures, choice of appropriate algorithms, answers to questions.

5.2 Example

For the following graph represented by its adjacency matrix,

0	1	0	0	0	0
1	0	1	0	0	0
0	0	0	1	0	0
0	0	0	0	1	0
0	0	0	0	0	1
0	0	1	0	0	0

Table 5.3: Adjacency matrix

- there are two clusters (cluster 1 in blue and cluster 2 in yellow) :

- the matrix N is :

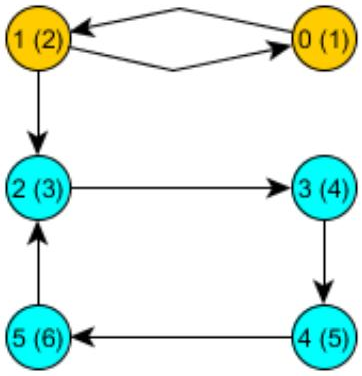

Figure 5.1: Clusters

0	0
1	0

Table 5.4: Adjacency matrix of clusters