McGill

Project Subject 1

Designing a Communication Network

ECSE 422: Fault Tolerant Computing – Winter 2016

Instruction:

Assume that you are asked to design a communication network connecting ***N*** cities using fiber optics. The costs of a direct link between each two cities are given in an input matrix, called **C**. So, C is an N×N matrix. The reliabilities of each fiber optic link (that connects two cities) are given by another N×N matrix called **R**. There can be **up to 3** fiber optic links between each two cities while the reliability and the cost of the parallel (redundant) links are equal. The network is considered operational (non-failed) as long as every two cities can have communication (direct connection or through other cities.

Write a program that can designs the optimal communication network in two selectable ways:

a) Meet a requested reliability goal while offering the minimum possible cost.

b) Meet a given cost constraint while offering highest possible reliability.

Your program may not be able find solutions for certain parameters. We will test the program with common inputs. So, if the program of Group *#i* can find a better solution compared to Group *#j* then Group *#j* will lose some points. Your program should take a text file as input defining the parameters. Here is the format of the input file and the outputs that your code must return.

```
%% Inputs
N            % number of cities
Matrix C     % N(N-1)/2 numbers (C is symmetrical), costs of inter-city
             % connection
Matrix R     % N(N-1)/2 numbers (matrix is symmetrical), reliabilities of
             % inter-city connections
a_b          % can be 1 or 0, indicates the problem that is to be solved
             % 0 means problem type a while 1 means problem type b (a and b
               described above)
```

Req_Reliability % Requested Reliability (will not be considered in problem type b, i.e., a_b=1)

Req_Cost % Requested cost (will not be considered in problem type a)

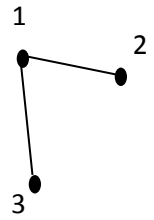
%%Outputs

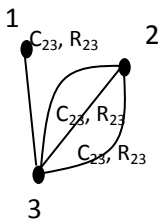
Matrix **Network** % N(N-1)/2 numbers. Each number, which can be 0, 1, 2 or 3, represents the number of redundant links between two cities. 0 represents no direct link.

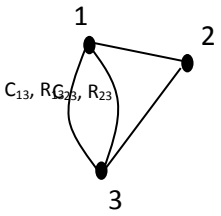
Cost % The overall cost of the designed network

Reliability % The reliability of the designed network

Example1: Following, you see three sample communication networks for connecting 3 cities and their corresponding ***Network*** matrix:







$$\begin{bmatrix}0 & 1 & 1\\ 1 & 0 & 0\\ 1 & 0 & 0\end{bmatrix} \qquad \begin{bmatrix}0 & 0 & 1\\ 0 & 0 & 3\\ 1 & 3 & 0\end{bmatrix} \qquad \begin{bmatrix}0 & 1 & 2\\ 1 & 0 & 1\\ 2 & 1 & 0\end{bmatrix}$$

Example2: For cost matrix of $\begin{bmatrix}0 & C_{12} & C_{13}\\ C_{12} & 0 & C_{23}\\ C_{13} & C_{23} & 0\end{bmatrix}$ the input C matrix in the input text file will look like:

$$\mathbf{C}= C_{12}\ ,\ C_{13}\ ,\ C_{23}$$

Programming language: You are free to use either C, C++, Python or Matlab for coding.

Deliverables: The source code, a 3-5 page report describing your algorithm and strategy (I may give you a sample input in coming weeks and ask you to include the snapshot of the result in your report).

Evaluation criteria:

1 The capability of your code to find better solutions.
2 Your algorithm (strategy) to solve the problem. Naïve strategies such as exhaustive search deserve to lose some points. Smart strategies will be given full credit. I do not compare the execution time of your codes, directly, since MATLAB code is naturally much slower than C or C++. I also do not expect you to report the timing order of your code (although I appreciate if you do). However, I will review and analyze your code and related description in your reports.

Team size: This small project can be accomplished **individually** or in a **team of two student**s. You are free to select you teammate.

Due date: April 8th, 2016 - 12:00PM