JDEP 283 **Homework 4** **Fall 2008**

Due Thursday, December 4, 2008

Name ______________________________

Instructions Follow instructions *carefully*. This homework consists of two parts; a set of analytical problem from the class text, Levitin, and a programming assignment. For the analytical part, you should solve all of them and submit them individually on or before the due date. For programing part, you are allowed to work with a partner of your choice. Programming part is based on linear programming. (A discription of the problem, given below, is also distributed by Prof. David Rosenbaum).
Clarity and legibility of presentation of your submission are as important as your answers to problems. You are very strongly advised to typeset your solution using some document processing system. If the grader cannot easily read your writings, you may not be awarded full points even if you claim your answers are correct. Staple this cover page to the front of your assignment for easier grading. For the programming part, be sure to submit all your program files via the webhandin. You should follow JDE coding standard which is available at the course homepage `http://www.cse.unl.edu/~vinod/jdef08/info.html`.

Problem	Page	Points	Score
8.3.3	298	5	
10.1.1a	349	5	
10.1.2abc	350	10	
10.1.9bc	351	15	
10.2.2ab	362	15	
problem sub total		50	
Program			
Correctness		40	
Style/Documentation		10	
program sub total		50	
Total		100	

TrainCo Project

Your team is part of TrainCo's (TC) IT Decision Technologies Group (DTG). Your goal is to develop a tool to minimize the cost of getting a variety of train cars from certain locations on TC's network to other locations.
A network is made up of nodes and links. A node is a starting or ending point for cars. A link connects two nodes. Not all nodes have links between them. There is a cost associated with moving a car along a link from one node to another. The cost varies by link. There is also a capacity or maximum number of cars that can travel across each link.
At the beginning of a period, orders arrive for cars that have to travel from one node to another. The Operations Department schedules the movement of cars for the period. Develop a linear programming tool to select the cost minimizing routes for cars to take in moving from their starting to ending nodes and calculate the total cost.
Let i and j represent two nodes on the network. Let h be the originating node for a car. Let $c_{i,j}$ equals the cost of moving a car from node i to node j and let x_{hij} equal the number of cars that start at node h and travel along the link from node i to node j. Then total cost is:

$$\text{Total Cost} \quad = \quad \sum_{hij} c_{ij} x_{hij}. \tag{1}$$

Linear programming is used to minimize the costs in equation (1) subject to the following constaints:

$$
\begin{aligned}
\sum_{j, i \neq j} (x_{hij} - x_{hji}) &= f_{hi} \text{ for all } h \text{ and } i && (2) \\
\sum_{h} x_{hij} &\leq y_{ij} \text{ for all nodes } i \text{ and } j. && (3)
\end{aligned}
$$

In equation (2), you are summing just over j, but do not include the elements x_{hij} or x_{ji} where $i = j$. In this equation, f_{hi} is the net inflow/outflow requirement at node i for cars that originated at node h. Positive numbers indicate net outflow. Negative numbers indicate net inflow. Thus $f_{hi} \geq 0$ for $h = i$ and $f_{hi} \leq 0$ for $h \neq i$. Finally, $\sum_{i} f_{hi} = 0$ for all h, meaning that the net flow of cars through the node must balance. In equation (3), $y_{i,j}$ is the maximum number of cars that can travel from node i to node j.

You will be given three files. The first contains a list of nodes and their identifiers. The format is: ⟨CHAR⟩, ⟨INT⟩. The second file contains a list of links. Each record has the starting node, ending node, cost of moving a car along the link and the maximum number of cars that can move along the link. Note that links are uni-directional so that there may be one record for a link starting at node i and ending at node j and another record for a link starting at node j and ending at node i. The format is ⟨INT⟩,⟨INT⟩,⟨REAL⟩,⟨INT⟩. In the third file, each record tells you a starting node and the number of cars at that node as well as upto to five ending nodes and the number of cars that have to go to each ending node. The format is ⟨INT⟩,⟨INT⟩,⟨INT⟩, ⟨INT⟩,⟨INT⟩,⟨INT⟩,⟨INT⟩,⟨INT⟩,⟨INT⟩,⟨INT⟩,⟨INT⟩. In this last file, if there are fewer than five ending nodes, the ending node and number of cars will be blank. Your output should tell the number of cars that pass along each link and the total cost.