Assignment 2 CEE 598 Traffic Modelling and Simulation

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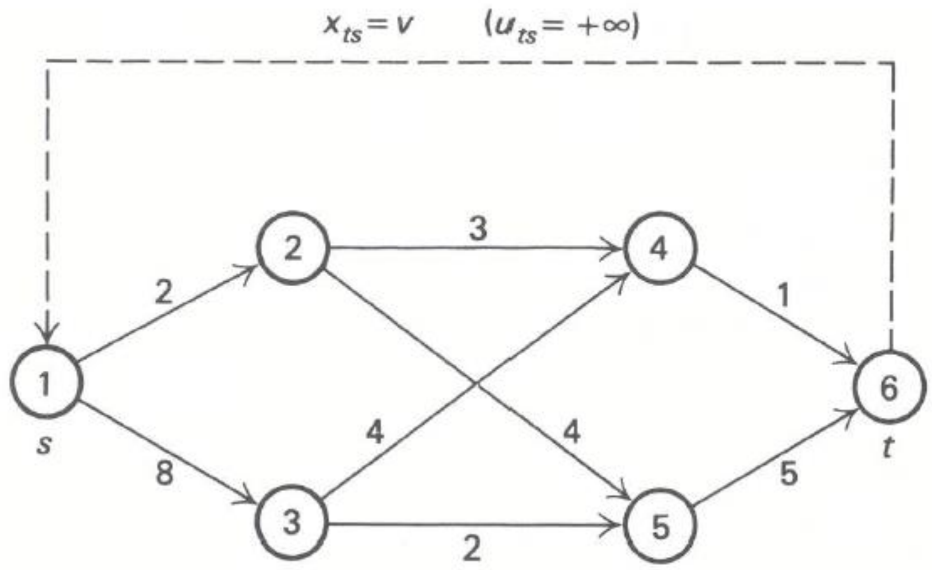
Q1 Maximum flow problem:

In this problem we are given 6 nodes in which we need to determine the maximum amount of flow which can be sent from source node 1 to sink node 6. We will solve this problem as follows:

In this we will introduce a virtual arc *t–s* with unlimited capacity as shown below:



Here x_{ts} simply returns the *v* units of flow from node *t* back to node *s*. Following conditions need to be satisfied to get solution.

$$\text{Maximize } x_{ts},$$

subject to:

$$\sum_j x_{ij} - \sum_k x_{ki} = 0 \qquad (i = 1, 2, \ldots, n),$$

$$0 \leq x_{ij} \leq u_{ij} \qquad (i = 1, 2, \ldots, n;\ j = 1, 2, \ldots, n).$$

Where x_{ij} represents the flow from node I to node j and k represents the intermediate nodes

Q2. Min-cost flow problem:

In this problem we need to determine the quantity of gas to be transported from its main field to the distribution center the whole quantity need to be transported subjected to the maximum usage rates and cost associated with each link and we our objective is to minimize the total cost of transportation subjected to following constraints:

$$\min \sum_{(v,w)\in E} c(v,w)f(v,w)$$

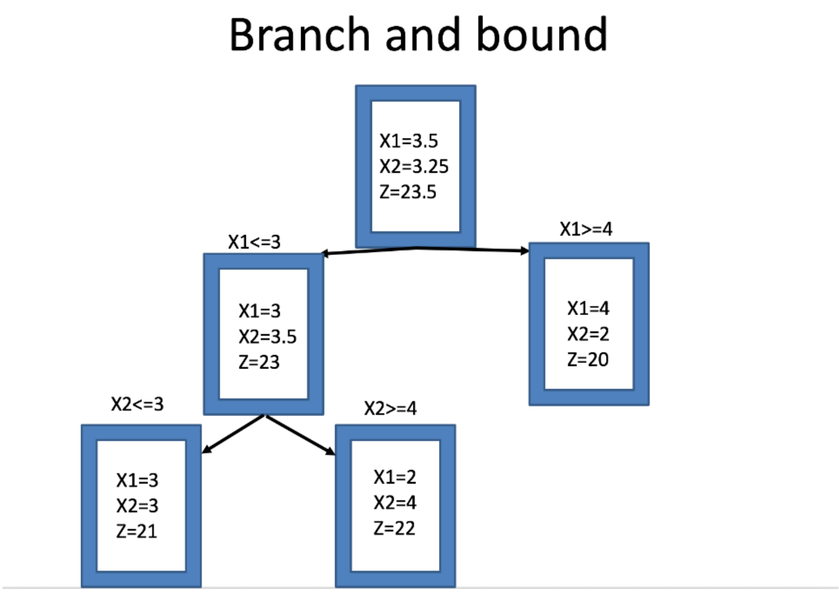
$$\textbf{subject to}$$

$$\begin{aligned} f(v,w) &\le u(v,w) && \forall (v,w)\in E \\ \sum_{w\in V} f(v,w) - \sum_{w\in V} f(w,v) &= b(v) && \forall v\in V \\ f(v,w) &\ge 0 && \forall (v,w)\in E \end{aligned}$$

Where v and w represents the node c(v,w) represents the cost associated with transportation of gas from node v to w. and f(v,w) represents the maximum usage of node v to w and b(v) represents the demand of node v.

Q3 Integer Programming model:

In this we are required to optimize the program in which some or all of the variables are integers in which we are given 3 equations which need to be maximized and find out the values of x_1 and x_2.



Q4 Warehouse Location Problem:

In this we are supposed to determine which warehouses to be operated and how much to ship from any warehouse to any customer which is formulated as follows:

$$y_i = \begin{cases} 1 & \text{if warehouse } i \text{ is opened,} \\ 0 & \text{if warehouse } i \text{ is not opened;} \end{cases}$$

$$x_{ij} = \text{Amount to be sent from warehouse } i \text{ to customer } j.$$

The relevant costs are:

f_i = Fixed operating cost for warehouse i, ifopened (for example, a cost to lease the warehouse),

c_{ij} = Per-unit operating cost at warehouse i plus the transportation cost for shipping from warehouse i to customer j.

There are two types of constraints for the model:

i) the demand d_j of each customer must be filled from the warehouses; and
ii) goods can be shipped from a warehouse only if it is opened.

The model is:

$$\text{Minimize } \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} + \sum_{i=1}^{m} f_i y_i,$$

subject to:

$$\begin{aligned}
&\sum_{i=1}^{m} x_{ij} = d_j && (j = 1, 2, \ldots, n),\\
&\sum_{j=1}^{n} x_{ij} - y_i \left(\sum_{j=1}^{n} d_j \right) \leq 0 && (i = 1, 2, \ldots, m),\\
&x_{ij} \geq 0 && (i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, n),\\
&y_i = 0 \quad \text{or} \quad 1 && (i = 1, 2, \ldots, m).
\end{aligned}$$