

## Problem Set 5

Due: Thursday, October 16, 2014

**Readings:** Chapter 5 of [BT].

**Note:** You would need to use an LP solver, for instance, CPLEX to which you have access.

**Problem 1: Exercise 5.2 of [BT]**

**Problem 2: Exercise 5.7 of [BT]**

**Problem 3: Exercise 5.13 of [BT]**

### Problem 4

Cisco's 12000 series routers are produced in three factories  $F_1, F_2$  and  $F_3$  and shipped from the factories to two distribution centers  $D_1$  and  $D_2$ . Let  $c_{ij}$  the transportation cost (in \$/router) from factory  $F_i$  to distribution center  $D_j$ , for  $i = 1, 2, 3$  and  $j = 1, 2$ . Let also  $p_i$ ,  $i = 1, 2, 3$ , the production cost (in \$/router) at factory  $F_i$ . We have

$$\mathbf{C} = (c_{ij}) = \begin{bmatrix} 10 & 100 \\ 80 & 120 \\ 60 & 50 \end{bmatrix}, \quad \mathbf{p} = (p_1, p_2, p_3) = (1100, 1400, 1250).$$

The monthly capacity at each factory  $i$  is denoted by  $u_i$  and the demand at distribution center  $j$  is denoted by  $d_j$ , for  $i = 1, 2, 3$  and  $j = 1, 2$ . We have

$$\mathbf{u} = (u_1, u_2, u_3) = (800, 1170, 1000), \quad \mathbf{d} = (d_1, d_2) = (1500, 1200).$$

Production should not exceed capacity at each factory and demand must be met at each distribution center.

- (a) Formulate as a linear programming problem the problem of devising a monthly production and transportation plan that minimizes the total production and transportation cost. You want to decide the number of routers produced at factory  $F_i$  and shipped to distribution center  $D_j$  for  $i = 1, 2, 3$  and  $j = 1, 2$ . Use CPLEX or any other LP solver to solve the problem and obtain sensitivity information.
- (b) If the demand at  $D_1$  increases by 100 routers, how is the optimal production and transportation cost affected ?

- (c) What is the impact on the total cost if we insist on producing one router at factory  $F_3$  and shipping it to distribution center  $D_1$  ?
- (d) Suppose the capacity at  $F_1$  increases to 1600. What is the impact on the optimal cost ? If you can not find the cost exactly calculate bounds on the impact in the cost. Justify your answer.
- (e) Suppose that the transportation cost from  $F_1$  to  $D_1$  increases by \$ 30. What is the impact on the optimal cost ? What is the new optimal production and transportation plan ?