Modeling with Auxiliary Decision Variables (4/12)

Exercise 1

Paris has come to you because she needs help paying off her credit card bills. She owes the amounts on her credit cards listed in the following table.

Credit Card	Balance	Monthly Rate
Saks Fifth Avenue	\$20,000	0.5%
Bloomingdale's	\$50,000	1.0%
Macy's	\$40,000	1.5%

Paris has agreed not to shop at any of these stores anymore, and she is willing to allocate up to \$5,000 per month to pay off these credit cards. All cards must be paid off within 36 months. Paris' goal is to minimize the total of all her payments.

To solve this problem, you must understand how interests on credit card loans are calculated. To illustrate, suppose Paris pays \$5,000 on Saks during month 1. Then her Saks balance at the beginning of month 2 is 20,000 – 5,000 + 0.005*20,000. This is because Paris incurs a 0.5% interest on her balance of 20,000 during month 1. The payment made during month 1 does not affect this interest.

Help Paris solve her problem by formulating it into a linear program.

Exercise 2

Recall the LP formulation from lab 5:

Input Data: - I: the set of fulfilment centers. - J: the set of demand regions. - K: the set of items - q_i is the capacity of FC i (in cubit feet). - d_{ij} is the distance from FC i to region j. - w_k is the shipping weight of item k (in lbs). - s_k is the storage size of item k (in cubit feet). - d_{jk} is the demand for item k in region j.

DV: Let x_{ijk} denote the amount of item k to ship from FC i to region j. (continuous)

LP: (It is assumed that i is summed over the set I, j over J and k over K.)

Minimize: $1.38 \sum_{i,j,k} w_k d_{ij} x_{ijk}$

subject to:

(FC capacity) $\sum_{j,k} s_k x_{ijk} \leq q_i$ for all fulfilment center i.

(Satisfying all demand) $\sum_{i} x_{ijk} \geq d_{jk}$ for all regions j and items k.

(Non-negativity) $x_{ijk} \geq 0$ for all i, j, and k.

Alter the above formulation to accommodate the following:

- every item can only be placed in at most 5 fulfilment centers.
- the total amount of each item shipped from a fulfilment center is either zero or at least 100 units.
- let the inventory level of item k at FC i before applying the above optimization be y_{ik}. Add the following non-linear term to the objective in a linear way. This term captures the cost of changing from current inventory level to the optimized level of $\sum_j x_{ijk}$.

$$0.01 \sum_{i,k} \left| y_{ik} - \sum_{j} (x_{ijk}) \right|$$