Santa Clara University

M5: Application Assignment

INSTRUCTIONS

Work with your group members to answer the following questions.

QUESTIONS

Question 1:

Snookers Restaurant is open from 8:00 a.m. to 10:00 p.m. daily. Besides the hours they are open for business, workers are needed an hour before opening and an hour after closing for setup and clean-up activities. The restaurant operates with both full-time and part-time workers on the following shifts:

Shift	Daily Pay Rate
7:00 a.m. – 11:00 a.m.	$32
7:00 a.m. – 3:00 p.m.	$80
11:00 a.m. – 3:00 p.m.	$32
11:00 a.m. – 7:00 p.m.	$80
3:00 p.m. – 7:00 p.m.	$32
3:00 p.m. – 11:00 p.m.	$80
7:00 p.m. – 11:00 p.m.	$32

The following numbers of workers are needed during each of the indicated time blocks.

Hours	Workers Needed
7:00 a.m. – 11:00 a.m.	11
11:00 a.m. – 1:00 p.m.	24
1:00 p.m. – 3:00 p.m.	16
3:00 p.m. – 5:00 p.m.	10
5:00 p.m. – 7:00 p.m.	22

7:00 p.m. – 9:00 p.m.	17
9:00 p.m. – 11:00 p.m.	6

At least one full time worker must be available during the hour before opening and after closing. Additionally, at least 30% of the employees should be full-time (8-hour) workers during the restaurant's busy periods from 11:00 a.m. – 1:00 p.m. and 5:00 p.m. – 7:00 p.m.

A. Formulate an ILP for this problem with the objective of minimizing total daily labor costs.
B. Implement your model and solve it.
C. What is the optimal solution?

Question 2:

A real estate developer is planning to build an apartment building specifically for graduate students on a parcel of land adjacent to a major university. Four types of apartments can be included in the building: efficiencies, and one-, two-, or three-bedroom units. Each efficiency requires 500 square feet; each one-bedroom requires 700 square feet; each two-bedroom apartment requires 800 square feet; and each three-bedroom unit requires 1,000 square feet.

The developer believes that the building should include no more than 15 one-bedroom units, 22 two-bedroom units, and 10 three-bedroom units. Local zoning ordinances do not allow the developer to build more than 40 units in this particular building location, and restrict the building to a maximum of 40,000 square feet.

The developer has already agreed to lease 5 one-bedroom units and 8 two-bedroom units to a local rental agency that is a "silent partner" in this endeavor. Market studies indicate that efficiencies can be rented for $350 per month, one-bedroom for $450 per month, two-bedrooms for $550 per month, and three-bedrooms for $750 per month.

How many rental units of each type should the developer include in the building plans in order to maximize the potential rental income from the building?

A. Formulate an LP model for this problem.
B. Create a model for this problem and solve it using Gurobi API.
C. What is the optimal solution?
D. Which constraint in this model limits the builder's potential rental income from increasing any further?

Question 3:

Bellows Lumber Yard, Inc. stocks standard length, 25-foot boards, which it cuts to custom lengths to fill individual customer orders. An order has just come in for 5,000 7-foot boards, 1,200 9-foot boards, and 300 11-foot boards. The lumber yard manager has identified six ways to cut the 25-foot boards to fill this order. The six cutting patterns are summarized in the following table:

Number of Boards Produced			
Cutting Pattern	**7-foot**	**9-foot**	**11-foot**
1	3	0	0

2	2	1	0
3	2	0	1
4	1	2	0
5	0	1	1
6	0	0	2

One possibility (cutting pattern 1) is to cut a 25-foot board into three 7-foot boards, and not to cut any 9- or 11-foot boards. Note that cutting pattern 1 uses a total of 21 feet of board and leaves a 4-foot piece of scrap. Another possibility (cutting pattern 4) is to cut a 25-foot board into one 7-foot board and two 9-foot boards (using all 25 feet of the board). The remaining cutting patterns have similar interpretations.

The lumber yard manager wants to fill this order using the fewest number of 25-foot boards as possible. To do this, the manager needs to determine how many 25-foot boards to run through each cutting pattern.

A. Formulate an LP model for this problem.
B. Create a model for this problem and solve it using Gurobi API.
C. What is the optimal solution?