School of Systems&Enterprises

EM 605

Elements of Operations Research

Lecture Problems

Solving Linear Programming Problems – Computer Solutions and Sensitivity Analysis

STEVENS INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY

The Crumbles Soup Company is a producer, in the midwestern U.S., of canned soups. The company's food processing plants are located in Columbus, Ohio and Indianapolis, Ind. The new director of logistics wants to reduce shipping costs from processing plants to distribution centers. The cost of shipping a case of soup from processing center to distribution center is shown below. The weekly capacity at the processing centers as well as the weekly requirements at the distribution centers are also provided in the table below:

	TOLEDO	**DAYTON**	**BOWLING**	**ST. LOUIS**	**Weekly Capacity (Cases)**
Columbus Indianapolis	$1.75 $ 1.90	$1.25 $1.25	$3.25 $2.50	$5.60 $3.00	3000 4000
Weekly Demand (cases)	1200	1800	900	2500	

The manager of a Burger Doodle-Do franchise wants to determine how many sausage biscuits and ham biscuits to prepare each morning for breakfast customers, and has brought you in (as a highly-overpaid consultant) to help decide. The two types of biscuits require the following resources:

Biscuit Type	Labor (hr)	Sausage (lb)	Ham (lb)	Flour (lb)
Sausage	0.01	0.1	------	0.04
Ham	0.024	------	0.15	0.04

The franchise has 6 hours of labor available each morning. The manager has a contract with a local grocer for 30 pounds of sausage and 30 pounds of ham each morning. The manager also purchases 16 pounds of flour. The profit for a sausage biscuit is $0.60 and the profit for a ham biscuit is $0.50.

a. What is the optimal solution point?
b. How much extra sausage and ham is left over at the optimal point?
c. Is there any idle labor time?
d. What (if anything) happens to the solution if the profit for a ham biscuit were to increase from $0.50 to $0.60?
e. What (if anything) is the effect on the optimal solution if the manager can get 2 additional pounds of flour?

Marie McCoy has committed to the local PTA to make some items for a bake sale next Saturday. She's decided to make some combination of chocolate cake, loaves of white bread, custard pies, and sugar cookies. Thursday evening, she went to the store and purchased 20 pounds of flour, 10 pounds of sugar, and 3 dozen eggs – the three main ingredients in all the baked goods she is thinking about making. The following table shows how much of each of the main ingredients is required for each baked good:

	Ingredients			
	Flour (cups)	**Sugar (cups)**	**Eggs**	**Baking Time (min)**
Cake	2.5	2	2	45
Bread	9	0.25	0	35
Pie	1.3	1	5	50
Cookies	2.5	1	2	16

There are 18.5 cups in a 5-pound bag of flour and 12 cups in a 5-pound bag of sugar. Marie plans to get up and start baking on Friday morning after her kids leave for school and finish before they return home after soccer practice (8 hours). She knows that the PTA will sell a chocolate cake for $12, a loaf of bread for $8, a custard pie for $10, and a batch of sugar cookies for $6. Marie must decide how many of each type of baked good she should make in order for the PTA to make the most money possible. She's turned to you, her friend, the highly-overpaid consultant, to help her.

For the PTA bake sale problem:

a. What is the optimal solution point?

b. If Marie could get any more of any ingredient, what should it be, and why?

c. If Marie could get 6 more eggs, 20 more cups of flour, or 30 more minutes of oven time, which should she get, and why?

d. Let's say we'd like the solution for this problem to be integer. If the solution values are not integers, how should Marie decide how many of each item to bake? How do total sales for the integer solution differ from the non-integer solution?

During the winter, Wee-Mow Lawn Service contracts with customers (both residential and commercial properties) to provide lawn care service starting in the spring. They've identified 50 possible residential customers and 15 potential commercial customers in the regional area they cover. Wee-Mow services a customer once every 2 weeks during the growing season. A residential lawn on average takes 1.2 hours to cut, and a commercial property requires 5 hours to cut; the service's available work time is 8 hours, 6 days per week. The profit for a residential lawn is $23, and the profit for a commercial property is $61. The service has established a weekly budget of $350 for management, gas, and other materials, plus equipment repair. Each residential lawn averages $12 in these costs, while each commercial property averages $20. Wee-Mow has heard of your professional success from the Burger Doodle-doo franchise and is willing to pay your exorbitant fee to determine the following:

a. How many residential and commercial jobs should Wee-Mow contract for from among its potential customers in order to maximize profits?
b. Which resources constrain how many jobs the service can contract for?
c. If Wee-Mow could increase its weekly budget by $50/week, or increase its workday to 9 hours, which would be more profitable?
d. If your optimal solution isn't integer, how should Wee-Mow express this discrepancy, and is there a way to handle it via the computer, without rerunning the problem?