

## Operations Management

### Homework 3

Due February 6, 2020

1. Magnolium Bakery needs to decide how many and what types of cupcakes to make for this week. Currently, they offer two flavors of cupcakes: blueberry lemon and red velvet. Blueberry lemon cupcakes sell for a profit of \$4 per cupcake, while red velvet cupcakes sell for the same profit of \$4 per cupcake.

There are two main ingredients in making their cupcakes: flour and sugar. Each blueberry lemon cupcake requires 2 cups of flour and 4 cups of sugar. Each red velvet cupcake requires 4 cups of flour and 3 cups of sugar. Magnolium has a total of 100 cups of flour and 120 cups of sugar to use. Also, they would like to make at least 5 blueberry lemon cupcakes.

Magnolium would like to determine how many of each type of cupcake to make.

a. Formulate the problem as a linear program.

b. Solve the linear program from part (a) above using Excel. Specifically, find the optimal number of each type of cupcake to make and the optimal profit of Magnolium. Please, submit a screenshot of your Excel spreadsheet including the solver parameters. Assume that fractions of cupcakes can be made.

2. Magnolium Bakery would like to expand their operations by introducing a new cupcake flavor: caramel cake. Caramel cake cupcakes sell for a profit of \$5 per cupcake. In addition, the bakery now needs to keep track of a new ingredient for each of their cupcakes, butter. The number of cups of each ingredient needed to make each cupcake flavor are given in the chart below.

Ingredient	Blueberry Lemon	Red Velvet	Caramel Cake
Flour	2	4	2
Sugar	4	3	4
Butter	0.2	0.3	0.1

Magnolium Bakery has 100 cups of flour, 120 cups of sugar, and 5 cups of butter available to make their cupcakes. As before, they would like to make at least 5 blueberry lemon cupcakes. In order to maximize their profit, the bakery has entered the following LP into Excel.

$$\begin{array}{ll}\text{maximize} & 4x_1 + 4x_2 + 5x_3 \\ \text{subject to} & \\ & 2x_1 + 4x_2 + 2x_3 \leq 100 \\ & 4x_1 + 3x_2 + 4x_3 \leq 120 \\ & 0.2x_1 + 0.3x_2 + 0.1x_3 \leq 5 \\ & x_1 \geq 5 \\ & x_1, x_2, x_3 \geq 0\end{array}$$

Solve the above LP using Excel and answer the following questions.

a. What is the optimal number of each cupcake flavor (fractions are allowed if necessary)? What is the maximum possible profit that Magnolium Bakery can earn? Please, print a copy of the Excel output.

b. Suppose that the profit of each blueberry lemon cupcake increases to \$6. Will this change the optimal number of blueberry lemon cupcakes?

c. By how much would the profit of a red velvet cupcake have to decrease before the bakery decides to reduce the number of red velvet cupcakes to make? (Assume that the profit of each blueberry lemon cupcake remains \$4.)

d. Suppose now that Magnolium Bakery is given an offer to buy one additional cup of butter at a price of \$1. Should they accept this offer? Why or why not? If the answer is yes, then what will be the new optimal amounts of each cupcake flavor?