

Assignment #3 – due Friday, January 31st, 2020

1. The Wisham family lives on a farm in South Georgia on which it produces a variety of crops and livestock, including pecans. It has 5 acres of pecan trees that yield approximately 1,000 pounds of unshelled pecans per acre each year. The family uses all of its pecan harvest to produce pecan pies, cookies, 1-pound bags of shelled pecans, and 5-pound bags of unshelled pecans, which it sells in town at the local farmers market. The family sells pies for \$5, packages of a dozen cookies for \$3, bags of shelled pecans for \$7, and bags of unshelled pecans for \$16. A shelled pecan is half the weight of an unshelled pecan. It requires 4 ounces of shelled pecans to make a pie, and 6 ounces of shelled pecans to make a dozen cookies. The pies and cookies are baked in the family oven, and there are 120 hours of baking time available. It takes 55 minutes to bake a batch of 4 pies and 15 minutes to bake a batch of 2 dozen cookies. It requires family members 6 minutes to shell the pecans for a pie and package it, 4 minutes to shell the pecans for cookies and to package them, 10 minutes to shell the pecans for a 1-pound bag of shelled pecans and package them, and 1 minute to package a bag of unshelled pecans; and there are 300 hours available from family members for shelling and packaging. The Wisham family wants to know how many pecan pies, dozens of cookies, and bags of shelled and unshelled pecans to produce in order to maximize its sales revenues. Formulate a linear programming model for this problem.
2. Solve the linear programming model formulated in the previous problem for the Wisham family farm using the computer.
 - (a) Are there any extra (slack) resources available?
 - (b) If the Wisham family could obtain additional resources, which one would be of most value to them? Assume that each additional pound of unshelled pecans and each additional hour of baking and packing time cost the same. How much would they be willing to pay for this resource? Why?
 - (c) If the family could obtain an additional 500 pounds of pecans or 30 hours of oven time, which should they choose?
 - (d) The family is thinking about buying a bigger oven for \$3,000. If they do so, they could make a batch of 5 pies or a batch of 3 dozen cookies at one time. Should they buy the oven? Explain your answer and base your decision on one year's sales only.
3. In the product mix example from Lecture 5, Quick-Screen is considering adding some extra operators who would reduce processing times for each of the four clothing items by 10%. This would also increase the cost of each item by 10% and thus reduce unit profits by this same amount (because an increase in selling price would not be possible).
 - (a) Can this type of sensitivity analysis be evaluated using only the original solution output, or will the model need to be solved again? Should Quick-Screen undertake this alternative?

Consider now the original formulation of the problem, prior to making the changes above.

- (b) In this problem, the profit per shirt is computed from the selling price minus fixed and variable costs. The computer solution output shows the shadow price for T-shirts to be \$4.11. If Quick-screen decided to acquire extra T-shirts, could the company expect to earn an additional \$4.11 for each extra T-shirt it acquires above 500, up to the sensitivity range limit of T-shirts?
- (c) If Quick-Screen produced equal numbers of each of the four shirts, how would the company reformulate the linear programming model to reflect this condition? What is the new solution to this reformulated model?
4. As a result of a recently passed bill, a congressmans district has been allocated \$4 million for programs and projects. It is up to the congressman to decide how to distribute the money. The congressman has decided to allocate the money to four ongoing programs because of their importance to his district – a job training program, a parks project, a sanitation project, and a mobile library. However, the congressman wants to distribute the money in a manner that will please the most voters, or, in other words, gain him the most votes in the upcoming election. His staff's estimates of the number of votes gained per dollar spent for the various programs are as follows:

Program	Votes/Dollar
Job training	0.02
Parks	0.09
Sanitation	0.06
Mobile library	0.04

In order also to satisfy several local influential citizens who financed his election, he is obligated to observe the following guidelines:

- None of the programs can receive more than 40% of the total allocation.
- The amount allocated to parks cannot exceed the total allocated to both the sanitation project and the mobile library.
- The amount allocated to job training must at least equal the amount spent on the sanitation project

Any money not spent in the district will be returned to the government; therefore, the congressman wants to spend it all. The congressman wants to know the amount to allocate to each program to maximize his votes.

- (a) Formulate a linear programming model for this problem.
- (b) Solve the model by using the computer.