HENDRIX
COLLEGE

Homework 3: Chapters 2 & 3

Mathematical Models

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Chapter 2

9. Reconsider the newspaper problem of Exercise 7, but now look at the newspaper's business expenses. The current weekly business expenses for the paper are as follows: \$80,000 for the editorial department (news, features, editorials); \$30,000 for the sales department (advertising); \$30,000 for the circulation department; and \$60,000 in fixed costs (mortgage, utilities, maintenance). The new management is considering cuts in the editorial department. It is estimated that the paper can operate with a minimum of a \$40,000/week editorial budget. Reducing the editorial budget will save money, but it will also affect the quality of the paper. Experience in other markets suggests that the paper will lose 2% of its subscribers and 1% of its advertisers for every 10% cut in the editorial budget. Management is also considering an increase in the sales budget. Recently the management of another paper in a similar market expanded its advertising sales budget by 20%. The result was a 15% increase in advertisements. The sales budget may be increased to as much as \$50,000/week, but the overall budget for business expenses will not be increased beyond the current level of \$200,000/week.

(a) Find the editorial and sales budget figures that maximize profit. Assume that the subscription price remains at \$1.50/week, and the advertising price stays at \$250/page. Use the five-step method, and model as a constrained optimization problem. Solve using the method of Lagrange multipliers.

(c) Draw a graph of the feasible region for this problem. Indicate the location of the optimal solution on this graph. Which of the constraints are binding at the optimal solution? How is this related to the shadow prices?

Chapter 3

2. Reconsider the pig problem of Example 1.1, but now suppose that the weight of the pig after t days is $w = 800/(1 + 3e^{-t/30})$ lbs.

(a) Show that the pig is gaining about 5 lbs/day at $t = 0$. What happens as t increases?

(b) Find the optimal time to sell the pig. Use the five-step approach, and model as a one–variable optimization problem.

10. Reconsider the newspaper problem of Exercise 7 in Chapter 2, but now suppose that we choose to maximize our profit margin (profit as a percentage of revenue). Assume that our business expenses remain fixed at \$200,000 per week.

(b) Let $z = f(x, y)$ denote the objective function you obtained in part (a). Use a computer algebra system to determine $F = \partial f/\partial x$ and$G = \partial f/\partial y$. Then determine $\partial F/\partial x$, $\partial F/\partial y$, $\partial G/\partial x$, and $\partial G/\partial y$.