

Assignment 3 (200 points)

Each question is worth 50 points. Questions 1 and 2 should be done in Excel (the formulation can be provided in a Word Document). Questions 3 and 4 should be done in a Word document.

Note, in addition to points being taken off for accuracy, points may also be taken off for lack of organization and failure to use Excel formulas and appropriate Cell referencing/addressing within the spreadsheets.

Instructions:

1. Formulate and Solve (Using Nonlinear Solver in Excel)

Start with a Blank Excel file and build the model from scratch. Clearly explain (type) your formulation.

A young R & D engineer at Carron Chemical Company has synthesized a sensational new fertilizer made of just two interchangeable basic raw materials. The company wants to take advantage of this opportunity and produce as much as possible of the new fertilizer. The company currently has \$40,000 to buy raw materials at a unit price of \$8000 and \$5000 per unit, respectively. When amounts x_1 and x_2 of the basic raw materials are combined, a quantity q of fertilizer results given by:

$$q = 4x_1 + 2x_2 - 0.5x_1^2 - 0.25x_2^2.$$

Formulate and solve as a constrained nonlinear program. Clearly indicate the variables, objective function, and constraints.

Leave the optimal solution in Excel. Clearly label variables, constraints, etc. Also, save your Excel file, I should be able to open Solver and see that you entered the formulation correctly.

2. Formulate and Solve (Using Nonlinear Solver in Excel)

Start with a Blank Excel file and build the model from scratch. Clearly explain (type) your formulation.

The area of a triangle with sides of length a , b , and c is $\sqrt{s(s-a)(s-b)(s-c)}$, where s is half the perimeter of the triangle. We have 60 feet of fence and want to fence a triangular-shaped area. Formulate a nonlinear program that will enable us to maximize the area of the fenced area. Formulate a constrained nonlinear program. Clearly indicate the variables, objective function, and constraints. *Recall, the length of a side of a triangle must be less than or equal to the sum of the lengths of the other two sides.*

Leave the optimal solution in Excel. Clearly label variables, constraints, etc. Also, save your Excel file, I should be able to open Solver and see that you entered the formulation correctly.

3. Goal Programming (Do Not Solve)

The Tiny Toy Company makes three types of new toys: the tiny tank, the tiny truck, and the tiny turtle. Plastic used in one unit of each is 1.5, 2.0 and 1.0 pounds, respectively. Rubber for one unit of each toy is 0.5, 0.5, and 1.0 pounds, respectively. Also, each tank uses 0.3 pounds of metal and the truck uses 0.6 pounds of metal during production. The average weekly availability for plastic is 16,000 pounds, 9,000 pounds of metal, and 5,000 pounds of rubber. It takes two hours of labor to make one tank, two hours for one truck, and one hour for a turtle. The company allows no more than 40 hours a week for production (priority #1). Finally, the cost of manufacturing one tank is \$7, 1 truck is \$5 and 1 turtle is \$4; a target budget of \$164,000 is initially used as a guideline for the company to follow.

- a) Minimize over-utilization of the weekly available supply of materials used in making the toys and place twice as much emphasis on the plastic (priority #2)

- b) Minimize the under and over-utilization of the budget. Maximize available labor hour usage (priority #3).

Formulate the above decision problem as a single linear goal program. Clearly identify your achievement vector (i.e., hierarchy of priority levels for the goals). Do not solve.

4. Goal Programming (Do Not Solve)

XYZ Company is planning an advertising campaign for its new product. The media considered are television and radio. Rated exposures per thousand dollars of advertising expenditure are 10,000 for TV and 7,500 for radio. Management has agreed that the campaign cannot be judged successful if total exposures are under 750,000. The campaign would be viewed as superbly successful if 1 million exposures occurred. In addition, the company has realized that the two most important audiences for its product are persons 18 to 21 years of age and persons 25 to 30 years of age. The following table estimates the number of individuals in the two age groups expected to be exposed to advertisements per \$ 1,000 of expenditures:

Exposures per \$1000		
Age	Television	Radio
18-21	2,500	3,000
25-30	3,000	1,500

Management has rank ordered five goals it wishes to achieve, arranged from highest to lowest priorities.

- Achieve total exposures of at least 750,000 persons.
- Avoid expenditures of more than \$100,000.
- Avoid expenditures of more than \$70,000 for television advertisements.
- Achieve at least 1 million total exposures.
- Reach at least 250,000 persons in each of the two age groups, 18-21 and 25-30 years. In addition, management realizes and wishes to account for the fact that the purchasing power of the 25-30 age group is twice that of the 18-21 age group.

Formulate the above decision problem as a single linear goal program. Clearly identify your achievement vector (i.e., hierarchy of priority levels for the goals). Do not solve.

Bonus (up to 25 points):

Solve Questions 1 and 2 using R or Python (or another software of your choice). Submit your code and input/output. Note, there are a number of packages available for either R or Python.