INSTITUTO SUPERIOR DE AGRONOMIA

Applied Operations Research

Goal programming – Exercises

1) The Dewright Company problem includes all three possible types of goals: a lower, one-sided goal (long-run profit); a two-sided goal (employment level); and an upper, one-sided goal (capital investment). Letting the decision variables *x*1, *x*2, *x*3 be the production rates of products 1, 2, and 3, respectively, we see that these goals can be stated as

profit goal is a lower one-sided goal: 12x1 + 9x2 + 15x3 ≥ 125

employment goal is a two-sided goal: 5x1 + 3x2 + 4x3 = 40

investment goal is an upper one-sided goal: 5x1 + 7x2 + 8x3 ≤ 55



Given the penalty weights incurred by missing these goals shown in the rightmost column of the table, find the production rates of the 3 products that minimize the sum of weighted penalties.

2) A project manager wants to find the quantities of 3 products. Producing 1 unit of: i) product 1 requires 40 employees, 2 tons of raw material and will bring the company a profit of 5 hundred €; ii) product 2 requires 30 employees, 4 tons of raw material and will bring the company a profit of 8 hundred €; and iii) product 3 requires 20 employees, 3 tons of raw material and will bring the company a profit of 4 hundred €.

The manager has 3 goals:

* The maximum number of employees that can be allocated to producing these 3 products is 100 employees
* There are 10 tons of raw material in the warehouse and he wants to consume no more no less than that
* The total profit is expected to be at least 30 hundred €

The manager suspects he might not be able to meet these 3 goals simultaneously therefore he sets some penalty weights to each of the goals:

* Each extra employee is associated to a penalty of 5
* Each ton below the goal is associated to a penalty of 8 (-) whereas each ton above the goal of 10 is associated to a penalty of 12 (+)
* If profit is less than 30 hundred €, each hundred € is associated to a penalty of 15

Formulate the problem as a linear programming problem and use excel solver (LP simplex) to find the combination of the 3 products that minimizes the penalties.

3) Reconsider the original version of the Dewright Co. problem presented in exercise 1 and summarized in the table below. After further reflection about the solution obtained by the simplex method, management now is asking some what-if questions.



a)Management wonders what would happen if the penalty weights in the rightmost column of the table were to be changed to 7, 4, 1, and 3, respectively. Would you expect the optimal solution to change? Why?

b) Management is wondering what would happen if the total profit goal were to be increased to wanting at least $140 million (without any change in the original penalty weights). Solve the revised model with this change.

c) Solve the revised model if both changes are made.

4) Consider the revised version of the Dewright Co. problem (exercise 1) now assuming the first-priority and second-priority goals as described in the table below. Using the simplex method (EXCEL solver) find the production rates for x1, x2, x3 that allow meeting the 2 sets of goals



a) solve the problem using the streamlined approach for preemptive goal programming and state goals have been met and/or any deviations to the goals.

b) Using preemptive goal programming and solve the problem sequentially describing which goals have been met and/or any deviations to the goals.

5) Davis is the owner of a resort hotel and to increase profits during the rest of the year, Davis wants to expand his convention business but, to do so, he needs to expand his conference facilities. So he hired a marketing research firm to determine the number and sizes of conference rooms that would be required by the conventions he wants to attract.

The results of this study indicated that Davis’s facilities should include at least 5 small (400 square foot) conference rooms, 10 medium (750 square foot) conference rooms, and 15 large (1,050 square foot) conference rooms.

Additionally, the marketing research firm indicated that if the expansion consisted of a total of 25,000 square feet, Davis would have the largest convention center among his competitors—which would be desirable for advertising purposes.

While discussing his expansion plans with an architect, Davis learned that he can expect to pay $18,000 for each small conference room in the expansion, $33,000 for each medium conference room, and $45,150 for each large conference room.

 Davis wants to limit his expenditures on the convention center expansion to approximately $1,000,000.

Determine the number of rooms to be built and the deviations to size expansion and budget limits:

a) considering all goals are equally important (non-preemptive goal programming)

b) considering the primary-goal is not exceeding the expansion size limit of 25000 sq ft (streamlined approach preemptive goal programming)

c) considering the primary-goal is building at least 15 large conference rooms (streamlined approach preemptive goal programming)