gkudeshi_09

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Assignment Overview :

This assignment focuses on exploring goal programming formulations and solutions to improve your understanding of crucial module outcomes. Throughout this task, you will develop expertise in formulating and modeling multi-objective models and categorizing goals based on their type and significance. The practical application involves a decision-making scenario within Emax Corporation's Research and Development Division. Management prioritizes maximizing total profit, maintaining workforce stability, and achieving a moderate increase in annual earnings. Importantly, the assignment emphasizes excluding any substantial earnings increase from the optimization process, reflecting management's strategic considerations for shareholder satisfaction and long-term sustainability.

Problem

The Research and Development Division of the Emax Corporation has developed three new products. A decision now needs to be made on which mix of these products should be produced. Management wants primary consideration given to three factors: total profit, stability in the workforce, and achieving an increase in the company's earnings next year from the $75 million achieved this year. In particular, using the units given in the following table, they want to

Maximize Z = P - 6C - 3D,

P = total (discounted) profit over the life of the new products, C = change (in either direction) in the current level of employment, D = decrease (if any) in next year's earnings from the current year's level.

The amount of any increase in earnings does not enter into Z, because management is concerned primarily with just achieving some increase to keep the stockholders happy. (It has mixed feelings about a large increase that then would be difficult to surpass in subsequent years.)

1. Define y1+ and y1-, respectively, as the amount over (if any) and the amount under (if any) the employment level goal. Define y2+ and y2- in the same way for the goal regarding earnings next year. Define x1, x2, and x3 as the production rates of Products 1, 2, and 3, respectively. With these definitions, use the goal programming technique to express y1+, y1- , y2+ and y2- algebraically in terms of x1, x2, and x3. Also express P in terms of x1, x2, and x3.
2. Express management's objective function in terms of x1, x2, x3, y1+, y1- , y2+ and y2-.
3. Formulate and solve the linear programming model. What are your findings?

Conclusion

1. Employment Penalty Representation:

- Variables: y1+ (over the goal) and y1- (under the goal) express penalties for the change in current employment levels.
- Significance: Reflects the deviation from the employment goal of 5000 employees.

2. Earnings Penalty Representation:

- Variables: y2+ (over the goal) and y2- (under the goal) signify penalties for the change in next year's earnings.
- Context: Captures the adjustment needed for achieving the desired earnings increase.

3. Linear Programming Models:

- Formulation: Models are created using y1a, y1b, y2a, y2b in terms of y1+, y1-, y2+, y2- respectively.
- Purpose: Sets the foundation for optimizing the decision-making process.

4. Production Rate Decision:

- Variables: x1, x2, x3 represent the production rates for products 1, 2, and 3.
- Optimization: To achieve maximum profit, 15 units of Product 3 are recommended.

5. Employment Stabilization Challenge:

- Objective: To stabilize employment at 5000, but y1a (exceeding by 2500 employees) incurs a penalty.
- Trade-off: Balancing profit maximization with workforce stability.

6. Earnings Stability:

- Variables: y2a and y2b capture changes in next year's earnings (in this case, "0").
- Outcome: Indicates a stable earnings forecast for the following year.

7. Objective Function Value:

- Profit Maximization: The objective function value of $225 million represents the sought-after profit.
- Conclusion: Illustrates the financial goal the corporation aims to achieve in this specific scenario.

Summary

• Started by installing the "lpSolveAPI" library, is used to activate linear programming problem solving, providing functions for model formulation and optimization.

• In this decision-making scenario for Emax Corporation's new products, the objective is to maximize the expression Z = P - 6C - 3D, where P represents total discounted profit, C denotes the change in employment, and D signifies the decrease in next year's earnings.

• The management, prioritizing profit, workforce stability, and a modest earnings increase, formulates goals and employs goal programming. The linear programming model is expressed in an ".lp" file, defining the objective function and constraints.

• Upon solving, the optimal solution indicates a maximum objective value of 225, with production rates for the three products and specific values for employment and earnings adjustments. This analysis aligns with management's goals and aids in decision-making for product production.

Loaded datasets from the necessary libraries

```
library(lpSolveAPI)
```

The following R code reads an optimization problem from a file named "gkudeshi.lp" and stores it in an object named "x"

```
x <- read.lp("gkudeshi_09.lp")
x
```

```
## Model name:
##                x1    x2    x3   y1a   y1b   y2a   y2b
## Maximize       20    15    25    -6    -6     0    -3
## Constraint1     6     4     5    -1     1     0     0   =  50
## Constraint2     8     7     5     0     0    -1     1  >=  75
## Kind          Std   Std   Std   Std   Std   Std   Std
## Type         Real  Real  Real  Real  Real  Real  Real
## Upper         Inf   Inf   Inf   Inf   Inf   Inf   Inf
## Lower           0     0     0     0     0     0     0
```

The following R code performs optimization using the "solve" function on the variable 'x', retrieves the objective value, variable values, and constraints from the optimization result

```
solve(x)
```

```
## [1] 0
```

```
get.objective(x)
```

```
## [1] 225
```

```
get.variables(x)
```

```
## [1]  0  0 15 25  0  0  0
```

```
get.constraints(x)
```

```
## [1] 50 75
```