Goal Programming Adithya

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SUMMARY These results showcase the identification of an optimal solution for the goal programming problem, providing valuable insights into recommended production levels and variations from the targets for each product. The decision variable values, under imposed constraints and penalties, address target deviations and aim to maximize profit. The optimal solution, with a linear programming value of 225, signifies the attainment of the best possible outcome within the specified conditions, aligning with the goal function.

The slack variables serve as indicators of precise constraint fulfillment or surplus, while the decision variables unveil the optimal choices for each scenario. Considering products (x_1, x_2, x_3) and constraints (Employment level, Earnings next year), the employment constraint (6x_1 + 4x_2 + 5x_3 = 50) and earnings next year constraint (8x_1 + 7x_2 + 5x_3 ≥ 75) are integral components. Expressing the total discounted profit (P = 20x_1 + 15x_2 + 25x_3) and incorporating change (C) in current employment level and decrease (D) in earnings for the following year, the management's objective function is represented as MaxZ = 20x_1 + 15x_2 + 25x_3 - 6(y_1^- + y_1^+) + 0(y_2-)-3(y_2+). 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, where 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? ***

```r
library(lpSolve)
library(lpSolveAPI)
em <- read.lp("C:\\Users\\manit\\Downloads\\Goal.lp")
print(em)
```

```
## Model name:
##             X1    X2    X3   Y1P   Y1M   Y2M   Y2P
## Maximize    20    15    25    -6    -6    -3     0
## R1           6     4     5    -1     1     0     0  =  50
## R2           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
```

```r
ematrix <- matrix(c("Total Profit", "Employment Level", "Earnings Next Year",
                    20,6,8,
                    15,4,7,
                    25,5,5,
                    "Maximize","=50",">=75",
                    "Millions of Dollars", "Hundreds of Employees",
"Millions of Dollars"), ncol=6, byrow = F)
colnames(ematrix) <- c("Factor","Product 1", "Product 2", "Product 3",
"Goal", "Units")
as.table(ematrix)
```

```
##   Factor             Product 1 Product 2 Product 3 Goal
## A Total Profit       20        15        25        Maximize
## B Employment Level   6         4         5         =50
## C Earnings Next Year 8         7         5         >=75
##   Units
## A Millions of Dollars
## B Hundreds of Employees
## C Millions of Dollars
```

```r
solve(em)
```

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

```r
get.objective(em)
```

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

```r
get.variables(em)
```

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