Goal Programming

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Assignment 5 | Module 9

The purpose of this assignment is to explore goal programming formulations and solutions.

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.) The impact of each of the new products (per unit rate of production) on each of these factors is shown in the following table:

	Unit Contribution				
	Product:				
Factor	**1**	**2**	**3**	**Goal**	**Units**
Total profit	20	15	25	Maximize	Millions of dollars
Employment level	6	4	5	= 50	Hundreds of employees
Earnings next year	8	7	5	≥ 75	Millions of dollars

Formulate the Goal Liner Programming model

Objective function:

$$Max\ Z = 20x_1 + 15x_2 + 25x_3 - 6y_{1^-} - 6y_{1^+} - 3y_{2^-}$$

S.T :

Employment Level

$$6x_1 + 4x_2 + 5x_3 + y_{1^-} - y_{1^+} = 50$$

Earnings Next Year

$$8x_1 + 7x_2 + 5x_3 + y_{2^-} - y_{2^+} = 75$$

Nonnegativity contraint

$$x_j \geq 0,\ where\ j = 1, 2, 3$$
$$y_{i^+} \geq 0,\ where\ i = 1, 2$$
$$y_{1^-} \geq 0,\ where\ i = 1, 2$$

Now, let's write the goal programming problem utilizing R Studio.

```
# Load the library needed
library(lpSolveAPI)

# Load the data
emax <- read.lp("emax.lp")
emax
```

```
Model name:
            x1    x2    x3   y1m   y1p   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
```

```
# Solve the goal programming
solve(emax)
```

```
[1] 0
```

As we can confim, the solver is giving 0 which means it is finding a solution.

```
# To get the objective solution
get.objective(emax)
```

```
[1] 225
```

Here, we are maximazing the profit while minimizing other business goals like workforce and earnings. As this value shows, the penalty for not satisfying the goals on the objective function is 225.

```r
# To get the variables solution
get.variables(emax)
```

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

This order is from how the variables were written in the objective function. In our case, the results are as follows: $x_1 = 0$, $x_2 = 0$, $x_3 = 15$, $y_{1^-} = 0$, $y_{1^+} = 25$, $y_{2^-} = 0$, $y_{2^-} = 0$, which means that the earnings (y_2) expectations are fully satisfied. Regarding the workforce, the goal projected is exceded by 25 and based on the total profit of product 3, it has a negative result on its profit by 15.