Assignment 5 - Goal Programming

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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.

Objective Function
Maximize Z = P - 6C - 3D, where
P = Total discounted profit over the life of the new products,
C = Change in either direction towards the current level of employment,
D = decrease if any in next year's earnings from the current year's level.

Loading required packages

```
library(lpSolve)
```

```
## Warning: package 'lpSolve' was built under R version 4.1.3
```

```
library(lpSolveAPI)
```

```
## Warning: package 'lpSolveAPI' was built under R version 4.1.3
```

Loading the LP file from the current directory and printing the model
Defining y1p and y1m as the amount over (if any) and the amount under (if any) the employment level goal.
Defining y2p and y2m 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.
Also expressing P in terms of x1, x2 and x3 and the objective function in terms of x1, x2, x3, y1p, y1m , y2p and y2m

```
emax_rd <- read.lp("emax.lp")
print(emax_rd)
```

```
## 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
```

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

```
table_emax <- 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, 

colnames(table_emax) <- c("Factor","Product 1", "Product 2", "Product 3", "Goal", "Units")

as.table(table_emax)
```

```
##   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
```

Solving the goal programming model to obtain the objective and variable values

```
solve(emax_rd)
```

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

```
get.objective(emax_rd)
```

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

```
get.variables(emax_rd)
```

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

Interpretation: 1.The units of combination which the firm needs to implement in order to maximize the objective function are X1 - Product 1, X2 - Product 2 and X3 - Product 3. It states that 20 units of Product 1 and 15 units of product 2 cannot be produced as expected as the resultant solution is 0. However, there is a change to X3 which means that only product that can be produced is product 3. ***15 Units of Product 3 to maximize the profit.***

2. The firm exceeded the employment levels by 25 hundred employees (Y1P) whereas the original goal was to stabilize the employment level with the maximum number of employees confined to 50 hundred employees. The company has to pay penalty for the rise in the employees count.
3. The primary goal of Y2P and Y2M was to determine the increase or decrease in the next year earnings. It can be clearly interpreted that there is no increase or decrease in the next year earnings as the current level states "0".
4. The profit that the firm is maximizing is 225 Million Dollars which can be clearly interpreted from the objective function value.