

Assignment 5 - Goal Programming

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2022-11-06

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, byrow=TRUE)

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.To maximize the goal function, the company must use the units of combination X1 - Product 1, X2 - Product 2, and X3 - Product 3. It claims that because the final answer is zero, it is impossible to manufacture 20 units of Product 1 and 15 units of Product 2 as anticipated. The only product that can be manufactured, however, is product 3 as a result of a change to X3. **15 Units of Product 3 to maximize the profit.**

2.While the initial objective was to stabilize the employment level with a maximum of 50 hundred employees, the company exceeded the employment levels by 25 hundred employees (Y1P). Due to the increase in staff, the corporation must pay a penalty.

3. Determining whether the earnings for the following year would increase or fall was the main objective of Y2P and Y2M. Given that the present level is “0,” it is obvious that there will be no change in earnings for the following year.
4. The objective function value makes it evident that the company is maximizing a profit of 225 million dollars.