

# Assignment-5

Ashvitha Mothakani

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Three new products have been developed by Emax Corporation's Research and Development Division. It is now necessary to decide which combination of these products should be produced. Three factors should be given priority consideration by management:

1. Total Profit, 2. Stability in the workforce and 3. 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 new product's life,  $C$  = Change in either direction in relation to current employment levels  $D$  = If there is a decrease in earnings from the current year, it will be minimal..

```
knitr::opts_chunk$set(message = FALSE)
knitr::opts_chunk$set(warning = FALSE)
```

Loading the required libraries

```
library(lpSolve)
library(lpSolveAPI)
```

The LP file from the current directory and the model printing

$Y1p$  and  $y1m$  are defined as the amount over (if any) and under (if any) the employment level goal.

Defining  $y2p$  and  $y2m$  in the same way for the earnings goal next year.

Define  $x1$ ,  $x2$ , and  $x3$  as the respective production rates of Products 1, 2, and 3.

Expressing  $P$  in terms of  $x1$ ,  $x2$ , and  $x3$ , as well as the objective function in terms of  $x1$ ,  $x2$ , and  $x3$ , as well as  $y1p$ ,  $y1m$ ,  $y2p$ , and  $y2m$

```
emax_rd <- read.lp("C:/Users/mashv/Downloads/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 following table shows the impact of each new product (per unit rate of production) on each of these factors:

```
emax_table <- 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(emax_table) <- c("Factor", "Product 1", "Product 2", "Product 3", "Goal", "Units")
as.table(emax_table)
```

```
##   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
```

Determining the objective and variable values by solving the goal programming model

```
solve(emax_rd)
```

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

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

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

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

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

### Explanation

1. In order to maximize the target function, the objective function must use  $X_1$ ,  $X_2$ , and  $X_3$  as combination units. The final solution was “0,” as indicated by the codes  $X_1$  for Product 1,  $X_2$  for Product 2, and  $X_3$  for Product 3, implying that 20 units of Product 1 and 15 units of Product 2 could not be manufactured. Because  $X_3$  has changed, the corporation can only produce 15 pieces of Product 3—the only product—to increase profits.

2. The goal was to stabilize the employment level with a maximum of 50 Hundred Employees, but in this case, the firm exceeded the employment levels by 25 Hundred Employees ( $y_1p$ ), for which they would be penalized.

3.  $y_2p$  and  $y_2m$  were designed to capture the increase or decrease in next year’s earnings from the current level, which in this case is “0,” indicating that there is no increase or decrease in next year’s earnings when compared to the current year. As a result, earnings for the following year are stable.

4. The objective function value, which in our case is 225 million dollars, represents the profit that the firm seeks to maximize.