QMM Module 9

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Based on the problem statement, the goal is to:

Maximize Z = P - 6*C - 3*D

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.

Subject to:

Total Profit: Maximize P = 20*X1 + 15*X2 + 25\*X3

Employment Level: 6*X1 + 4*X2 + 5\*X3 = 50

Earnings Next Year: 8*X1 + 7*X2 + 5\*X3 >= 75

As a result, the auxillery variables become:

Y1 = 6*X1 + 4*X2 + 5*X3 - 50 Y2 = 8*X1 + 7*X2 + 5*X3 - 75

Which becomes:

(Y1P - Y1M) = 6*X1 + 4*X2 + 5*X3 - 50 (Y2P - Y2M) = 8*X1 + 7*X2 + 5*X3 - 75

Therefore, the final setup of the problem statement is:

Maximize Z = 20*X1 + 15*X2 + 25*X3 - 6*Y1P - 6*Y1M - 3*Y2M

Subject to:

6*X1 + 4*X2 + 5*X3 - (Y1P - Y1M) = 50 8*X1 + 7*X2 + 5*X3 - (Y2P - Y2M) = 75

And:

X1, X2, X3 >= 0 Y1P, Y1M, Y2P, Y2M >= 0

Lastly, we will run this problem in R as a linear programming model and discuss the results.

# This problem will require the "lpSolveAPI" library  
require(lpSolveAPI)

## Loading required package: lpSolveAPI

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

#Set Working Directory  
getwd()

## [1] "D:/MSBA/QMM/Assignment module 9"

setwd("D:/MSBA/QMM/Assignment module 9")

# Import the .lp file for this problem  
lpm <- read.lp(filename = "emax.lp", type = "lp")  
# Return the linear programming model  
lpm

## 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

# Solve the linear programming model  
solve(lpm)

## [1] 0

get.objective(lpm)

## [1] 225

get.variables(lpm)

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

Based on the output of the linear programming model, we can conclude several things.

X1 = 0 X2 = 0 X3 = 15 Y1P = 25 Y1M = 0 Y2M = 0 Y2P = 0

This leads us to the conclusion that only product 3 should be included in the product mix. A 225 unit object value would result from this combination. The employment level goal will be exceeded by 25 units, which translates to 2,500 employees and a penalty of 150 units to the objective function, while the profits goal for the upcoming year is fully satisfied.