Qmm Assignment1

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Three satellite facilities owned by the Weigelt Corporation have extra manufacturing capability. The good news is that the company has a new product ready to start production, and all three factories have the capacity to do so, so part of the surplus capacity may be utilized in this way. There are three sizes that may be produced for this item: large, medium, and small, with corresponding net unit profits of $420, $360, and $300. Regardless of the size or mix of sizes involved, plants 1, 2, and 3 have the surplus capacity to create 750, 900, and 450 units of this #product each day, respectively.  
  
The manufacturing rates of a new product are limited by available in-process storage space in Plants 1, 2, and 3, with daily requirements for big, medium, and small sizes. Sales projections suggest these sizes would sell 900, 1,200, and 750 pieces daily.  
  
By calculating the percentage of each plant's size output, management intends to develop a new product using the extra capacity of all factories, with the goal of minimizing layoffs and maximizing profit.  
  
  
a. Define the decision variables  
  
The variables that should be considered while making a choice include how many units of the new product, regardless of its size, should be produced at each factory to increase the company's profit.  
  
Note:  
  
#$X\_i$ = means the number of units produced on each plant, where $i$= 1 (Plant 1), 2 (Plant 2), and 3 (Plant 3)  
  
#L, M, and S = means the product's size, where L = large, M = medium, and S = small.  
  
#The decision variables are:  
  
#$X\_iL$ = number of large items produced on plant $i$, where $i$= 1 (Plant 1), 2 (Plant 2), and 3 (Plant 3).  
  
#$X\_iM$ = number of medium items produced on plant $i$, where $i$= 1 (Plant 1), 2 (Plant 2), and 3 (Plant 3).  
  
#$X\_iS$ = number of small items produced on plant $i$, where $i$= 1 (Plant 1), 2 (Plant 2), and 3 (Plant 3).  
  
#b. Formulate a linear programming model for this problem.  
  
#Let  
  
#$X\_iL$ = number of large items produced on plant $i$, where $i$= 1 (Plant 1), 2 (Plant 2), and 3 (Plant 3).  
  
#$X\_iM$ = number of medium items produced on plant $i$, where $i$= 1 (Plant 1), 2 (Plant 2), and 3 (Plant 3).  
  
#$X\_iS$ = number of small items produced on on plant $i$, where $i$= 1 (Plant 1), 2 (Plant 2), and 3 (Plant 3).  
  
#Maximize profit  
  
#$Z= 420 \ (X\_1L + X\_2L + X\_3L) + 360 \ (X\_1M + X\_2M + X\_3M) + 300 \ (X\_1S + X\_2S + X\_3S)$  
#Constraints:  
  
#Total number of size’s units produced regardless the plant:  
  
#$L = X\_1L + X\_2L + X\_3L$  
  
#$M = X\_1M + X\_2M + X\_3M$  
  
#$S = X\_1S + X\_2S + X\_3S$  
#Production capacity per unit by plant each day:  
  
#Plant 1 = $X\_1L + X\_1M + X\_1S \ 750$  
  
#Plant 2 = $X\_2L + X\_2M + X\_2S \ 900$  
  
#Plant 3 = $X\_3L + X\_3M + X\_3S \ 450$  
#Storage capacity per unit by plant each day:  
#Plant 1 = $20 X\_1L + 15 X\_1M + 12 X\_1S \ 13000$  
  
#Plant 2 = $20 X\_2L + 15 X\_2M + 12 X\_2S \ 12000$  
  
#Plant 3 = $20 X\_3L + 15 X\_3M + 12 X\_3S \ 5000$  
  
#Sales forecast per day:  
  
#$L = X\_1L + X\_2L + X\_3L \ 900$  
  
#$M = X\_1M + X\_2M + X\_3M \ 1200$  
  
#$S = X\_1S + X\_2S + X\_3S \ 750$  
#The plants should use the same percentage of their excess capacity to produce the new product.  
  
#$\dfrac {X\_1L + X\_1M + X\_1S} {750}$ = $\dfrac {X\_2L + X\_2M + X\_2S} {900}$ = $\dfrac {X\_3L + X\_3M + X\_3S} {450}$  
  
  
#It can be simplified as:  
#a) $900 (X\_1L + X\_1M + X\_1S) - 750 (X\_2L + X\_2M + X\_2S) = 0$  
  
#b) $450 (X\_2L + X\_2M + X\_2S) - 900 (X\_3L + X\_3M + X\_3S) = 0$  
  
#c) $450 (X\_1L + X\_1M + X\_1S) - 750 (X\_3L + X\_3M + X\_3S) = 0$  
  
#All values must be greater or equal to zero  
  
#$L, M,$ and $S \ge 0$  
  
#$X\_iL, X\_iM,$ and $X\_iS \ge 0$  
  
#---------------SOLUTION USING R---------------------------  
  
```r  
# Import the lpSolve package.   
library(lpSolve)  
  
  
# Setting coefficients of the objective function assignment\_objfunc  
assignment\_objfunc <- c(420, 420, 420,  
 360, 360, 360,  
 300, 300, 300)  
# Setting the left hand side of the problem's constraints as assignment\_leftconst  
assignment\_leftconst <- matrix(c(1, 1, 1, 0, 0, 0, 0, 0, 0,  
 0, 0, 0, 1, 1, 1, 0 ,0, 0,  
 0, 0, 0, 0, 0, 0, 1, 1, 1,  
 20, 15, 12, 0, 0, 0, 0, 0, 0,  
 0, 0, 0, 20, 15, 12, 0, 0, 0,  
 0, 0, 0, 0, 0, 0, 20, 15, 12,  
 1, 0, 0, 1, 0, 0, 1, 0, 0,  
 0, 1, 0, 0, 1, 0, 0, 1, 0,  
 0, 0, 1, 0, 0, 1, 0, 0, 1,  
 900, 900, 900, -750, -750, -750, 0, 0, 0,  
 0, 0, 0, 450, 450, 450, -900, -900, -900,  
 450, 450, 450, 0, 0, 0, -750, -750, -750), nrow = 12, byrow = TRUE)  
# Setting the right hand side of the problem's constraints as assignment\_rightconst  
assignment\_rightconst <- c(750,  
 900,  
 450,  
 13000,  
 12000,  
 5000,  
 900,  
 1200,  
 750,  
 0,  
 0,  
 0)  
  
  
# Setting the unequality signs as assignment\_uneqsigns  
assignment\_uneqsigns <- c("<=",  
 "<=",  
 "<=",  
 "<=",  
 "<=",  
 "<=",  
 "<=",  
 "<=",  
 "<=",  
 "=",  
 "=",  
 "=")  
# Set up the final lp problem  
lp("max", assignment\_objfunc, assignment\_leftconst, assignment\_uneqsigns, assignment\_rightconst)

## Success: the objective function is 716666.7

# To get the solution of the lp problem  
lp("max", assignment\_objfunc, assignment\_leftconst, assignment\_uneqsigns, assignment\_rightconst)$solution

## [1] 0.0000 694.4444 0.0000 0.0000 500.0000 333.3333 0.0000 0.0000  
## [9] 416.6667