QMM LP Model In R

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2023-09-23

```
The Weigelt Corporation has three branch plants with excess production
capacity. Fortunately, the corporation has a new product ready to begin
production, and all three plants have this capability, so some of the excess
capacity can be used in this way. This product can be made in three sizes--
large, medium, and small--that yield a net unit profit of $420, $360, and
$300, respectively. Plants 1, 2, and 3 have the excess capacity to produce
750, 900, and 450 units per day of this product, respectively, regardless of
the size or combination of sizes involved.

The amount of available in-process storage space also imposes a limitation on
the production rates of the new product. Plants 1, 2, and 3 have 13,000,
12,000, and 5,000 square feet, respectively, of in-process storage space
available for a day's production of this product. Each unit of the large,
medium, and small sizes produced per day requires 20, 15, and 12 square feet,
respectively. Sales forecasts indicate that if available, 900, 1,200, and 750
units of the large, medium, and small sizes, respectively, would be sold per
day.

At each plant, some employees will need to be laid off unless most of the
plant’s excess production capacity can be used to produce the new product. To
avoid layoffs if possible, management has decided that the plants should use
the same percentage of their excess capacity to produce the new product.
Management wishes to know how much of each of the sizes should be produced by
each of the plants to maximize profit.

Solve the problem using lpSolve, or any other equivalent library in R
```

```r
Weigelt_Plant <- matrix(c(750,900,450,13000,12000,5000), ncol = 3, byrow =
TRUE )

colnames(Weigelt_Plant) <- c("Plant1","Plant2","Plant3")
rownames(Weigelt_Plant) <- c("Capacity","Space Available(Sq.Ft)")

final=as.table(Weigelt_Plant)

final
```

```
##                         Plant1 Plant2 Plant3
## Capacity                   750    900    450
## Space Available(Sq.Ft)   13000  12000   5000
```

```r
Weigelt_Decleration <- matrix(c(900,1200,750,20,15,12,"$420","$360","$300"),
ncol = 3, byrow = TRUE )

colnames(Weigelt_Decleration) <- c("Large","Medium","Small")
rownames(Weigelt_Decleration) <- c("Sales","Space Req(Sq.Ft)","Profit$")

final=as.table(Weigelt_Decleration)

final

##                   Large  Medium  Small
## Sales             900    1200    750
## Space Req(Sq.Ft)  20     15      12
## Profit$           $420   $360    $300
```

Explanation

Declaring decision Variable

Assume

Let's $A_g k$ will be number of Units and size g(where g can be "Large", "Medium", "Small") produced in three different plant which is mentioned as k ("Plant1", "Plant2", "Plant3")

For better Understanding we consider Sizes and Plants as mentioned below.

(Sizes)

Large = l

Medium = m

Small = s

(Plants)

Plant1 = $p1$

Plant1 = $p2$

Plant3 = $p3$

Small size product

Number of small sized units produced at Plant 1 = $A_s, p1$

Number of small sized units produced at Plant 2 = $A_s, p2$

Number of small sized units produced at Plant 3 = $A_s, p3$

Medium size product

Number of Medium sized units produced at Plant 1 = $A_m, p1$

Number of Medium sized units produced at Plant 2 = $A_m, p2$

Number of Medium sized units produced at Plant 3 = $A_m, p3$

Large size product

Number of Large sized units produced at Plant 1 = $A_l, p1$

Number of Large sized units produced at Plant 2 = $A_l, p2$

Number of Large sized units produced at Plant 3 = $A_l, p3$

Declaring Objective function

```
   Management wishes to know how much of each of the sizes should be
produced by each of the plants to maximize profit.
```

$$ Max \hspace{.2cm} Z = 420(A_l,p1+A_l,p2+A_l,p3)+360(A_m,p1+A_m,p2+A_m,p3)+300(A_s,p1+A_s,p2+A_s,p3)$$

Production Capacity constraint

```
  Each plant have there own capacity to produce three different size of
productes as mentioned below.
```

Plant1 capacity

$$(A_s, p1 + A_m, p1 + A_l, p1) \leq 750$$

Plant2 capacity

$$(A_s, p2 + A_m, p2 + A_l, p2) \leq 900$$

Plant3 capacity

$$(A_s, p3 + A_m, p3 + A_l, p3) \leq 450$$

Storage Constraints

Plant1

$$20A_l, p1 + 15A_m, p1 + 12A_s, p1 \leq 13000$$

Plant2

$$20A_l,p2 + 15A_m,p2 + 12A_s,p2 \le 12000$$

plant3

$$20A_l,p3 + 15A_m,p3 + 12A_s,p3 \le 5000$$

Sales Constraints

Small Size product Capacity

$$A_s,p1 + A_s,p2 + A_s,p3 \le 750$$

Medium Size product Capacity

$$A_m,p1 + A_m,p2 + A_m,p3 \le 1200$$

Large Size product Capacity

$$A_l,p1 + A_l,p2 + A_l,p3 \le 900$$

Same capacity constraints

Management has decided that the plants should use the same percentage of their excess capacity to produce the new product

$$A_s,p1 + A_s,p2 + A_s,p3/750 = A_m,p1 + A_m,p2 + A_m,p3/1200 \\ = A_l,p1 + A_l,p2 + A_l,p3/900$$

Non-Negativity Contraints

```
Note: As Mentioned above G is the size of products and K refers all three
plants
```

$$A_gk \ge 0$$

Solution in R Markdown

```
library(lpSolve)
```

Objective function Weigelt Corporation Management wishes to know how much of each of the sizes should be produced by each of the plants to maximize profit

MaxZ= 420L,P1+420L,P2+420L,P3+360M,P1+360M,P2+360,P3+300S,P1+300S,P2+300S,P3

```
function_obj<-c(300,360,420,300,360,420,300,360,420)
```

Constraints

Below are the three different constraints which are mentioned in matrix form

Production capacity Constraints

Storage constraints

Sales Constraints

```
function_contrnt <-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,
                            12,15,20,0,0,0,0,0,0,
                            0,0,0,12,15,20,0,0,0,
                            0,0,0,0,0,0,12,15,20,
                            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), nrow = 9, byrow = TRUE)
```

Set the direction of the inequalities using subject to equation for this

```
function_direction <-c("<=","<=","<=","<=","<=","<=","<=","<=","<=")
```

Set the right hand side of the coefficients for all Constraints

```
function_RHS <-c(750,900,450,13000,12000,5000,750,1200,900)
```

Objective function total profit

```
lp("max", function_obj, function_contrnt, function_direction, function_RHS)

## Success: the objective function is 708000
```

Final Values of each varible

```
lp("max", function_obj, function_contrnt, function_direction,
function_RHS)$solution

## [1]   0.0000 400.0000 350.0000 500.0000 400.0000   0.0000 250.0000
133.3333
## [9]   0.0000
```