QMM Assignment

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#Defining the Decision variables:

##Decision variables for 3 plants

A1= Quantity of products produced by Plant1 of size large

B1= Quantity of products produced by Plant1 of size medium

C1= Quantity of products produced by Plant1 of size small

A2= Quantity of products produced by Plant2 of size large

B2= Quantity of products produced by Plant2 of size medium

C2= Quantity of products produced by Plant2 of size small

A3= Quantity of products produced by Plant3 of size large

B3= Quantity of products produced by Plant3 of size medium

C3= Quantity of products produced by Plant3 of size small

#further we need to specify objective function, constraints, direction, right hand side(constants) to solve the problem.

##Objective Function:

The objective function to maximize the profit. So,

max z= 420*(A1+A2+A3) + 360*(B1+B2+B3) + 300*(C1+C2+C3)

That can be written as,

max z= 420A1 +360B1 +300C1 +420A2 +360B2 +300C2 +420A3 +360B3 +300C3

##Constraints:

A1 +B1 +C1 <=750

A2 +B2 +C2 <=900

A3 +B3 +C3 <=450

20A1 +15B1 +12C1 <= 13000

20A2 +15B2 +12C2 <= 12000

20A3 +15B3 +12C3 <= 5000

A1 +A2 +A3 <= 900

B1 +B2 +B3 <= 1200

C1 +C2 +C3 <= 750

(A1 +B1 +C1)/ 750 = (A2 +B2 +C2)/ 900 = (A3 +B3 +C3)/ 450

Non Negativity Constraints,

A1, A2, A3, B1, B2, B3, C1, C2, C3 >= 0

The above constraints can be written as,

A1 +B1 +C1 +0*A2 +0*B2 +0*C2 +0*A3 +0*B3 +0*C3 <=750

0*A1 +0*B1 +0*C1 +A2 +B2 +C2 +0*A3 +0*B3 +0*C3 <=900

0*A1 +0*B1 +0*C1 +0*A2 +0*B2 +0*C2 +A3 +B3 +C3 <=450

20A1 +15B1 +12C1 +0*A2 +0*B2 +0*C2 +0*A3 +0*B3 +0*C3 <= 13000

0*A1 +0*B1 +0*C1 +20A2 +15B2 +12C2 +0*A3 +0*B3 +0*C3 <= 12000

0*A1 +0*B1 +0*C1 +0*A2 +0*B2 +0*C2 +20A3 +15B3 +12C3 <= 5000

A1 +0*B1 +0*C1 +A2 +0*B2 +0*C2 +A3 +0*B3 +0*C3 <= 900

0*A1 +B1 +0*C1 +0*A2 +B2 +0*C2 +0*A3 +B3 +0*C3 <= 1200

0*A1 +0*B1 +C1 +0*A2 +0*B2 +C2 +0*A3 +0*B3 +C3 <= 750

900*A1 +900*B1 +900*C1 -750*A2 -750*B2 -750*C2 +0*A3 +0*B3 +0*C3 =0

0*A1 +0*B1 +0*C1 +450*A2 +450*B2 +450*C2 -900*A3 -900*B3 -900*C3 =0

450*A1 +450*B1 +450*C1 +0*A2 +0*B2 +0*C2 -900*A3 -900*B3 -900*C3 =0

#Calling the 'lpSolve' library and declaring the objective function as 'f.obj'

```
#library
library(lpSolve)
#objective function
f.obj <- c(420,360,300,420,360,300,420,360,300)
```

#Declaring the constraints as 'f.con'

```
f.con <- 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),ncol = 9, byrow=TRUE)
```

#Declaring the directions as 'f.dir'

```
f.dir <- c("<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "<=",
           "=",
           "=",
           "=")
```

#Declaring the Right hand side constants as 'f.rhs'

```
f.rhs <- c(750,900,450,13000,12000,5000,900,1200,750,0,0,0)
```

#Calling the LP function to Solve the problem based on objective function to maximize the profit

```
f.max <- lp("max",f.obj,f.con,f.dir,f.rhs)
f.max
```

```
## Success: the objective function is 696000
```

#Calling the LP function to get the values for Variables defined above

```
f.max$solution
```

```
## [1] 516.6667 177.7778   0.0000   0.0000 666.6667 166.6667   0.0000
0.0000
## [9] 416.6667
```

#Calling the LP function to Solve the problem based on objective function to maximize the profit using 'int.vec'

```
f.max2 <- lp("max",f.obj,f.con,f.dir,f.rhs,int.vec=1:9) #int.vec to get exact values of variables without decimals
f.max2

## Success: the objective function is 694680
```

#Calling the LP function to get the values for Variables defined above, with int.vec

```
f.max2$solution

## [1] 530 160   0   0 688 140   1   8 405
```

Conclusion:

After Resolving the given Problem using Linear programming with the 'LpSolve' method in "R Programming" by considering all the constraints, I have found that,

- The maximum Profit of the industry was '$694680'

The Quantities of the products produced by each plant were

1. Quantity of products produced by Plant1 of size large=530
2. Quantity of products produced by Plant1 of size medium=160
3. Quantity of products produced by Plant1 of size small=0
4. Quantity of products produced by Plant2 of size large=0
5. Quantity of products produced by Plant2 of size medium=688
6. Quantity of products produced by Plant2 of size small=140
7. Quantity of products produced by Plant3 of size large=1
8. Quantity of products produced by Plant3 of size medium=8
9. Quantity of products produced by Plant3 of size small=405