Assignment_4

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Directions of the problem:

The Weigelt Corporation has three branch plants with excess production capacity.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.

```
library(lpSolve)
```

Let p, q, r be large, medium and small size products respectively. Therefore,

z = 420p1 + 360p2 + 300p3 (Large)

z = 420q1 + 360q2 + 300q3 (Medium)

z = 420r1 + 360r2 + 300r3 (Small)

Thus, coefficients of the objective function are:

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

Excess production capacity constraints:

p1 + q1 + r1 <= 750 (Plant-1)

p2 + q2 + r2 <= 900 (Plant-2)

p3 + q3 + r3 <= 450 (Plant-3)

Storage capacity constraints:

20p1 + 15q1 + 12r1 <= 13000 (Plant-1)

20p2 + 15q2 + 12r2 <= 12000 (Plant-2)

20p3 + 15q3 + 12r3 <= 5000 (Plant-3)

Sales forecast constraints:

p1 + q1 + r1 <= 900 (Plant-1)

p2 + q2 + r2 <= 1200 (Plant-2)

p3 + q3 + r3 <= 750 (Plant-3)

At each plant, as a result of the excess capacity, employees will need to be laid off. So, the management decided that the plants should use the same percentage of the excess capacity to produce the new product.

Therefore, the percentage of excess capacity used should be:

(p1 + q1 + r1) / 750 = (p2 + q2 + r2) / 900 = (p3 + q3 + r3) / 450

After simplification, the equations for the above constraints are:

900p1 + 900q1 + 900r1 - 750p2 - 750q2 - 750r2 = 0

450p2 + 450q2 + 450r2 - 900p3 - 900q3 - 900r3 = 0

450p1 + 450q1 + 450r1 - 750p3 - 750q3 - 750r3 = 0

Thus, set matrix corresponding to coefficients of constraints by rows.

(Note: Since Non-negative constraints are automatically assumed, those are not considered seperately)

```
LHS <- matrix(c(1, 1, 1, 0, 0, 0, 0, 0, 0,     #production capacity
                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,  #storage capacity
                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,     #Sales Forecast
                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, #Layoff
                0, 0, 0, 450, 450, 450, -900, -900, -900,
                450, 450, 450, 0, 0, 0, -750, -750, -750), nrow = 12, byrow = TRUE)
```

Left hand side coefficients

```
LHS
```

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
##  [1,]    1    1    1    0    0    0    0    0    0
##  [2,]    0    0    0    1    1    1    0    0    0
##  [3,]    0    0    0    0    0    0    1    1    1
##  [4,]   20   15   12    0    0    0    0    0    0
##  [5,]    0    0    0   20   15   12    0    0    0
##  [6,]    0    0    0    0    0    0   20   15   12
##  [7,]    1    0    0    1    0    0    1    0    0
##  [8,]    0    1    0    0    1    0    0    1    0
##  [9,]    0    0    1    0    0    1    0    0    1
## [10,]  900  900  900 -750 -750 -750    0    0    0
## [11,]    0    0    0  450  450  450 -900 -900 -900
## [12,]  450  450  450    0    0    0 -750 -750 -750
```

equalities and inequalities b/w LHS and RHS

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

Right hand side coefficients

```
RHS <- c(750, 900, 450, 13000, 12000, 5000, 900, 1200, 750, 0, 0, 0)
```

```
##Final value (z)
max_z=lp("max", ObjFunc, LHS, signs, RHS, int.vec = 1:9)
max_z
```

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

```
max_z$solution
```

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

```
max_z$objval
```

```
## [1] 694680
```