Assignment: Solve LP Model

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To formulate a Linear Programming (LP) problem to solve using R libraries

The Max objective function $X = 420(P_a + P_b + P_c) + 360(Q_a + Q_b + Q_c) + 300(R_a + R_b + R_c)$

Rearraning Max objective function $X = 420P_a{+}360Q_a{+}300Q_a{+}420P_b{+}360Q_b{+}300Q_b{+}420P_c{+}360Q_c{+}300Q_c$

sub to

$$P_a + Q_a + Q_a \leq 750$$
$$P_b + Q_b + R_b \leq 900$$
$$P_c + Q_c + R_c \leq 450$$
$$20P_a + 15Q_a + 12R_a \leq 13000$$
$$20P_b + 15Q_b + 12R_b \leq 12000$$
$$20P_c + 15Q_c + 12R_c \leq 5000$$
$$P_a + P_b + P_c \leq 900$$
$$Q_a + Q_b + Q_c \leq 1200$$
$$R_a + R_b + R_c \leq 750$$
$$(P_a + Q_a + Q_a) * (100/750) = (P_b + Q_b + Q_b) * (100/900) = (P_c + Q_c + Q_c) * (100/450)$$

Non-neg constraints

$$P_a, P_b, P_c, Q_a, Q_b, Q_c, Q_a, Q_b, Q_c \geq 0$$

A representation of a Linear Programming (LP) problem that can be solved with R libraries.

$$P_a + Q_a + Q_a + 0P_b + 0Q_b + 0Q_b + 0P_c + 0Q_c + 0Q_c \leq 750$$
$$0P_a + 0Q_a + 0Q_a + P_b + Q_b + Q_b + 0P_c + 0Q_c + 0Q_c \leq 900$$
$$0P_a + 0Q_a + 0Q_a + 0P_b + 0Q_b + 0Q_b + P_c + Q_c + Q_c \leq 450$$
$$20P_a + 15Q_a + 12Q_a + 0P_b + 0Q_b + 0Q_b + 0P_c + 0Q_c + 0Q_c \leq 13000$$
$$0L_1 + 0M_1 + 0S_1 + 20L_2 + 15M_2 + 12S_2 + 0L_3 + 0M_3 + 0S_3 \leq 12000$$
$$0P_a + 0Q_a + 0Q_a + 0P_b + 0Q_b + 0Q_b + 20P_c + 15Q_c + 12Q_c \leq 5000$$
$$P_a + 0Q_a + 0Q_a + P_b + 0Q_b + 0Q_b + P_c + 0Q_c + 0Q_c \leq 900$$
$$0P_a + Q_a + 0Q_a + 0P_b + Q_b + 0Q_b + 0P_c + Q_c + 0Q_c \leq 1200$$
$$0P_a + 0Q_a + Q_a + 0P_b + 0Q_b + Q_b + 0P_c + 0Q_c + Q_c \leq 750$$
$$900P_a + 900Q_a + 900Q_a - 750P_b - 750Q_b - 750Q_b + 0P_c + 0Q_c + 0Q_c = 0$$
$$0P_a + 0Q_a + 0Q_a + 450P_b + 450Q_b + 450Q_b - 900P_c - 900Q_c - 900Q_c = 0$$
$$450P_a + 450Q_a + 450Q_a + 0P_b + 0Q_b + 0Q_b - 750P_c - 750Q_c - 750Q_c = 0$$

```r
library(lpSolve)
```

```
## Warning: package 'lpSolve' was built under R version 4.3.3
```

```r
#Obj function
f.obj<-c(420,360,300,420,360,300,420,360,300)

#Restrictions
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),nrow = 12,byrow = TRUE)

#Orientation of inequality constraints
f.dir<-c("<=","<=","<=","<=","<=","<=","<=","<=","<=","=","=","=")
#Coefficients on the right-hand side
f.rhs<-c(750,900,450,13000,12000,5000,900,1200,750,0,0,0)


#Maximum value of the objective function (Z)
lp('max',f.obj, f.con, f.dir, f.rhs)
```

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

Interpreting the output from the optimization routines

The output indicates that the maximum value of the objective function is 696,000. This means that the highest profit achievable by Weigelt Corporation from all its production plants combined is $696,000.

Interpret the o/p from LP solution

```r
# variable values
lp('max',f.obj, f.con, f.dir, f.rhs)$solution
```

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

The values above are the result of the LP solution. These values indicate the following conclusions.:
The number of large units to be produced in plant 1 is approximately 516.67, which can be rounded to 516 units. The number of medium units to be produced in plant 1 is approximately 177.78, rounded to 177 units.
The number of small units to be produced in plant 1 is 0 units.

The number of large units to be produced in plant 2 is 0 units
The number of medium units to be produced in plant 2 is approximately 666.67, which can be rounded to 666 units.
The number of small units to be produced in plant 2 is approximately 166.67, rounded to 166 units.

The number of large units to be produced in plant 3 is 0 units
The number of medium units to be produced in plant 3 is 0 units
The number of small units to be produced in plant 3 is approximately 416.67, which can be rounded to 416 units.