vkaja\_2

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**Problem Formulation for Weigelt Corporation**

**Objective:** Maximize profit Z:

Z = *420(L1 +M1 +S1)+360(L2 +M2 +S2)+300(L3+M3 +S3)*

 #Where Li​,Mi​,Si​ represent the units of large, medium, and small products produced in Plant i (for i=1,2,3)

**Subject to Constraints**

*L1 +M1 +S1≤750  #Plant 1*

*L2 +M2 +S2≤900  #Plant 2*

*L3+M3 +S3 ≤450  #Plant 3*

**Storage Space Constraints**

*20L1 +15M1 +12S1≤ 13000 #Plant 1 (13,000 sq ft)*

*20L2 +15M2 +12S2 ≤ 12000  #Plant 2 (12,000 sq ft)*

*20L3 +15M3 +12S3 ≤ 5000  #Plant 3 (5,000 sq ft)*

*#Where each unit requires storage space: Large: 20 sq ft, Medium: 15 sq ft, Small: 12 sq ft.*

**Sales Forecast Constraints**

Maximum sales available if produced: Large: 900 units, Medium: 1,200 units, Small: 750 units.

*L1 +L2+L3 ≤900  #Total Large units*

*M1+M2+M3≤1200  #Total Medium units*

*S1 +S2+S3 ≤750  #Total Small units*

Non-Negative Constraints

*L1, L2, L3, M1, M2, M3 ,S1, S2, S3 ≥ 0*

Hence the above constraints can be written as follows:

*L1 +M1 +S1+0L2+0M2+0S2+0L3+0M3 +0S3 ≤750*

*0L1 +0M1 +0S1+ L2 +M2 +S2 + 0L3+0M3 +0S3 ≤900*

*0L1 +0M1 +0S1+0L2+0M2+0S2+ L3+M3 +S3 ≤450*

*20L1+15M1 +12S1 +0L2+0M2+0S2+0L3+0M3 +0S3 ≤13000*

*0L1 +0M1 +0S1+20L2 +15M2+12S2+0L3+0M3 +0S3 ≤12000*

*0L1 +0M1 +0S1+0L2+0M2+0S2+20L3+15M3+12S3 ≤5000*

*L1 +0M1 +0S1+ L2+0M2+0S2+L3+0M3 +0S3 ≤900*

*0L1 +M1 +0S1+0L2+M2+0S2+0L3+M3 +0S3 ≤1200*

*0L1 +0M1 +S1+0L2+0M2+S2 +0L3+0M3+S3 ≤750*

#Load the required package for linear programming  
library(lpSolve)

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

#Set up the objective function: net profits for large, medium, and small sizes across three plants  
objective\_function <- c(420, 360, 300, # Plant 1 profits  
 420, 360, 300, # Plant 2 profits  
 420, 360, 300) # Plant 3 profits  
  
#Set up the constraints matrix  
#Each row represents a constraint:   
#1. Total production capacity for each plant  
#2. Storage space constraints for each plant  
#3. Sales forecast limits for each product size  
confusion\_mat <- matrix(c(  
# Total production capacity (Plant 1, 2, and 3)  
1, 1, 1, 0, 0, 0, 0, 0, 0, # Plant 1  
0, 0, 0, 1, 1, 1, 0, 0, 0, # Plant 2  
0, 0, 0, 0, 0, 0, 1, 1, 1, # Plant 3  
#Storage space constraints  
20, 15, 12, 0, 0, 0, 0, 0, 0, # Plant 1  
0, 0, 0, 20, 15, 12, 0, 0, 0, # Plant 2  
0, 0, 0, 0, 0, 0, 20, 15, 12, # Plant 3  
# Sales forecast constraints  
1, 0, 0, 1, 0, 0, 1, 0, 0, # Large size  
0, 1, 0, 0, 1, 0, 0, 1, 0, # Medium size  
0, 0, 1, 0, 0, 1, 0, 0, 1 # Small size  
), nrow = 9, byrow = TRUE)  
  
#Define the direction of the inequality constraints (all are less than or equal)  
f.direction <- rep("<=", 9)  
  
#Set up the right-hand side coefficients for each constraint  
rhs\_coeffecients <- c(750, 900, 450, # Production capacity for each plant  
 13000, 12000, 5000, # Storage space for each plant  
 900, 1200, 750) # Sales forecast limits  
  
#Solve the linear programming problem to maximize profit  
solution <- lp("max", objective\_function, confusion\_mat, f.direction, rhs\_coeffecients)  
  
# Value of z  
lp("max", objective\_function, confusion\_mat, f.direction, rhs\_coeffecients)

## Success: the objective function is 708000

#Output the solution, which includes optimal production quantities for each size at each plant  
print(solution$solution)

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