QMM Assignment 2

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#Formulation of LP Problem

The objective function is $Max \quad z = 420(L_1 + M_1 + S_1) + 360(L_2 + M_2 + S_2) + 300(L_3 + M_3 + S_3)$

Subject to

$$L_1 + M_1 + S_1 \leq 750$$

$$L_2 + M_2 + S_2 \leq 900$$

$$L_3 + M_3 + S_3 \leq 450$$

$$20L_1 + 15M_1 + 12S_1 \leq 13000$$

$$20L_2 + 15M_2 + 12S_2 \leq 12000$$

$$20L_3 + 15M_3 + 12S_3 \leq 5000$$

$$L_1 + L_2 + L_3 \leq 900$$

$$M_1 + M_2 + M_3 \leq 1200$$

$$S_1 + S_2 + S_3 \leq 750$$

Non Negative Constraints

$$L_1, L_2, L_3, M_1, M_2, M_3, S_1, S_2, S_3 \geq 0$$

The above constraints can be written as follows

$$L_1 + M_1 + S_1 + 0L_2 + 0M_2 + 0S_2 + 0L_3 + 0M_3 + 0S_3 \leq 750$$

$$0L_1 + 0M_1 + 0S_1 + L_2 + M_2 + S_2 + 0L_3 + 0M_3 + 0S_3 \leq 900$$

$$0L_1 + 0M_1 + 0S_1 + 0L_2 + 0M_2 + 0S_2 + L_3 + M_3 + S_3 \leq 450$$

$$20L_1 + 15M_1 + 12S_1 + 0L_2 + 0M_2 + 0S_2 + 0L_3 + 0M_3 + 0S_3 \leq 13000$$

$$0L_1 + 0M_1 + 0S_1 + 20L_2 + 15M_2 + 12S_2 + 0L_3 + 0M_3 + 0S_3 \leq 12000$$

$$0L_1 + 0M_1 + 0S_1 + 0L_2 + 0M_2 + 0S_2 + 20L_3 + 15M_3 + 12S_3 \leq 5000$$

$$L_1 + 0M_1 + 0S_1 + L_2 + 0M_2 + 0S_2 + L_3 + 0M_3 + 0S_3 \leq 900$$

$$0L_1 + M_1 + 0S_1 + 0L_2 + M_2 + 0S_2 + 0L_3 + M_3 + 0S_3 \leq 1200$$

$$0L_1 + 0M_1 + S_1 + 0L_2 + 0M_2 + S_2 + 0L_3 + 0M_3 + S_3 \leq 750$$

```r
# Install and load the lpSolve library if not already installed
if (!require(lpSolve)) {
  install.packages("lpSolve")
  library(lpSolve)
}
```

```
## Loading required package: lpSolve
```

```r
# Objective function coefficients (for all three plants)
obj_coef <- rep(c(420, 360, 300), 3)

# Constraints for storage space and production capacity
const_coef <- rbind(
  # Production capacity
  c(1, 1, 1, 0, 0, 0, 0, 0, 0),
  c(0, 0, 0, 1, 1, 1, 0, 0, 0),
  c(0, 0, 0, 0, 0, 0, 1, 1, 1),
  # Storage space
  c(20, 15, 12, 0, 0, 0, 0, 0, 0),
  c(0, 0, 0, 20, 15, 12, 0, 0, 0),
  c(0, 0, 0, 0, 0, 0, 20, 15, 12)
)

# Right-hand side for storage space and production capacity constraints
rhs_const <- c(750, 900, 450, 13000, 12000, 5000)

# Add sales forecasts as constraints
sales_forecast_constraints <- matrix(0, 3, 9)
sales_forecast_constraints[1, c(1,4,7)] <- 1
sales_forecast_constraints[2, c(2,5,8)] <- 1
sales_forecast_constraints[3, c(3,6,9)] <- 1
```

```r
# Combine the constraints
const_coef <- rbind(const_coef, sales_forecast_constraints)
rhs_const <- c(rhs_const, c(900, 1200, 750))

# Constraint directions (all are '<=')
const_dir <- rep("<=", nrow(const_coef))

# Solve the LP model
lp_solution <- lp(direction = "max", objective.in = obj_coef, const.mat = const_coef, const.dir = const_

# Print the solution
print(lp_solution)
```

```
## Success: the objective function is 707940
```

```r
 #Extract solution values
production_plan <- lp_solution$solution

# Format and print the production plan for each plant
for (plant in 1:3) {
  start_idx <- (plant - 1) * 3 + 1
  end_idx <- start_idx + 2
  plant_production <- production_plan[start_idx:end_idx]
  cat(sprintf("Plant %d:\n", plant))
  cat(sprintf("  Large: %d units\n", plant_production[1]))
  cat(sprintf("  Medium: %d units\n", plant_production[2]))
  cat(sprintf("  Small: %d units\n\n", plant_production[3]))
}
```

```
## Plant 1:
##   Large: 350 units
##   Medium: 400 units
##   Small: 0 units
##
## Plant 2:
##   Large: 0 units
##   Medium: 400 units
##   Small: 500 units
##
## Plant 3:
##   Large: 0 units
##   Medium: 134 units
##   Small: 249 units
```