QMM ASSIGNMENT

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Question 1

Decision Variables

- X: Number of Collegiate backpacks to produce per week.
- Y: Number of Mini backpacks to produce per week.

Objective Function

Maximize the total profit (Z):

$$Z = 32X + 24Y$$

Constraints

1. Material Constraint:

$$3X + 2Y \leq 5000$$

2. Sales Constraints:

$$X \leq 1000$$

$$Y \leq 1200$$

3. Labor Constraint:

$$45X + 40Y \leq 35 \times 40 \times 60$$

4. Non-negativity Constraints:

$$X \geq 0$$

$$Y \geq 0$$

Solution using R

```r
library(lpSolve)

# Define the objective function coefficients
obj_coef <- c(32, 24)

# Define the matrix of constraint coefficients
mat_coef <- matrix(c(3, 2, 1, 0, 0, 1, 45, 40), ncol = 2, byrow = TRUE)

# Define the right-hand side of constraints
rhs <- c(5000, 1000, 1200, 35 * 40 * 60)

# Define the constraint types (<=)
con_types <- rep("<=", length(rhs))

# Solve the linear programming problem
lp_result <- lp("max", obj_coef, mat_coef, con_types, rhs)

# Print the solution
cat("Collegiate backpacks to produce per week:", lp_result$solution[1], "\n")
```

```
## Collegiate backpacks to produce per week: 1000
```

```r
cat("Mini backpacks to produce per week:", lp_result$solution[2], "\n")
```

```
## Mini backpacks to produce per week: 975
```

```r
cat("Maximum profit per week:", lp_result$objval, "\n")
```

```
## Maximum profit per week: 55400
```

Question 2

Decision Variables

Let's define the decision variables: - X_1: The number of large-sized units produced at Plant 1. - X_2: The number of medium-sized units produced at Plant 2. - X_3: The number of small-sized units produced at Plant 3.

Objective Function

Maximize the total profit (Z):

$$Z = 420X_1 + 360X_2 + 300X_3$$

Constraints

1. Capacity Constraints:

   - Plant 1 can produce up to 750 units per day.
   - Plant 2 can produce up to 900 units per day.
   - Plant 3 can produce up to 450 units per day.

$$X_1 \leq 750$$

$$X_2 \leq 900$$

$$X_3 \leq 450$$

2. Storage Space Constraints:

   - Plant 1 has 13,000 square feet of in-process storage space.
   - Plant 2 has 12,000 square feet of in-process storage space.
   - Plant 3 has 5,000 square feet of in-process storage space.
   - Each unit of the large, medium, and small sizes produced per day requires 20, 15, and 12 square feet, respectively.

$$20X_1 + 15X_2 + 12X_3 \leq 13,000$$

$$20X_1 + 15X_2 + 12X_3 \leq 12,000$$

$$20X_1 + 15X_2 + 12X_3 \leq 5,000$$

3. Sales Forecasts:

   - Sales forecasts indicate that if available, 900, 1,200, and 750 units of the large, medium, and small sizes, would be sold per day.

$$X_1 \leq 900$$

$$X_2 \leq 1200$$

$$X_3 \leq 750$$

4. Non-negativity Constraints:

$$X_1 \geq 0$$

$$X_2 \geq 0$$

$$X_3 \geq 0$$

5. Percentage constraint -

Assume,

A1 = Lx1 + Mx1 + Sx1

A2 = Lx2 + Mx2 + Sx2

A3 = Lx3 + Mx3 + Sx3

$$(A1/750) * 100$$

$$(A2/900) * 100$$

$$(A3/450) * 100$$

Non-negativity of decision variables -

$$(Lx1, Mx1, Sx1, Lx2, Mx2, Sx2, Lx3, Mx3 \ \ and \ \ Sx3) \geq 0$$