QUANTITATIVE MANAGEMENT MODELING
(BA-64018-006)
Assignment 1

1. Back Savers is a company that produces backpacks primarily for students. They are considering offering some combination of two different models—the Collegiate and the Mini. Both are made out of the same rip-resistant nylon fabric. Back Savers has a longterm contract with a supplier of the nylon and receives a 5000 square-foot shipment of the material each week. Each Collegiate requires 3 square feet while each Mini requires 2 square feet. The sales forecasts indicate that at most 1000 Collegiates and 1200 Minis can be sold per week. Each Collegiate requires 45 minutes of labor to produce and generates a unit profit of $32. Each Mini requires 40 minutes of labor and generates a unit profit of $24. Back Savers has 35 laborers that each provides 40 hours of labor per week. Management wishes to know what quantity of each type of backpack to produce per week.

a. Clearly define the decision variables

X1 = The number of **Collegiate backpacks** to produce **per week**.
X2=: The number of **Mini backpacks** to produce **per week.**

b. What is the objective function?

The objective here is:
to maximize the total profit, which is the total of the profit from Collegiate backpacks and the profit from Mini backpacks:

Maximize $Z=32X_1+24X_2$

c. What are the constraints?

1- $3x_1+2x_2 \leq 5000$, which means, the nylon that used in both backpack models should not be more than 5000 square fee per week
2- $X_1 \leq 1000$
$X_2 \leq 1200$
Means that, the company can sell at most 1200 mini backpacks per week and 1000 Collegiate backpacks per week.
3- $45x_1+40x_2 \leq 35 \text{ X } 40$
Means that, Back Savers has 35 laborers working 40 hours per week. each Collegiate requires 45 minutes of labor, while each Mini requires 40 minutes of labor.
4- $x_1 , x_2 \geq 0$

d. Write down the full mathematical formulation for this LP problem

Maximize $Z=32 X_1+24X_2$

Subject to the restrictions:

$3x_1+2x_2 \leq 5000$
$X_1 \leq 1000$
$X_2 \leq 1200$
$45x_1+40x_2 \leq 35 X 40$
$x_1 , x_2 \geq 0$

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

a. Define the decision variables

Were 1,2 and 3 are the numbers of the plant for each size

Large1, X_{L1}	Medium 1, X_{M1}	Small 1, X_{S1}
Large 2, X_{L2}	Medium 2, X_{M2}	Small 2, X_{S2}
Large 3, X_{L3}	Medium 3, X_{M3}	Small 3, X_{S3}

b. Formulate a linear programming model for this problem:

Objective Function:

$\mathbf{Z} = 420(X_{L1}+ X_{L2}+ X_{L3})+360(X_{M1}+ X_{M2} X_{M3})+300(X_{S1}+ X_{S2}+ X_{S3})$

Subject to the restrictions:

$X_{L1}+ X_{M1}+ X_{S1} \leq 750$
$X_{L2}+ X_{M2}+ X_{S2} \leq 900$
$X_{L3}+ X_{M3}+ X_{S3} \leq 450$

$20X_{L1}+ 15X_{M1}+ 12X_{S1} \leq 13000$
$20X_{L2}+ 15X_{M2}+ 12X_{S2} \leq 12000$
$20X_{L3}+ 15X_{M3}+ 12X_{S3} \leq 5000$

$X_{L1}+ X_{L2}+ X_{L3} \leq 900$
$X_{M1}+ X_{M2}\ X_{M} \leq 1200$
$X_{S1}+ X_{S2}+ X_{S3} \leq 750$

Each plant should use the same percentage of their excess capacity to produce the new product:
$(X_{L1}+ X_{M1}+ X_{S1}) / 750 = (X_{L2}+ X_{M2}+ X_{S2} \leq) / 900 = (X_{L3}+ X_{M3}+ X_{S3}) /450$

All variables should be ≥ 0