Assignment 2

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```
knitr::opts_chunk$set(echo = TRUE,comment = NA)
```

LP MODEL

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 long-term 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.

```
data= matrix(c(3, 45, '$32', 2, 40, '$24'), ncol=3, byrow= TRUE)

# specify the column names and row names of matrix
colnames(data) = c('Material','Labor','Profit')
rownames(data) <- c('Collegiate','Mini')

# assign to table
final=as.table(data)

# display
final
```

```
           Material Labor Profit
Collegiate 3        45    $32
Mini       2        40    $24
```

Management wishes to know what quantity of each type of backpack to produce per week.

Assume

The number of backpacks - Collegiates =

$$B_c$$

The number of backpacks - minis =

$$B_m$$

The number of hours for labor - collegiates =

$$L_c$$

The number of hours for labor - mini =

$$L_m$$

(a) The decision variables are

$$= B_c, B_m, L_c, \quad and \quad L_m$$

(b) The objective function would be to maximize the net profit

$$Max \quad Z = 32B_c + 24B_m$$

(c) The constraints are

Fabric constraint:

$$3B_c + 2B_m \leq 5000$$

Demand constraint:

$$B_c \leq 1000B$$
$$B_m \leq 1200$$

Labor contraint:

$$3/4B_c + 2/3B_m$$

(d) LP Model

$$Max \quad Z = 32B_c + 24B_m$$

Such that

Fabric constraint:

$$3B_c + 2B_m \leq 5000$$

Demand constraint:

$$B_c \leq 1000B$$
$$B_m \leq 1200$$

Labor contraint:

$$3/4B_c + 2/3B_m$$

Non-negativity of the decision variables:

$$B_c \geq 0 \quad B_m \geq 0 \quad L_c \geq 0 \quad L_m \geq 0$$

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.

```r
data= matrix(c('P1_L', 'P1_M', 'P1_S', 'P2_L', 'P2_M', 'P2_S', 'P3_L', 'P3_M', 'P3_S'), ncol=3, byrow=TR

# specify the column names and row names of matrix
colnames(data) <- c('Large', 'Medium', 'Small')
rownames(data) <- c('Plant 1','Plant 2','Plant 3')

# assign to table
final=as.table(data)

# display
final
```

```
        Large Medium Small
Plant 1 P1_L  P1_M   P1_S
Plant 2 P2_L  P2_M   P2_S
Plant 3 P3_L  P3_M   P3_S
```

Assume

The production rate of plant 1 - Large in square feet

$$= P1_L$$

The production rate of plant 1 - Medium in square feet

$$= P1_M$$

The production rate of plant 1 - Small in square feet

$$= P1_S$$

The production rate of plant 2 - Large in square feet

$$= P2_L$$

The production rate of plant 2 - Medium in square feet

$$= P2_M$$

The production rate of plant 2 - Small in square feet

$$= P2_S$$

The production rate of plant 3 - Large in square feet

$$= P3_L$$

The production rate of plant 3 - Medium in square feet

$$= P3_M$$

The production rate of plant 3 - Small in square feet

$$= P3_S$$

(a) The decision variables are

$$= P1_L, P1_M, P1_S, P2_L, P2_M, P2_S, P3_L, P3_M \ \ and \ \ P3_S$$

(b) The LP model of the given problem is

$$Max \quad Z = 420P1_L + 360P1_M + 300P1_S + 420P2_L + 360P2_M + 300P2_S + 420P3_L + 360P3_M + 300P3_S$$

Such that

Storage constraint:

$$20P1_L + 15P1_M + 12P1_S \leq 13000,$$
$$20P2_L + 15P2_M + 12P2_S \leq 12000,$$
$$20P3_L + 15P3_M + 12P3_S \leq 5000$$

Capacity constraint:

$$P1_L + P1_M + P1_S \leq 750,$$
$$P2_L + P2_M + P2_S \leq 900,$$
$$P3_L + P3_M + P3_S \leq 450$$

Demand constraint:

$$P1_L + P1_M + P1_S \leq 900,$$
$$P2_L + P2_M + P2_S \leq 1200,$$
$$P3_L + P3_M + P3_S \leq 750$$

Percentage constraint:

Assuming,

P1_L + P1_M + P1_S = P1

P2_L + P2_M + P2_S = P2

P3_L + P3_M + P3_S = P3

$$(P1/750) * 100$$
$$(P2/900) * 100$$
$$(P3/450) * 100$$

Non-negativity of the decision variables:

$$(P1_L, P1_M, P1_S, P2_L, P2_M, P2_S, P3_L, P3_M \ \ and \ \ P3_S) \geq 0$$