**Questions 3:**

**(Weigelt Production)** 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.

* 1. Define the decision variables
  2. Formulate a linear programming model for this problem.
  3. Solve the problem using *lpsolve*, or any other equivalent library in R.

**Solution:**

**Given:**

Cost Coefficient:

Net Profit of Products of Large Size = $420

Net Profit of Products of Medium Size = $360

Net Profit of Products of Small Size = $300

Excess capacity produced by Plants all sizes per day:

Plant 1 = 750 units

Plant 2 = 900 units

Plant 3 = 450 units

In process Storage space of:

Plant 1 = 13,000 sq. ft.

Plant 2 = 12,000 sq. ft.

Plant 3 = 5,000 sq. ft.

Units produced per day:

Large = 20 sq. ft.

Medium = 15 sq. ft.

Small = 12 sq. ft.

Sales forecast – Units sold per day if available

Large = 900 units

Medium = 1200 units

Small = 750 units

1. **Decision Variable:**

Let,

Xij = Quantity of each sizes i of products produced by each plant j in Weigelt Corporation.

i = Sizes of products produced by Weigelt Corporation (Large, Medium, Small),

i = L, M, S

j = Plants in which the products are produced by Weigelt Corporation.

j = 1, 2, 3

1. **Objective function:**

To find the maximum total number of products produced in each size by each plant in Weigelt Corporation to gain maximum profit.

Maxz = 420 (XL1 + XL2 + XL3) + 360 (XM1 + XM2 + XM3) + 300 (XS1 + XS2 + XS3)

1. **Constraints:**
2. **Excess Capacity**

XL1 + XM1 + XS1 <= 750 units

XL2 + XM2 + XS2 <= 900 units

XL3 + XM3 + XS3 <= 450 units

1. **Storage Space**

20XL1 + 15 XM1 + 12 XS1 <= 13,000 sq. ft.

20XL2 + 15 XM2 + 12 XS2 <= 12,000 sq. ft.

20XL3 + 15 XM3 + 12 XS3 <= 5,000 sq. ft.

1. **Sales forecast**

XL1 +XL2 + XL3 <= 900 units

XM1 + XM2 + XM3 <= 1200 units

XS1 + XS2 + XS3 <= 750 units

1. **Avoid Layoff**

Same percentage of excess capacity to be used to produce new product thus the ratio of the excess capacities by every plants should be the same.

XL1 + XM1 + XS1 : 750 units :: XL2 + XM2 + XS2 : 900 units

XL2 + XM2 + XS2 : 900 units :: XL3 + XM3 + XS3 : 450 units

XL3 + XM3 + XS3 : 450 units :: XL1 + XM1 + XS1 : 750 units

Hence,

900(XL1 + XM1 + XS1) = 750(XL2 + XM2 + XS2)

450(XL2 + XM2 + XS2) = 900(XL3 + XM3 + XS3)

750(XL3 + XM3 + XS3) = 450(XL1 + XM1 + XS1)

1. **Mathematical representation of Liner Programming model:**

Let,

Xij = Quantity of each sizes i of products produced by each plant j in Weigelt Corporation

i = L, M,S

j = 1, 2, 3

Maxz = 420 (XL1 + XL2 + XL3) + 360 (XM1 + XM2 + XM3) + 300 (XS1 + XS2 + XS3)

Subject To,

XL1 + XM1 + XS1 <= 750 units

XL2 + XM2 + XS2 <= 900 units

XL3 + XM3 + XS3 <= 450 units

20XL1 + 15 XM1 + 12 XS1 <= 13,000 sq. ft.

20XL2 + 15 XM2 + 12 XS2 <= 12,000 sq. ft.

20XL3 + 15 XM3 + 12 XS3 <= 5,000 sq. ft.

XL1 +XL2 + XL3 <= 900 units

XM1 + XM2 + XM3 <= 1200 units

XS1 + XS2 + XS3 <= 750 units

900(XL1 + XM1 + XS1) - 750(XL2 + XM2 + XS2) = 0

450(XL2 + XM2 + XS2) - 900(XL3 + XM3 + XS3) = 0

750(XL3 + XM3 + XS3) - 450(XL1 + XM1 + XS1) = 0

Xij >= 0

Rest is continued in the R program