QMM Assignment

2023-09-06

Assignment Module 2 Problem 1- The LP Model

```
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
(b) What is the objective function?
(c) What are the constraints?
(d) Write down the full mathematical formulation for this LP problem
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```r
Back_Savers <- matrix(c(45,3,1000,"$32",
               40,2,1200,"$24"), ncol=4, byrow=TRUE)

colnames(Back_Savers) <- c("Labor","Materil(sq.ft)","Sales","profit($)")
rownames(Back_Savers) <- c("Collegiate","Mini")

final=as.table(Back_Savers)

final
```

```
##            Labor Materil(sq.ft) Sales profit($)
## Collegiate 45    3              1000  $32
## Mini       40    2              1200  $24
```

Explanation

Declaring decision Variable

Assume

No. of collegiate bags can be produce per week = C_x

No. of Mini bags can be produce per week = M_x

Declaring Objective function

Management wants to know how much quantity of each type of bags can produce in week, and also by declaring this objective we can also get how much profit that “Back Savers” will make.

$$ Max \hspace{.2cm} Z = 32c_x+24m_x $$

Declaring constrain

Material

Back Savers have agreement with nylon suppler so the company will get the 5000 sq.ft of Material every week.

$$3c_x + 2m_x \leq 5000$$

Labor

Back Savers has 30 labor’s where each one can produce 40 hours in week

$$45c_x + 40m_x \leq 30 * 40 * 60$$

Sales

Back savers company can produce only the mentioned quantity

$$C_x \le 1000 \hspace{.2cm} and \hspace{.2cm}M_x \le 1200 $$

Non-Negative Constrains

Production of each bags(Collegaite and Mini) can not be in negative

$$ C_x \ge 0 \hspace{.2cm} and \hspace{.2cm} M_x \ge 0 $$

Matematical formulation

$$ Max \hspace{.2cm} Z = 32c_x+24m_x $$

$$3c_x + 2m_x \leq 5000$$

$$45C_X + 40M_X \leq 35 * 40 * 60$$

$$C_x \leq 1000$$

$$M_x \leq 1200$$

$$C_x \geq 0$$

$$M_x \geq 0$$

End of Problem 1

Assignment Module 2 Problem 2- The LP Model

```
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

b. Formulate a linear programming model for this problem.

Weigelt_Plant <- matrix(c(750,900,450,13000,12000,5000), ncol = 3, byrow =
TRUE )

colnames(Weigelt_Plant) <- c("Plant1","Plant2","Plant3")
rownames(Weigelt_Plant) <- c("Capacity","Space Available(Sq.Ft)")

final=as.table(Weigelt_Plant)

final

##                        Plant1 Plant2 Plant3
## Capacity                  750    900    450
## Space Available(Sq.Ft)  13000  12000   5000
```

```
Weigelt_Decleration <- matrix(c(900,1200,750,20,15,12,"$420","$360","$300"),
ncol = 3, byrow = TRUE )

colnames(Weigelt_Decleration) <- c("Large","Medium","Small")
rownames(Weigelt_Decleration) <- c("Sales","Space Req(Sq.Ft)","Profit$")

final=as.table(Weigelt_Decleration)

final

##                  Large Medium Small
## Sales            900   1200   750
## Space Req(Sq.Ft) 20    15     12
## Profit$          $420  $360   $300
```

Explanation

Declaring decision Variable

Assume

Let's $A_g k$ will be number of Units and size g(where g can be "Large", "Medium", "Small") produced in three different plant which is mentioned as k ("Plant1", "Plant2", "Plant3")

For better Understanding we consider Sizes and Plants as mentioned below.

(Sizes)

Large = l

Medium = m

Small = s

(Plants)

Plant1 = $p1$

Plant1 = $p2$

Plant3 = $p3$

Small size product

Number of small sized units produced at Plant 1 = $A_s, p1$

Number of small sized units produced at Plant 2 = $A_s, p2$

Number of small sized units produced at Plant 3 = $A_s, p3$

Medium size product

Number of Medium sized units produced at Plant 1 = $A_m, p1$

Number of Medium sized units produced at Plant 2 = $A_m, p2$

Number of Medium sized units produced at Plant 3 = $A_m, p3$

Large size product

Number of Large sized units produced at Plant 1 = $A_l, p1$

Number of Large sized units produced at Plant 2 = $A_l, p2$

Number of Large sized units produced at Plant 3 = $A_l, p3$

Declaring Objective function

```
   Management wishes to know how much of each of the sizes should be
produced by each of the plants to maximize profit.
```

$$ Max \hspace{.2cm} Z = 420(A_l,p1+A_m,p2+A_s,p3)+360(A_m,p1+A_m,p2+A_m,p3)+300(A_s,p1+A_s,p2+A_s,p3)$$

Production Capacity constraint

```
  Each plant have there own capacity to produce three different size of
productes as mentioned below.
```

Plant1 capacity

$$(A_s, p1 + A_m, p1 + A_l, p1) \leq 750$$

Plant2 capacity

$$(A_s, p2 + A_m, p2 + A_l, p2) \leq 900$$

Plant3 capacity

$$(A_s, p3 + A_m, p3 + A_l, p3) \leq 450$$

Storage Constraints

Plant1

$$20A_l, p1 + 15A_m, p1 + 12A_s, p1 \leq 13000$$

Plant2

$$20A_l, p2 + 15A_m, p2 + 12A_s, p2 \leq 12000$$

plant3

$$20A_l,p3 + 15A_m,p3 + 12A_s,p3 \leq 5000$$

Sales Constraints

Small Size product Capacity

$$A_s,p1 + A_s,p2 + A_s,p3 \leq 750$$

Medium Size product Capacity

$$A_m,p1 + A_m,p2 + A_m,p3 \leq 1200$$

Large Size product Capacity

$$A_l,p1 + A_l,p2 + A_l,p3 \leq 900$$

Non-Negativity Contraints

```
Note: As Mentioned above G is the size of products and K refers all three
plants
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$$A_g k \geq 0$$

Matematical formulation

$$ Max \hspace{.2cm} Z = 420(A_l,p1+A_m,p2+A_s,p3)+360(A_m,p1+A_m,p2+A_m,p3)+300(A_s,p1+A_s,p2+A_s,p3)$$

Constraints

$$(A_s,p1 + A_m,p1 + A_l,p1) \leq 750$$

$$(A_s,p2 + A_m,p2 + A_l,p2) \leq 900$$

$$(A_s,p3 + A_m,p3 + A_l,p3) \leq 450$$

$$20A_l,p1 + 15A_m,p1 + 12A_s,p1 \leq 13000$$

$$20A_l,p2 + 15A_m,p2 + 12A_s,p2 \leq 12000$$

$$20A_l,p3 + 15A_m,p3 + 12A_s,p3 \leq 5000$$

$$A_s,p1 + A_s,p2 + A_s,p3 \leq 750$$

$$A_m,p1 + A_m,p2 + A_m,p3 \leq 1200$$

$$A_l,p1 + A_l,p2 + A_l,p3 \leq 900$$

$$A_g k \geq 0$$