qmm assignment 2

2023-09-25

#Question

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.

Answer:

Formulation of LP problem

The objective function is Max Z = 420(L1 + L2 + L3) + 360(M1 + M2 + M3) + 300(S1 + S2 + S3)

Rearraning the objective function Max Z = 420L1+360M1+300S1+420L2+360M2+300S2+420L3+360M3+300S3

subject to L1 + M1 + S1 ≤ 750

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                L2 + M2 + S2 ≤ 900

                L3 + M3 + S3 ≤ 450

                20L1 + 15M1 + 12S1 ≤ 13000

                20L2 + 15M2 + 12S2 ≤ 12000

                20L3 + 15M3 + 12S3 ≤ 5000

                L1 + L2 + L3 ≤ 900

                M1 + M2 + M3 ≤ 1200

                S1 + S2 + S3 ≤ 750
```

Non negativity constraints

```
    L1, L2, L3, M1, M2, M3, S1, S2, S3 ≥ 0
```

The above LP problem constaraints can be written as

L1 + M1 + S1 + 0L2 + 0M2 + 0S2 + 0L3 + 0M3 + 0S3 ≤ 750

0L1 + 0M1 + 0S1 + L2 + M2 + S2 + 0L3 + 0M3 + 0S3 ≤ 900

0L1 + 0M1 + 0S1 + 0L2 + 0M2 + 0S2 + L3 + M3 + S3 ≤ 450

20L1 + 15M1 + 12S1 + 0L2 + 0M2 + 0S2 + 0L3 + 0M3 + 0S3 ≤ 13000

0L1 + 0M1 + 0S1 + 20L2 + 15M2 + 12S2 + 0L3 + 0M3 + 0S3 ≤ 12000

0L1 + 0M1 + 0S1 + 0L2 + 0M2 + 0S2 + 20L3 + 15M3 + 12S3 ≤ 5000

L1 + 0M1 + 0S1 + L2 + 0M2 + 0S2 + L3 + 0M3 + 0S3 ≤ 900

0L1 + M1 + 0S1 + 0L2 + M2 + 0S2 + 0L3 + M3 + 0S3 ≤ 1200

0L1 + 0M1 + S1 + 0L2 + 0M2 + S2 + 0L3 + 0M3 + S3 ≤ 750

```
##install the required packages
#install.packages("lpsolve")
library(lpSolve)

#the objective function is to maximize Z
#Z = 420L1+360M1+300S1+420L2+360M2+300S2+420L3+360M3+300S3

f.obj<-c(420,360,300,420,360,300,420,360,300)
#matrix form of constraints
f.con <-matrix(c(1,1,1,0,0,0,0,0,0,
                 0,0,0,1,1,1,0,0,0,
                 0,0,0,0,0,0,1,1,1,
                 20,15,12,0,0,0,0,0,0,
                 0,0,0,20,15,12,0,0,0,
                 0,0,0,0,0,0,20,15,12,
                 1,0,0,1,0,0,1,0,0,
                 0,1,0,0,1,0,0,1,0,
                 0,0,1,0,0,1,0,0,1), nrow = 9, byrow = TRUE)

# set the direction of the inequalities using subject to equation for this.
f.dir <-c("<=",
          "<=",
          "<=",
          "<=",
          "<=",
          "<=",
          "<=",
          "<=",
          "<=")

#set right hand side of the coefficients
f.rhs <-c(750,900,450,13000,12000,5000,900,1200,750)

lp("max", f.obj, f.con, f.dir, f.rhs)
```

```
## Success: the objective function is 708000
```

```
#values of variables
lp("max", f.obj, f.con, f.dir, f.rhs)$solution
```

```
## [1] 350.0000 400.0000   0.0000   0.0000 400.0000 500.0000   0.0000 133.3333
## [9] 250.0000
```