Vkarri_2

2023-09-24

The decision variables are:

For the quantities produced at Plant 1 [P1]:

L1: L1 is the no.of units of the Large size product

M1: M1 is the no.of units of the Medium size product

S1: S1 is the no.of units of the Small size product

For the quantities produced at Plant 2 [P2]:

L2: L2 is the no.of units of the Large size product

M2: M2 is the no.of units of the Medium size product

S2: S2 is the no.of units of the Small size product

For the quantities produced at Plant 3 [P3]:

L3: L3 is the no.of units of the Large size product

M3: M3 is the no.of units of the Medium size product

S3: S3 is the no.of units of the Small size product

Formulation of LP problem

Objective function is Zmax $= 420(L_1 + L_2 + L_3) + 360(M_1 + M_2 + M_3) + 300(S_1 + S_2 + S_3)$

Expanding the objective function Zmax $= 420L_1+360M_1+300S_1+420L_2+360M_2+300S_2+420L_3+360M_3+300S_3$ subject to

$$L_1 + M_1 + S_1 \leq 750$$
$$L_2 + M_2 + S_2 \leq 900$$
$$L_3 + M_3 + S_3 \leq 450$$
$$20L_1 + 15M_1 + 12S_1 \leq 13000$$
$$20L_2 + 15M_2 + 12S_2 \leq 12000$$
$$20L_3 + 15M_3 + 12S_3 \leq 5000$$
$$L_1 + L_2 + L_3 \leq 900$$
$$M_1 + M_2 + M_3 \leq 1200$$
$$S_1 + S_2 + S_3 \leq 750$$

The non-negativity constraints

$$L_1, L_2, L_3, M_1, M_2, M_3, S_1, S_2, S_3 \geq 0$$

The above LP problem constraints can now be written as

$$L_1 + M_1 + S_1 + 0L_2 + 0M_2 + 0S_2 + 0L_3 + 0M_3 + 0S_3 \leq 750$$

$$0L_1 + 0M_1 + 0S_1 + L_2 + M_2 + S_2 + 0L_3 + 0M_3 + 0S_3 \leq 900$$
$$0L_1 + 0M_1 + 0S_1 + 0L_2 + 0M_2 + 0S_2 + L_3 + M_3 + S_3 \leq 450$$
$$20L_1 + 15M_1 + 12S_1 + 0L_2 + 0M_2 + 0S_2 + 0L_3 + 0M_3 + 0S_3 \leq 13000$$
$$0L_1 + 0M_1 + 0S_1 + 20L_2 + 15M_2 + 12S_2 + 0L_3 + 0M_3 + 0S_3 \leq 12000$$
$$0L_1 + 0M_1 + 0S_1 + 0L_2 + 0M_2 + 0S_2 + 20L_3 + 15M_3 + 12S_3 \leq 5000$$
$$L_1 + 0M_1 + 0S_1 + L_2 + 0M_2 + 0S_2 + L_3 + 0M_3 + 0S_3 \leq 900$$
$$0L_1 + M_1 + 0S_1 + 0L_2 + M_2 + 0S_2 + 0L_3 + M_3 + 0S_3 \leq 1200$$
$$0L_1 + 0M_1 + S_1 + 0L_2 + 0M_2 + S_2 + 0L_3 + 0M_3 + S_3 \leq 750$$

```
if (!require(lpSolve)) {
  install.packages("lpSolve")
  library(lpSolve)
}
```

```
## Loading required package: lpSolve
```

```
# Objective function
obj_coef <- rep(c(420, 360, 300), 3)

# Constraints
const_coef <- rbind(
  # Production capacity
  c(1, 1, 1, 0, 0, 0, 0, 0, 0),
  c(0, 0, 0, 1, 1, 1, 0, 0, 0),
  c(0, 0, 0, 0, 0, 0, 1, 1, 1),
  # Storage space
  c(20, 15, 12, 0, 0, 0, 0, 0, 0),
  c(0, 0, 0, 20, 15, 12, 0, 0, 0),
  c(0, 0, 0, 0, 0, 0, 20, 15, 12)
)

# Right-hand side for storage space and production
rhs_const <- c(750, 900, 450, 13000, 12000, 5000)

# sales forecasts as constraints
sales_forecast_constraints <- matrix(0, 3, 9)
sales_forecast_constraints[1, c(1,4,7)] <- 1
sales_forecast_constraints[2, c(2,5,8)] <- 1
sales_forecast_constraints[3, c(3,6,9)] <- 1

# Combining
const_coef <- rbind(const_coef, sales_forecast_constraints)
rhs_const <- c(rhs_const, c(900, 1200, 750))

# Constraint directions (all are '<=')
const_dir <- rep("<=", nrow(const_coef))

#the LP model
lp_solution <- lp(direction = "max", objective.in = obj_coef, const.mat = const_coef, const.dir = const

print(lp_solution)
```

```
## Success: the objective function is 707940
```

```r
# Extraction
production_plan <- lp_solution$solution

for (plant in 1:3) {
  start_idx <- (plant - 1) * 3 + 1
  end_idx <- start_idx + 2
  plant_production <- production_plan[start_idx:end_idx]
  cat(sprintf("Plant %d:\n", plant))
  cat(sprintf("  Large: %d units\n", plant_production[1]))
  cat(sprintf("  Medium: %d units\n", plant_production[2]))
  cat(sprintf("  Small: %d units\n\n", plant_production[3]))
}
```

```
## Plant 1:
##   Large: 350 units
##   Medium: 400 units
##   Small: 0 units
##
## Plant 2:
##   Large: 0 units
##   Medium: 400 units
##   Small: 500 units
##
## Plant 3:
##   Large: 0 units
##   Medium: 134 units
##   Small: 249 units
```