MIS64018-004 Assignment 2 Module4

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```
#Set working directory, install and load the package lpSolveAPI
setwd("~/Desktop/R/64018/Assignment module 4")
library(lpSolveAPI)
```

Next, we will list the objective function and constraints.

The objective function is to $Max \ \ Z = 420(L_1 + L_2 + L_3) + 360(M_1 + M_2 + M_3) + 300(S_1 + S_2 + S_3)$

which can also be written as $Z = 420L_1 + 420L_2 + 420L_3 + 360M_1 + 360M_2 + 360M_3 + 300S_1 + 300S_2 + 300S_3$

Subject to the following capacity constraints

$$L_1 + M_1 + S_1 \leq 750$$

$$L_2 + M_2 + S_2 \leq 900$$

$$L_3 + M_3 + S_3 \leq 450$$

Storage constraints

$$20L_1 + 15M_1 + 12S_1 \leq 13000$$

$$20L_2 + 15M_2 + 12S_2 \leq 12000$$

$$20L_3 + 15M_3 + 12S_3 \leq 5000$$

Sale constraints

$$L_1 + L_2 + L_3 \leq 900$$

$$M_1 + M_2 + M_3 \leq 1200$$

$$S_1 + S_2 + S_3 \leq 750$$

Same percentage production among three plants

$$L_1 + M_1 + S_1)/(L_2 + M_2 + S_2)/(L_3 + M_3 + S_3) = 750 : 900 : 450$$

Which can be broken down to

$$(L_1 + M_1 + S_1)/(L_2 + M_2 + S_2) = 750 : 900$$

$$(L_2 + M_2 + S_2)/(L_3 + M_3 + S_3) = 900 : 450$$

Which are equivalent to the following

$$900L_1 + 900M_1 + 900S_1 - 750L_2 - 750M_2 - 750S_2 = 0$$

$$450L_2 + 450M_2 + 450S_2 - 900L_3 - 900M_3 - 900S_3 = 0$$

Second equation can be further simplified to:

$$L_2 + M_2 + S_2 - 2L_3 - 2M_3 - 2S_3 = 0$$

Non-negativity constraints

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

All the 11 constraints as follows:

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

$$0L_1 + L_2 + 0L_3 + 0M_1 + M_2 + 0M_3 + 0S_1 + S_2 + 0S_3 \leq 900$$

$$0L_1 + 0L_2 + L_3 + 0M_1 + 0M_2 + M_3 + 0S_1 + 0S_2 + S_3 \leq 450$$

$$20L_1 + 0L_2 + 0L_3 + 15M_1 + 0M_2 + 0M_3 + 12S_1 + 0S_2 + 0S_3 \leq 13000$$

$$0L_1 + 20L_2 + 0L_3 + 0M_1 + 15M_2 + 0M_3 + 0S_1 + 12S_2 + 0S_3 \leq 12000$$

$$0L_1 + 0L_2 + 20L_3 + 0M_1 + 0M_2 + 15M_3 + 0S_1 + 0S_2 + 12S_3 \leq 5000$$

$$L_1 + L_2 + L_3 + 0M_1 + 0M_2 + 0M_3 + 0S_1 + 0S_2 + 0S_3 \leq 900$$

$$0L_1 + 0L_2 + 0L_3 + M_1 + M_2 + M_3 + 0S_1 + 0S_2 + 0S_3 \leq 1200$$

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

$$900L_1 + 900M_1 + 900S_1 - 750L_2 - 750M_2 - 750S_2 = 0$$

$$L_2 + M_2 + S_2 - 2L_3 - 2M_3 - 2S_3 = 0$$

Considering the first 9 constraints,

```
library("lpSolve")
f.obj <- c(420,420,420,360,360,360,300,300,300)
f.con <- matrix(c(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,
                  20,0,0,15,0,0,12,0,0,
                  0,20,0,0,15,0,0,12,0,
                  0,0,20,0,0,15,0,0,12,
                  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), nrow = 9, byrow = TRUE)
f.dir <- c("<=",
            "<=",
           "<=",
            "<=",
           "<=",
           "<=",
            "<=",
            "<=",
            "<=")
f.rhs <- c(750,
            900,
            450,
            13000,
            12000,
            5000,
            900,
            1200,
            750)

# Final value output
lp("max", f.obj, f.con,f.dir,f.rhs)
```

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

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

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

Considering all 11 constraints,

```
lprec <- make.lp(0,9)  #start with 0 constraint and 9 variables
set.objfn(lprec, c(420, 420, 420, 360, 360, 360, 300, 300, 300))#objective func
lp.control(lprec, sense = 'max')  # this is a maximization problem

#Add the constraints
add.constraint(lprec, c(1,0,0,1,0,0,1,0,0), "<=", 750)
add.constraint(lprec, c(0,1,0,0,1,0,0,1,0), "<=", 900)
add.constraint(lprec, c(0,0,1,0,0,1,0,0,1), "<=", 450)
add.constraint(lprec, c(20,0,0,15,0,0,12,0,0),"<=",13000)
add.constraint(lprec, c(0,20,0,0,15,0,0,12,0), "<=", 12000)
add.constraint(lprec, c(0,0,20,0,0,15,0,0,12),"<=", 5000)
add.constraint(lprec,c(1,1,1,0,0,0,0,0,0), "<=", 900)
add.constraint(lprec, c(0,0,0,1,1,1,0,0,0), "<=",1200)
add.constraint(lprec, c(0,0,0,0,0,0,1,1,1), "<=", 750)
add.constraint(lprec, c(900,-750,0, 900,-750,0,900,-750,0),"=",0)
add.constraint(lprec, c(0,450,-900,0,450,-900,0,450,-900),"=",0)

#set variable names and name the constraints
RowNames <- c("Capacity1", "Capacity2", "Capacity3", "Storage1","Storage2",
              "Storage3","Sale1","Sale2","Sale3","Perc1","Perc2")
ColNames <- c("L1", "L2", "L3","M1","M2","M3", "S1","S2","S3")
dimnames(lprec) <- list(RowNames, ColNames)

# The model can also be saved to a file
write.lp(lprec, filename = "wliu16.lp", type = "lp")

x <- read.lp("wliu16.lp") # create an lp object x
x
```

```
solve(lprec)
```

```
## [1] 0
```

The objective function is 696,000

```
get.objective(lprec)
```

```
## [1] 696000
```

```
get.variables(lprec)
```

```
## [1] 516.6667   0.0000   0.0000 177.7778 666.6667   0.0000   0.0000 166.6667
## [9] 416.6667
```

The 9 variables are 516.6667, 0, 0, 177.7778, 666.6667, 0,0, 166.6667, 416.6667

In conclusion if considering first 9 constraints: The optimal output is 708000 and 9 variables are 350.0000 0.0000 0.0000 400.0000 400.0000 133.3333 0.0000 500.0000 250.0000 Plant1 produces 350 large and 400 medium products Plant2 produces 400 medium and 500 small products Plant3 produces 133.3333 medium and 250 small products

If considering all 11 constraints,the optimal max profit is 696,000 Plant1 produces 516.6667 large and 177.7778 medium products, Plant2 produces 666.6667 medium and 166.6667 small products Plant3 produces 416.6667 small products. If the number of products are integers, we will take a neighboring set of the optimal that can satisfy the percentage constraint approx (not 100%). Plant1 can produce 516 large and 177 medium products. Plant 2 should produce 666 medium and 166 small products while Plant 3 should produce 416 small products to reach a max profit of 694,800

$$Z = 420 * 516 + 360 * (177 + 666) + 300 * (166 + 416) = 694,800$$