MGMT-3453-X20: Homework 10-12

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Problem 10

```r
FOOD_A = .75
FOOD_B = .15

# Starch 200A + 700B <= 1400
starch = c(200, 700)
# Protein 400A + 100B >= 400
protein = c(400, 100)
# Maximum product a in lbs 1A <= 2
lbs_a = c(2, 0)
# Calories 600A + 900B <= 3600
# Calories 600A + 900B >= 1800
upper_calorie = c(600, 900)
lower_calorie = c(600, 900)

# Capacity for each
capacity_starch = 1400
min_protein = 400
capacity_a = 2
capacity_calorie = 3600
min_calorie = 1800
```

```r
library(lpSolve)

# Minimization problem
direction = "min"
# Contribution for each product towards total spend
p.contribution = c(FOOD_A, FOOD_B)
# Capacity/ min of each product
p.products = matrix(
  c(starch, protein, lbs_a, upper_calorie, lower_calorie), nrow = 5, byrow = TRUE
)
# Direction - is it min or max
p.direction = c('<=', '>=', '<=', '<=', '>=')
# Capacity right hand side
p.capacity = c(capacity_starch, min_protein, capacity_a, capacity_calorie, min_calorie)

resp_food = lp(
```

```
  direction = direction, objective.in = p.contribution,
  const.mat = p.products, const.dir = p.direction, const.rhs = p.capacity
)
```

Answer 10:

0.5384 pound A, 1.8461 pounds B will give the least expensive required meal. Contribution will be the total cost in this scenario: 0.68076 We can calculate the slack and surplus for each variable by multiplying the payoff coefficient variable for the answer by the product matrix coefficient, and subtracting from the capacity or limit.

```
resp_food$solution
```

```
## [1] 0.5384615 1.8461538
```

```
resp_food
```

```
## Success: the objective function is 0.6807692
```

Problem 11

The key here is that the maximum number of products that can be sold of product three by sales is 80. This is a normal constraint just like each other capacity limit.

Contribution or payoff for each of the products:

- Maximization: achieve the best product mix that will give the highest profit.

```
# Contribution
X1 = 20
X2 = 6
X3 = 8
```

```
# milling 8X1 + 2X2 + 3X3 <= 800
milling = c(8, 2, 3)
# lathe 4X1 + 3X2 + 0X3 <= 480
lathe = c(4, 3, 0)
# grinder 2X1 + 0X2 + 1X3 <= 320
grinder = c(2, 0, 1)
# x3_production 0X1 + 0X2 + 1X3 <= 80
x3_production = c(0, 0, 1)

cap_milling = 800
cap_lathe = 480
cap_grinder = 320
cap_x3 = 80
```

```
library(lpSolve)
# Maximize profit
z.direction = 'max'
# Contribution of each product
z.contribution = c(X1, X2, X3)
# Subject to capacity matrix
z.subject_to = matrix(
  c(milling, lathe, grinder, x3_production), nrow = 4, byrow = TRUE
)
z.directions = c('<=', '<=', '<=', '<=')
z.capacity = c(cap_milling, cap_lathe, cap_grinder, cap_x3)

z.resp = lp(
  direction = z.direction, objective.in = z.contribution,
  const.mat = z.subject_to, const.dir = z.directions, const.rhs = z.capacity
)
```

Answer 11: Production is 45X1, 100X2, and 80X3 which will produce a payoff of:

```
z.resp$solution
```

```
## [1]  45 100  80
```

```
z.resp
```

```
## Success: the objective function is 2140
```

Problem 12

```
library(lpSolve)
# Contribution is 2.50 for all drinks
drink.direction = 'max'

# Subject to: capacity for each input
gin = 120
bourbon = 108
vermouth = 60
scotch = 72
vodka = 48
Martini = 60

# not all drinks require an input - transpose
# need the ingredients as parts of each output, a drink.
drink.matrix = matrix(
  c(
    # S,     M,    AB,   SD,   KC,   SR
```

```r
    c(0,   1.5,  0,   0,   0,   2), # gin
    c(0,   0,    0,   2,   2,   0), # bourbon
    c(0,   .25,  0,   0,   1,   0), # vermouth
    c(2,   0,    1.5, 0,   0,   .5), # scotch
    c(0,   0,    1.5, 0,   0,   1), # vodka
    c(0,   1,    0,   0,   0,   0) # Martini
  ), nrow = 6, byrow = TRUE
)

# Contribution is 2.50
drink.contribution = rep(2.50, 6)

# Direction - capacity <=
drink.direction_capacity = rep('<=', 6)

# Drink capacity - right hand side
# [spirits, drinks]
# g, b, v, s, v
drink.capacity = c(gin, bourbon, vermouth, scotch, vodka, Martini)

drink.resp = lp(
  direction = drink.direction, objective.in = drink.contribution,
  const.mat = drink.matrix, const.dir = drink.direction_capacity,
  const.rhs = drink.capacity
)
```

Answer 12

```r
# The payoff is:
drink.resp
```

```
## Success: the objective function is 416.875
```

```r
drink.resp$solution
```

```
## [1] 15.75 60.00 22.00 54.00  0.00 15.00
```