QMM Assignment 2

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**1a) Solution:**

Let’s say Fi is the Full Time Consultants who are working in below 3 shifts and i =1,2,3

8am - 4pm

noon - 8pm

4pm – 12am

Pj is the Part Time Consultants working in below 4 shifts and j = 1,2,3,4.

8am – noon

noon – 4pm

4pm – 8pm

8pm – midnight

Amount payable for Full time consultants = $14/hr

Amount payable for Part time consultants = $12/hr

Zmin = Minimum cost.

Zmin = 8\*14(F1 + F2 + F3) + 4\*12(P1 + P2 + P3 + P4).

**Constraints**:

F1 + P1 ≥ 4

F1 + F2 + P2≥ 8

F2 + F3 + P3 ≥ 10

F3 + P4 ≥ 6

F1 ≥ P1

F1 + F2 ≥ P2

F2 + F3 ≥ P3

F3 ≥ P4

Fi ≥ 0, Pj ≥ 0.

P1 = 2, P2 = 4, P3 = 5, P4 = 3 and

F1 = 2, F2 = 2, F3 = 3

Zmin = 8\*14(2+2+3) + 4\*12(2+4+5+3)

= 112(7) + 48(14)

= 1456

Full time consultants are 7

Part time consultants are 14

**1b) Solution:**

Full-time consultants will get a break for 1hr during 8hr and There is no break for Part-time consultants.

Lunch time for Full- time consultants start 3rdhr or 4th hr.

Let’s consider the minimum cost function is Zmin1.

Therefore,

Zmin1 = 8\*14(F1 + F2 + F3) -14\*(F1 + F2 + F3) + 4\*12(P1 + P2 + P3 + P4).

The minimum constraints will remain same, so

= 112(2+2+3) – 14(2+2+3) +4\*12(2+4+5+3)

= 112(7) - 14(7) + 48(14)

= 784 – 98 + 672

= 1358

Zmin – Zmin1 = 1456 – 1358

= 98

**2) Solution:**

BackSavers LP Graphical representation

X axis represent as Collegiate

Y axis represent as Mini

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | x1 | x2 | >= | 0 |
| Price | 32 | 24 |  |  |
| material | 3 | 2 | <= | 5000 |
| labor | 45 | 40 | <= | 84000 |

|  |  |  |
| --- | --- | --- |
| x1 | <= | 1000 |
| x2 | <= | 1200 |

|  |  |  |
| --- | --- | --- |
| Intercepts | A | B |
|  | 0 | 2500 |
|  | 1666.667 | 0 |
|  | 0 | 2100 |
|  | 1866.667 | 0 |

**3a) Solution:**

**Decision variables:**

Let’s say Yij , where i represents plants 1,2,3 and j represents size l, m, s.

Y1l, Y1m, Y1s variables for plant 1

Y2l, Y2m, Y2s variables for plant 2

Y3l, Y3m, Y3s variables for plant 3

**3b) Solution:**

**Linear programming model:**

Zmax is the maximum profit

Net unit profit of $420, $360, and $300

Zmax =420\*(Y1l + Y2l + Y3l) + 360\*(Y1m + Y2m + Y3m) + 300\*(Y1s + Y2s + Y3s)

Since, plants 1, 2, and 3 have the excess capacity to produce 750, 900, and 450

Constraints for Max capacity:

Y1l + Y1m + Y1s ≤ 750

Y2l + Y2m + Y2s ≤ 900

Y3l + Y3m + Y3s ≤ 450

Plants 1, 2, and 3 have 13,000, 12,000, and 5,000 square feet, respectively, of in-process storage space available for days production:

Storage space:

20\*Y1l + 15\*Y1m + 12\*Y1s ≤ 13000

20\*Y2l + 15\*Y2m + 12\*Y2s ≤ 12000

20\*Y3l + 15\*Y3m + 12\*Y3s ≤ 5000

900, 1,200, and 750 units of the large, medium, and small sizes, respectively, would be sold per day

900\*(Y1l + Y1m + Y1s) – 750\*(Y2l + Y2m + Y2s) = 0

450\*(Y2l + Y2m + Y2s) – 900\*(Y3l + Y3m + Y3s) = 0

450\*(Y1l + Y1m + Y1s) – 750\*(Y3l + Y3m + Y3s) = 0

Y1l+Y2l+Y3l <=900

Y1m+y2m+y3m <=1200

Y1s+Y2s+Y3s <=750

Yij ≥ 0 where i = 1, 2, 3 and j = l, m, s

**3c) Solution :**

library(lpSolveAPI)  
setwd("C:/Users/nihar/OneDrive/Desktop/Fall Assignments/QMM/Assignment 2")

a linear program with 9 decision variables and 0 constraints

lp <- make.lp(0,9, verbose = "neutral")  
lp

## Model name:   
## a linear program with 9 decision variables and 0 constraints

Add the constraints

add.constraint(lp, c(1,1,1,0,0,0,0,0,0), "<=", 750 )  
add.constraint(lp, c(0,0,0,1,1,1,0,0,0), "<=", 900)  
add.constraint(lp, c(0,0,0,0,0,0,1,1,1), "<=", 450)  
add.constraint(lp, c(20,15,12,0,0,0,0,0,0), "<=", 13000)  
add.constraint(lp, c(0,0,0,20,15,12,0,0,0), "<=", 12000)  
add.constraint(lp, c(0,0,0,0,0,0,20,15,12), "<=", 5000)  
add.constraint(lp, c(1,1,1,0,0,0,0,0,0), "<=", 900)  
add.constraint(lp, c(0,0,0,1,1,1,0,0,0), "<=", 1200)  
add.constraint(lp, c(0,0,0,0,0,0,1,1,1), "<=", 750)  
add.constraint(lp, c(6, 6, 6, -5, -5, -5, 0, 0, 0), "=", 0)  
add.constraint(lp, c( 3, 3, 3, 0, 0, 0, -5, -5, -5), "=", 0)

Create objective function. We need maximum profit so change sense to max

set.objfn(lp, c(420,360,300,420,360,300,420,360,300))  
lp.control(lp, sense='max')

## $anti.degen  
## [1] "none"  
##   
## $basis.crash  
## [1] "none"  
##   
## $bb.depthlimit  
## [1] -50  
##   
## $bb.floorfirst  
## [1] "automatic"  
##   
## $bb.rule  
## [1] "pseudononint" "greedy" "dynamic" "rcostfixing"   
##   
## $break.at.first  
## [1] FALSE  
##   
## $break.at.value  
## [1] 1e+30  
##   
## $epsilon  
## epsb epsd epsel epsint epsperturb epspivot   
## 1e-10 1e-09 1e-12 1e-07 1e-05 2e-07   
##   
## $improve  
## [1] "dualfeas" "thetagap"  
##   
## $infinite  
## [1] 1e+30  
##   
## $maxpivot  
## [1] 250  
##   
## $mip.gap  
## absolute relative   
## 1e-11 1e-11   
##   
## $negrange  
## [1] -1e+06  
##   
## $obj.in.basis  
## [1] TRUE  
##   
## $pivoting  
## [1] "devex" "adaptive"  
##   
## $presolve  
## [1] "none"  
##   
## $scalelimit  
## [1] 5  
##   
## $scaling  
## [1] "geometric" "equilibrate" "integers"   
##   
## $sense  
## [1] "maximize"  
##   
## $simplextype  
## [1] "dual" "primal"  
##   
## $timeout  
## [1] 0  
##   
## $verbose  
## [1] "neutral"

To identify the variables and constraints, Set the variable names and the constraints

set.bounds(lp, lower = c(0, 0, 0, 0, 0, 0, 0, 0, 0), columns = c(1,2,3,4,5,6,7,8,9))

RowNames <- c("Con1", "Con2", "Con3", "storage1", "Storage2", "Storage33", "Sale1", "Sale2", "Sale3", "%C1", "%C2")  
ColNames <- c("Large1", "Medium1", "Small1", "Large2", "Medium2", "Small2", "Large3", "Medium3", "Small3")  
dimnames(lp) <- list(RowNames, ColNames)  
lp

## Model name:   
## a linear program with 9 decision variables and 11 constraints

write.lp(lp, filename = "QMMAssignment2.lp", type = "lp")  
solve(lp)

## [1] 0

get.objective(lp)

## [1] 696000

get.variables(lp)

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