HW3 - SPO

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Problem 1

Part (1)

Part (2)

```r
library(lpSolve)
```

```
## Warning: package 'lpSolve' was built under R version 3.6.2
```

```r
c=c(-1,4)
A=matrix(0,3,2)
A[1,1:2]=c(-10,20)
A[2,1:2]=c(5,10)
A[3,1:2]=c(1,0)
A
```

```
##      [,1] [,2]
## [1,]  -10   20
## [2,]    5   10
## [3,]    1    0
```

```r
dir=c("<=",'<=','<=')
B=c(22,49,5)
s=lp("max",c,A,dir,B,all.int = TRUE)
s$status
```

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

```r
cat('Solutions are : ',s$solution)
```

```
## Solutions are :  2 2
```

```r
cat('\nObjective Value : ',s$objval)
```

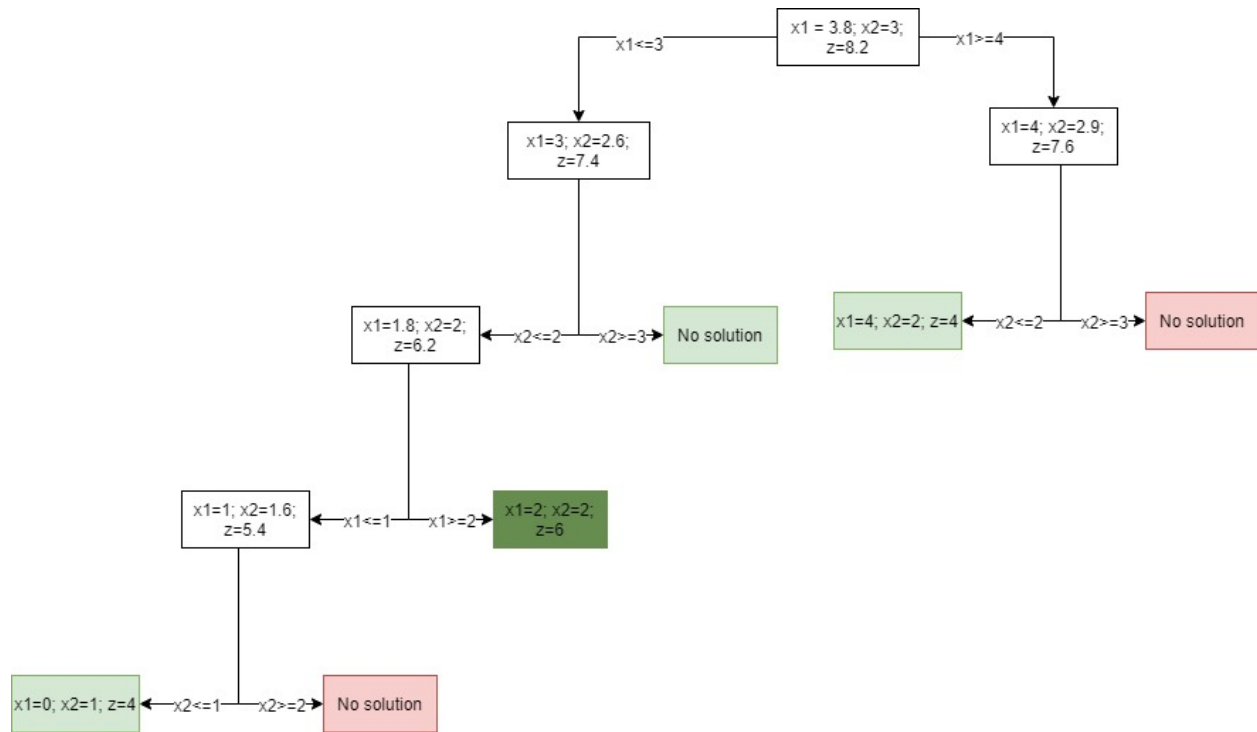```
##
Objective Value : 6
```

1

x1 = 3.8; x2=3; z=8.2

x1<=3          x1>=4

x1=3; x2=2.6; z=7.4

x1=4; x2=2.9; z=7.6

x1=1.8; x2=2; z=6.2    x2<=2    x2>=3    No solution

x1=4; x2=2; z=4    x2<=2    x2>=3    No solution

x1=1; x2=1.6; z=5.4    x1<=1    x1>=2    x1=2; x2=2; z=6

x1=0; x2=1; z=4    x2<=1    x2>=2    No solution

Figure 1: Question 1

# Part (3)

Feasible solutions = 16

```
count = 0
cat("Feasible Solutions are:\n")
```

```
## Feasible Solutions are:
```

```
for (i in seq(0,5,1)){
  for (j in seq(0,20,1)){
    if ((-10*i+20*j<=22)&(5*i+10*j<=49)){
      cat("(",i,",",j,")\n")
      count=count+1
    }
  }
}
```

```
## ( 0 , 0 )
## ( 0 , 1 )
## ( 1 , 0 )
## ( 1 , 1 )
## ( 2 , 0 )
## ( 2 , 1 )
## ( 2 , 2 )
## ( 3 , 0 )
```

```
## ( 3 , 1 )
## ( 3 , 2 )
## ( 4 , 0 )
## ( 4 , 1 )
## ( 4 , 2 )
## ( 5 , 0 )
## ( 5 , 1 )
## ( 5 , 2 )
```

```r
cat("\n Total Count = ",count)
```

```
##
##  Total Count =  16
```

Difference = 16-8 = 8

Problem 2

```r
library(lpSolve)
c=c(9,5,6,4)
A=matrix(0,3,4)
A[1,1:4]=c(6,3,5,2)
A[2,1:4]=c(0,0,1,1)
A[3,1:4]=c(1,1,0,0)
A
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    6    3    5    2
## [2,]    0    0    1    1
## [3,]    1    1    0    0
```

```r
dir=c("<=",'<=','>=')
B=c(11,1,1)
s=lp("max",c,A,dir,B,all.bin = TRUE)
s$status
```

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

```r
cat('Solutions are : ',s$solution)
```

```
## Solutions are :  1 1 0 1
```

```r
cat('\nObjective Value : ',s$objval)
```

```
##
## Objective Value :  18
```

Investment strategy : invest in building for factory and warehouse with exception for warehouse in Austin.

Problem 3

Part (1)

Part (2)

```r
library(lpSolve)
c=rep(1,12)
A=matrix(0,12,12)

A[1,]  = c(1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0, 0)
A[2,]  = c(0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0)
A[3,]  = c(1, 0, 1, 0, 0, 0, 1, 1, 1, 0, 0, 0)
A[4,]  = c(0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0)
A[5,]  = c(1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0)
A[6,]  = c(0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0)
A[7,]  = c(1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0)
A[8,]  = c(1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0)
A[9,]  = c(1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0)
A[10,] = c(0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1, 1)
A[11,] = c(0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1)
A[12,] = c(0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1)

dir=rep('>=',12)

B=rep(1,12)
s=lp("min",c,A,dir,B,all.bin = TRUE)
s$status
```

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

```r
cat('Solutions are : ',s$solution)
```

```
## Solutions are :  1 0 0 0 0 0 0 1 0 1 0 0
```

```r
cat('\nObjective Value (The minimum number of hubs) : ',s$objval)
```

```
##
## Objective Value (The minimum number of hubs) :  3
```

Recommendation hubs: Atlanta, New York, Salt Lake City

Question 3:

if $x_1, x_2 \ldots \ldots x_{12}$ be 1 for hub

0 for not being hub

$\Rightarrow$ lets minimize $x_1 + x_2 + \cdots x_{12}$

Constrains:

$$x_1 + x_3 + x_5 + x_7 + x_8 + x_9 \geq 1$$

$$x_2 + x_8 + x_9 \geq 1$$

$$x_1 + x_3 + x_7 + x_8 + x_9 \geq 1$$

$$x_4 + x_{10} \geq 1$$

$$x_1 + x_5 + x_7 \geq 1$$

$$x_6 + x_{10} + x_{11} \geq 1$$

$$x_1 + x_3 + x_5 + x_7 \geq 1$$

$$x_1 + x_2 + x_3 + x_8 + x_9 \geq 1$$

$$x_4 + x_6 + x_{10} + x_{11} + x_{12} \geq 1$$

$$x_6 + x_{10} + x_{11} + x_{12} \geq 1$$

$$x_{10} + x_{11} + x_{12} \geq 1$$

Figure 2: Qiestion 3

5

Question 4:

Initial roll's width = 120 inches

patterns possible:

25 in	37 in	54 in	Wastage
4	0	0	$120-100=20$
3	1	0	$120-112=8$
0	0	2	$120-108=12$
0	3	0	$120-111=9$
1	2	0	$120-99=21$
1	1	1	$120-116=4$
2	0	1	$120-104=16$

$x_1, x_2, x_3 \cdots x_7 \rightarrow$ No; of times each
pattern is used.

Minimize: $20x_1 + 8x_2 + 12x_3 + 9x_4 + 21x_5 + 4x_6$
$+ 16x_7$

constraint:

$4x_1 + 3x_2 + x_5 + x_6 + 2x_7 \geqslant 233$

$x_2 + 3x_4 + 2x_5 + x_6 \geqslant 148$

$2x_3 + x_6 + x_7 \geqslant 106$

Figure 3: Questio 4

Problem 4

Part (1)

Part (2)

```r
C = c(20,8,12,9,21,4,16)
A = matrix(0, 3, 7)

A[1,] = c(4, 3, 0, 0, 1, 1, 2)
A[2,] = c(0, 1, 0, 3, 2, 1, 0)
A[3,] = c(0, 0, 2, 0, 0, 1, 1)

b = c(233, 148, 106)

dir = rep(">=", 3)

s=lp("min",C,A,dir,b,compute.sens = 1, all.int = TRUE)
```

```r
cat("Status is:",s$status,"\n")
```

```
## Status is: 0
```

```r
cat("Solution is:",s$solution,"\n")
```

```
## Solution is: 0 42 0 0 0 107 0
```

```r
cat("Wastage is:",s$objval,"\n")
```

```
## Wastage is: 764
```

Problem 5

```r
A = matrix(0, 7, 7)
A[1,] = c(0, 1, 1, 1, 1, 1, 0)
A[2,] = c(0, 0, 1, 1, 1, 1, 1)
A[3,] = c(1, 0, 0, 1, 1, 1, 1)
A[4,] = c(1, 1, 0, 0, 1, 1, 1)
A[5,] = c(1, 1, 1, 0, 0, 1, 1)
A[6,] = c(1, 1, 1, 1, 0, 0, 1)
A[7,] = c(1, 1, 1, 1, 1, 0, 0)

b = c(5, 13, 12, 10, 14, 8, 6)
C = c(330, 360, 360, 360, 360, 330, 300)

dir = rep(">=", 7)
s=lp("min",C,A,dir,b,compute.sens = 1, all.int = TRUE)
```

Question 5:

Decision variables:

x_1 — Sunday, Monday off

x_2 — Monday, Tuesday off

.

x_7 — Saturday, Sunday off

Minimizing: $300x_1 + 360x_2 + 360x_3 + 360x_4 + 360x_5 + 330x_6 + 300x_7$

Constraint:

$x_3 + x_4 + x_5 + x_6 + x_7 \geq 13$

$x_2 + x_3 + x_4 + x_5 + x_6 \geq 5$

$x_1 + x_4 + x_5 + x_6 + x_7 \geq 12$

$x_1 + x_2 + x_5 + x_6 + x_7 \geq 16$

$x_1 + x_2 + x_3 + x_6 + x_7 \geq 14$

$x_1 + x_2 + x_3 + x_4 + x_7 \geq 8$

$x_1 + x_2 + x_3 + x_4 + x_5 \geq 6$

Figure 4: Question 5

```r
s$status
```

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

```r
cat('Solutions are : ',s$solution)
```

```
## Solutions are :  2 0 3 0 1 1 8
```

```r
cat('\nObjective Value : ',s$objval)
```

```
##
## Objective Value :   4830
```

Ideal Pattern - M-F with Saturday and Sunday off.