BT1101

Lab 10: Integer Optimisation

Installing and loading packages

```r
# load required packages
# install any package below if it's first time loaded in your computer.
library(lpSolve)
```

Simplified Diet Problem

Integer optimisation

```
# solving model: integer optimization
objective.fn <- c(8,10)
const.mat <- matrix(c(0.4, 1.2,
                      6,10,
                      0.4,0.6),
                      ncol=2,
                      byrow=TRUE)
const.dir <- c(">=", ">=", ">=")
const.rhs <- c(70, 50, 12)

lp.solution <- lp("min", objective.fn, const.mat,
                  const.dir, const.rhs, int.vec=c(1,2))

lp.solution
```

```
## Success: the objective function is 588
```

```
lp.solution$solution
```

```
## [1]  1 58
```

Linear optimisation

```
#defining parameters
objective.fn <- c(8, 10)
const.mat <- matrix(c(0.4, 1.2,
                      6, 10,
                      0.4, 0.6) ,
                    ncol=2 ,
                    byrow=TRUE)
const.dir <- c(">=", ">=", ">=")
const.rhs <- c(70, 50, 12)

#solving model
lp.solution <- lp("min",
                  objective.fn,
                  const.mat,
                  const.dir,
                  const.rhs,
                  compute.sens=TRUE)
lp.solution$solution
```

0.00000 58.33333

```
lp.solution
```

```
## Success: the objective function is 583.3333
```

What happens to the shadow prices?

What if we round-off the decision variable values?

```
#defining parameters
objective.fn <- c(1000, 1200, 1500)
const.mat <- matrix(c(30, 40, 50,
                      20, 50, 40,
                      30, 10, 15) ,
                      ncol=3 ,
                      byrow=TRUE)

const.dir <- c(">=", ">=", ">=")
const.rhs <- c(5000, 3000, 2500)

#solving model
lp.solution_relaxint <- lp("min", objective.fn,
                  const.mat, const.dir,
                  const.rhs, compute.sens=TRUE, all.int = FALSE)

lp.solution_relaxint
```

```
## Success: the objective function is 154761.9
```

```
lp.solution_relaxint$solution
```

```
## [1] 47.61905  0.00000 71.42857
```

Close factory B

```
#all.int : all variables should be integers
objective.fn <- c(1000, 1200, 1500)
const.mat <- matrix(c(30, 40, 50,
                      20, 50, 40,
                      30, 10, 15) ,
                      ncol=3 ,
                      byrow=TRUE)

const.dir <- c(">=", ">=", ">=")
const.rhs <- c(5000, 3000, 2500)

#solving model
lp.solution <- lp("min", objective.fn,
                  const.mat, const.dir,
                  const.rhs, compute.sens=TRUE, all.int = TRUE)

lp.solution
```

```
## Success: the objective function is 154800
```

```
lp.solution$solution #decision variables values
```

```
## [1] 48  4 68
```

Open factory B for 4 days

Part One: Lab Session Completion and Discussion

Question 1

John is interested in buying ads to market his new startup. He sees the following options:

Ad	Cost per ad	Reach	Limits
Radio Ad	$100	500	40
Newspaper Ad	$250	2000	10
Social Media Ad	$50	300	80

The “limits” in the table above are imposed by each advertiser, so the Newspaper will only run a maximum of 10 Newspaper Ads. Reach is an estimated number of people that the ad will reach, per ad that John buys (e.g. if he buys 1 Radio ad, it will reach 500 people. If he buys 2, it will reach 1000 people.)

John has a budget of $5000, and wants to find out how many ads he should purchase to maximize his total reach.

1a) Identify the decision variables, objective function and constraints. Write out the optimization problem in a table.

Define Decision Variables X_1, X_2 , X_3 corresponding to how many ads of each type (Radio, Newspaper, Social Media) are bought

Maximize total reach using decision variables X_1, X_2, X_3	**Reach = 500 X_1 + 2000 X_2 + 300 X_3**
Subject to	
Budget Constraint	$100X_1 + 250X_2 + 50X_3 \leq 5000$
Limit Constraint 1	$X_1 + \quad + \quad \leq 40$
Limit Constraint 2	$\quad + X_2 + \quad \leq 10$
Limit Constraint 3	$\quad + \quad + X_3 \leq 80$
Non-Negativity Constraint 1	$X_1 + \quad + \quad \geq 0$
Non-Negativity Constraint 2	$\quad + X_2 + \quad \geq 0$
Non-Negativity Constraint 3	$\quad + \quad + X_3 \geq 0$
Integer Constraints	X_1, X_2, X_3 all integers

(b) Write R code to solve this problem. What is the optimal solution, and what is the value of the objective function at this optimal solution?

```
#defining parameters
objective.fn <- c(500, 2000, 300)
const.mat <- matrix(c(100, 250, 50, 1, 0, 0, 0, 1, 0, 0, 0, 1) , ncol=3 , byrow=TRUE)
const.dir <- c("<=", "<=", "<=", "<=")
const.rhs <- c(5000, 40, 10, 80)

#solving model
lp.solution <- lp("max", objective.fn, const.mat, const.dir, const.rhs, int.vec=c(1:3))
lp.solution$solution #decision variables values
```

```
## [1]  0 10 50
```

```
lp.solution
```

```
## Success: the objective function is 35000
```

He should buy 10 Newspaper Ads and 50 Social Media ads.

Any Questions?