PRACTICAL 1

GRAPHICAL METHOD USING R PROGRAMMING

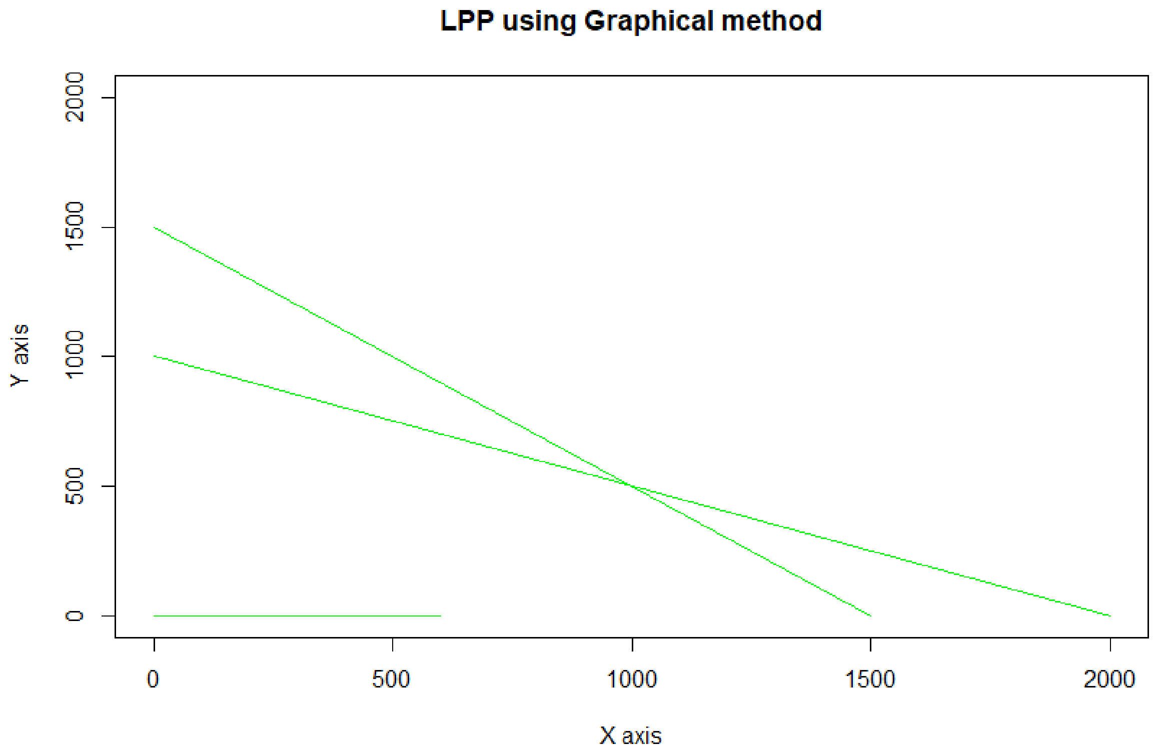
```
# R Program
#Find a geometrical interpretation and solution as well for the following LP problem
#Max z= 3x1 + 5x2
#subject to constraints:
#x1+2x2<=2000
#x1+x2<=1500
#x2<=600
#x1,x2>=0

# Load lpSolve
require(lpSolve)

## Set the coefficients of the decision variables -> C of objective function
C <- c(3,5)

# Create constraint martix B
A <- matrix(c(1, 2,
              1, 1,
              0, 1
), nrow=3, byrow=TRUE)

# Right hand side for the constraints
B <- c(2000,1500,600)

# Direction of the constraints
constranints_direction <- c("<=", "<=", "<=")
```

```
# Create empty example plot
plot.new()
plot.window(xlim=c(0,2000), ylim=c(0,2000))
axis(1)
axis(2)
title(main="LPP using Graphical method")
title(xlab="X axis")
title(ylab="Y axis")
box()
# Draw one line
segments(x0 = 2000, y0 = 0, x1 = 0, y1 = 1000, col = "green")
segments(x0 = 1500, y0 = 0, x1 = 0, y1 = 1500, col = "green")
segments(x0 = 0, y0 = 0, x1 = 600, y1 = 0, col = "green")

# Find the optimal solution
optimum <- lp(direction="max",
              objective.in = C,
              const.mat = A,
              const.dir = constranints_direction,
              const.rhs = B,
              all.int = T)
# Print status: 0 = success, 2 = no feasible solution
print(optimum$status)
# Display the optimum values for x1,x2
best_sol <- optimum$solution
names(best_sol) <- c("x1", "x2")
print(best_sol)
# Check the value of objective function at optimal point
print(paste("Total cost: ", optimum$objval, sep=""))
```

OUTPUT:

```
[Workspace loaded from ~/.RData]

> # Right hand side for the constraints
> B <- c(2000,1500,600)
> # R Program
> # Load lpSolve
> require(lpSolve)
Loading required package: lpSolve
> ## Set the coefficients of the decision variables -> C
> C <- c(3,5)
> # Create constraint martix B
> A <- matrix(c(1, 2,
+              1, 1,
+              0, 1
+ ), nrow=3, byrow=TRUE)
>
> # Right hand side for the constraints
> B <- c(2000,1500,600)
>
> # Direction of the constraints
> constranints_direction <- c("<=", "<=", "<=")
>
>
> # Create empty example plot
> #plot(2000, 2000, col = "white", xlab = "", ylab = "")
> plot.new()
> plot.window(xlim=c(0,2000), ylim=c(0,2000))
> axis(1)
> axis(2)
> title(main="LPP using Graphical method")
> title(xlab="X axis")
> title(ylab="Y axis")
> box()
> # Draw one line
> segments(x0 = 2000, y0 = 0, x1 = 0, y1 = 1000, col = "green")
> segments(x0 = 1500, y0 = 0, x1 = 0, y1 = 1500, col = "green")
> segments(x0 = 0, y0 = 0, x1 = 600, y1 = 0, col = "green")
>
>
>
> # Find the optimal solution
> optimum <- lp(direction="max",
+              objective.in = C,
+              const.mat = A,
+              const.dir = constranints_direction,
+              const.rhs = B,
+              all.int = T)
> # Print status: 0 = success, 2 = no feasible solution
> print(optimum$status)
[1] 0
> # Display the optimum values for x1,x2
> best_sol <- optimum$solution
```

```
> names(best_sol) <- c("x1", "x2")
> print(best_sol)
  x1   x2
1000  500
>
> # Check the value of objective function at optimal point
> print(paste("Total cost: ", optimum$objval, sep=""))
[1] "Total cost: 5500"
```



PRACTICAL 2

Simplex Method with 2 variables using Python

```
from scipy.optimize import linprog

#Max z=3x1+2x2

#subject to

#x1 + x2 <=4

#x1 - x2 <=2

#x1,x2>=0

obj = [-3, -2]


lhs_ineq = [[ 1,  1],  # Red constraint left side

...             [1,  -1]]  # Blue constraint left side


rhs_ineq = [4,  # Red constraint right side

...             2]  # Blue constraint right side


bnd = [(0, float("inf")),  # Bounds of x

...       (0, float("inf"))]  # Bounds of y


>>> opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,

...               bounds=bnd,method="revised simplex")

>>> opt


opt.fun


opt.success


opt.x
```

jupyter simplex1with2variables Last Checkpoint: a day ago (unsaved changes)

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Sonve following linear programming problem with two variables using simplex method.

Max z=3x1+2x2

subject to

x1 + x2 <=4

x1 - x2 <=2

x1,x2>=0

In [1]:
```
from scipy.optimize import linprog
```

In [13]:
```
obj = [-3, -2]
```

In [14]:
```
lhs_ineq = [[ 1,  1],  # left side of first constraint
...             [1,  -1]]  # left side of second constraint
```

In [15]:
```
rhs_ineq = [4,  # right side constant of first constraint
...             2]  # right side constant of first constraint
```

In [16]:
```
bnd = [(0, float("inf")),  # Bounds of x
...        (0, float("inf"))]  # Bounds of y
```

In [17]:
```
>>> opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...               bounds=bnd,method="revised simplex")
>>> opt
```

Out[17]:
```
    con: array([], dtype=float64)
    fun: -11.0
message: 'Optimization terminated successfully.'
    nit: 2
  slack: array([0., 0.])
 status: 0
success: True
      x: array([3., 1.])
```

In [18]:
```
opt.fun
```

Out[18]:
```
-11.0
```

PRACTICAL 3

Simplex Method with 3 variables using Python

```
from scipy.optimize import linprog
#Min z= x1-3x2+2x3
#subject to
#3x1-x2+3x3<=7
#-2x1+4x2<=12
#-4x1+3x2+8x3<=10
#x1,x2,x3>=0

obj = [1, -3, 2]

lhs_ineq = [[ 3,  -1, 3],  # Red constraint left side
...            [-2, 4, 0],  # Blue constraint left side
...              [ -4, 3, 8]]  # Yellow constraint left side

rhs_ineq = [7,  # Red constraint right side
...            12,  # Blue constraint right side
...             10]  # Yellow constraint right side

bnd = [(0, float("inf")),  # Bounds of x
...       (0, float("inf")),
...       (0, float("inf"))]  # Bounds of y

>>> opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...              bounds=bnd,
...              method="revised simplex")
>>> opt
```

jupyter SimplexWith3Variables Last Checkpoint: 2 hours ago (autosaved)

Logout

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Run Code

In [27]:
```
from scipy.optimize import linprog
```

In [28]:
```
#Min z= x1-3x2+2x3
#subject to
#3x1-x2+3x3<=7
#-2x1+4x2<=12
#-4x1+3x2+8x3<=10
#x1,x2,x3>=0

obj = [1, -3, 2]
```

In [29]:
```
lhs_ineq = [[ 3,  -1, 3],  # Red constraint left side
...             [-2, 4, 0],  # Blue constraint left side
...               [ -4, 3, 8]]  # Yellow constraint left side
```

In [30]:
```
rhs_ineq = [7,  # Red constraint right side
...             12,  # Blue constraint right side
...              10]  # Yellow constraint right side
```

In [33]:
```
bnd = [(0, float("inf")),  # Bounds of x
...         (0, float("inf")),
...         (0, float("inf"))]  # Bounds of y
```

In [34]:
```
>>> opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...               bounds=bnd,
...               method="revised simplex")
>>> opt
```

Out[34]:
```
     con: array([], dtype=float64)
     fun: -11.0
 message: 'Optimization terminated successfully.'
     nit: 2
   slack: array([ 0.,  0., 11.])
  status: 0
 success: True
       x: array([4., 5., 0.])
```

PRACTICAL 4

Simplex Method with Equality Constraints Using Python

```
from scipy.optimize import linprog
#Max z=x+2y
#subject to
#2x+y<=20
#-4x+5y<=10
#-x+2y>=-2
#-x+5y=15
#x,y>=0
obj = [-1, -2]

lhs_ineq = [[ 2,  1],  # Red constraint left side
...         [-4,  5],  # Blue constraint left side
...         [ 1, -2]]  # Yellow constraint left side

rhs_ineq = [20,  # Red constraint right side
...         10,  # Blue constraint right side
...          2]  # Yellow constraint right side

lhs_eq = [[-1, 5]]  # Green constraint left side
rhs_eq = [15]       # Green constraint right side

bnd = [(0, float("inf")),  # Bounds of x
...    (0, float("inf"))]  # Bounds of y

opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...           A_eq=lhs_eq, b_eq=rhs_eq, bounds=bnd,
...           method="revised simplex")
Opt
```

method =”revised simplex” solves linear programming problem using two phase simplex method.

:

```
con: array([0.])
     fun: -16.818181818181817
 message: 'Optimization terminated successfully.'
     nit: 3
   slack: array([ 0.        , 18.18181818,  3.36363636])
  status: 0
 success: True
       x: array([7.72727273, 4.54545455])
```

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Run Code

In [1]:
```python
from scipy.optimize import linprog
```

In [2]:
```python
#Max z=x+2y
#subject to
#2x+y<=20
#-4x+5y<=10
#-x+2y>=-2
#-x+5y=15
#x,y>=0
obj = [-1, -2]
```

In [3]:
```python
lhs_ineq = [[ 2,  1],  # Red constraint left side
...          [-4,  5],  # Blue constraint left side
...          [ 1, -2]]  # Yellow constraint left side
```

In [4]:
```python
rhs_ineq = [20,  # Red constraint right side
...         10,  # Blue constraint right side
...          2]  # Yellow constraint right side
```

In [5]:
```python
lhs_eq = [[-1, 5]]  # Green constraint left side
```

In [6]:
```python
rhs_eq = [15]       # Green constraint right side
```

In [7]:
```python
bnd = [(0, float("inf")),  # Bounds of x
...    (0, float("inf"))]  # Bounds of y
```

In [8]:
```python
opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...           A_eq=lhs_eq, b_eq=rhs_eq, bounds=bnd,
...           method="revised simplex")
```

In [9]:
```python
opt
```

Out[9]:
```
     con: array([0.])
     fun: -16.818181818181817
 message: 'Optimization terminated successfully.'
     nit: 3
   slack: array([ 0.        , 18.18181818,  3.36363636])
  status: 0
 success: True
       x: array([7.72727273, 4.54545455])
```

PRACTICAL 5

BigM Simplex Method using Python

Solve Following linear programming problem using Big M Simplex method.

Min z= 4x1 + x2

subjected to:

3x1 + 4x2 >= 20

x1 + 5x2 >= 15

x1, x2 >= 0

```
from scipy.optimize import linprog

obj = [4, 1]

lhs_ineq = [[ -3,  -4],  # left side of first constraint

...                  [-1,  -5]]  # right side of first constraint


rhs_ineq = [-20,  # right side of first constraint

...                 -15]  # right side of Second constraint


bnd = [(0, float("inf")),  # Bounds of x1

...        (0, float("inf"))]  # Bounds of x2


>>> opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,

...                bounds=bnd,method="interior-point")

>>> opt
```

method =” interior-point**” solves linear programming problem using default simplex method.**

jupyter BigM Simplex Method Last Checkpoint: 37 minutes ago (autosaved)

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Trusted | Python 3

Run Code

Solve Following linear programming problem using Big M Simplex method.

Min z= 4x1 + x2

subjected to:

3x1 + 4x2 >= 20

x1 + 5x2 >= 15

x1, x2 >= 0

In [41]:
```
from scipy.optimize import linprog
```

In [42]:
```
obj = [4, 1]
```

In [43]:
```
lhs_ineq = [[ -3,  -4],  # left side of first constraint
...             [-1,  -5]]  # right side of first constraint
```

In [44]:
```
rhs_ineq = [-20,  # right side of first constraint
...            -15]  # right side of Second constraint
```

In [45]:
```
bnd = [(0, float("inf")),  # Bounds of x1
...        (0, float("inf"))]  # Bounds of x2
```

In [48]:
```
>>> opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...               bounds=bnd,method="interior-point")
>>> opt
```

Out[48]:
```
     con: array([], dtype=float64)
     fun: 5.000000000236447
 message: 'Optimization terminated successfully.'
     nit: 5
   slack: array([1.64277481e-10, 1.00000000e+01])
  status: 0
 success: True
       x: array([6.01160437e-11, 5.00000000e+00])
```

In [ ]:

PRACTICAL 6

RESOURCE ALLOCATION PROBLEM BY SIMPLEX METHOD

Use SciPy to solve the resource allocation problem stated as follows:

Max z= 20x1 + 12x2 +40x3 + 25x4 ....(profit)

subjected to:

```
x1 + x2 + x3 + x4 <= 50  -------------(manpower)

3x1 + 2x2 + x3    <= 100 -------------(material A)

       x2 + 2x3   <= 90  -------------(material B)


    x1, x2, x3, x4 >= 0
```

```
from scipy.optimize import linprog
obj = [-20, -12, -40, -25]     #profit objective function

lhs_ineq = [[1, 1, 1, 1],      # Manpower
...          [3, 2, 1, 0],               # Material A
...          [0, 1, 2, 3]]               # Material B

rhs_ineq = [ 50,  # Manpower
...          100,  # Material A
...           90]  # Material B

opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...            method="revised simplex")

Opt
```

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Use SciPy to solve the resource allocation problem stated as follows:

Max z= 20x1 + 12x2 +40x3 + 25x4 ....(profit)

subjected to:

```
x1 + x2 + x3 + x4 <= 50  -------------(manpower)

3x1 + 2x2 + x3    <= 100 -------------(material A)

       x2 + 2x3   <= 90  -------------(material B)


    x1, x2, x3, x4 >= 0
```

In [12]:
```
from scipy.optimize import linprog
```

In [13]:
```
obj = [-20, -12, -40, -25]      #profit objective function
```

In [14]:
```
lhs_ineq = [[1, 1, 1, 1],  # Manpower
...         [3, 2, 1, 0],  # Material A
...         [0, 1, 2, 3]]  # Material B
```

In [15]:
```
rhs_ineq = [ 50,  # Manpower
...         100,  # Material A
...          90]  # Material B
```

In [16]:
```
opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...           method="revised simplex")
```

In [17]:
```
opt
```

Out[17]:
```
     con: array([], dtype=float64)
     fun: -1900.0
 message: 'Optimization terminated successfully.'
     nit: 2
   slack: array([ 0., 40.,  0.])
  status: 0
 success: True
       x: array([ 5.,  0., 45.,  0.])
```

The result tells you that the maximal profit is 1900 and corresponds to x_1 = 5 and x_3 = 45. It's not profitable to produce the second and fourth products under the given conditions. You can draw several interesting conclusions here:

The third product brings the largest profit per unit, so the factory will produce it the most.

The first slack is 0, which means that the values of the left and right sides of the manpower (first) constraint are the same. The factory produces 50 units per day, and that's its full capacity.

The second slack is 40 because the factory consumes 60 units of raw material A (15 units for the first product plus 45 for the third) out of a potential 100 units.

The third slack is 0, which means that the factory consumes all 90 units of the raw material B. This entire amount is consumed for the third product. That's why the factory can't produce the second or fourth product at all and can't produce more than 45 units of the third product. It lacks the raw material B.

opt.status is 0 and opt.success is True, indicating that the optimization problem was successfully solved with the optimal feasible solution.

INFEASIBILITY IN SIMPLEX METHOD

 # Solve following linear programming problem using Simplex method

WHILE SOLVING LINEAR PROGRAMMING PROBLEM USING SIMPLEX METHOD, IF ONE OR MORE ARTIFICIAL VARIABLES REMAIN IN THE BASIS AT POSITIVE LEVEL AT THE END OF PHASE 1 COMPUTATION , THE PROBLEM HAS NO FEASIBLE SOLUTION(INFEASIBLE SOLUTION).

Example:

Max z= 200x - 300y

subject to

2x+3y>=1200

x+y<=400

2x+3/2y>=900

x,y>=0

```
from scipy.optimize import linprog
obj = [-200, 300]
lhs_ineq = [[ -2,  -3],  # Red constraint left side
...           [1,  1],  # Blue constraint left side
...           [ -2, -1.5]]  # Yellow constraint left side

rhs_ineq = [-1200,  # Red constraint right side
...           400,  # Blue constraint right side
...            -900]  # Yellow constraint right side

bnd = [(0, float("inf")),  # Bounds of x
...       (0, float("inf"))]  # Bounds of y

opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...            bounds=bnd,
...             method="revised simplex")
```

opt

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Run Markdown

INFEASIBILITY IN SIMPLEX METHOD

Solve following linear programming problem using Simplex method

WHILE SOLVING LINEAR PROGRAMMING PROBLEM USING SIMPLEX METHOD, IF ONE OR MORE ARTIFICIAL VARIABLES REMAIN IN THE BASIS AT POSITIVE LEVEL AT THE END OF PHASE 1 COMPUTATION , THE PROBLEM HAS NO FEASIBLE SOLUTION(INFEASIBLE SOLUTION).

Example:

Max z= 200x - 300y
subject to

2x+3y>=1200

x+y<=400

2x+3/2y>=900

x,y>=0

In [1]:
```
from scipy.optimize import linprog
```

In [9]:
```
obj = [-200, 300]
```

In [10]:
```
lhs_ineq = [[ -2,  -3],  # Red constraint left side
...             [1,  1],  # Blue constraint left side
...             [ -2, -1.5]]  # Yellow constraint left side
```

In [11]:
```
rhs_ineq = [-1200,  # Red constraint right side
...             400,  # Blue constraint right side
...             -900]  # Yellow constraint right side
```

In [12]:
```
bnd = [(0, float("inf")),  # Bounds of x
...        (0, float("inf"))]  # Bounds of y
```

In [13]:
```
opt = linprog(c=obj, A_ub=lhs_ineq, b_ub=rhs_ineq,
...               bounds=bnd,
...               method="revised simplex")
```

In [14]:
```
opt
```

Out[14]:
```
     con: array([], dtype=float64)
     fun: 120000.0
 message: 'The problem appears infeasible, as the phase one auxiliary problem terminated successfully with a
residual of 3.0e+02, greater than the tolerance 1e-12 required for the solution to be considered feasible. C
onsider increasing the tolerance to be greater than 3.0e+02. If this tolerance is unacceptably large, the pr
oblem is likely infeasible.'
     nit: 1
   slack: array([   0.,    0., -300.])
  status: 2
 success: False
       x: array([  0., 400.])
```

PRACTICAL 8

DUAL SIMPLEX METHOD

```
##SOLVE FOLLOWING LINEAR PROGRAMMING PROBLEM USING DUAL SIMPLEX METHOD USING R PROGRAMMING

# Max z=40x1+50x2

#subject to

#2x1 + 3x2 <= 3

#8x1 + 4x2 <= 5

# x1, x2>=0



# Import lpSolve package

library(lpSolve)


# Set coefficients of the objective function

f.obj <- c(40, 50)



# Set matrix corresponding to coefficients of constraints by rows

# Do not consider the non-negative constraint; it is automatically assumed

f.con <- matrix(c(2, 3,

                  8, 4), nrow = 2, byrow = TRUE)



# Set unequality signs

f.dir <- c("<=",
```

```
          "<=")

# Set right hand side coefficients
f.rhs <- c(3,
          5)



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

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

# Sensitivities
lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)
$sens.coef.from
lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)
$sens.coef.to

# Dual Values (first dual of the constraints and then dual of the
variables)
# Duals of the constraints and variables are mixed
lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)$duals

# Duals lower and upper limits
lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)
$duals.from
lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)$duals.to
```

OUTPUT:

```
##SOLVE FOLLOWING LINEAR PROGRAMMING PROBLEM USING DUAL SIMPLEX METHOD USING R PROG
> # Max z=40x1+50x2
> #subject to
> #2x1 + 3x2 <= 3
> #8x1 + 4x2 <= 5
> # x1, x2>=0
>
>
> # Import lpSolve package
> library(lpSolve)
>
> # Set coefficients of the objective function
> f.obj <- c(40, 50)
>
> # Set matrix corresponding to coefficients of constraints by rows
> # Do not consider the non-negative constraint; it is automatically assumed
> f.con <- matrix(c(2, 3,
+                 8, 4), nrow = 2, byrow = TRUE)
>
> # Set unequality signs
> f.dir <- c("<=",
+          "<=")
>
> # Set right hand side coefficients
> f.rhs <- c(3,
+          5)
>
> # Final value (z)
> lp("max", f.obj, f.con, f.dir, f.rhs)
Success: the objective function is 51.25
>
> # Variables final values
> lp("max", f.obj, f.con, f.dir, f.rhs)$solution
[1] 0.1875 0.8750
>
> # Sensitivities
> lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)$sens.coef.from
[1] 33.33333 20.00000
> lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)$sens.coef.to
[1] 100  60
>
> # Dual Values (first dual of the constraints and then dual of the variables)
> # Duals of the constraints and variables are mixed
> lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)$duals
[1] 15.00  1.25  0.00  0.00
>
> # Duals lower and upper limits
> lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)$duals.from
[1]  1.25e+00  4.00e+00 -1.00e+30 -1.00e+30
> lp("max", f.obj, f.con, f.dir, f.rhs, compute.sens=TRUE)$duals.to
[1] 3.75e+00 1.20e+01 1.00e+30 1.00e+30
```

PRACTICAL 9

TRANSPORTATION PROBLEM

##sOLVE FOLLOWING TRANSPORTATION PROBLEM IN WHICH CELL ENTRIES REPRESENT UNIT COSTS USING R PROGRAMMING.

```
#   "Customer 1", "Customer 2", "Customer 3", "Customer 4"
SUPPLY

#sUPPLIER 1     10          2               20            11          15

#sUPPLIER 1     12          7               9            20          25

#sUPPLIER 1     4          14               16            18          10

#DEMAND          5          15              15            15


# Import lpSolve package

library(lpSolve)


# Set transportation costs matrix

costs <- matrix(c(10, 2, 20, 11,

                  12, 7, 9, 20,

                  4, 14 , 16, 18), nrow = 3, byrow = TRUE)


# Set customers and suppliers' names

colnames(costs) <- c("Customer 1", "Customer 2", "Customer
3", "Customer 4")

rownames(costs) <- c("Supplier 1", "Supplier 2", "Supplier 3")


# Set unequality/equality signs for suppliers

row.signs <- rep("<=", 3)
```

```
# Set right hand side coefficients for suppliers
row.rhs <- c(15, 25, 10)

# Set unequality/equality signs for customers
col.signs <- rep(">=", 4)

# Set right hand side coefficients for customers
col.rhs <- c(5, 15, 15, 15)

# Final value (z)
TotalCost <- lp.transport(costs, "min", row.signs, row.rhs,
col.signs, col.rhs)

# Variables final values
lp.transport(costs, "min", row.signs, row.rhs, col.signs, col.rhs)
$solution
print(TotalCost)
```

OUTPUT:

```
> ##sOLVE FOLLOWING TRANSPORTATION PROBLEM IN WHICH CELL ENTRIES REPRESENT UNIT COSTS
>
> #          "Customer 1", "Customer 2", "Customer 3", "Customer 4"  SUPPLY
> #sUPPLIER 1     10          2              20           11          15
> #sUPPLIER 1     12          7              9            20          25
> #sUPPLIER 1     4           14             16           18          10
> #DEMAND         5           15             15           15
>
> # Import lpSolve package
> library(lpSolve)
>
> # Set transportation costs matrix
> costs <- matrix(c(10, 2, 20, 11,
+                   12, 7, 9, 20,
+                   4, 14 , 16, 18), nrow = 3, byrow = TRUE)
>
> # Set customers and suppliers' names
```

```
> colnames(costs) <- c("Customer 1", "Customer 2", "Customer 3", "Customer 4")
> rownames(costs) <- c("Supplier 1", "Supplier 2", "Supplier 3")
>
> # Set unequality/equality signs for suppliers
> row.signs <- rep("<=", 3)
>
> # Set right hand side coefficients for suppliers
> row.rhs <- c(15, 25, 10)
>
> # Set unequality/equality signs for customers
> col.signs <- rep(">=", 4)
>
> # Set right hand side coefficients for customers
> col.rhs <- c(5, 15, 15, 15)
>
> # Final value (z)
> TotalCost <- lp.transport(costs, "min", row.signs, row.rhs, col.signs, col.rhs)
>
>
> # Variables final values
> lp.transport(costs, "min", row.signs, row.rhs, col.signs, col.rhs)$solution
     [,1] [,2] [,3] [,4]
[1,]    0    5    0   10
[2,]    0   10   15    0
[3,]    5    0    0    5
>
> print(TotalCost)
Success: the objective function is 435


>
```

PRACTICAL 10

ASSIGNMENT PROBLEM

#SOLVE FOLLOWING ASSIGNMENT PROBLEM REPRESENTED IN FOLLOWING MATRIX USING R PROGRAMMING

```
# Assignment Problem

#       JOB1    JOB2    JOB3

#W1     15      10      9

#W2     9       15      10

#W3     10      12      8


# Import lpSolve package

library(lpSolve)


# Set assignment costs matrix

costs <- matrix(c(15, 10, 9,

                  9, 15, 10,

                  10, 12 ,8), nrow = 3, byrow = TRUE)


# Print assignment costs matrix

costs


# Final value (z)

lp.assign(costs)


# Variables final values

lp.assign(costs)$solution
```

OUTPUT:

```
> #SOLVE FOLLOWING ASSIGNMENT PROBLEM REPRESENTED IN FOLLOWING MATRIX USING R PROGRA
> # Assignment Problem
> #       JOB1    JOB2    JOB3
> #W1     15      10      9
```

```
> #W2     9      15     10
> #W3     10     12      8
>
> # Import lpSolve package
> library(lpSolve)
>
> # Set assignment costs matrix
> costs <- matrix(c(15, 10, 9,
+                  9, 15, 10,
+                  10, 12 ,8), nrow = 3, byrow = TRUE)
>
> # Print assignment costs matrix
> costs
     [,1] [,2] [,3]
[1,]   15   10    9
[2,]    9   15   10
[3,]   10   12    8
>
> # Final value (z)
> lp.assign(costs)
Success: the objective function is 27
>
> # Variables final values
> lp.assign(costs)$solution
     [,1] [,2] [,3]
[1,]    0    1    0
[2,]    1    0    0
[3,]    0    0    1


>
```