# Assignment 5

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Installing required packages

```
library(lpSolveAPI)
library(Benchmarking)
```

```
## Loading required package: ucminf
```

```
## Loading required package: quadprog
```

Setting Working Directory

```
setwd("C:/Users/anura/Desktop/Quant Management Modelling/Assignment 5")
```

Input and output vectors

```
x <- matrix(c(150,400,320,520,350,320,0.2,0.7,1.2,2.0,1.2,0.7),ncol = 2)
y <-
matrix(c(14000,14000,42000,28000,19000,14000,3500,21000,10500,42000,25000,150
00),ncol = 2)
colnames(y) <- c("Reimbursed Patient-Days","Privately Paid Patient-Days")
colnames(x) <- c("Staff Hours per Day","Supplies per Day")
x
```

```
##      Staff Hours per Day Supplies per Day
## [1,]                 150              0.2
## [2,]                 400              0.7
## [3,]                 320              1.2
## [4,]                 520              2.0
## [5,]                 350              1.2
## [6,]                 320              0.7
```

```
y
```

```
##      Reimbursed Patient-Days Privately Paid Patient-Days
## [1,]                   14000                        3500
## [2,]                   14000                       21000
## [3,]                   42000                       10500
## [4,]                   28000                       42000
## [5,]                   19000                       25000
## [6,]                   14000                       15000
```

FDH Method

```
FDH <- dea(x,y,RTS = "fdh")
FDH
```

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

```
peers(FDH)
```

```
##      peer1
## [1,]     1
## [2,]     2
## [3,]     3
## [4,]     4
## [5,]     5
## [6,]     6
```

```
lambda(FDH)
```

```
##      L1 L2 L3 L4 L5 L6
## [1,]  1  0  0  0  0  0
## [2,]  0  1  0  0  0  0
## [3,]  0  0  1  0  0  0
## [4,]  0  0  0  1  0  0
## [5,]  0  0  0  0  1  0
## [6,]  0  0  0  0  0  1
```

CRS Method

```
CRS <- dea(x,y,RTS = "crs")
CRS
```

```
## [1] 1.0000 1.0000 1.0000 1.0000 0.9775 0.8675
```

```
peers(CRS)
```

```
##      peer1 peer2 peer3
## [1,]     1    NA    NA
## [2,]     2    NA    NA
## [3,]     3    NA    NA
## [4,]     4    NA    NA
## [5,]     1     2     4
## [6,]     1     2     4
```

```
lambda(CRS)
```

```
##             L1         L2 L3        L4
## [1,] 1.0000000 0.00000000  0 0.0000000
## [2,] 0.0000000 1.00000000  0 0.0000000
## [3,] 0.0000000 0.00000000  1 0.0000000
## [4,] 0.0000000 0.00000000  0 1.0000000
## [5,] 0.2000000 0.08048142  0 0.5383307
## [6,] 0.3428571 0.39499264  0 0.1310751
```

VRS Method

```
VRS <- dea(x,y,RTS = "vrs")
VRS
```

```
## [1] 1.0000 1.0000 1.0000 1.0000 1.0000 0.8963
```

```
peers(VRS)
```

```
##      peer1 peer2 peer3
## [1,]     1    NA    NA
## [2,]     2    NA    NA
## [3,]     3    NA    NA
## [4,]     4    NA    NA
## [5,]     5    NA    NA
## [6,]     1     2     5
```

```
lambda(VRS)
```

```
##             L1        L2 L3 L4        L5
## [1,] 1.0000000 0.0000000  0  0 0.0000000
## [2,] 0.0000000 1.0000000  0  0 0.0000000
## [3,] 0.0000000 0.0000000  1  0 0.0000000
## [4,] 0.0000000 0.0000000  0  1 0.0000000
## [5,] 0.0000000 0.0000000  0  0 1.0000000
## [6,] 0.4014399 0.3422606  0  0 0.2562995
```

IRS Method

```
IRS <- dea(x,y,RTS = "irs")
IRS
```

```
## [1] 1.0000 1.0000 1.0000 1.0000 1.0000 0.8963
```

```
peers(IRS)
```

```
##      peer1 peer2 peer3
## [1,]     1    NA    NA
## [2,]     2    NA    NA
## [3,]     3    NA    NA
## [4,]     4    NA    NA
## [5,]     5    NA    NA
## [6,]     1     2     5
```

```
lambda(IRS)
```

```
##             L1        L2 L3 L4        L5
## [1,] 1.0000000 0.0000000  0  0 0.0000000
## [2,] 0.0000000 1.0000000  0  0 0.0000000
## [3,] 0.0000000 0.0000000  1  0 0.0000000
## [4,] 0.0000000 0.0000000  0  1 0.0000000
## [5,] 0.0000000 0.0000000  0  0 1.0000000
## [6,] 0.4014399 0.3422606  0  0 0.2562995
```

DRS Method

```
DRS <- dea(x,y,RTS = "drs")
DRS
```

```
## [1] 1.0000 1.0000 1.0000 1.0000 0.9775 0.8675
```

```
peers(DRS)
```

```
##      peer1 peer2 peer3
## [1,]     1    NA    NA
## [2,]     2    NA    NA
## [3,]     3    NA    NA
## [4,]     4    NA    NA
## [5,]     1     2     4
## [6,]     1     2     4
```

```
lambda(DRS)
```

```
##             L1         L2 L3        L4
## [1,] 1.0000000 0.00000000  0 0.0000000
## [2,] 0.0000000 1.00000000  0 0.0000000
## [3,] 0.0000000 0.00000000  1 0.0000000
## [4,] 0.0000000 0.00000000  0 1.0000000
## [5,] 0.2000000 0.08048142  0 0.5383307
## [6,] 0.3428571 0.39499264  0 0.1310751
```

FRH Method

```
FRH <- dea(x,y,RTS = "add")
FRH
```

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

```
peers(FRH)
```

```
##      peer1
## [1,]     1
## [2,]     2
## [3,]     3
## [4,]     4
## [5,]     5
## [6,]     6
```

```
lambda(FRH)
```

```
##      L1 L2 L3 L4 L5 L6
## [1,]  1  0  0  0  0  0
## [2,]  0  1  0  0  0  0
## [3,]  0  0  1  0  0  0
## [4,]  0  0  0  1  0  0
## [5,]  0  0  0  0  1  0
## [6,]  0  0  0  0  0  1
```

```
Table <- data.frame(FDH=c(1, 1, 1, 1, 1, 1), CRS=c(1, 1, 1, 1, 0.9775,
0.8675), VRS=c(1, 1, 1, 1, 1, 0.8963), IRS=c(1, 1, 1, 1, 1,0.8963), DRS=c(1,
1, 1, 1, 0.9775, 0.8675), FRH=c(1, 1, 1, 1, 1, 1))
Combined <- cbind(x,y, Table)
Combined
```

```
##   Staff Hours per Day Supplies per Day Reimbursed Patient-Days
## 1                 150              0.2                   14000
## 2                 400              0.7                   14000
## 3                 320              1.2                   42000
## 4                 520              2.0                   28000
## 5                 350              1.2                   19000
## 6                 320              0.7                   14000
##   Privately Paid Patient-Days FDH    CRS    VRS    IRS    DRS FRH
## 1                        3500   1 1.0000 1.0000 1.0000 1.0000   1
## 2                       21000   1 1.0000 1.0000 1.0000 1.0000   1
## 3                       10500   1 1.0000 1.0000 1.0000 1.0000   1
## 4                       42000   1 1.0000 1.0000 1.0000 1.0000   1
## 5                       25000   1 0.9775 1.0000 1.0000 0.9775   1
## 6                       15000   1 0.8675 0.8963 0.8963 0.8675   1
```

DMU 1,2,3 & 4 have efficiencies of 1 for all DEA analysis.

DMU 5 has efficiency of 1 for FDH;VRS;IRS;FRH analysis but efficiency of 0.9775 for both CRS and DRS

DMU 6 has efficiency of 1 for FDH and FRH analysis, for CRS and DRS analysis - 0.8675; VRS and IRS 0.8963

#*Question 2

```
library(lpSolveAPI)
emax <- read.lp("emax_corp.lp")
emax
```

```
## Model name:
##             X1    X2    X3   Y1p   Y1m   Y2m   Y2p
## Maximize    20    15    25    -6    -6    -3     0
## R1           6     4     5    -1     1     0     0  =  50
## R2           8     7     5     0     0     1    -1  =  75
## Kind       Std   Std   Std   Std   Std   Std   Std
## Type      Real  Real  Real  Real  Real  Real  Real
## Upper      Inf   Inf   Inf   Inf   Inf   Inf   Inf
## Lower        0     0     0     0     0     0     0
```

```
solve(emax)
```

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

```
get.objective(emax)
```

```
## [1] 225
```

```
get.variables(emax)
```

```
## [1]  0  0 15 25  0  0  0
```

The objective function is 225. X1 = 0, X2 = 0, X3 = 15, Y1p = 25, Y1m = 0, Y2m = 0. This implies that since y1 = 0 and y2 = 0, so the first and second goals are fully satisfied.