QMM .Asgn- 8

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```
# Loading the required packages

##install.packages("Benchmarking")
library(Benchmarking)
```

```
## Warning: package 'Benchmarking' was built under R version 4.1.2

## Loading required package: lpSolveAPI

## Warning: package 'lpSolveAPI' was built under R version 4.1.2

## Loading required package: ucminf

## Warning: package 'ucminf' was built under R version 4.1.2

## Loading required package: quadprog

##
## Loading Benchmarking version 0.30h, (Revision 244, 2022/05/05 16:31:31) ...

## Build 2022/05/05 16:31:40
```

```
#install.packages("cowplot")
library(cowplot)
```

```
## Formulating the problem

## Using benchmarking library to solve DEA

## Reading the data
## * input : staff hours and supplies per days.

## * Output: Reimbursed Patient-Days and Privately paid patient days.

input <-  matrix(c(150,400,320,520,350,320,0.2,0.7,1.2,2.0,1.2,0.7),ncol = 2)
Output <- matrix(c(14000,14000,42000,28000,19000,14000,3500,21000,10500,42000,25000,15000),ncol = 2)
colnames(input)<-c('staff Hours(Per Day)','Supplies(Per Day)')
colnames(Output)<-c('Reimbursed Patient','Privately Paid Patient')
rownames(input)<-c('Facility1','Facility2','Facility3','Facility4','Facility5','Facility6')
rownames(Output)<-c('Facility1','Facility2','Facility3','Facility4','Facility5','Facility6')
input
```

```
##           staff Hours(Per Day) Supplies(Per Day)
## Facility1                  150               0.2
## Facility2                  400               0.7
## Facility3                  320               1.2
## Facility4                  520               2.0
## Facility5                  350               1.2
## Facility6                  320               0.7
```

```
Output
```

```
##           Reimbursed Patient Privately Paid Patient
## Facility1              14000                  3500
## Facility2              14000                 21000
## Facility3              42000                 10500
## Facility4              28000                 42000
## Facility5              19000                 25000
## Facility6              14000                 15000
```

```
# DEA analysis using FDH

# Analysing the input and output
Analysis_fdh <- dea(input,Output,RTS = "fdh")

#Efficiency of the DEA with FDH assumption

Efficiency_fdh <- as.data.frame(Analysis_fdh$eff)
colnames(Efficiency_fdh) <- c("Efficiency_FDH")

# Finding  the peers
peers_fdh <- as.data.frame(Analysis_fdh$peers)
colnames(peers_fdh) <- c("Peers_FDH")

# Using Lambda Function
lambda_fdh <- as.data.frame(Analysis_fdh$lambda)
colnames(lambda_fdh) <-c("FHD_Lambda1","FHD_Lambda2","FHD_Lambda3","FHD_Lambda4","FHD_Lambda5","FHD_Lam

# Analysing peers , lambda and efficiency
dea_fdh <- cbind(Efficiency_fdh,peers_fdh,lambda_fdh)
rownames(dea_fdh) <- c('F1','F2','F3','F4','F5','F6')

# Summarise
dea_fdh
```

```
##    Efficiency_FDH Peers_FDH FHD_Lambda1 FHD_Lambda2 FHD_Lambda3 FHD_Lambda4
## F1              1         1           1           0           0           0
## F2              1         2           0           1           0           0
## F3              1         3           0           0           1           0
## F4              1         4           0           0           0           1
## F5              1         5           0           0           0           0
## F6              1         6           0           0           0           0
##    FHD_Lambda5 FHD_Lambda6
## F1           0           0
## F2           0           0
```

```
## F3           0           0
## F4           0           0
## F5           1           0
## F6           0           1
```

```
# DEA analysis using CRS

# Analysing the input and output
Analysis_CRS <- dea(input,Output,RTS = "crs")

#Efficiency of the DEA with CRS assumption
Efficiency_CRS <- as.data.frame(Analysis_CRS$eff)
colnames(Efficiency_CRS) <- c("Efficiency_CRS")

# Finding  the peers
peers_CRS <- peers(Analysis_CRS)
colnames(peers_CRS) <- c("Peer1_CRS","Peer2_CRS","Peer3_CRS")

# Using Lambda Function
lambda_CRS <- lambda(Analysis_CRS)
colnames(lambda_CRS) <- c("CRS_Lambda1","CRS_Lambda2","CRS_Lambda3","CRS_Lambda4")

# Analysing peers , lambda and efficiency
dea_CRS <- cbind(Efficiency_CRS,peers_CRS,lambda_CRS)
rownames(dea_CRS) <- c('F1','F2','F3','F4','F5','F6')

# Summarise
dea_CRS
```

```
##    Efficiency_CRS Peer1_CRS Peer2_CRS Peer3_CRS CRS_Lambda1 CRS_Lambda2
## F1      1.0000000         1        NA        NA   1.0000000  0.00000000
## F2      1.0000000         2        NA        NA   0.0000000  1.00000000
## F3      1.0000000         3        NA        NA   0.0000000  0.00000000
## F4      1.0000000         4        NA        NA   0.0000000  0.00000000
## F5      0.9774987         1         2         4   0.2000000  0.08048142
## F6      0.8674521         1         2         4   0.3428571  0.39499264
##    CRS_Lambda3 CRS_Lambda4
## F1           0   0.0000000
## F2           0   0.0000000
## F3           1   0.0000000
## F4           0   1.0000000
## F5           0   0.5383307
## F6           0   0.1310751
```

```
# Using VSR


# Analysing the input and output
Analysis_VRS <- dea(input,Output,RTS = "vrs")

#Efficiency of the DEA with CRS assumption
Efficiency_VRS <- as.data.frame(Analysis_VRS$eff)
colnames(Efficiency_VRS) <- c("Efficiency_VRS")
```

```r
# Finding  the peers
peers_VRS <- peers(Analysis_VRS)
colnames(peers_VRS) <- c("Peer1_VRS","Peer2_VRS","Peer3_VRS")

# Using Lambda Function
lambda_VRS <- lambda(Analysis_VRS)
colnames(lambda_VRS) <- c("VRS_Lambda1","VRS_Lambda2","VRS_Lambda3","VRS_Lambda4","VRS_Lambda5")

# Analysing peers , lambda and efficiency
dea_VRS <- cbind(Efficiency_VRS,peers_VRS,lambda_VRS)
rownames(dea_VRS) <- c('F1','F2','F3','F4','F5','F6')

# Summarise
dea_VRS
```

```
##    Efficiency_VRS Peer1_VRS Peer2_VRS Peer3_VRS VRS_Lambda1 VRS_Lambda2
## F1      1.0000000         1        NA        NA   1.0000000   0.0000000
## F2      1.0000000         2        NA        NA   0.0000000   1.0000000
## F3      1.0000000         3        NA        NA   0.0000000   0.0000000
## F4      1.0000000         4        NA        NA   0.0000000   0.0000000
## F5      1.0000000         5        NA        NA   0.0000000   0.0000000
## F6      0.8963283         1         2         5   0.4014399   0.3422606
##    VRS_Lambda3 VRS_Lambda4 VRS_Lambda5
## F1           0           0   0.0000000
## F2           0           0   0.0000000
## F3           1           0   0.0000000
## F4           0           1   0.0000000
## F5           0           0   1.0000000
## F6           0           0   0.2562995
```

```r
## DEA analysis with IRS

# Analysing the input and output
Analysis_IRS <- dea(input,Output,RTS = "irs")

#Efficiency of the DEA with CRS assumption
Efficiency_IRS <- as.data.frame(Analysis_IRS$eff)
colnames(Efficiency_IRS) <- c("Efficiency_IRS")

# Finding  the peers
peers_IRS <- peers(Analysis_IRS)
colnames(peers_IRS) <- c("Peer1_IRS","Peer2_IRS","Peer3_IRS")

# Using Lambda Function
lambda_IRS <- lambda(Analysis_IRS)
colnames(lambda_IRS) <- c("IRS_Lambda1","IRS_Lambda2","IRS_Lambda3","IRS_Lambda4","IRS_Lambda5")

# Analysing peers , lambda and efficiency
dea_IRS <- cbind(Efficiency_IRS,peers_IRS,lambda_IRS)
rownames(dea_IRS) <- c('F1','F2','F3','F4','F5','F6')

# Summarise
dea_IRS
```

```
##    Efficiency_IRS Peer1_IRS Peer2_IRS Peer3_IRS IRS_Lambda1 IRS_Lambda2
## F1      1.0000000         1        NA        NA   1.0000000   0.0000000
## F2      1.0000000         2        NA        NA   0.0000000   1.0000000
## F3      1.0000000         3        NA        NA   0.0000000   0.0000000
## F4      1.0000000         4        NA        NA   0.0000000   0.0000000
## F5      1.0000000         5        NA        NA   0.0000000   0.0000000
## F6      0.8963283         1         2         5   0.4014399   0.3422606
##    IRS_Lambda3 IRS_Lambda4 IRS_Lambda5
## F1           0           0   0.0000000
## F2           0           0   0.0000000
## F3           1           0   0.0000000
## F4           0           1   0.0000000
## F5           0           0   1.0000000
## F6           0           0   0.2562995
```

```
## DEA analysis using DRS

# Analysing the input and output
Analysis_DRS <- dea(input,Output,RTS = "drs")

#Efficiency of the DEA with DRS assumption
Efficiency_DRS <- as.data.frame(Analysis_DRS$eff)
colnames(Efficiency_DRS) <- c("Efficiency_DRS")

# Finding  the peers
peers_DRS <- peers(Analysis_DRS)
colnames(peers_DRS) <- c("Peer1_DRS","Peer2_DRS","Peer3_DRS")

# Using Lambda Function
lambda_DRS <- lambda(Analysis_DRS)
colnames(lambda_DRS) <- c("_Lambda1","DRS_Lambda2","DRS_Lambda3","DRS_Lambda4")

# Analysing peers , lambda and efficiency
dea_DRS <- cbind(Efficiency_DRS,peers_DRS,lambda_DRS)
rownames(dea_CRS) <- c('F1','F2','F3','F4','F5','F6')

# Summarise
dea_DRS
```

```
##           Efficiency_DRS Peer1_DRS Peer2_DRS Peer3_DRS  _Lambda1 DRS_Lambda2
## Facility1      1.0000000         1        NA        NA 1.0000000  0.00000000
## Facility2      1.0000000         2        NA        NA 0.0000000  1.00000000
## Facility3      1.0000000         3        NA        NA 0.0000000  0.00000000
## Facility4      1.0000000         4        NA        NA 0.0000000  0.00000000
## Facility5      0.9774987         1         2         4 0.2000000  0.08048142
## Facility6      0.8674521         1         2         4 0.3428571  0.39499264
##           DRS_Lambda3 DRS_Lambda4
## Facility1           0   0.0000000
## Facility2           0   0.0000000
## Facility3           1   0.0000000
## Facility4           0   1.0000000
## Facility5           0   0.5383307
## Facility6           0   0.1310751
```

```r
## DEA analysis using FRH

# Analysing the input and output
Analysis_FRH <- dea(input,Output,RTS = "add")

#Efficiency of the DEA with DRS assumption
Efficiency_FRH <- as.data.frame(Analysis_FRH$eff)
colnames(Efficiency_FRH) <- c("Efficiency_FRH")

# Finding  the peers
peers_FRH <- peers(Analysis_FRH)
colnames(peers_FRH) <- c("Peer1_FRH")


# Using Lambda Function
lambda_FRH <- lambda(Analysis_FRH)
colnames(lambda_FRH) <- c("FRH_Lambda1","FRH_Lambda2","FRH_Lambda3","FRH_Lambda4","FRH_Lambda5","FRH_La

# Analysing peers , lambda and efficiency
dea_FRH <- cbind(Efficiency_FRH,peers_FRH,lambda_FRH)
rownames(dea_FRH) <- c('F1','F2','F3','F4','F5','F6')

# Summarise
dea_FRH
```

```
##    Efficiency_FRH Peer1_FRH FRH_Lambda1 FRH_Lambda2 FRH_Lambda3 FRH_Lambda4
## F1              1         1           1           0           0           0
## F2              1         2           0           1           0           0
## F3              1         3           0           0           1           0
## F4              1         4           0           0           0           1
## F5              1         5           0           0           0           0
## F6              1         6           0           0           0           0
##    FRH_Lambda5 FRH_Lambda6
## F1           0           0
## F2           0           0
## F3           0           0
## F4           0           0
## F5           1           0
## F6           0           1
```