Assignment 1

Rohith Chandra

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Question 1 -

```
# Step 1 - Creating matrix for the problem
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, 15000),ncol = 2)

# Assign column names to the matrix
colnames(x) <- c("Staff_Hours_per_day","Supplies_per_day")
colnames(y) <- c("Reimbursed_patient_days", "Privately_paid_patient-days")
```

Formulating and performing DEA analysis

1. DEA Analysis using FDH

```
library(Benchmarking)

## Warning: package 'Benchmarking' was built under R version 4.2.1

## Loading required package: lpSolveAPI

## Warning: package 'lpSolveAPI' was built under R version 4.2.1

## Loading required package: ucminf

## Warning: package 'ucminf' was built under R version 4.2.1

## Loading required package: quadprog

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

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

library(tidyverse)

## ── Attaching packages ─────────────────────────────────────── tidyverse 1.
3.1 ──

## ✓ ggplot2 3.3.6     ✓ purrr   0.3.4
## ✓ tibble  3.1.7     ✓ dplyr   1.0.9
```

```
## ✓ tidyr   1.2.0     ✓ stringr 1.4.0
## ✓ readr   2.1.2     ✓ forcats 0.5.1

## Warning: package 'ggplot2' was built under R version 4.2.1

## ── Conflicts ─────────────────────────────────────── tidyverse_conflict
s() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
```

```
# Analyse DEA using FDH with the input x and output y variables
fdh_ana = dea(x,y,RTS = "fdh")

#Finding the efficiency value to dataset
fdh_eff = as.data.frame(fdh_ana$eff)
print(fdh_eff)
```

```
##   fdh_ana$eff
## 1           1
## 2           1
## 3           1
## 4           1
## 5           1
## 6           1
```

2. DEA Analysis using CRS

```
# Analyse DEA using CRS with input x and output y variables
crs_ana = dea(x,y,RTS = "crs")

#Finding the efficiency value to dataset
crs_eff = as.data.frame(crs_ana$eff)
print(crs_ana)
```

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

3. DEA Analysis using VRS

```
# Analyse DEA using VRS with input x and output y variables
vrs_ana = dea(x,y,RTS = "vrs")

#Finding the efficiency value to dataset
vrs_eff = as.data.frame(vrs_ana$eff)
print(vrs_ana)
```

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

4. DEA Analysis using IRS

```
# Analyse DEA using IRS with input x and output y values
irs_ana <- dea(x,y,RTS = "irs")

#Finding efficiency value to dataset
```

```
irs_eff = as.data.frame(irs_ana$eff)
print(irs_ana)

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

5. DEA Analysis using DRS

```
# Analyse DEA using DRS with input x and output y values
drs_ana = dea(x,y,RTS = "drs")

#Finding efficiency value to dataset
drs_eff = as.data.frame(drs_ana$eff)
print(drs_ana)

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

6. DEA Analysis using FRH

```
# Analyse DEA using FRH with input x and output y values
frh_ana = dea(x,y,RTS = "add")

#Finding efficiency value to dataset
frh_eff = as.data.frame(frh_ana$eff)
print(frh_ana)

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

Question 2 - Determining the Peers and Lambdas under each of the DEA assumption

1. Peers and Lambdas for FDH

```
# Determining peers
fdh_peers <- peers(fdh_ana)

# Determining the weights using lambda function for the  peer values
fdh_lamda <- lambda(fdh_ana)
```

2. Peers and Lambdas for CRS

```
# Determining peers
crs_peers <- peers(crs_ana)

# Weights using lambda function for the  peer values
crs_lamda <- lambda(crs_ana)
```

3. Peers and Lambdas for VRS

```
# Determining peers
vrs_peers <- peers(vrs_ana)

# Weights using lambda function for the peer values
vrs_lamda <- lambda(vrs_ana)
```

4. Peers and Lambdas for IRS

```
# Determining peers
irs_peers <- peers(irs_ana)

# Weights using lambda function for the peer values
irs_lamda <- lambda(irs_ana)
```

5. Peers and Lambdas for DRS

```
# Determining peers
drs_peers <- peers(drs_ana)

# Weights using lambda function for the peer values
drs_lamda <- lambda(drs_ana)
```

6. Peers and Lambdas for FDH

```
# Identify the peers
frh_peers <- peers(frh_ana)

# Weights given to the peers using lambda function
frh_lamda <- lambda(frh_ana)
```

Question 3 - Summarizing results in a tabular format

```
fdh_result <- data.frame(fdh_eff,fdh_peers, fdh_lamda)
crs_result <- data.frame(crs_eff,crs_peers, crs_lamda)
vrs_result <- data.frame(vrs_eff,vrs_peers, vrs_lamda)
irs_result <- data.frame(irs_eff,irs_peers, irs_lamda)
drs_result <- data.frame(drs_eff,drs_peers, drs_lamda)
frh_result <- cbind(frh_eff,frh_peers, frh_lamda)

fdh_result
```

```
##   fdh_ana.eff peer1 L1 L2 L3 L4 L5 L6
## 1           1     1  1  0  0  0  0  0
## 2           1     2  0  1  0  0  0  0
## 3           1     3  0  0  1  0  0  0
## 4           1     4  0  0  0  1  0  0
## 5           1     5  0  0  0  0  1  0
## 6           1     6  0  0  0  0  0  1
```

```
crs_result
```

```
##   crs_ana.eff peer1 peer2 peer3        L1         L2 L3        L4
## 1   1.0000000     1    NA    NA 1.0000000 0.00000000  0 0.0000000
## 2   1.0000000     2    NA    NA 0.0000000 1.00000000  0 0.0000000
## 3   1.0000000     3    NA    NA 0.0000000 0.00000000  1 0.0000000
## 4   1.0000000     4    NA    NA 0.0000000 0.00000000  0 1.0000000
## 5   0.9774987     1     2     4 0.2000000 0.08048142  0 0.5383307
## 6   0.8674521     1     2     4 0.3428571 0.39499264  0 0.1310751
```

```
vrs_result
```

```
##   vrs_ana.eff peer1 peer2 peer3        L1        L2 L3 L4        L5
## 1   1.0000000     1    NA    NA 1.0000000 0.0000000  0  0 0.0000000
## 2   1.0000000     2    NA    NA 0.0000000 1.0000000  0  0 0.0000000
## 3   1.0000000     3    NA    NA 0.0000000 0.0000000  1  0 0.0000000
## 4   1.0000000     4    NA    NA 0.0000000 0.0000000  0  1 0.0000000
## 5   1.0000000     5    NA    NA 0.0000000 0.0000000  0  0 1.0000000
## 6   0.8963283     1     2     5 0.4014399 0.3422606  0  0 0.2562995
```

```
irs_result
```

```
##   irs_ana.eff peer1 peer2 peer3        L1        L2 L3 L4        L5
## 1   1.0000000     1    NA    NA 1.0000000 0.0000000  0  0 0.0000000
## 2   1.0000000     2    NA    NA 0.0000000 1.0000000  0  0 0.0000000
## 3   1.0000000     3    NA    NA 0.0000000 0.0000000  1  0 0.0000000
## 4   1.0000000     4    NA    NA 0.0000000 0.0000000  0  1 0.0000000
## 5   1.0000000     5    NA    NA 0.0000000 0.0000000  0  0 1.0000000
## 6   0.8963283     1     2     5 0.4014399 0.3422606  0  0 0.2562995
```

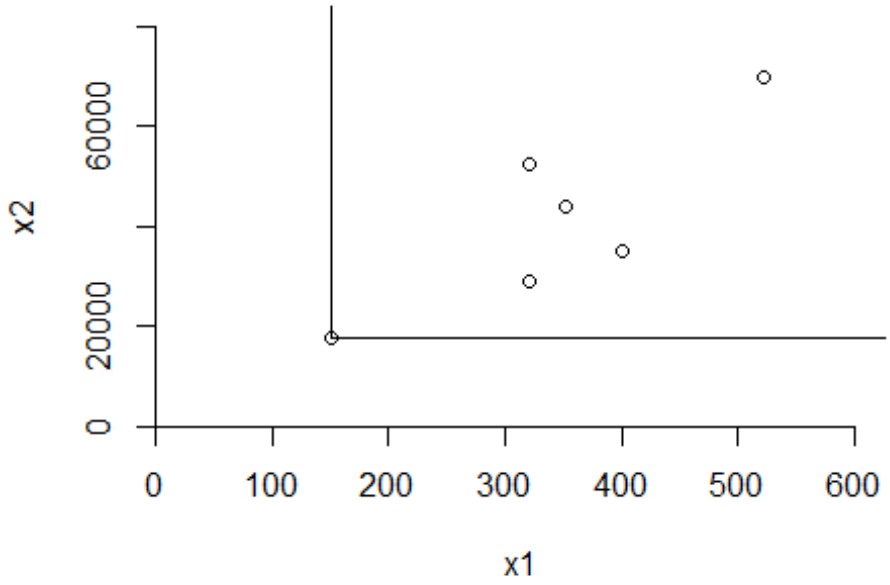
```
drs_result
```

```
##   drs_ana.eff peer1 peer2 peer3        L1         L2 L3        L4
## 1   1.0000000     1    NA    NA 1.0000000 0.00000000  0 0.0000000
## 2   1.0000000     2    NA    NA 0.0000000 1.00000000  0 0.0000000
## 3   1.0000000     3    NA    NA 0.0000000 0.00000000  1 0.0000000
## 4   1.0000000     4    NA    NA 0.0000000 0.00000000  0 1.0000000
## 5   0.9774987     1     2     4 0.2000000 0.08048142  0 0.5383307
## 6   0.8674521     1     2     4 0.3428571 0.39499264  0 0.1310751
```

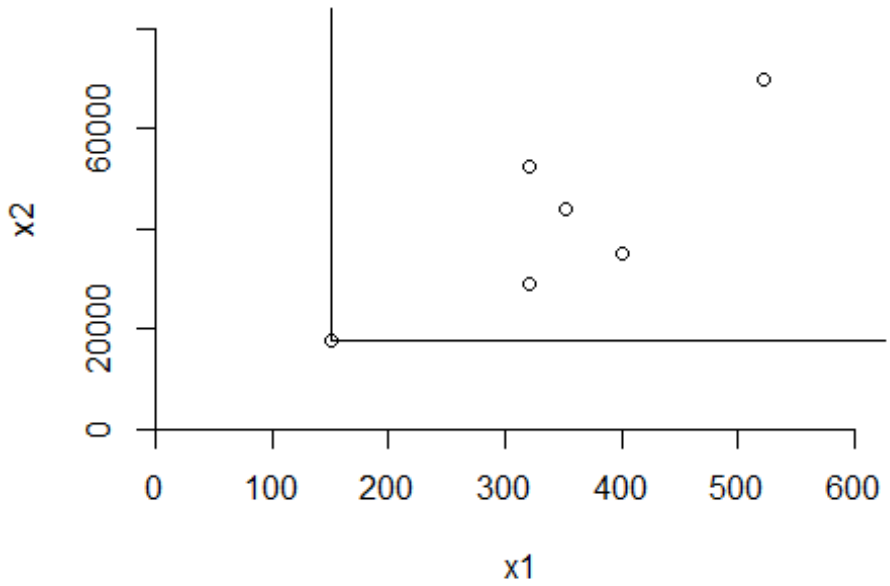
```
frh_result
```

```
##   frh_ana$eff peer1 L1 L2 L3 L4 L5 L6
## 1           1     1  1  0  0  0  0  0
## 2           1     2  0  1  0  0  0  0
## 3           1     3  0  0  1  0  0  0
## 4           1     4  0  0  0  1  0  0
## 5           1     5  0  0  0  0  1  0
## 6           1     6  0  0  0  0  0  1
```

```
dea.plot.isoquant(x,y,RTS = "fdh")
```




```
dea.plot.isoquant(x,y,RTS = "crs")
```



```
dea.plot.isoquant(x,y,RTS = "vrs")
dea.plot.isoquant(x,y,RTS = "irs")
dea.plot.isoquant(x,y,RTS = "drs")
```

Question 4 - Comapre and contrast the above results

In simple terms - In FDH, the peer value was given one unit, both lamda and efficiency values are 1 and from the result table it states that every DMU and facility is having maximum capacity and effectiveness. In CRS, the lamdas and peers it is observed that the efficiency of facilities 1, 2, 3, and 4 are 100% which means they use CRS fully. The efficiency for 5 and 6 is 97.74% and 86.74% respectively which can be improved.In VRS, the lamdas and peers we can tell facilities—numbers 1, 2, 3, 4, and 5 has maximum efficieny/productivity. With facility 6, which has an efficiency of 89.63%. In IRS, Facilities 1, 2, 3, 4, and 5 operate at full productivity, IRS and VRS are both achieved. For facility 6, has 89.63% efficiency requires improvement from units 1, 2, and 5.In DRS, Facilities 1, 2, 3, and 4, Decreasing Returns to Scale (DRS) performs well in terms of efficiency and for facilities 5 and 6 needs improvement and require a portion of facilities 1, 2, and 4 in order to get maximum efficiency of 1.In FRH, all Facilities are efficient which are observed in peer and lambda. For the DMUs - 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.