

# Assignment Assignment: Module 8 - DEA

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## Loading Packages

```
library(Benchmarking)

## Loading required package: lpSolveAPI

## Loading required package: ucminf

## Loading required package: quadprog

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

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

## Given data

```
tab <- matrix(c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6",
               150,400,320,520,350,320,
               0.2,0.7,1.2,2.0,1.2,0.7,
               14000,14000,42000,28000,19000,14000,
               3500,21000,10500,42000,25000,15000), ncol=5, byrow=F)
colnames(tab) <- c('DMU','Staff.Hours.per.day', 'Supplies.per.day', 'Reimbursed.patient.days', 'Privately
#rownames(tab) <- c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")
tab <- as.data.frame(tab)

x<-matrix(c(150,400,320,520,350,320,
           0.2,0.7,1.2,2,1.2,0.7),ncol=2)
y<-matrix(c(14000,14000,42000,28000,19000,14000,
           3500,21000,10500,42000,25000,15000),ncol=2)
colnames(y)<-c("Reimbursed","Private")
colnames(x)<-c("Staff","Supplies")
rownames(x)<-c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")
tab
```

```
##          DMU Staff.Hours.per.day Supplies.per.day Reimbursed.patient.days
## 1 Facility 1                150              0.2             14000
## 2 Facility 2                400              0.7             14000
## 3 Facility 3                320              1.2            42000
## 4 Facility 4                520              2             28000
## 5 Facility 5                350              1.2            19000
## 6 Facility 6                320              0.7             14000
## Privately.paid.patient.days
## 1                3500
## 2               21000
## 3               10500
## 4               42000
## 5               25000
## 6               15000
```

## Question 1

```
crs<-dea(x,y,RTS='crs')
tab$crs.efficiency<-crs$eff

vrs<-dea(x,y,RTS='vrs')
tab$vrs.efficiency<-vrs$eff

irs<-dea(x,y,RTS='irs')
tab$irs.efficiency<-irs$eff

drs<-dea(x,y,RTS='drs')
tab$drs.efficiency<-drs$eff

fdh<-dea(x,y,RTS='fdh')
tab$fdh.efficiency<-fdh$eff

frh<-dea(x,y,RTS='fdh+')
tab$frh.efficiency<-frh$eff

tab
```

```
##          DMU Staff.Hours.per.day Supplies.per.day Reimbursed.patient.days
## 1 Facility 1                150              0.2             14000
## 2 Facility 2                400              0.7             14000
## 3 Facility 3                320              1.2            42000
## 4 Facility 4                520              2             28000
## 5 Facility 5                350              1.2            19000
## 6 Facility 6                320              0.7             14000
## Privately.paid.patient.days crs.efficiency vrs.efficiency irs.efficiency
## 1                3500      1.0000000      1.0000000      1.0000000
```

## 2	21000	1.0000000	1.0000000	1.0000000
## 3	10500	1.0000000	1.0000000	1.0000000
## 4	42000	1.0000000	1.0000000	1.0000000
## 5	25000	0.9774987	1.0000000	1.0000000
## 6	15000	0.8674521	0.8963283	0.8963283
##	drs.efficiency	fdh.efficiency	frh.efficiency	
## 1	1.0000000	1	1	
## 2	1.0000000	1	1	
## 3	1.0000000	1	1	
## 4	1.0000000	1	1	
## 5	0.9774987	1	1	
## 6	0.8674521	1	1	

## Question 2 Peers and Lamba

```

crs1<-c()
crs1$efficiency<-crs$eff
crs1$peers<-peers(crs)
crs1$lambda<-lambda(crs)

crs1<- as.data.frame(crs1)
rownames(crs1)<-c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")

vrs1<-c()
vrs1$efficiency<-vrs$eff
vrs1$peers<-peers(vrs)
vrs1$lambda<-lambda(vrs)

vrs1<- as.data.frame(vrs1)
rownames(vrs1)<-c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")

drs1<-c()
drs1$efficiency<-drs$eff
drs1$peers<-peers(drs)
drs1$lambda<-lambda(drs)

drs1<- as.data.frame(drs1)
rownames(drs1)<-c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")

irs1<-c()
irs1$efficiency<-irs$eff
irs1$peers<-peers(irs)
irs1$lambda<-lambda(irs)

irs1<- as.data.frame(irs1)
rownames(irs1)<-c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")

fdh1<-c()
fdh1$efficiency<-fdh$eff
fdh1$peers<-peers(fdh)
fdh1$lambda<-lambda(fdh)

```

```

fdh1<- as.data.frame(fdh1)
rownames(fdh1)<-c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")

frh1<-c()
frh1$efficiency<-frh$eff
frh1$peers<-peers(frh)
frh1$lambda<-lambda(frh)

frh1<- as.data.frame(frh1)
rownames(frh1)<-c("Facility 1","Facility 2","Facility 3","Facility 4","Facility 5","Facility 6")

```

### Question 3 Summarize

#### CRS

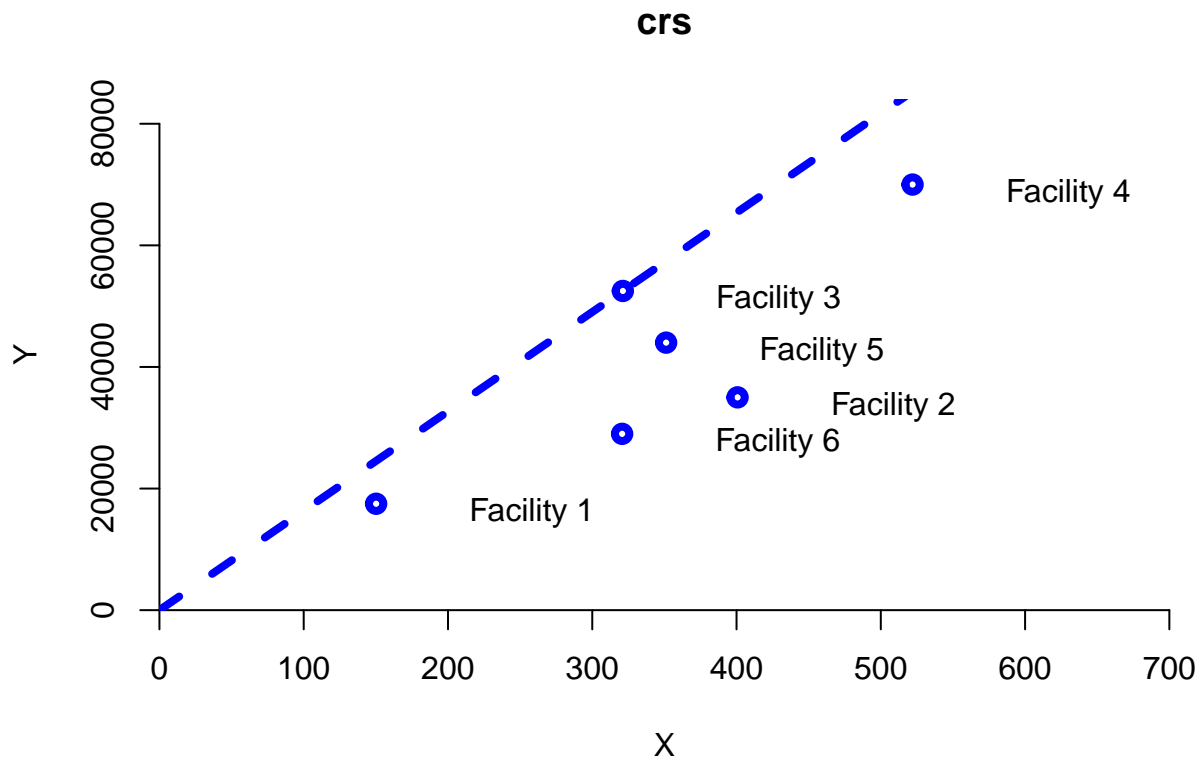
```
crs1
```

```

##           efficiency peers.peer1 peers.peer2 peers.peer3 lambda.L_Facility.1
## Facility 1  1.0000000         1         NA         NA         1.0000000
## Facility 2  1.0000000         2         NA         NA         0.0000000
## Facility 3  1.0000000         3         NA         NA         0.0000000
## Facility 4  1.0000000         4         NA         NA         0.0000000
## Facility 5  0.9774987         1         2         4         0.2000000
## Facility 6  0.8674521         1         2         4         0.3428571
##           lambda.L_Facility.2 lambda.L_Facility.3 lambda.L_Facility.4
## Facility 1      0.00000000         0         0.0000000
## Facility 2      1.00000000         0         0.0000000
## Facility 3      0.00000000         1         0.0000000
## Facility 4      0.00000000         0         1.0000000
## Facility 5      0.08048142         0         0.5383307
## Facility 6      0.39499264         0         0.1310751

```

```
dea.plot(x,y,RTS="crs",ORIENTATION="in-out",txt=rownames(x), main="crs",lty="dashed",lwd=4, col="blue",
```

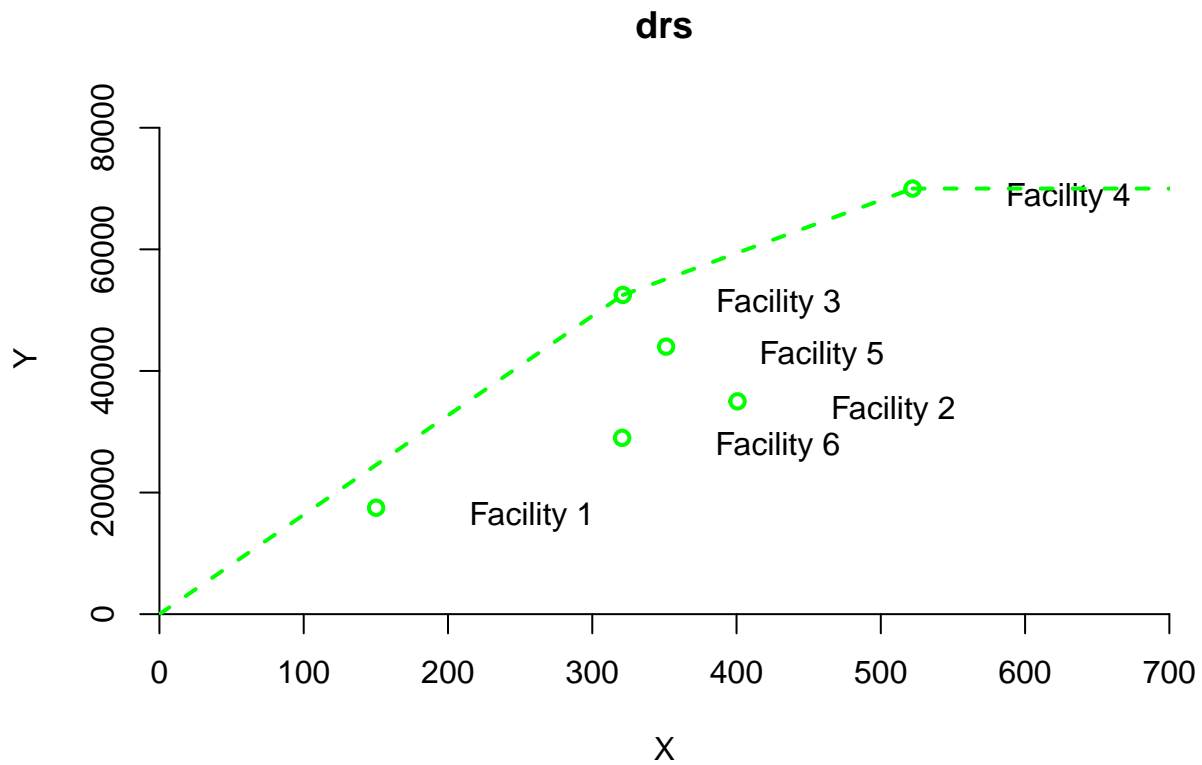


## DRS

drs1

```
##          efficiency peers.peer1 peers.peer2 peers.peer3 lambda.L_Facility.1
## Facility 1  1.0000000          1         NA         NA          1.0000000
## Facility 2  1.0000000          2         NA         NA          0.0000000
## Facility 3  1.0000000          3         NA         NA          0.0000000
## Facility 4  1.0000000          4         NA         NA          0.0000000
## Facility 5  0.9774987          1          2          4          0.2000000
## Facility 6  0.8674521          1          2          4          0.3428571
##          lambda.L_Facility.2 lambda.L_Facility.3 lambda.L_Facility.4
## Facility 1          0.00000000          0          0.0000000
## Facility 2          1.00000000          0          0.0000000
## Facility 3          0.00000000          1          0.0000000
## Facility 4          0.00000000          0          1.0000000
## Facility 5          0.08048142          0          0.5383307
## Facility 6          0.39499264          0          0.1310751
```

```
dea.plot(x,y,RTS="drs",ORIENTATION="in-out",txt=rownames(x),main="drs",lty="dashed",lwd=2,col='green',x
```



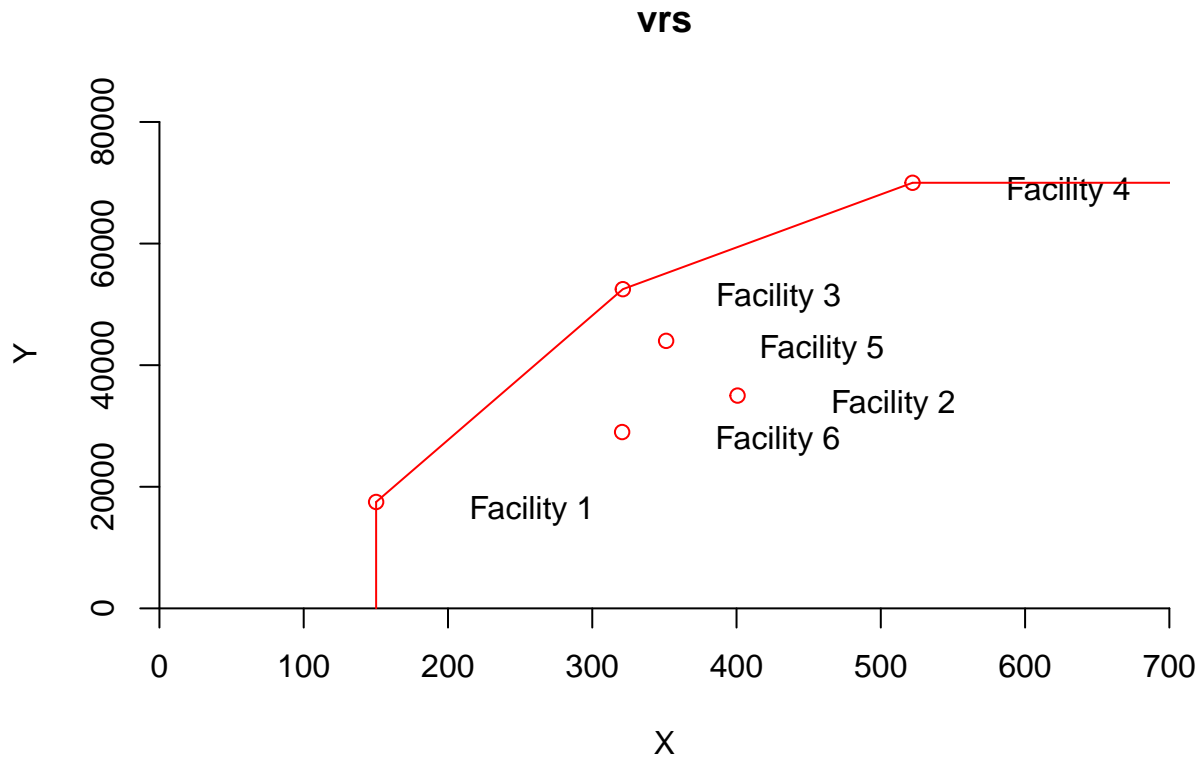
## VRS

vrs1

```
##          efficiency peers.peer1 peers.peer2 peers.peer3 lambda.L_Facility.1
## Facility 1  1.0000000          1          NA          NA          1.0000000
## Facility 2  1.0000000          2          NA          NA          0.0000000
## Facility 3  1.0000000          3          NA          NA          0.0000000
## Facility 4  1.0000000          4          NA          NA          0.0000000
## Facility 5  1.0000000          5          NA          NA          0.0000000
## Facility 6  0.8963283          1          2          5          0.4014399
##          lambda.L_Facility.2 lambda.L_Facility.3 lambda.L_Facility.4
## Facility 1      0.0000000          0          0
## Facility 2      1.0000000          0          0
## Facility 3      0.0000000          1          0
## Facility 4      0.0000000          0          1
## Facility 5      0.0000000          0          0
## Facility 6      0.3422606          0          0
##          lambda.L_Facility.5
## Facility 1      0.0000000
## Facility 2      0.0000000
## Facility 3      0.0000000
## Facility 4      0.0000000
## Facility 5      1.0000000
```

```
## Facility 6          0.2562995
```

```
dea.plot(x,y,RTS="vrs",ORIENTATION="in-out",txt=rownames(x),main='vrs',col='red',xlim=c(0,700))
```



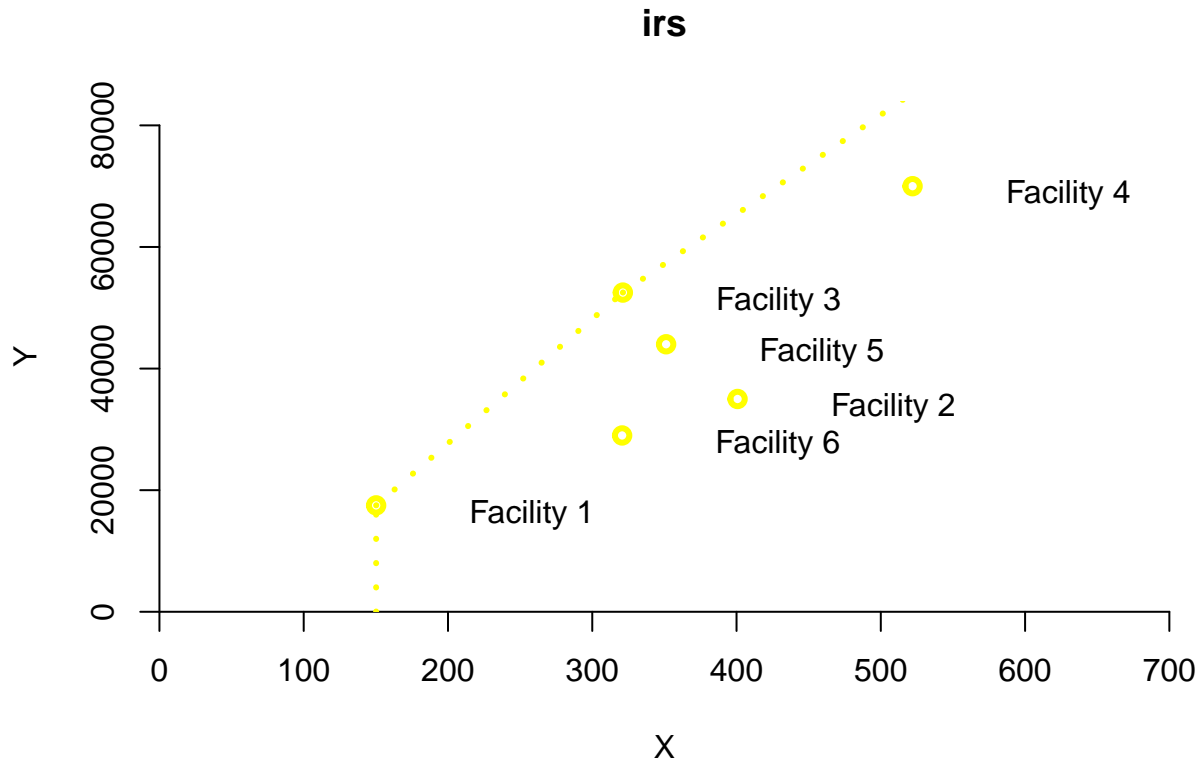
**IRS**

```
irs1
```

```
##          efficiency peers.peer1 peers.peer2 peers.peer3 lambda.L_Facility.1
## Facility 1  1.0000000         1         NA         NA         1.0000000
## Facility 2  1.0000000         2         NA         NA         0.0000000
## Facility 3  1.0000000         3         NA         NA         0.0000000
## Facility 4  1.0000000         4         NA         NA         0.0000000
## Facility 5  1.0000000         5         NA         NA         0.0000000
## Facility 6  0.8963283         1         2         5         0.4014399
##          lambda.L_Facility.2 lambda.L_Facility.3 lambda.L_Facility.4
## Facility 1      0.0000000         0         0
## Facility 2      1.0000000         0         0
## Facility 3      0.0000000         1         0
## Facility 4      0.0000000         0         1
## Facility 5      0.0000000         0         0
## Facility 6      0.3422606         0         0
##          lambda.L_Facility.5
```

```
## Facility 1      0.0000000
## Facility 2      0.0000000
## Facility 3      0.0000000
## Facility 4      0.0000000
## Facility 5      1.0000000
## Facility 6      0.2562995
```

```
dea.plot(x,y,RTS="irs",ORIENTATION="in-out",txt=rownames(x),main="irs",lty="dotted",lwd=3,col='yellow',
```



## FDH

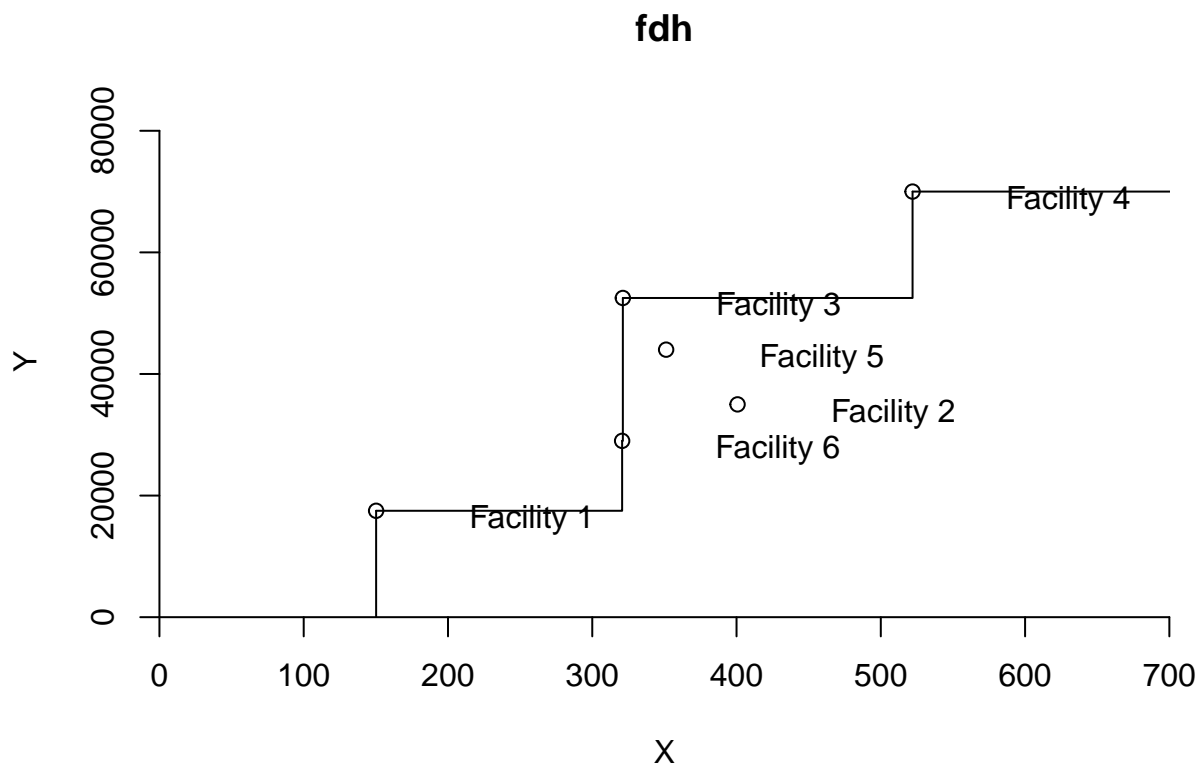
```
fdh1
```

```
##      efficiency peer1 lambda.L_Facility.1 lambda.L_Facility.2
## Facility 1      1     1                1                0
## Facility 2      1     2                0                1
## Facility 3      1     3                0                0
## Facility 4      1     4                0                0
## Facility 5      1     5                0                0
## Facility 6      1     6                0                0
##      lambda.L_Facility.3 lambda.L_Facility.4 lambda.L_Facility.5
## Facility 1              0                0                0
## Facility 2              0                0                0
```



```
## Facility 3      1      0      0
## Facility 4      0      1      0
## Facility 5      0      0      1
## Facility 6      0      0      0
##      lambda.L_Facility.6
## Facility 1      0
## Facility 2      0
## Facility 3      0
## Facility 4      0
## Facility 5      0
## Facility 6      1
```

```
dea.plot(x,y,RTS="fdh",ORIENTATION="in-out",txt=rownames(x),main="fdh",xlim=c(0,700))
```



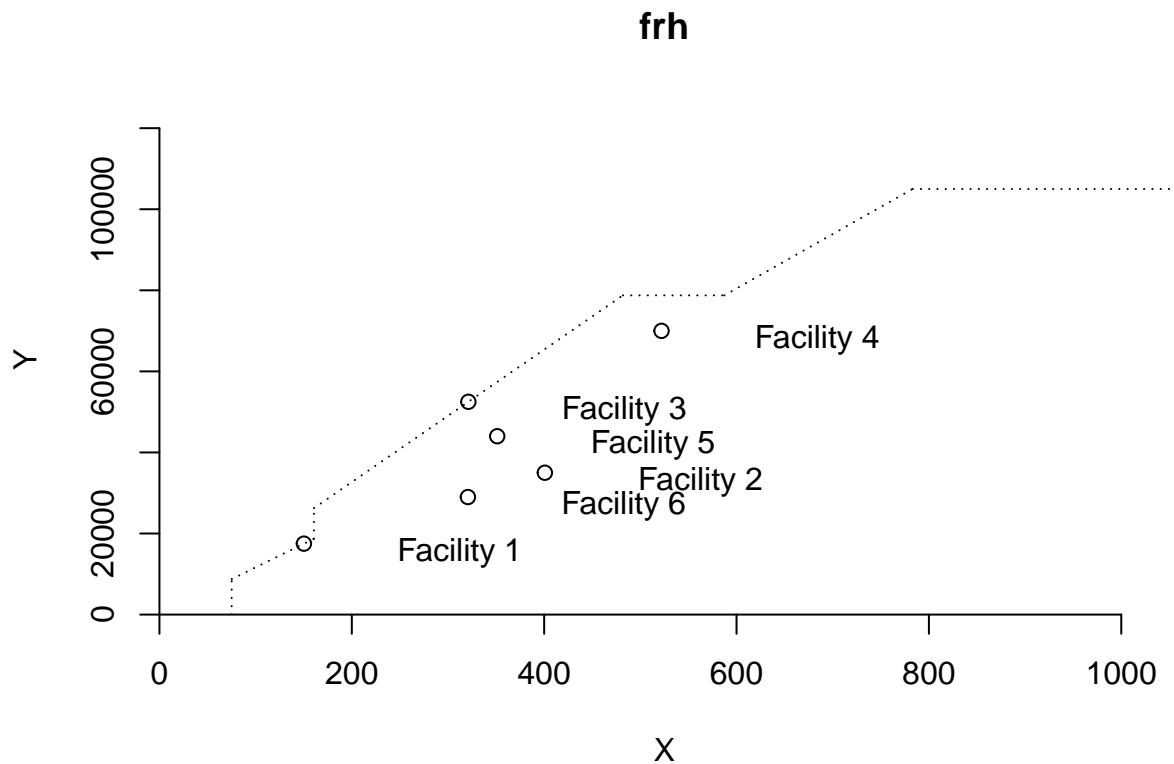
## FRH

```
frh1
```

```
##      efficiency peer1 lambda.L_Facility.1 lambda.L_Facility.2
## Facility 1      1      1      1      0
## Facility 2      1      2      0      1
## Facility 3      1      3      0      0
## Facility 4      1      4      0      0
```

```
## Facility 5      1      5      0      0
## Facility 6      1      6      0      0
##      lambda.L_Facility.3 lambda.L_Facility.4 lambda.L_Facility.5
## Facility 1      0      0      0
## Facility 2      0      0      0
## Facility 3      1      0      0
## Facility 4      0      1      0
## Facility 5      0      0      1
## Facility 6      0      0      0
##      lambda.L_Facility.6
## Facility 1      0
## Facility 2      0
## Facility 3      0
## Facility 4      0
## Facility 5      0
## Facility 6      1
```

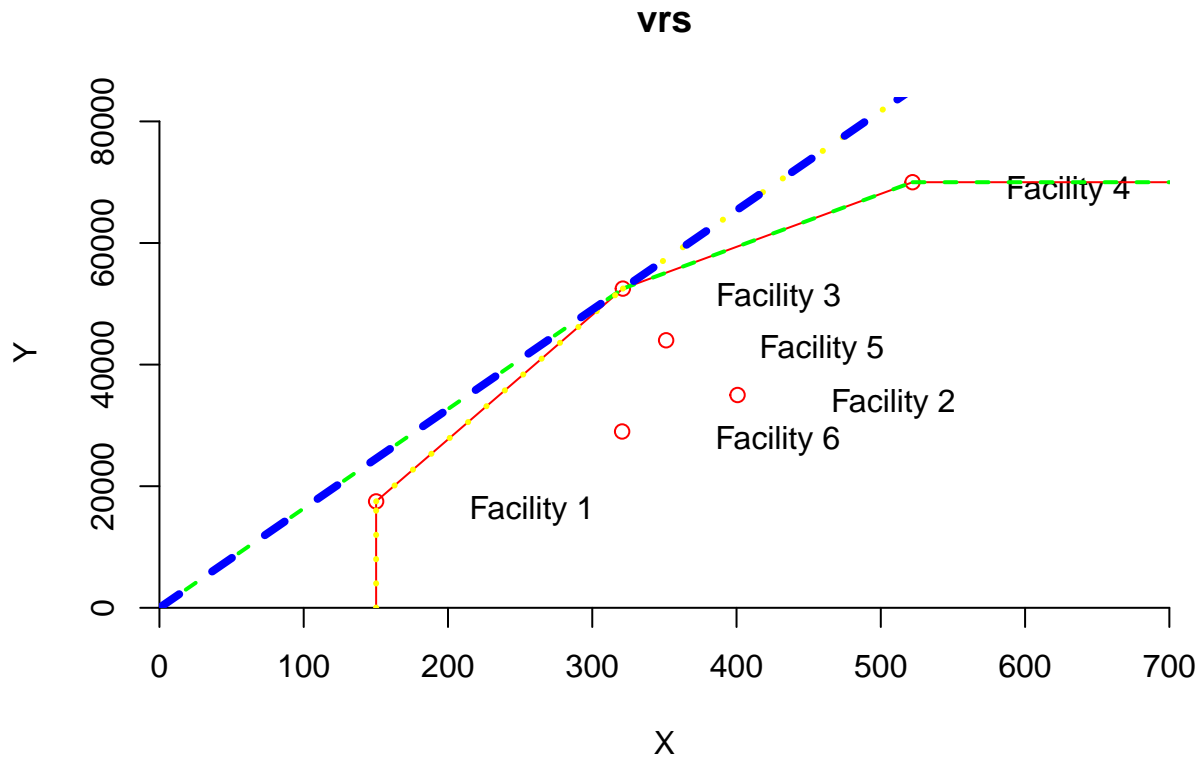
```
dea.plot(x,y,RTS="fdh+",ORIENTATION="in-out",txt=rownames(x),lty="dotted",main="frh",param=.5,xlim=c(0,1000))
```



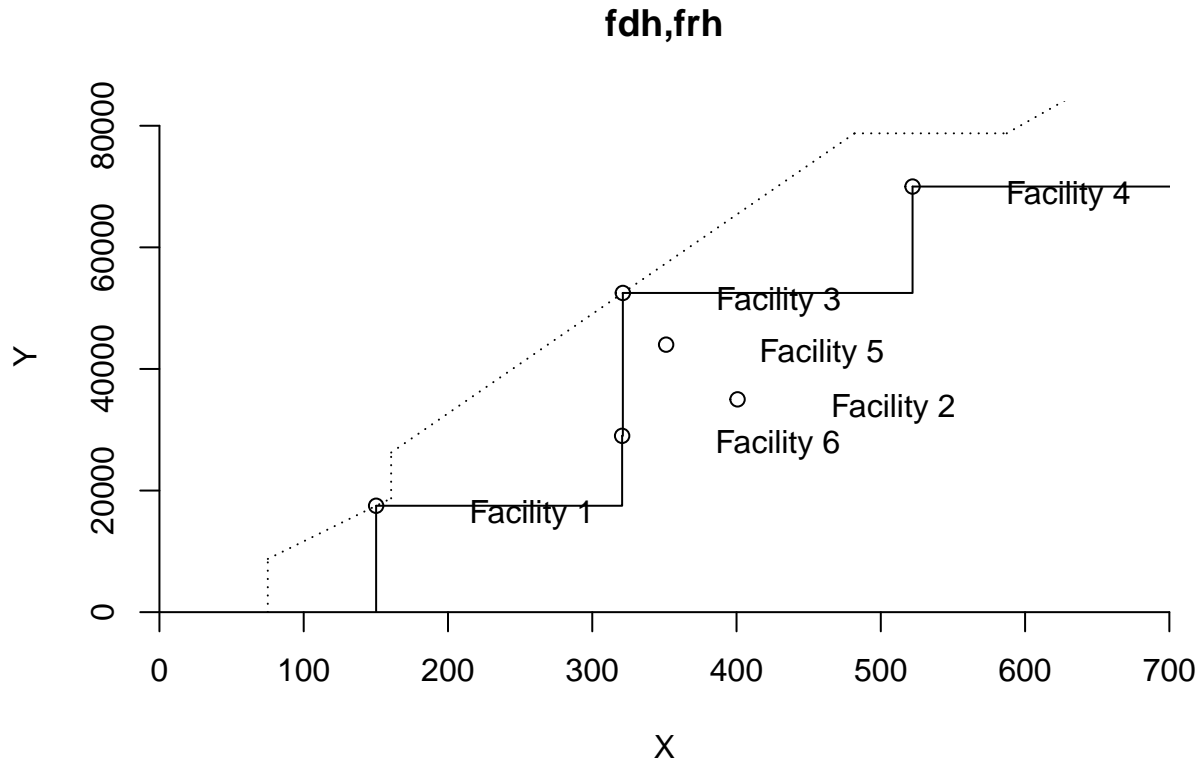
plots

```
dea.plot(x,y,RTS="vrs",ORIENTATION="in-out",txt=rownames(x),main='vrs',col='red',xlim=c(0,700))
dea.plot(x,y,RTS="drs",ORIENTATION="in-out",add=TRUE,lty="dashed",lwd=2,col='green',xlim=c(0,700))
```

```
dea.plot(x,y,RTS="irs",ORIENTATION="in-out",add=TRUE,lty="dotted",lwd=3,col='yellow',xlim=c(0,700))
dea.plot(x,y,RTS="crs",ORIENTATION="in-out",add=TRUE,lty="dashed",lwd=4, col="blue",xlim=c(0,700))
```



```
dea.plot(x,y,RTS="fdh",ORIENTATION="in-out",txt=rownames(x),main="fdh,frh",xlim=c(0,700))
dea.plot(x,y,RTS="fdh+",ORIENTATION="in-out",add=TRUE,lty="dotted",param=.5,xlim=c(0,700))
```



#### Question 4 Obeservations and results

1. In CRS, we can observe that facilities 1,2,3,4 have highest efficiency of 1. hence they don't have any peers other than itself and also we can observe distances in the lambda columns.
2. In DRS, we can observe that facilities 1,2,3,4 have highest efficiency similar to crs. hence we can observe same values of peers and lamba as same.
3. In VRS, we can observe that facilities 1,2,3,4,5 have highest efficiency. there is only one facility with less than 1, hence it has a peer which is facility 1,2,5 with lamba 1.
4. In IRS, we can observe that similar to vrs facilities 1,2,3,4,5 have highest efficiency.
5. In FDH and FRH, we can observe same efficiency lambda and peer values.

In conclusion, we can see that there are similar values observed in different RTS, the plots and tracing for each one varies as shown above. In general, if not specified we usually use CRS as RTS method for calculation of efficiency.