Module 8 - DEA

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Load benchmarking library

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

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

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

Set up data as input and output vectors for benchmarking

```
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_paid")
colnames(x) <- c("staff_hours","supplies")
x
```

```
##      staff_hours supplies
## [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 private_paid
## [1,]      14000         3500
## [2,]      14000        21000
## [3,]      42000        10500
## [4,]      28000        42000
## [5,]      19000        25000
## [6,]      14000        15000
```

Run DEA analysis using CRS

```
d1 <- dea(x,y,RTS = "crs")
d1
```

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

Peers and lamda for CRS

```
peers(d1)
```

```
##      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(d1)
```

```
##             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
```

Run DEA analysis using FDH

```
d2 <- dea(x,y,RTS = "fdh")
d2
```

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

Peers and lamda for FDH

```
peers(d2)
```

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

```
lambda(d2)
```

```
##      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
```

Run DEA analysis using VRS

```
d3 <- dea(x,y,RTS = "vrs")
d3
```

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

Peers and lamda for VRS

```
peers(d3)
```

```
##      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(d3)
```

```
##             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
```

Run DEA analysis using IRS

```
d4 <- dea(x,y,RTS = "irs")
d4
```

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

Peers and lamda for IRS

```
peers(d4)
```

```
##      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(d4)
```

```
##             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
```

Run DEA analysis using DRS

```
d5 <- dea(x,y,RTS = "drs")
d5
```

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

Peers and lamda for DRS

```
peers(d5)
```

```
##      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(d5)
```

```
##             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
```

Run DEA analysis using FRH

```
d6 <- dea(x,y,RTS = "add")
d6
```

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

Peers and lamda for FRH

```
peers(d6)
```

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

```
lambda(d6)
```

```
##      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
```

Tabular Summary of the Peers and Lambda results for different DEA model assumptions

DMU	FDH		CRS		VRS		IRS		DRS		FRH	
	Peers	Lamdas	Peers	Lamdas	Peers	Lamdas	Peers	Lamdas	Peers	Lamdas	Peers	Lamdas
Facilitity 1	1	1	1	1	1	1	1	1	1	1	1	1
Facilitity 2	2	1	2	1	2	1	2	1	2	1	2	1
Facilitity 3	3	1	3	1	3	1	3	1	3	1	3	1
Facilitity 4	4	1	4	1	4	1	4	1	4	1	4	1
Facilitity 5	5	1	1, 2, 4	0.2, 0.08, 0.54	5	1	5	1	1, 2, 4	0.2, 0.08, 0.54	5	1
Facilitity 6	6	1	1, 2, 4	0.34, 0.39, 0.13	1, 2, 5	0.40, 0.34, 0.26	1, 2, 5	0.40, 0.34, 0.26	1, 2, 4	0.34, 0.39, 0.13	6	1

Results across all different DEA assumptions are the same for Facilities 1-4, thus they are efficient across all modeling assumptions. However, Facility 6 is not effient for all except the FRH assumption and Facility 5 is not efficient for CRS and DRS assumptions of the DEA model.

The FDH and FRH assumptions results in all facilities being efficient because neither applies the convexity assumption, which connects facilities 1-4 in all but the VRS and IRS model assumptions. The VRS and IRS model assumptions also include Facility 5 as efficient.