QMM_assignment5_sseetham

Ananth Kumar

02/11/2021

.libPaths("C:\Users\Ananth\OneDrive\Desktop\MSBA Kent\Fall 2021\Fundamentals of Machine Learning\Assignment\Ass 2") install.packages("Benchmarking")

```
library(Benchmarking)

X <- matrix(c(150,400,320,520,350,320,0.2,0.7,1.2,2.0,1.2,0.7),ncol = 2)
# <- matrix(c(0.2,0.7,1.2,2.0,1.2,0.7))
Y <- matrix(c(14000,14000,42000,28000,19000,14000,3500,21000,10500,42000,25000,15000),ncol=2)



colnames(Y) <- c("TP","RP")
colnames(X) <- c("staffing labor per hour", "cost of supplies per day")
X
```

```
##      staffing labor per hour cost of 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
```

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

FDH

```
FDH <- dea(X,Y,RTS = "fdh")
FDH
```

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

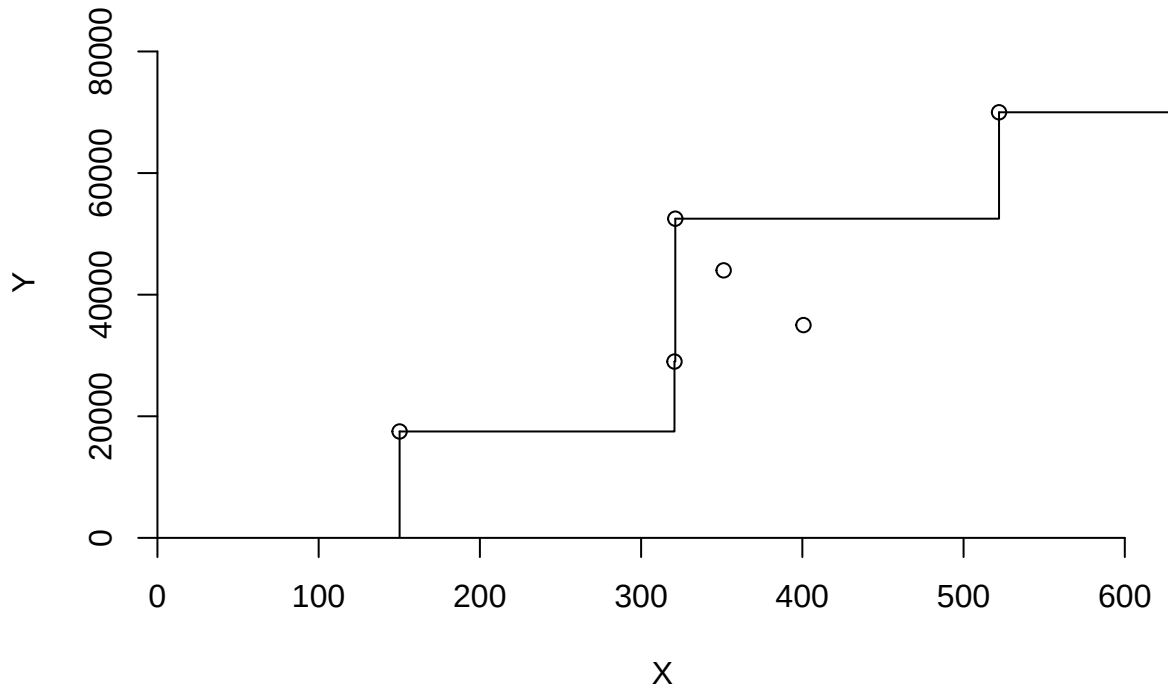
```
peers(FDH)
```

```
##      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
```

```
dea.plot.frontier(X,Y,RTS="fdh")
```



```r
summary(FDH, digits=4)
```

```
## Summary of efficiencies
## FDH technology and input orientated efficiency
## Number of firms with efficiency==1 are 6 out of 6
## Mean efficiency: 1
## ---
##   Eff range      #   %
##         E ==1    6 100
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1       1       1       1       1       1
```

CRS

```r
CRS <- dea(X,Y,RTS = "crs")
CRS
```

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

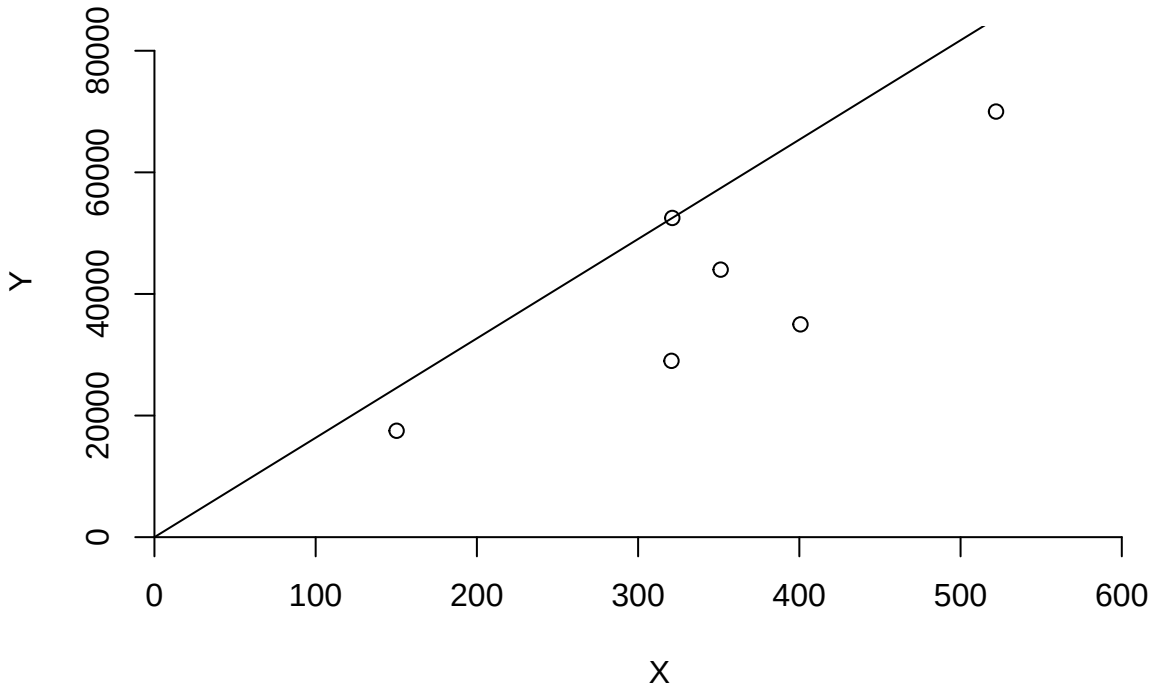
```r
peers(CRS)
```

```
##      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
```

```r
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
```

```r
dea.plot.frontier(X,Y,RTS="crs")
```




```
summary(CRS, digits=4)
```

```
## Summary of efficiencies
## CRS technology and input orientated efficiency
## Number of firms with efficiency==1 are 4 out of 6
## Mean efficiency: 0.974
## ---
##   Eff range      #  %
##   0.8<= E <0.9   1 17
##   0.9<= E <1     1 17
##         E ==1    4 67
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.8675  0.9831  1.0000  0.9742  1.0000  1.0000
```

VRS

```
VRS <- dea(X,Y,RTS = "vrs")
VRS
```

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

```
peers(VRS)
```

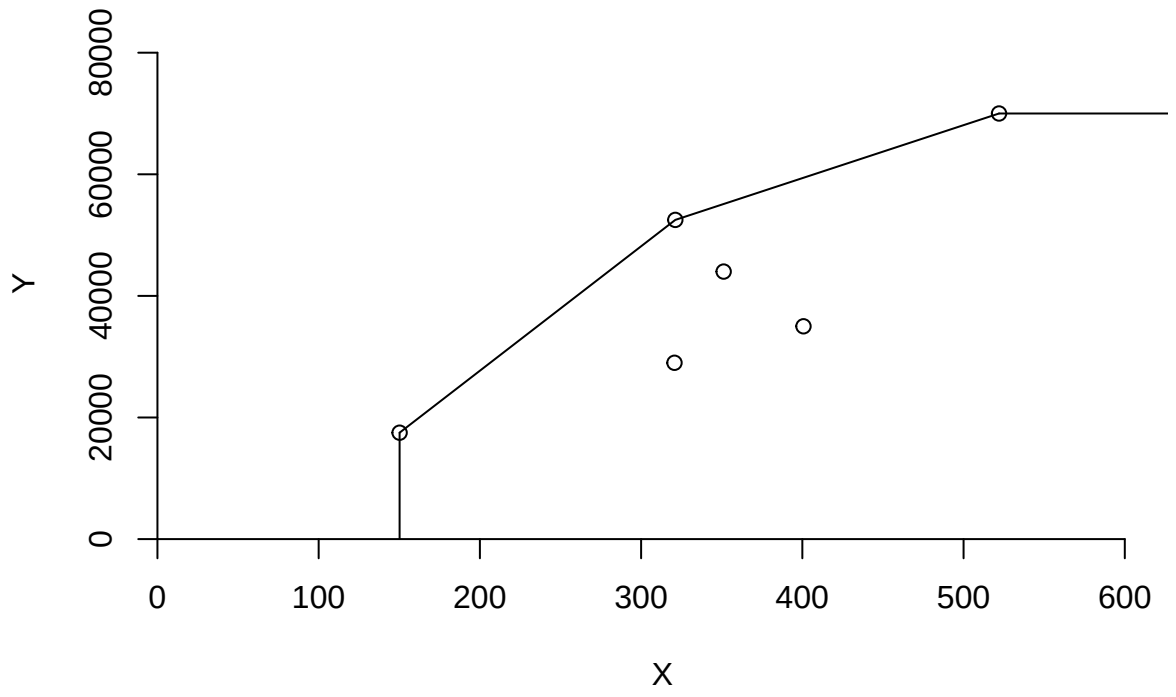
```
##      peer1 peer2 peer3
```

```
## [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
```

```
dea.plot.frontier(X,Y,RTS="vrs")
```




```
summary(VRS, digits=4)
```

```
## Summary of efficiencies
## VRS technology and input orientated efficiency
## Number of firms with efficiency==1 are 5 out of 6
```

```
## Mean efficiency: 0.983
## ---
##   Eff range      #  %
##   0.8<= E <0.9   1 17
##   0.9<= E <1     0  0
##         E ==1    5 83
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.8963  1.0000  1.0000  0.9827  1.0000  1.0000
```

IRS

```
IRS <- dea(X,Y,RTS = "irs")
IRS
```

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

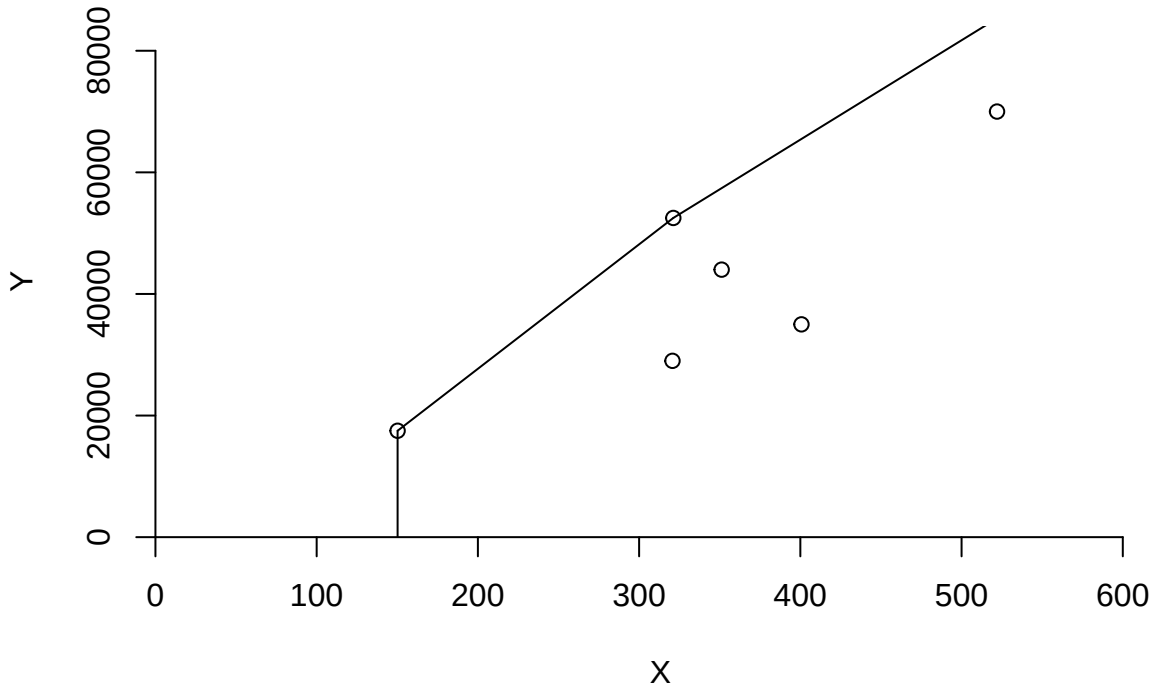
```
peers(IRS)
```

```
##      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
```

```
dea.plot.frontier(X,Y,RTS="irs")
```




```
summary(IRS, digits=4)
```

```
## Summary of efficiencies
## IRS technology and input orientated efficiency
## Number of firms with efficiency==1 are 5 out of 6
## Mean efficiency: 0.983
## ---
##   Eff range      #  %
##   0.8<= E <0.9   1 17
##   0.9<= E <1     0  0
##         E ==1    5 83
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.8963  1.0000  1.0000  0.9827  1.0000  1.0000
```

DRS

```
DRS <- dea(X,Y,RTS = "drs")
DRS
```

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

```
peers(DRS)
```

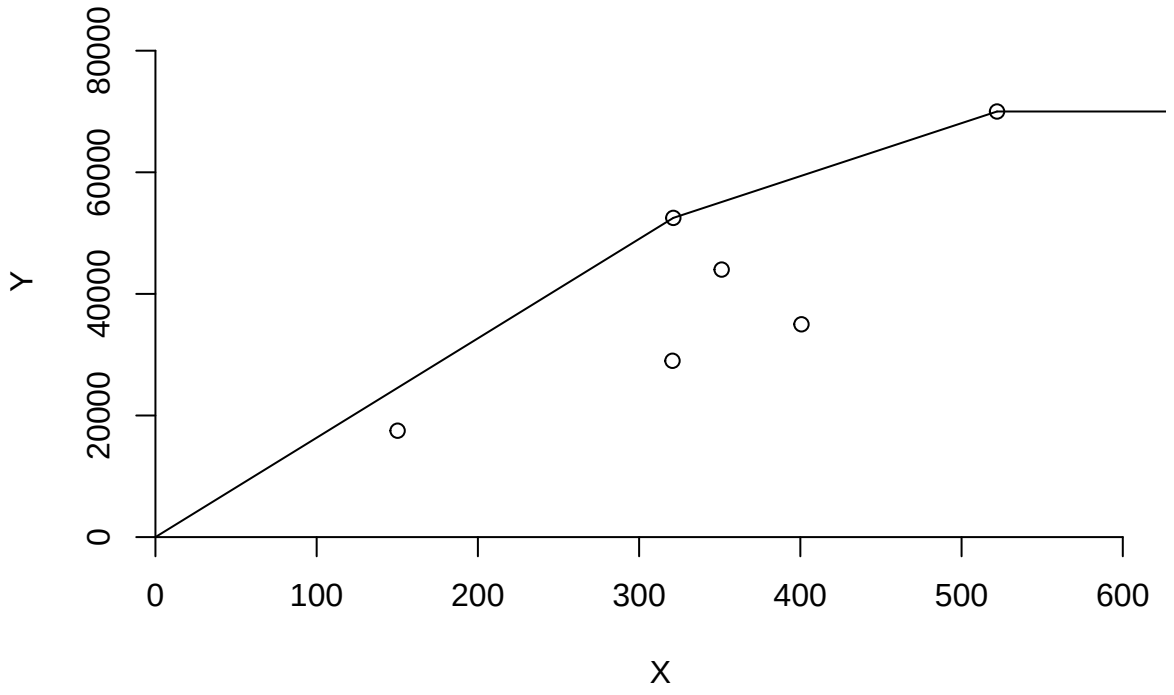
```
##      peer1 peer2 peer3
```

```
## [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
```

```
dea.plot.frontier(X,Y,RTS="drs")
```




```
summary(DRS, digits=4)
```

```
## Summary of efficiencies
## DRS technology and input orientated efficiency
## Number of firms with efficiency==1 are 4 out of 6
```

```
## Mean efficiency: 0.974
## ---
##   Eff range      #  %
##   0.8<= E <0.9   1 17
##   0.9<= E <1     1 17
##         E ==1    4 67
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.8675  0.9831  1.0000  0.9742  1.0000  1.0000
```

FRH

```
FRH <- dea(X,Y,RTS = "add")
FRH
```

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

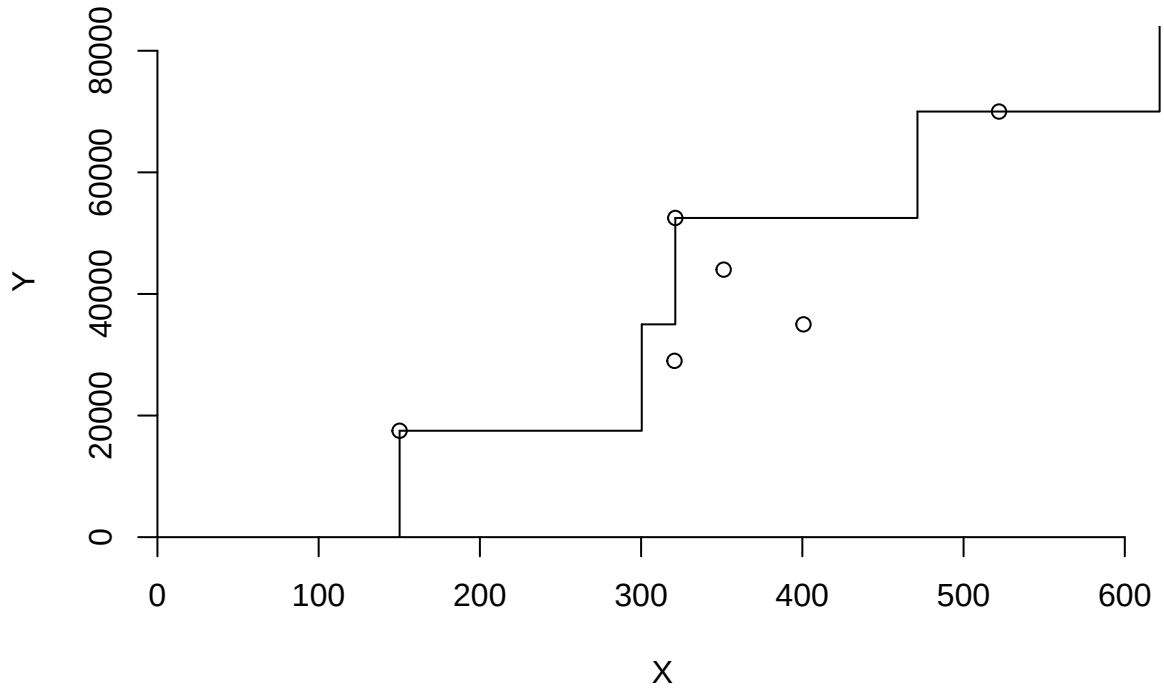
```
peers(FRH)
```

```
##      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
```

```
dea.plot.frontier(X,Y,RTS="add")
```




```
summary(FRH, digits=4)
```

```
## Summary of efficiencies
## ADD technology and input orientated efficiency
## Number of firms with efficiency==1 are 6 out of 6
## Mean efficiency: 1
## ---
##   Eff range      #   %
##         E ==1    6 100
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1       1       1       1       1       1
```

4) On contrast we can see that the different DEA technologies yielded

DEA techs Efficiency FDH Number of firms with efficiency==1 are 6 out of 6, Mean efficiency: 1 CRS Number of firms with efficiency==1 are 4 out of 6, Mean efficiency: 0.974 VRS Number of firms with efficiency==1 are 5 out of 6, Mean efficiency: 0.983 IRS Number of firms with efficiency==1 are 5 out of 6, Mean efficiency: 0.983 DRS Number of firms with efficiency==1 are 4 out of 6, Mean efficiency: 0.974 FRH Number of firms with efficiency==1 are 6 out of 6, Mean efficiency: 1

```
List = list(FDH,CRS,VRS,IRS,DRS,FRH)
List
```

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

```
## [1] 1 1 1 1 1 1
##
## [[2]]
## [1] 1.0000 1.0000 1.0000 1.0000 0.9775 0.8675
##
## [[3]]
## [1] 1.0000 1.0000 1.0000 1.0000 1.0000 0.8963
##
## [[4]]
## [1] 1.0000 1.0000 1.0000 1.0000 1.0000 0.8963
##
## [[5]]
## [1] 1.0000 1.0000 1.0000 1.0000 0.9775 0.8675
##
## [[6]]
## [1] 1 1 1 1 1 1
```

QUESTION2)

Solution :

Y1 =6x1 + 4x2 + 5x3 -> employee Y2 = 8x1 +7x2 + 5x3 _> next year earning.

Yi = yi+ - yi - ,I =1,2,3

Yi+ = { yi , Yi>= 0 , otherwise 0

Yi - = { |yi|, yi <= 0

Objective function :

Max: 20x1 + 15x2 + 25x3 - 6y1m -6y1n –3y2n;

s.t

6x1 + 4x2 + 5x3 - y1m + y1n = 50; 8x1 + 7x2 + 5x3 - y2m + y2n = 75;

Initial LP

/* Objective function */

Max: 20x1 + 15x2 + 25x3 - 6y1m -6y1n –3y2n;

/* Constraints */

6x1 + 4x2 + 5x3 - y1m + y1n = 50; 8x1 + 7x2 + 5x3 - y2m + y2n = 75;

```
library(lpSolve)

Q2 <- read.lp("Q2.lp")

solve(Q2)
```

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

```
get.objective(Q2)
```

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

```
get.variables(Q2)
```

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

```
get.constraints(Q2)
```

```
## [1] 50 75
```

From the results we see that the Maximize profit is 225 million dollars, and we can observe that x1 =0 , x2 = 0, x3 = 15 and Y+ employee is 25,000 which is not a feasible solution.

Hence, increasing the increase Y+ to 1000(random number), to get optimal solution

Below is the new LP formulation:

/* Objective function */

Max: 20x1 + 15x2 + 25x3 - 1000y1m - 6y1n – 3y2n;

/* Constraints */

6x1 + 4x2 + 5x3 - y1m + y1n = 50; 8x1 + 7x2 + 5x3 - y2m + y2n = 75;

We can observe that increase in employeement y1m is set to 1000 instead 6 , this will negate the increase in workforce observed in the previous lp.

```
Second = read.lp("Second.lp")
solve(Second)
```

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

```
get.objective(Second)
```

```
## [1] 208.3333
```

```
get.variables(Second)
```

```
## [1] 0.000000 8.333333 3.333333 0.000000 0.000000 0.000000 0.000000
```

```
get.constraints(Second)
```

```
## [1] 50 75
```

Now we can see that the Maximum profit is 208.3 Million. Emax corporation should produce 0 from product 1 and 8 of product 2and 3 of product 3, i.e

x1 = 0 ; x2 = 8 ; x3 = 3 and we can see that y1+ = 0, y1- = 0 , y2+ = 0 , y2- = 0. which solves the question and the constraints are 50 and 75 which optimul