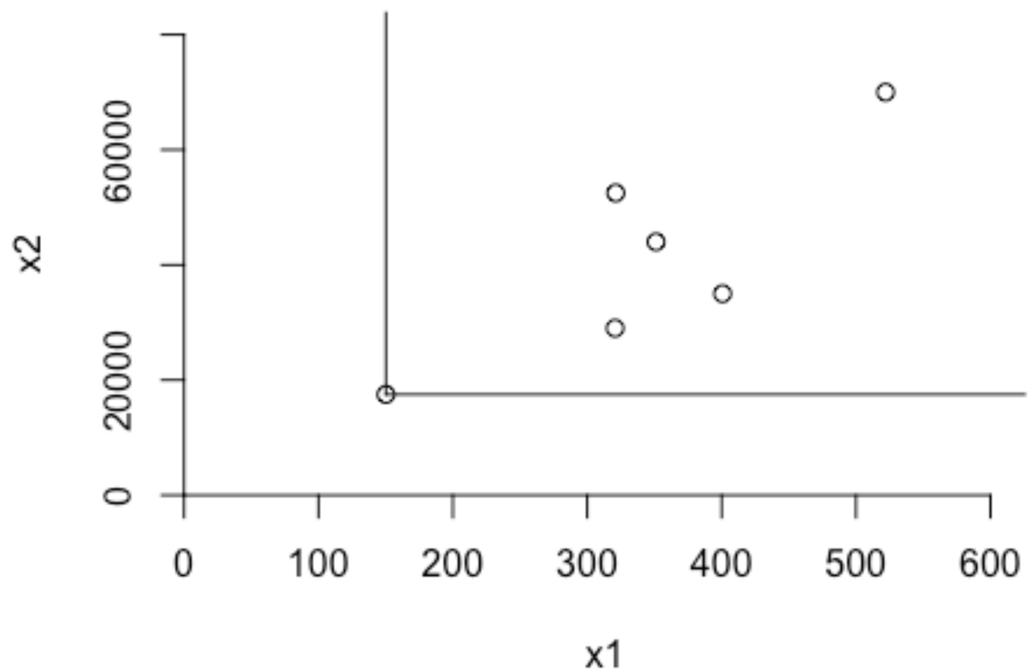
# QMM Assignment #5

```
library(Benchmarking)

## Loading required package: lpSolveAPI

## Loading required package: ucminf

## Loading required package: quadprog

library(lpSolveAPI)
library(ucminf)
library(quadprog)
```

#1) Formulate and perform DEA analysis under all DEA assumptions of FDH, CRS, VRS, IRS, DRS, and FRH.

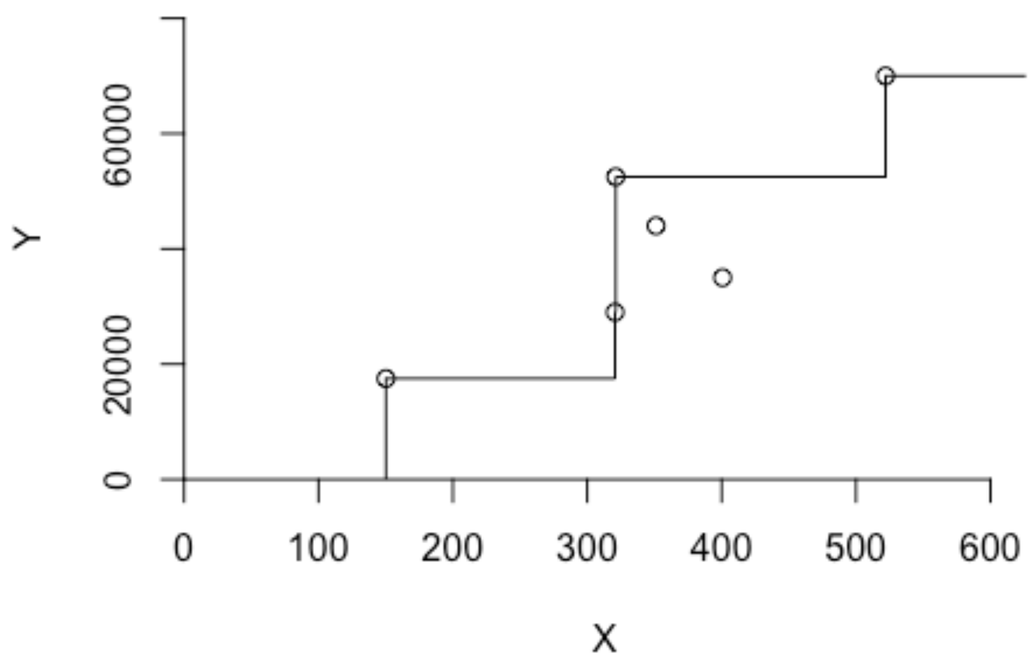
```
# Using Benchmarking Libraries for DEA
library(Benchmarking)
library(lpSolveAPI)
library(ucminf)
library(quadprog)
X <- matrix(c(150,400,320,520,350,320,0.2,0.7,1.2,2.0,1.2,.7), ncol=2)
Y <-
matrix(c(14000,14000,42000,28000,19000,14000,3500,21000,10500,42000,25000,150
00), ncol=2)

colnames(X) <- c("TP", "RP")
colnames(Y) <- c("Staffing Labor Per Hour", "Cost of Supplies per day")
X

##       TP  RP
## [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

##      Staffing Labor Per Hour Cost of Supplies per day
## [1,]                   14000                     3500
## [2,]                   14000                    21000
## [3,]                   42000                    10500
## [4,]                   28000                    42000
## [5,]                   19000                    25000
## [6,]                   14000                    15000
```

```
#DEA Analysis

e <- dea(X,Y,RTS = "crs")             # provide the input and output
e

## [1] 1.0000 1.0000 1.0000 1.0000 0.9775 0.8675

peers(e)                              # identify the peers

##      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(e)                             # identify the relative weights given to
the peers

##             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.isoquant(X,Y,RTS="crs")      # plot the results
```




```
#FDH Assumptions

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")
```




```
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

#VRS Assumptions

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

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

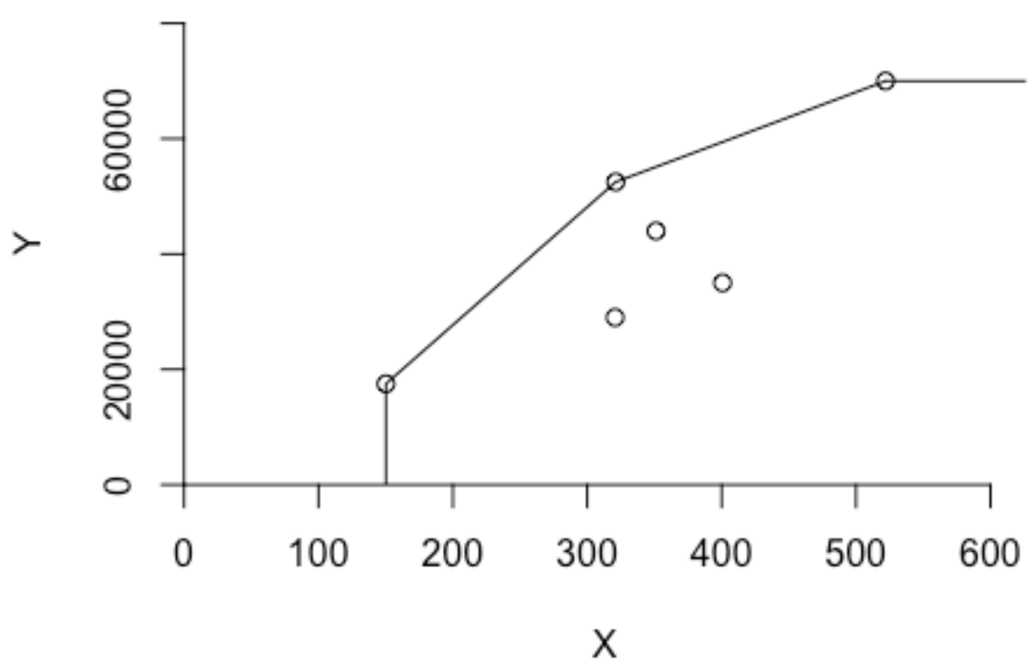
```
peers(VRS)
```

```
##      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 Assumptions

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

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

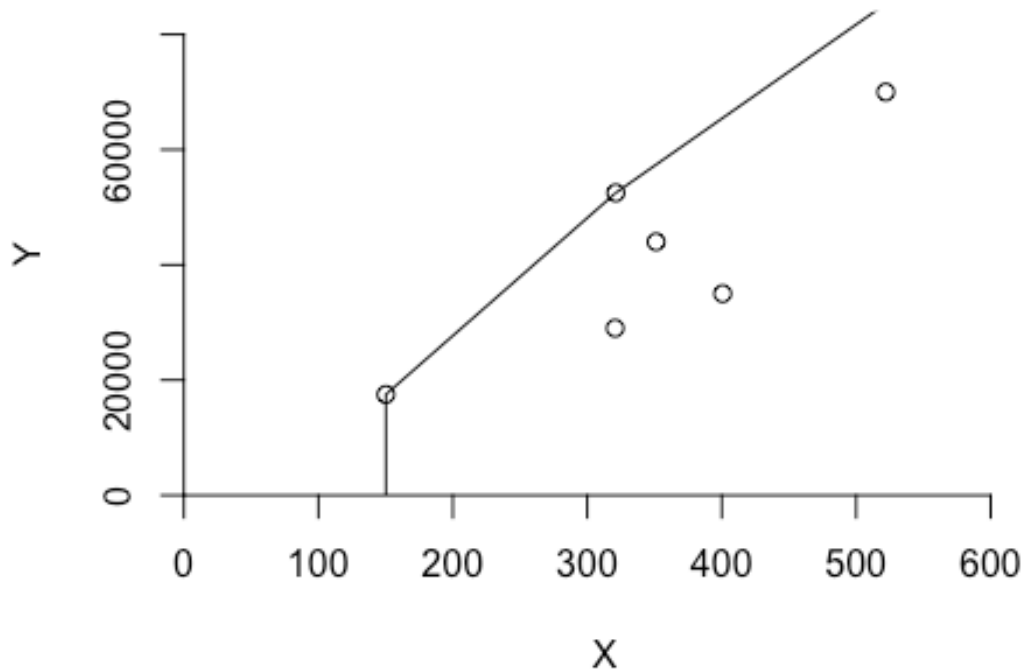
```
peers(IRS)
```

```
##      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")
```



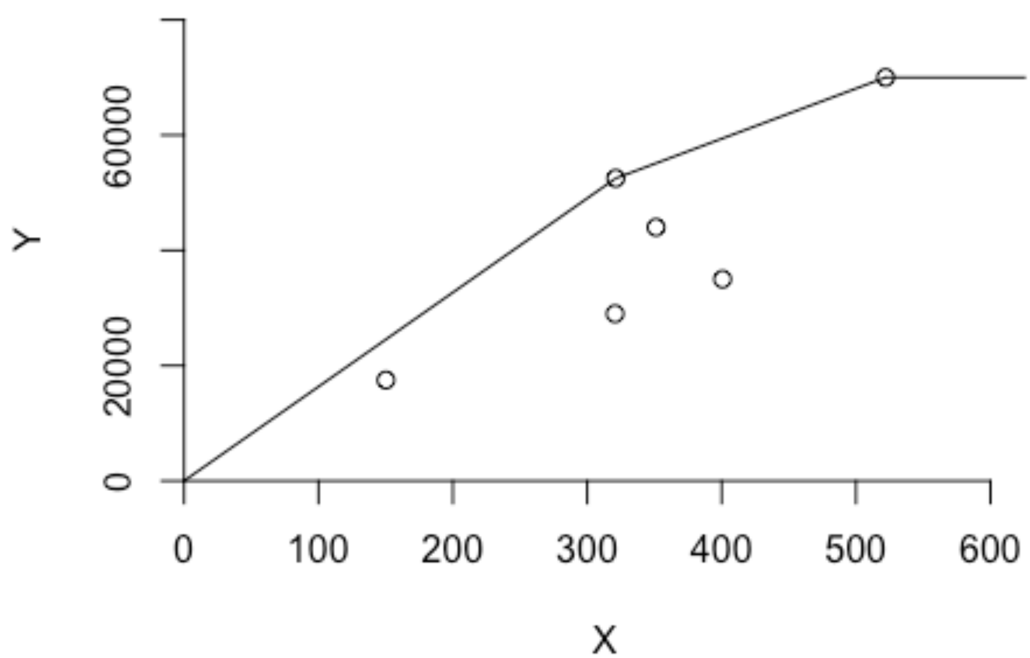

```
summary(IRS, digits=4)

## 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 Assumptions

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

## [1] 1.0000 1.0000 1.0000 1.0000 1.0000 0.8963

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
```

```
#CRS Assumptions

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

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

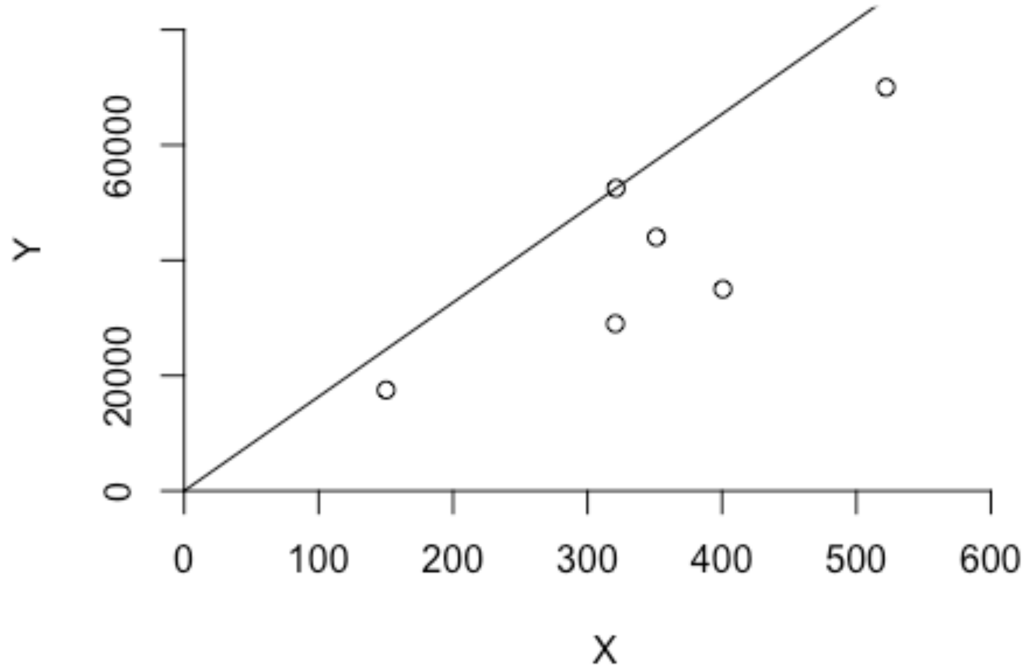
```
peers(CRS)
```

```
##      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
```

```
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
```

```
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
```

#Express management's objective function in terms of x1, x2, x3, y1+, y1- , y2+ and y2-. Formulate and solve the linear programming model. What are your findings?

```
library(lpSolve)
library(lpSolveAPI)
lprec <- read.lp("QMM Assignment #5.lp")
solve(lprec)

## [1] 0
```

```
get.objective(lprec)

## [1] 225

get.variables(lprec)

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

get.constraints(lprec)

## [1] 50 75

X <- "QMM Assignment #5.lp"
```

#Solving the lp, it can be found that 225 million is the maximum profit.

```
library(lpSolve)
library(lpSolveAPI)
lprec <- read.lp("QMMnumber2.lp")
solve(lprec)

## [1] 0

get.objective(lprec)

## [1] 208.3333

get.variables(lprec)

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

get.constraints(lprec)

## [1] 50 75

Y <- "QMMnumber2.lp"
```

**The optimal solution is 208.333 for maximum profit. I that suggest the EMAX produces 0 from product 1, 8 from product 2, 3 from product 3.**