

# vorticity

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## R Markdown

Read the data for vorticity analysis

```
setwd("C:/Users/siris/Documents/rstudio-projects/vorticity")
```

```
## read all echo data
```

```
echo <- read.csv("data.csv", header = TRUE, sep = ",", stringsAsFactors = TRUE)
```

```
summary(echo)
```

```
##      i..ID      Country      Age      Gender
##  Min.   : 1.00    Myao    :49    Min.   :24.00    Min.   :0.0000
## 1st Qu.:24.75    poland  :26    1st Qu.:52.00    1st Qu.:0.0000
## Median :48.50          : 1    Median :61.00    Median :0.0000
## Mean   :49.67    FS10   : 1    Mean   :60.98    Mean   :0.1087
## 3rd Qu.:75.25    FS11   : 1    3rd Qu.:73.00    3rd Qu.:0.0000
## Max.   :99.00    FS12   : 1    Max.   :83.00    Max.   :1.0000
##      (Other):17    NA's    :4      NA's    :4
##      BSA      HRmin      SBP      DBP
##  Min.   :1.50    Min.   : 45.00    Min.   :100.0    Min.   : 50.00
## 1st Qu.:1.75    1st Qu.: 59.95    1st Qu.:119.2    1st Qu.: 64.00
## Median :1.99    Median : 69.00    Median :130.0    Median : 78.00
## Mean   :1.95    Mean   : 70.29    Mean   :133.9    Mean   : 76.69
## 3rd Qu.:2.09    3rd Qu.: 78.00    3rd Qu.:144.2    3rd Qu.: 87.25
## Max.   :2.61    Max.   :114.00    Max.   :185.0    Max.   :106.00
## NA's    :27      NA's    :16      NA's    :38      NA's    :38
##      Etiology      NYHA      EchoLA      EchoIVS
##  Min.   :1.000    Min.   :1.000    Min.   :28.30    Min.   : 1.350
## 1st Qu.:2.000    1st Qu.:1.000    1st Qu.:35.85    1st Qu.: 8.275
## Median :2.000    Median :1.000    Median :41.00    Median : 9.750
## Mean   :2.507    Mean   :1.407    Mean   :41.30    Mean   : 9.590
## 3rd Qu.:3.000    3rd Qu.:1.000    3rd Qu.:46.23    3rd Qu.:10.750
## Max.   :6.000    Max.   :4.000    Max.   :55.10    Max.   :16.000
## NA's    :27      NA's    :5      NA's    :50      NA's    :2
##      EchoPW      EchoDd      EchoDs      bEF
##  Min.   : 1.360    Min.   :33.00    Min.   :20.0    Min.   :12.00
## 1st Qu.: 8.000    1st Qu.:44.00    1st Qu.:28.0    1st Qu.:48.50
## Median : 9.000    Median :48.65    Median :33.0    Median :61.00
## Mean   : 9.407    Mean   :50.83    Mean   :36.4    Mean   :55.44
## 3rd Qu.:10.975    3rd Qu.:54.85    3rd Qu.:39.0    3rd Qu.:66.50
## Max.   :16.000    Max.   :99.00    Max.   :91.0    Max.   :75.00
## NA's    :2      NA's    :2      NA's    :3      NA's    :33
##      RWT      LVMass      EchoLVMI      EchoEDV
##  Min.   :0.1500    Min.   : 16.75    Min.   : 7.261    Min.   : 57.20
## 1st Qu.:0.3200    1st Qu.:130.07    1st Qu.: 68.863    1st Qu.: 88.47
## Median :0.3500    Median :164.74    Median : 82.227    Median :111.00
```

##	Mean	:0.3644	Mean	:181.50	Mean	: 90.237	Mean	:134.34
##	3rd Qu.:	0.4200	3rd Qu.:	202.18	3rd Qu.:	105.706	3rd Qu.:	143.90
##	Max.	:0.5900	Max.	:477.98	Max.	:240.188	Max.	:455.50
##	NA's	:87	NA's	:2	NA's	:29	NA's	:2
##	EchoESV		EchoSV		EchoEF		AbnormaleF50	
##	Min.	: 18.30	Min.	: 31.50	Min.	:10.00	Min.	:0.0000
##	1st Qu.:	30.00	1st Qu.:	51.00	1st Qu.:	46.00	1st Qu.:	0.0000
##	Median	: 43.35	Median	: 62.00	Median	:57.00	Median	:0.0000
##	Mean	: 69.79	Mean	: 65.27	Mean	:53.72	Mean	:0.2842
##	3rd Qu.:	74.00	3rd Qu.:	77.00	3rd Qu.:	65.00	3rd Qu.:	1.0000
##	Max.	:366.50	Max.	:129.00	Max.	:78.00	Max.	:1.0000
##	NA's	:2	NA's	:3	NA's	:1	NA's	:1
##	EchoTMfEwave		EchoTMfAwave		TimeTMFDecT		EchoTMfEtoA	
##	Min.	: 24.00	Min.	: 21.00	Min.	:115.0	Min.	:0.360
##	1st Qu.:	59.40	1st Qu.:	53.00	1st Qu.:	170.2	1st Qu.:	0.807
##	Median	: 68.50	Median	: 67.10	Median	:196.0	Median	:1.096
##	Mean	: 71.29	Mean	: 67.58	Mean	:207.3	Mean	:1.207
##	3rd Qu.:	81.00	3rd Qu.:	83.00	3rd Qu.:	238.0	3rd Qu.:	1.408
##	Max.	:132.00	Max.	:120.00	Max.	:362.0	Max.	:6.000
##	NA's	:2	NA's	:4	NA's	:2	NA's	:3
##	EchoLAVI		EchSepTDIe		EchoLatTDIe		EchoAveTDIe	
##	Min.	:16.34	Min.	: 2.00	Min.	: 1.000	Min.	: 1.500
##	1st Qu.:	26.73	1st Qu.:	5.00	1st Qu.:	6.500	1st Qu.:	5.607
##	Median	:33.92	Median	: 6.00	Median	: 8.190	Median	: 7.405
##	Mean	:36.56	Mean	: 6.44	Mean	: 8.419	Mean	: 7.339
##	3rd Qu.:	44.68	3rd Qu.:	8.00	3rd Qu.:	10.000	3rd Qu.:	9.000
##	Max.	:94.00	Max.	:13.50	Max.	:21.300	Max.	:16.900
##	NA's	:8	NA's	:5	NA's	:11	NA's	:5
##	EchoSeptEe		EchoRVSP		EchoLVM		EchoLVMII	
##	Min.	: 4.890	Min.	:21.00	Min.	: 16.75	Min.	: 7.261
##	1st Qu.:	8.188	1st Qu.:	27.50	1st Qu.:	130.07	1st Qu.:	68.863
##	Median	:11.155	Median	:32.00	Median	:164.74	Median	: 82.227
##	Mean	:12.853	Mean	:35.62	Mean	:181.50	Mean	: 90.237
##	3rd Qu.:	14.238	3rd Qu.:	38.50	3rd Qu.:	202.18	3rd Qu.:	105.706
##	Max.	:55.000	Max.	:76.00	Max.	:477.98	Max.	:240.188
##	NA's	:6	NA's	:53	NA's	:2	NA's	:29
##	TimePIVRRms		TimePIvEonset		TimePIvEonsetNorRR		TimePIvEpeak	
##	Min.	: 586.9	Min.	:242.8	Min.	:227.8	Min.	:356.2
##	1st Qu.:	808.0	1st Qu.:	397.8	1st Qu.:	434.9	1st Qu.:	498.0
##	Median	: 898.9	Median	:454.7	Median	:497.1	Median	:564.1
##	Mean	: 928.5	Mean	:446.5	Mean	:491.6	Mean	:552.6
##	3rd Qu.:	1054.6	3rd Qu.:	497.3	3rd Qu.:	559.0	3rd Qu.:	608.1
##	Max.	:1704.0	Max.	:614.1	Max.	:680.0	Max.	:738.9
##	NA's	:10	NA's	:12	NA's	:12	NA's	:12
##	TimePIvEpeakNorRR		TimeVsonset		TimePeakVSE		Tracking	
##	Min.	:262.3	Min.	:366.0	Min.	:422.0	Min.	:0.0000
##	1st Qu.:	542.5	1st Qu.:	460.8	1st Qu.:	507.2	1st Qu.:	0.0000
##	Median	:614.2	Median	:506.5	Median	:583.6	Median	:1.0000
##	Mean	:609.8	Mean	:506.2	Mean	:577.2	Mean	:0.5761
##	3rd Qu.:	683.4	3rd Qu.:	542.5	3rd Qu.:	617.4	3rd Qu.:	1.0000
##	Max.	:840.6	Max.	:683.0	Max.	:864.0	Max.	:1.0000
##	NA's	:12	NA's	:20	NA's	:15	NA's	:4
##	VortexArea		VortexIntensity		VortexDepth		VortexLength	
##	Min.	:0.0930	Min.	:-0.6000	Min.	:0.0990	Min.	:0.2305

```

## 1st Qu.:0.2473 1st Qu.: -0.5037 1st Qu.:0.3913 1st Qu.:0.4894
## Median :0.3257 Median : -0.4479 Median :0.4528 Median :0.5918
## Mean :0.3071 Mean : -0.3243 Mean :0.4332 Mean :0.5669
## 3rd Qu.:0.3682 3rd Qu.: -0.3212 3rd Qu.:0.4934 3rd Qu.:0.6539
## Max. :0.4549 Max. : 0.4472 Max. :0.6118 Max. :0.8262
##
## EnergyDissipation VorticityFluctuation KineticEnergyFluctuation
## Min. :0.1912 Min. :0.6954 Min. :0.8944
## 1st Qu.:0.6624 1st Qu.:0.8361 1st Qu.:1.1506
## Median :1.0175 Median :0.8740 Median :1.3370
## Mean :1.1603 Mean :0.8733 Mean :1.3541
## 3rd Qu.:1.5210 3rd Qu.:0.9165 3rd Qu.:1.5201
## Max. :3.2823 Max. :0.9757 Max. :2.0779
##
## ShearStressFluctuation KineticEnergyEarlyD KineticEnergyLateD
## Min. : -0.3042 Min. :1.100 Min. :0.5434
## 1st Qu.: -0.0037 1st Qu.:1.848 1st Qu.:1.5305
## Median : 0.0919 Median :2.271 Median :1.9211
## Mean : 0.1100 Mean :2.596 Mean :2.0767
## 3rd Qu.: 0.2127 3rd Qu.:3.119 3rd Qu.:2.5937
## Max. : 0.6324 Max. :7.120 Max. :4.0359
## NA's :2 NA's :2
## KineticEnergyOnsetSystole LAVI35 SeptTDIe7
## Min. :0.2880 Min. :0.0000 Min. :0.0000
## 1st Qu.:0.6910 1st Qu.:0.0000 1st Qu.:0.0000
## Median :0.8125 Median :0.0000 Median :1.0000
## Mean :0.8793 Mean :0.4773 Mean :0.5714
## 3rd Qu.:1.0286 3rd Qu.:1.0000 3rd Qu.:1.0000
## Max. :2.0183 Max. :1.0000 Max. :1.0000
## NA's :2 NA's :8 NA's :5
## LatTDIe10 EtoTDIe14 TRVmax Diastolic4count
## Min. :0.0000 Min. :0.0000 Min. :0.0000 Min. :0.000
## 1st Qu.:0.0000 1st Qu.:0.0000 1st Qu.:0.0000 1st Qu.:1.000
## Median :1.0000 Median :0.0000 Median :0.0000 Median :2.000
## Mean :0.6353 Mean :0.3111 Mean :0.4419 Mean :1.969
## 3rd Qu.:1.0000 3rd Qu.:1.0000 3rd Qu.:1.0000 3rd Qu.:3.000
## Max. :1.0000 Max. :1.0000 Max. :1.0000 Max. :4.000
## NA's :11 NA's :6 NA's :53
## DiastDysfunction3of4 DiastCount DiastDysfunASE
## Min. :0.0000 Min. :0.0000 Min. :0.0000
## 1st Qu.:0.0000 1st Qu.:0.0000 1st Qu.:0.0000
## Median :0.0000 Median :0.0000 Median :0.0000
## Mean :0.3958 Mean :0.6771 Mean :0.4792
## 3rd Qu.:1.0000 3rd Qu.:1.0000 3rd Qu.:1.0000
## Max. :1.0000 Max. :2.0000 Max. :1.0000
##

```

```
str(echo)
```

```

## 'data.frame': 96 obs. of 64 variables:
## $ i..ID : int 1 4 9 10 15 18 19 28 29 31 ...
## $ Country : Factor w/ 23 levels " ", "FS10", "FS11", ...: 22 22 22 22 22 22 22 22 22 22 ...
## $ Age : int 72 52 55 61 73 61 50 52 77 81 ...
## $ Gender : int 0 0 0 0 0 0 0 0 0 0 ...
## $ BSA : num 1.53 2.09 2.61 1.96 1.65 1.87 1.59 1.54 2 1.74 ...

```

```

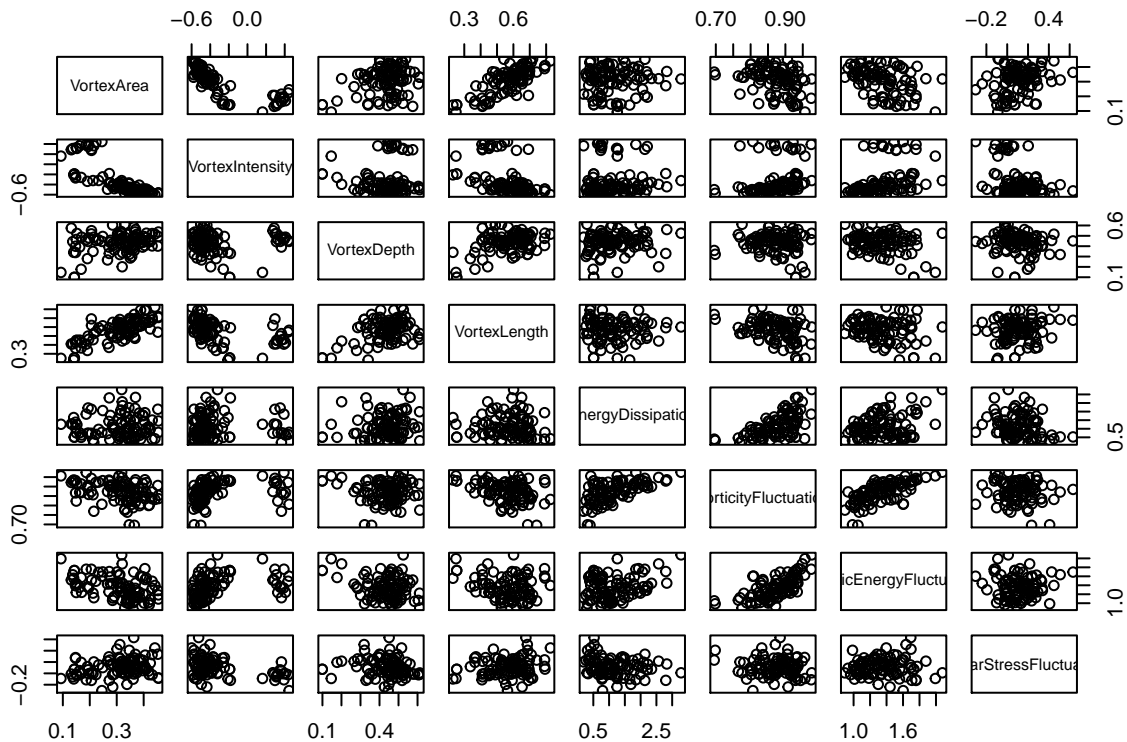
## $ HRmin : num 74.3 62.4 74.4 84.9 49 ...
## $ SBP : int 170 140 134 130 170 122 140 110 130 170 ...
## $ DBP : int 90 88 92 80 80 60 88 64 88 64 ...
## $ Etiology : int NA NA NA NA 4 5 NA 5 1 2 ...
## $ NYHA : int 1 1 1 1 1 1 1 1 1 1 ...
## $ EchoLA : num NA NA NA NA NA NA NA NA NA NA ...
## $ EchoIVS : num 9 11 10 10 9 11 8 8 10 9 ...
## $ EchoPW : num 9 11 10 11 8 11 8 9 11 9 ...
## $ EchoDd : num 44 46 51 50 58 40 42 39 46 55 ...
## $ EchoDs : num 27 34 34 30 39 25 27 27 34 43 ...
## $ bEF : int 68 64 60 64 61 73 68 57 52 43 ...
## $ RWT : num NA NA NA NA NA NA NA NA NA NA ...
## $ LVMass : num 128 181 188 194 189 ...
## $ EchoLVMI : num 83.7 86.7 72 99.2 114.7 ...
## $ EchoEDV : num 78 143 116 134 173 109 75 112 153 140 ...
## $ EchoESV : num 22 60 43 53 69 35 26 55 46 74 ...
## $ EchoSV : num 56 83 73 81 104 74 49 57 107 66 ...
## $ EchoEF : num 71 58 63 61 60 68 65 50 70 47 ...
## $ AbnormaleF50 : int 0 0 0 0 0 0 0 0 0 1 ...
## $ EchoTMfEwave : num 61 63 58 76 58 76 73 56 68 60 ...
## $ EchoTMfAwave : num 70 51 59 78 43 100 59 50 59 40 ...
## $ TimeTMFDecT : int 118 192 229 211 211 189 174 214 185 238 ...
## $ EchoTMfEtoA : num 0.871 1.235 0.983 0.974 1.349 ...
## $ EchoLAVI : num 24 27 26 35 41 28 29 29 48 49 ...
## $ EchSepTDIe : num 8 9 6 9 6 9 10 9 7 7 ...
## $ EchoLatTDIe : num 10 13 10 10 10 10 12 10 7 9 ...
## $ EchoAveTDIe : num 9 11 8 9.5 8 9.5 11 9.5 7 8 ...
## $ EchoSeptEe : num 7.63 7 9.67 8.44 9.67 8.44 7.3 6.22 9.71 8.57 ...
## $ EchoRVSP : num 27 NA 21 NA 29 32 37 27 42 40 ...
## $ EchoLVM : num 128 181 188 194 189 ...
## $ EchoLVMII : num 83.7 86.7 72 99.2 114.7 ...
## $ TimePIVRRms : num 815 966 810 714 1234 ...
## $ TimePIvEonset : num 470 465 427 408 474 ...
## $ TimePIvEonsetNorRR : num 576 481 527 571 384 ...
## $ TimePIvEpeak : num 521 584 546 539 617 ...
## $ TimePIvEpeakNorRR : num 639 604 674 755 500 ...
## $ TimeVsonset : int 505 501 465 461 504 445 484 599 574 536 ...
## $ TimePeakVSE : num 521 584 550 505 617 ...
## $ Tracking : int 1 1 1 1 1 1 1 1 1 1 ...
## $ VortexArea : num 0.432 0.337 0.286 0.333 0.455 ...
## $ VortexIntensity : num -0.584 -0.46 -0.402 -0.448 -0.565 ...
## $ VortexDepth : num 0.522 0.337 0.406 0.411 0.537 ...
## $ VortexLength : num 0.682 0.526 0.523 0.549 0.717 ...
## $ EnergyDissipation : num 1.51 1.02 1.01 1.39 1.45 ...
## $ VorticityFluctuation : num 0.872 0.825 0.874 0.925 0.854 ...
## $ KineticEnergyFluctuation : num 1.33 1.07 1.12 1.36 1.19 ...
## $ ShearStressFluctuation : num -0.0267 0.0814 0.1668 0.1603 -0.0858 ...
## $ KineticEnergyEarlyD : num 2.16 3.15 2.21 2 3.8 ...
## $ KineticEnergyLateD : num 1.77 1.53 3.28 3.43 1.91 ...
## $ KineticEnergyOnsetSystole : num 0.815 0.525 0.938 0.554 0.868 ...
## $ LAVI35 : int 0 0 0 1 1 0 0 0 1 1 ...
## $ SeptTDIe7 : int 0 0 1 0 1 0 0 0 0 0 ...
## $ LatTDIe10 : int 0 0 0 0 0 0 0 0 1 1 ...
## $ EtoTDIe14 : int 0 0 0 0 0 0 0 0 0 0 ...

```

```
## $ TRVmax : int 0 NA 0 NA 0 0 1 0 1 1 ...
## $ Diastolic4count : int 0 0 1 1 2 0 1 0 3 3 ...
## $ DiastDysfunction3of4 : int 0 0 0 0 0 0 0 0 1 1 ...
## $ DiastCount : int 0 0 0 0 0 0 0 0 1 2 ...
## $ DiastDysfunASE : int 0 0 0 0 0 0 0 0 1 1 ...
```

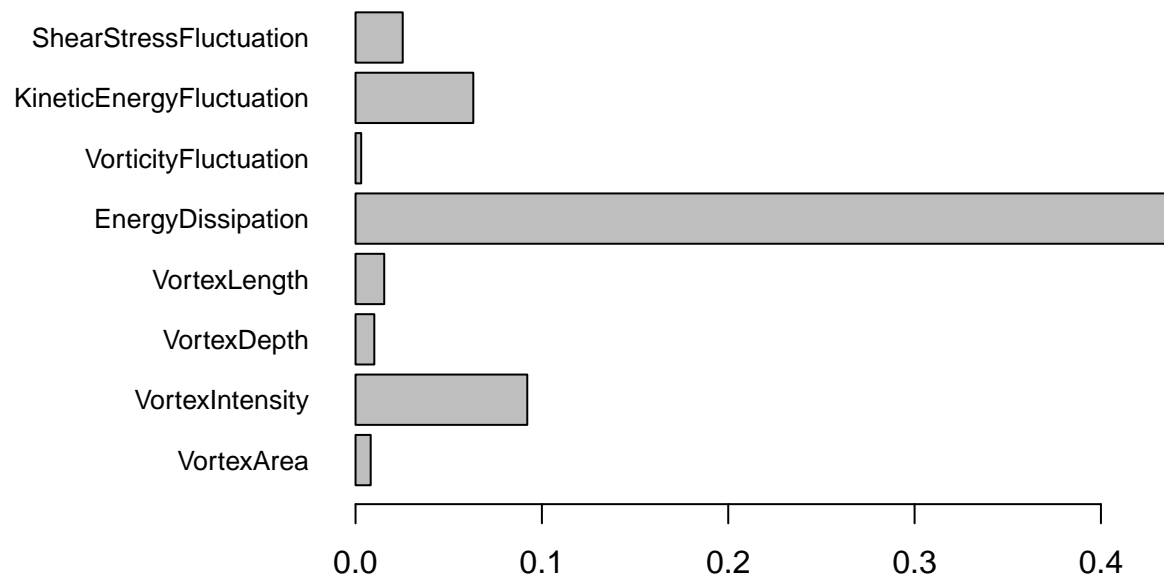
```
## There are several missing data. We only select the ones we care about - the vortex data.
vorticity.data <- echo[,c(45:52)]
```

```
#
plot(vorticity.data)
```

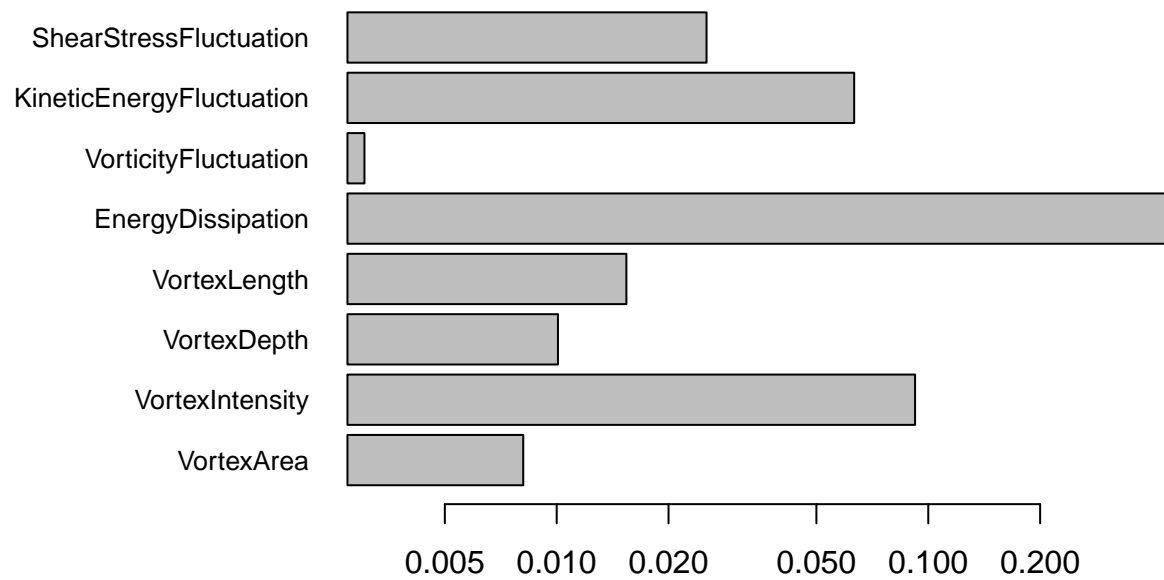


```
mar <- par()$mar
par(mar=mar+c(0,5,0,0))

# seems like the variables are in different scales
barplot(sapply(vorticity.data, var), horiz=T, las=1, cex.names=0.8)
```

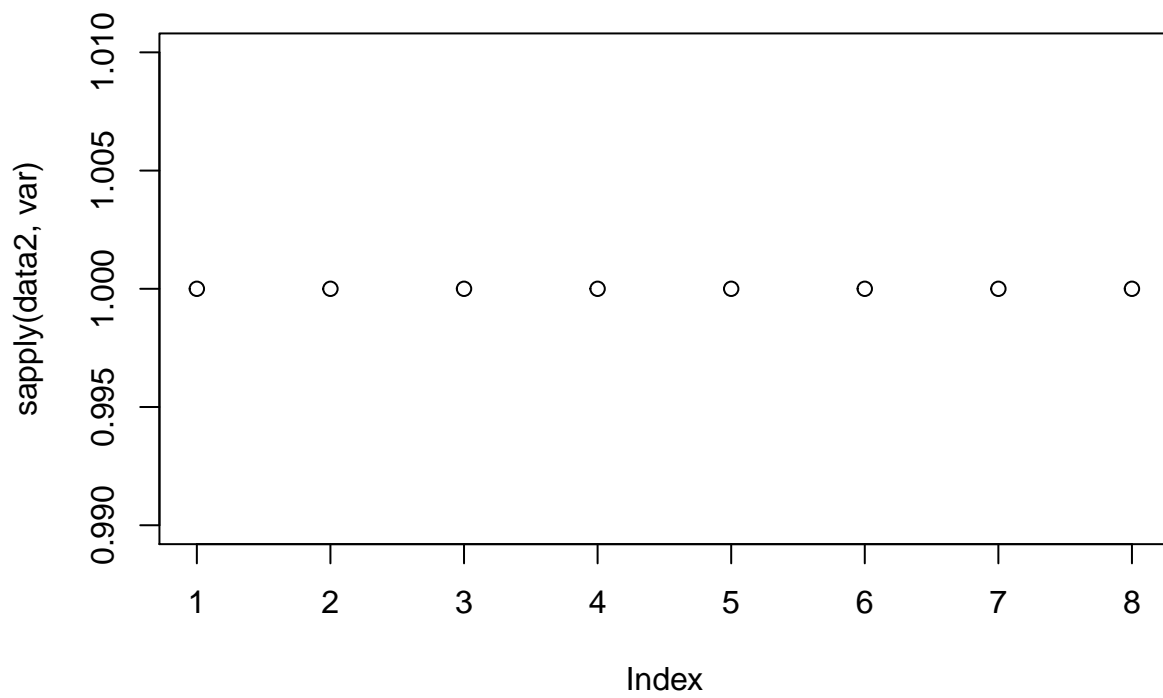


```
# in log scale  
barplot(sapply(vorticity.data, var), horiz=T, las=1, cex.names=0.8, log='x')
```



```
par(mar=mar)

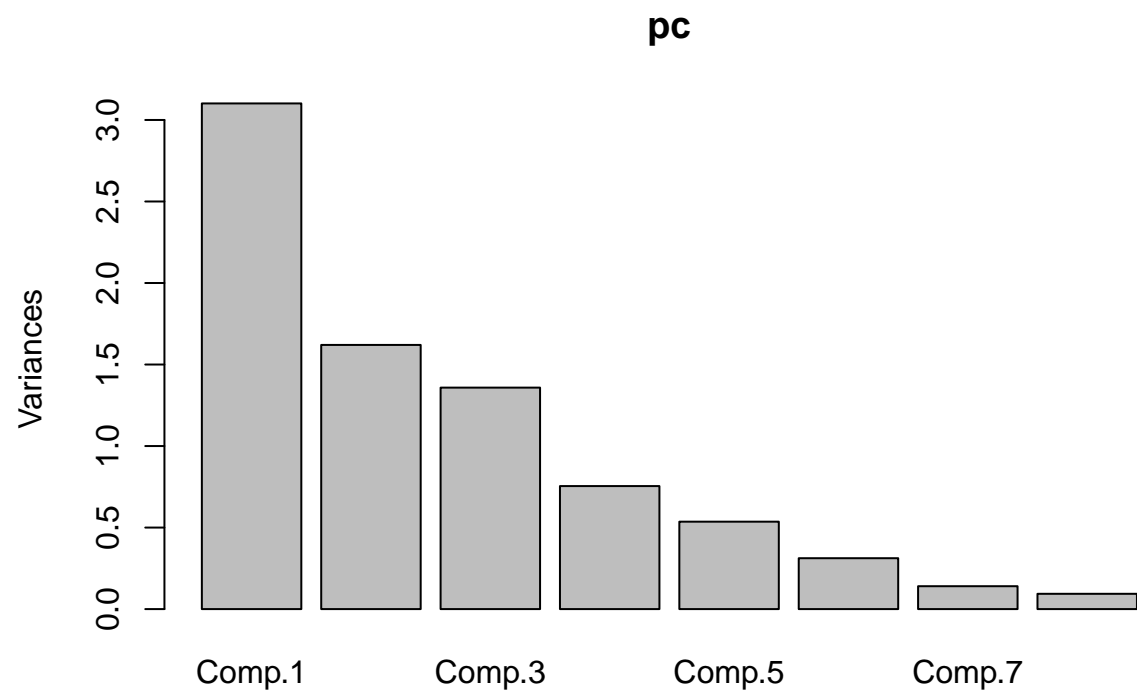
# Scale
data2 <- data.frame(scale(vorticity.data))
# Verify variance is uniform
plot(sapply(data2, var))
```



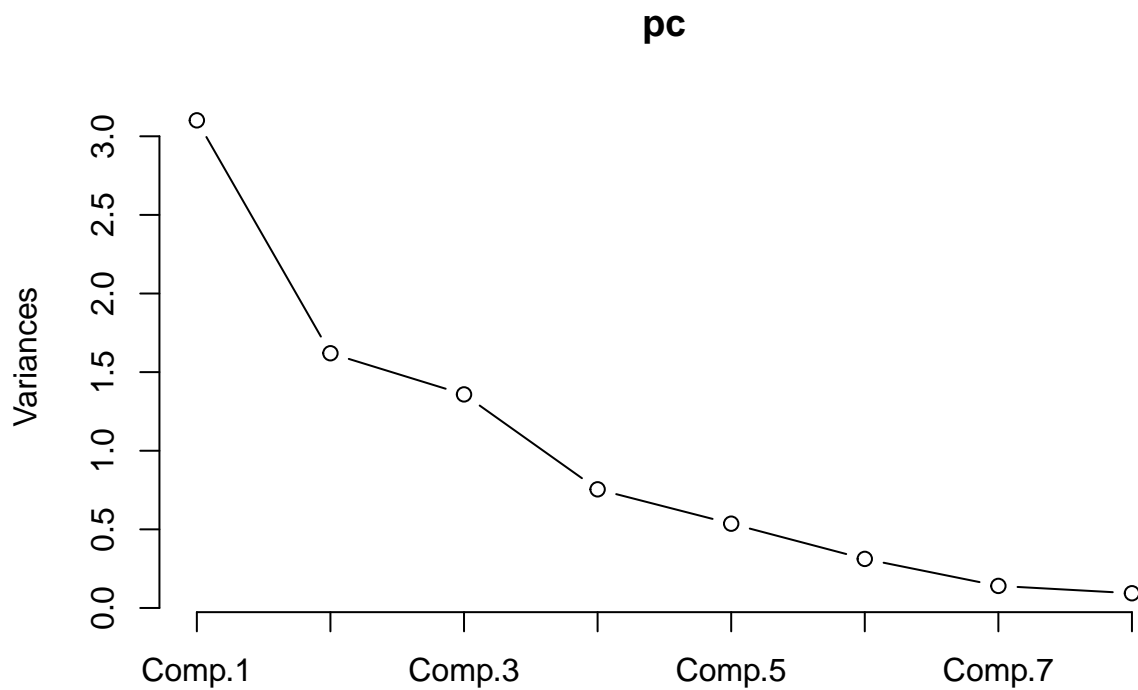
## Calculating PCA

```
# Proceed with principal components  
pc <- princomp(data2)  
plot(pc)
```





```
plot(pc, type='l')
```



```
summary(pc) # 4 components is both 'elbow' and explains >85% variance
```

```
## Importance of components:
##               Comp.1   Comp.2   Comp.3   Comp.4   Comp.5
## Standard deviation  1.7610829 1.2728542 1.1654740 0.86863697 0.73218492
## Proportion of Variance 0.3917574 0.2046515 0.1715785 0.09530908 0.06771723
## Cumulative Proportion 0.3917574 0.5964090 0.7679874 0.86329652 0.93101375
##               Comp.6   Comp.7   Comp.8
## Standard deviation  0.55864939 0.37462455 0.30611837
## Proportion of Variance 0.03942179 0.01772761 0.01183686
## Cumulative Proportion 0.97043554 0.98816314 1.00000000
```

```
# Get principal component vectors using prcomp instead of princomp
```

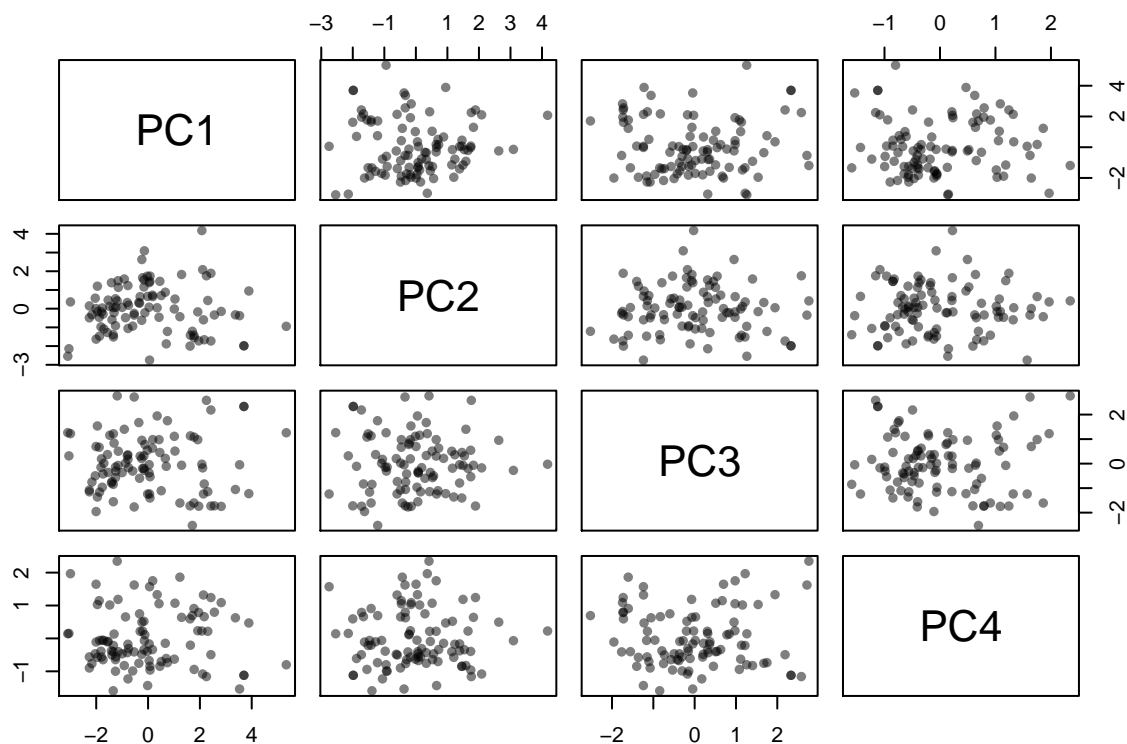
```
pc <- prcomp(data2)
```

```
# First for principal components
```

```
comp <- data.frame(pc$x[,1:4])
```

```
# Plot
```

```
plot(comp, pch=16, col=rgb(0,0,0,0.5))
```



```
library(rgl)
# Multi 3D plot
plot3d(comp$PC1, comp$PC2, comp$PC3)
plot3d(comp$PC1, comp$PC3, comp$PC4)
```

## Hierarchical Clustering packages

### Load packages

```
suppressPackageStartupMessages(library(tidyverse))
suppressPackageStartupMessages(library(cluster))
suppressPackageStartupMessages(library(factoextra))
suppressPackageStartupMessages(library(dendextend))

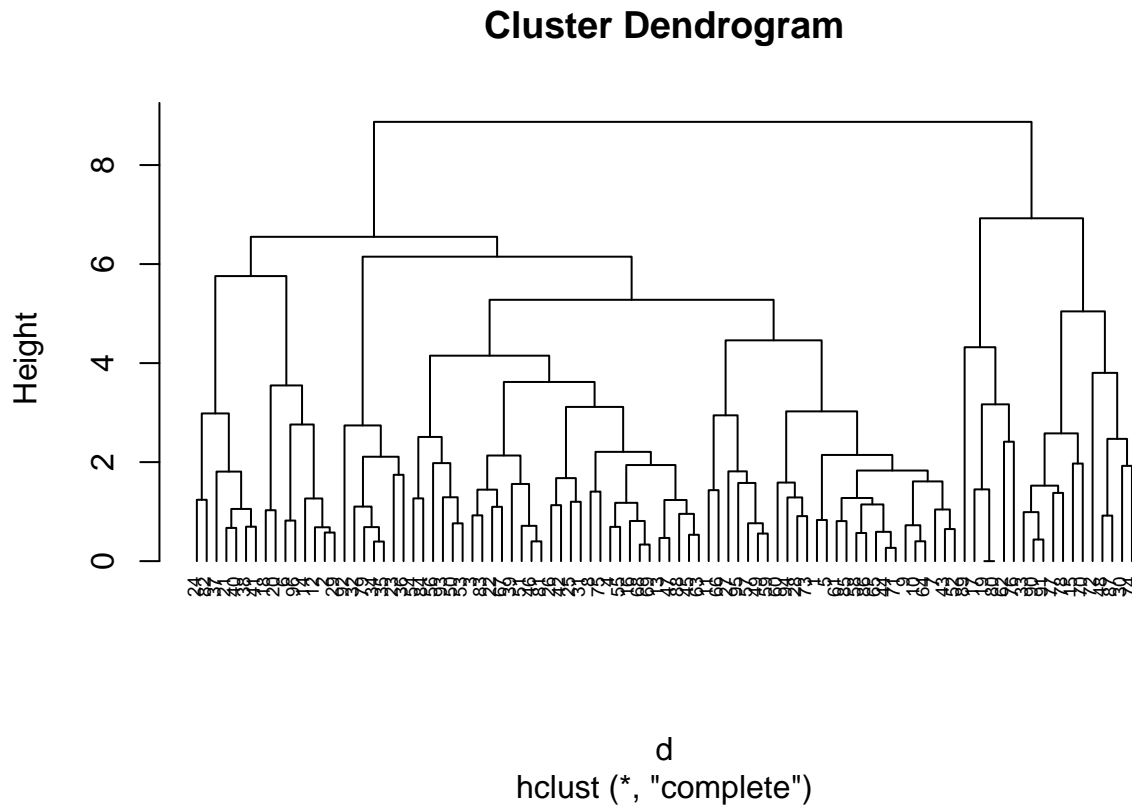
library(tidyverse) # data manipulation
library(cluster)   # clustering algorithms
library(factoextra) # clustering visualization
library(dendextend) # for comparing two dendrograms
```

```
# Dissimilarity matrix
d <- dist(comp, method = "euclidean")

# Hierarchical clustering using Complete Linkage
hcl <- hclust(d, method = "complete" )

# Plot the obtained dendrogram
```

```
plot(hc1, cex = 0.6, hang = -1)
```



## For Hierarchical Clustering

using Agnes to check the cluster structure

```
## average single complete ward
## 0.7656333 0.6595636 0.8810995 0.9480419
```

we select Ward's method since it's the strongest structure

```
library(dplyr)
require(graphics)

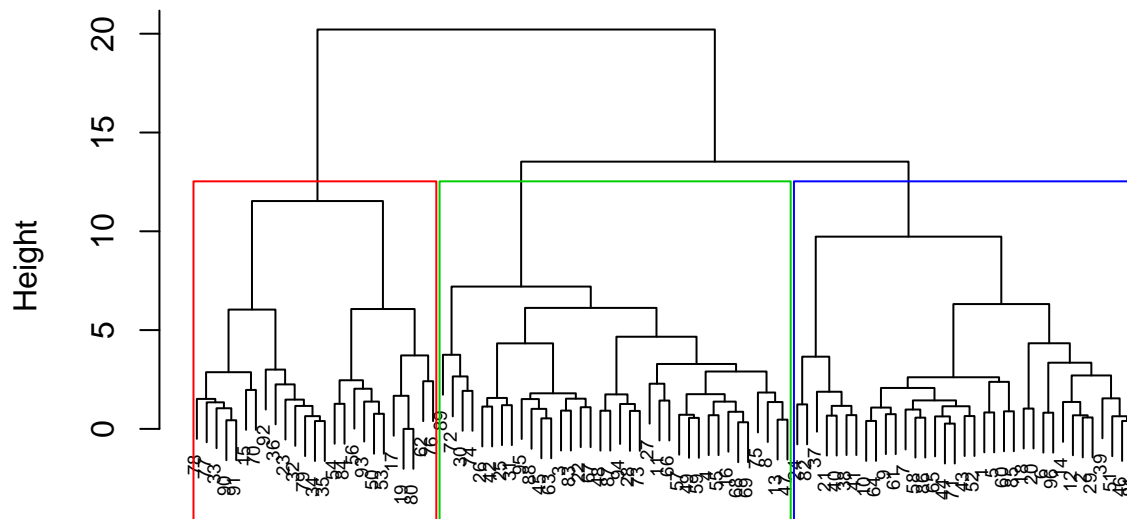
# Ward's method
hc5 <- hclust(dist(comp, method = "euclidean"), method = "ward.D2" )

# Cut tree into 4 groups
sub_grp <- cutree(hc5, k = 3)

echo.cluster <- echo %>%
mutate(cluster = sub_grp)
```

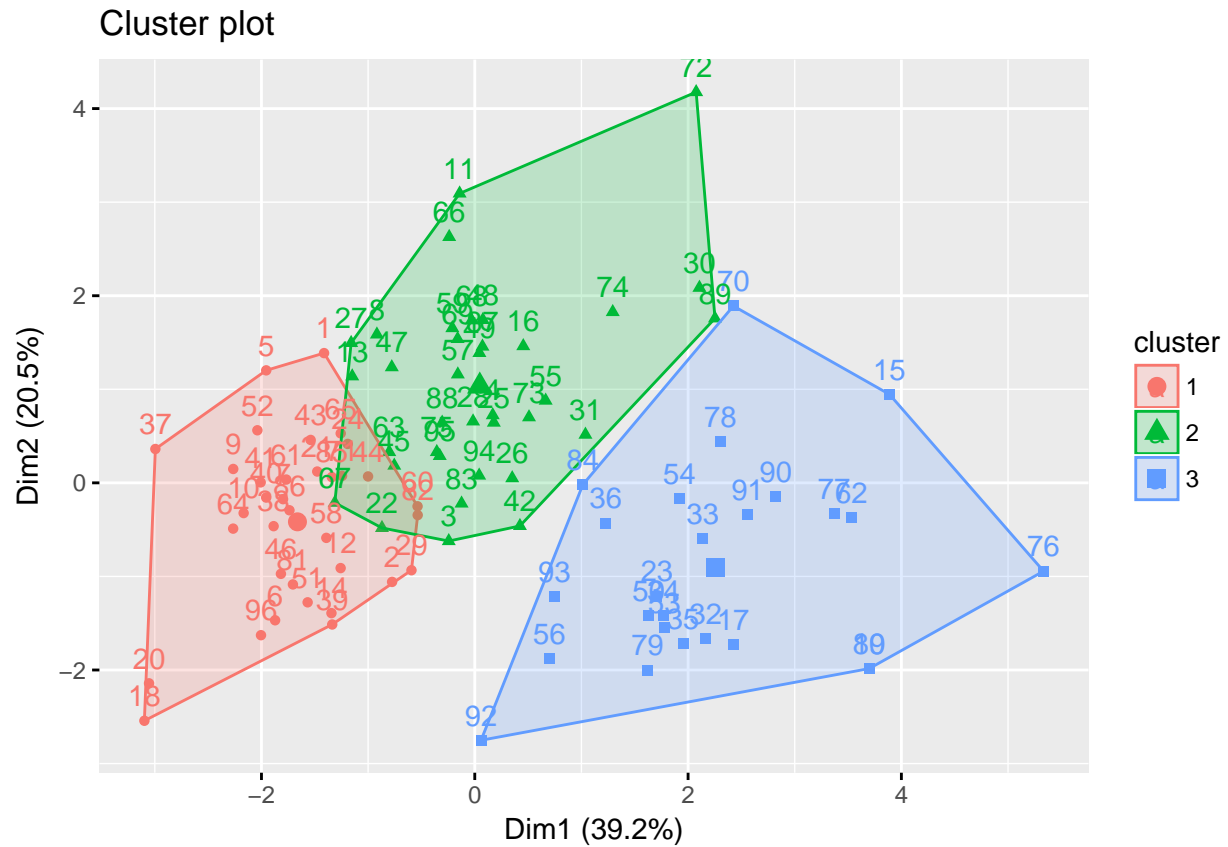
```
plot(hc5, cex=0.6)
rect.hclust(hc5, k = 3, border = 2:5)
```

## Cluster Dendrogram



```
dist(comp, method = "euclidean")
hclust (*, "ward.D2")
```

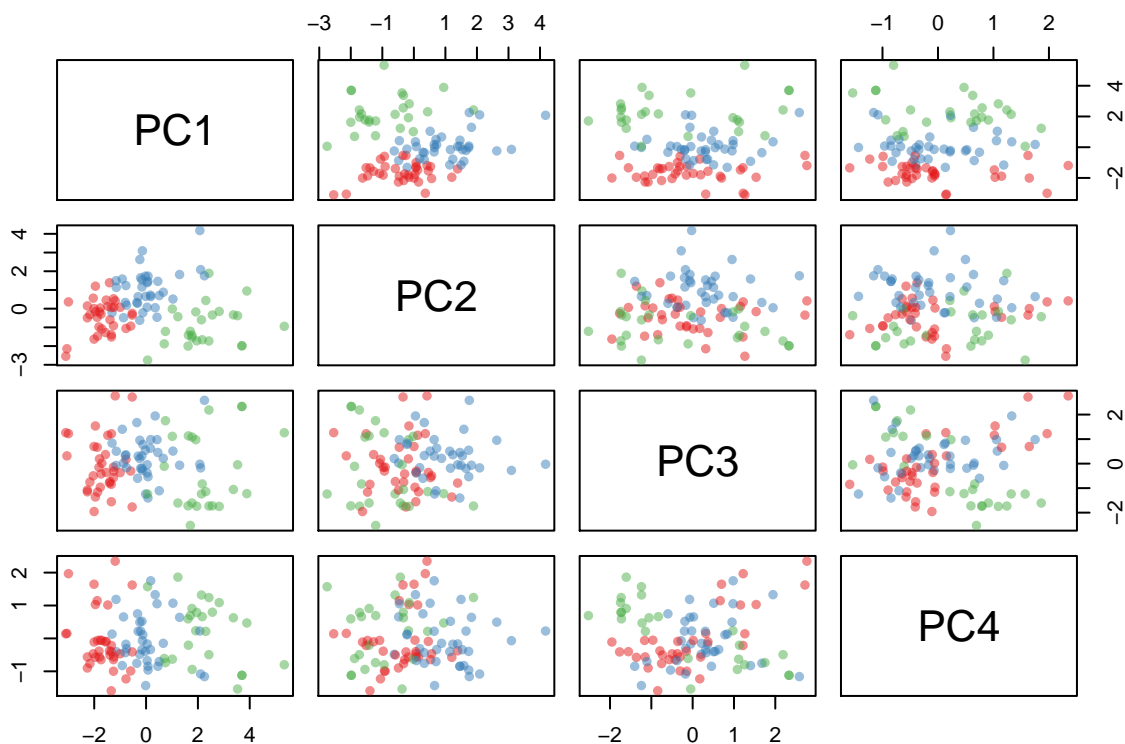
```
fviz_cluster(list(data = vorticity.data, cluster = sub_grp))
```



## PCA plot with cluster

```
library(RColorBrewer)

palette(alpha(brewer.pal(9, 'Set1'), 0.5))
plot(comp, col=sub_grp, pch=16)
```



```
# 3D plot
plot3d(comp$PC1, comp$PC2, comp$PC3, col=sub_grp)
plot3d(comp$PC1, comp$PC3, comp$PC4, col=sub_grp)

# Cluster sizes
sort(table(sub_grp))

## sub_grp
## 3 1 2
## 25 35 36

clust <- names(sort(table(sub_grp)))

# First cluster
row.names(echo.cluster[sub_grp==clust[1],])

## [1] "15" "17" "19" "23" "32" "33" "34" "35" "36" "50" "53" "54" "56" "62"
## [15] "70" "76" "77" "78" "79" "80" "84" "90" "91" "92" "93"

# Second Cluster
row.names(echo.cluster[sub_grp==clust[2],])

## [1] "1" "2" "5" "6" "7" "9" "10" "12" "14" "18" "20" "21" "24" "29"
## [15] "37" "38" "39" "40" "41" "43" "44" "46" "51" "52" "58" "60" "61" "64"
## [29] "65" "71" "81" "82" "85" "86" "96"

# Third Cluster
row.names(echo.cluster[sub_grp==clust[3],])
```

```
## [1] "3" "4" "8" "11" "13" "16" "22" "25" "26" "27" "28" "30" "31" "42"
## [15] "45" "47" "48" "49" "55" "57" "59" "63" "66" "67" "68" "69" "72" "73"
## [29] "74" "75" "83" "87" "88" "89" "94" "95"
```

## Analysis of demographics with cluster

### Age vs Cluster

```
# Age vs Cluster
aov.age <- aov(echo.cluster$Age ~ echo.cluster$cluster)
summary(aov.age)

##               Df Sum Sq Mean Sq F value Pr(>F)
## echo.cluster$cluster 1      12   12.36    0.07  0.792
## Residuals           90  15862   176.24
## 4 observations deleted due to missingness

#age range
echo.cluster$age.range <- cut(echo.cluster$Age, breaks=c(0,40, 60, 80, 200), right = FALSE, labels = c(
# Age range by cluster
# 1 : 0-39
# 2: 40 - 59
# 3: 60 - 79
# 4: 80 +

age.table <- table(echo.cluster$cluster, echo.cluster$age.range)

chisq.test(age.table)

## Warning in chisq.test(age.table): Chi-squared approximation may be
## incorrect

##
## Pearson's Chi-squared test
##
## data:  age.table
## X-squared = 5.4256, df = 6, p-value = 0.4905
```

### NYHA vs Cluster

```
nyha.tbl <- table(echo.cluster$cluster, echo.cluster$NYHA)

chisq.test(nyha.tbl)

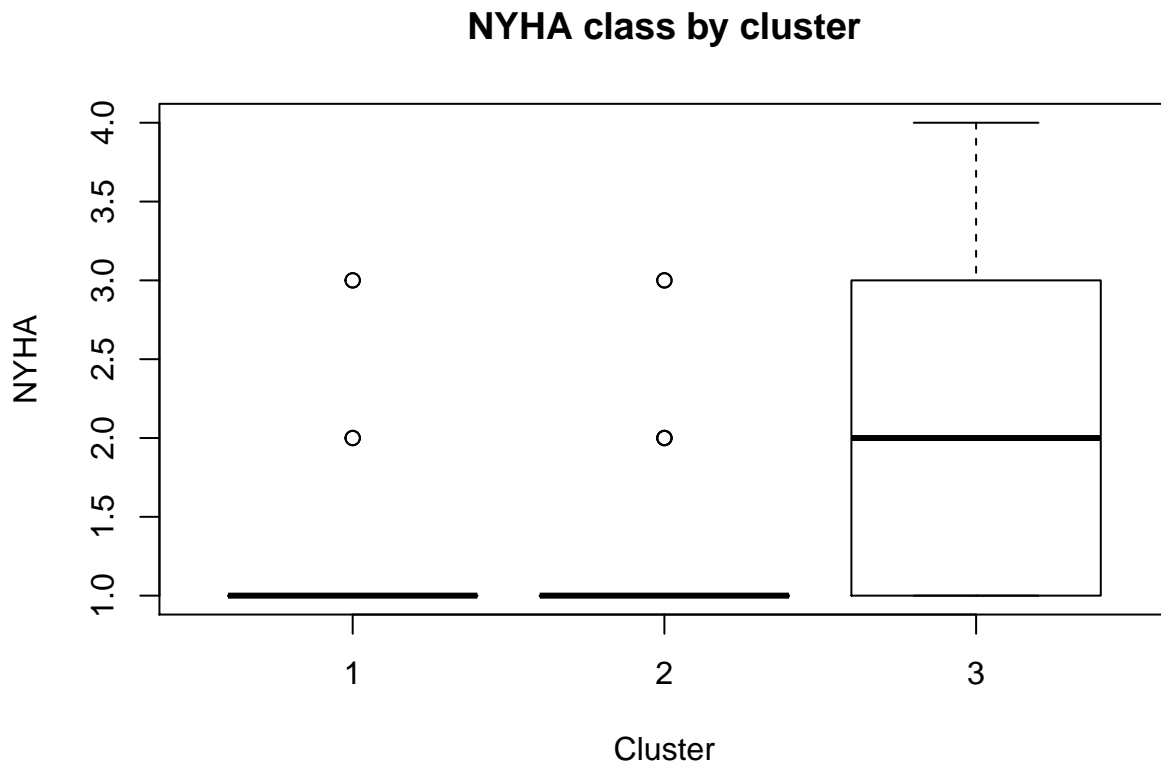
## Warning in chisq.test(nyha.tbl): Chi-squared approximation may be incorrect

##
## Pearson's Chi-squared test
##
## data:  nyha.tbl
```



```
## X-squared = 22.544, df = 6, p-value = 0.0009645
```

```
boxplot(echo.cluster$NYHA ~ echo.cluster$cluster, xlab = "Cluster", ylab = "NYHA", main = "NYHA class by
```



## Diastolic 4 Parameter Count

```
dias.tbl <- table(echo.cluster$cluster, echo.cluster$Diastolic4count)
```

```
chisq.test(dias.tbl)
```

```
## Warning in chisq.test(dias.tbl): Chi-squared approximation may be incorrect
```

```
##
```

```
## Pearson's Chi-squared test
```

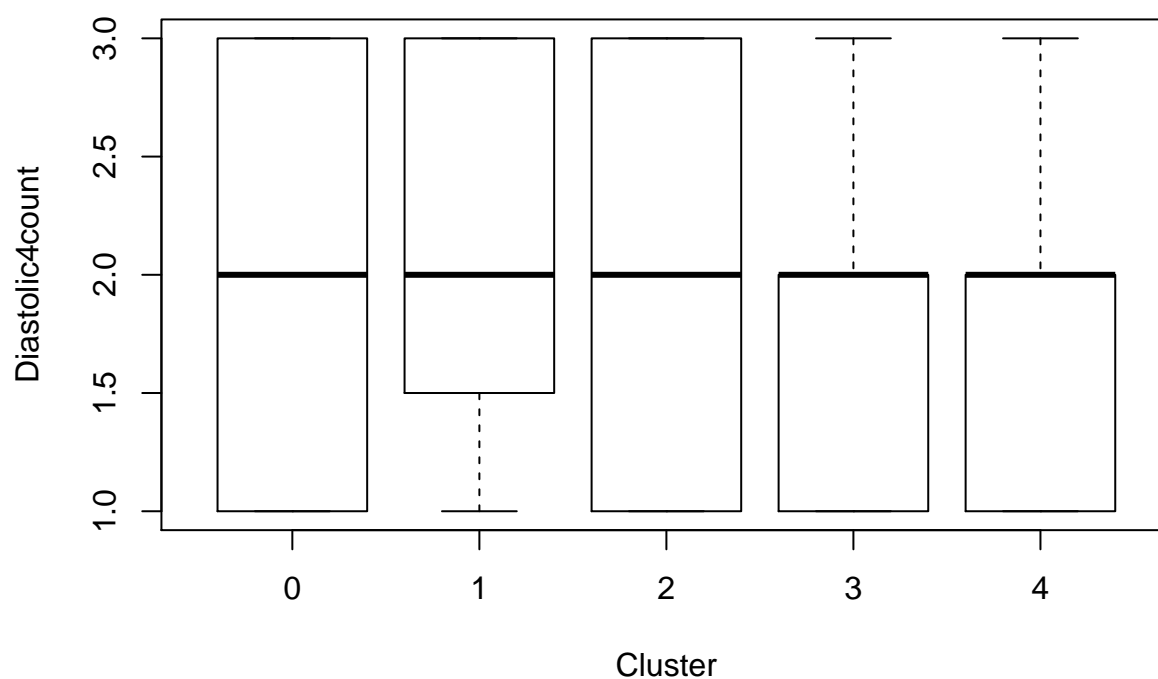
```
##
```

```
## data: dias.tbl
```

```
## X-squared = 5.8019, df = 8, p-value = 0.6694
```

```
boxplot(echo.cluster$cluster ~ echo.cluster$Diastolic4count, xlab = "Cluster", ylab = "Diastolic4count"
```

### Diastolic4count class by cluster



### Diastolic Dysfunction 3 or 4 of 4

```
dias.dysfn.tbl <- table(echo.cluster$cluster, echo.cluster$DiastDysfunction3of4)
```

```
chisq.test(dias.dysfn.tbl)
```

```
##
```

```
## Pearson's Chi-squared test
```

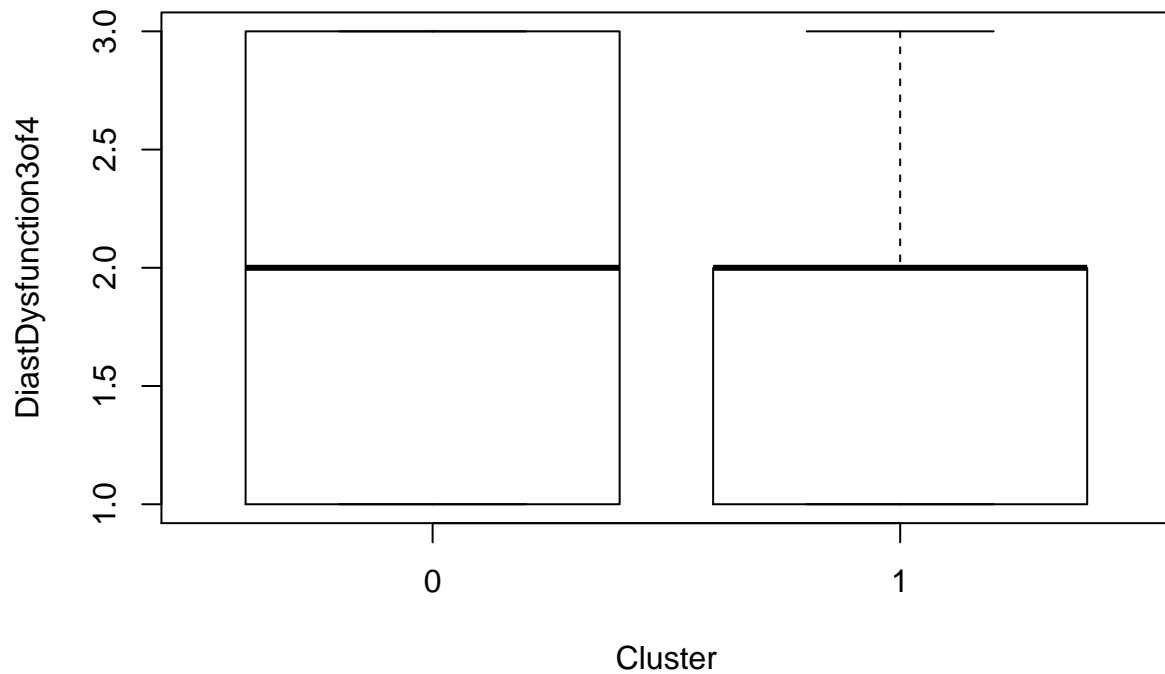
```
##
```

```
## data: dias.dysfn.tbl
```

```
## X-squared = 1.9152, df = 2, p-value = 0.3838
```

```
boxplot(echo.cluster$cluster ~ echo.cluster$DiastDysfunction3of4, xlab = "Cluster", ylab = "DiastDysfun
```

### DiastDysfunction3of4 class by cluster



### Diastolic Count (low EF or 3/4)

```
low.ef.tbl <- table(echo.cluster$cluster, echo.cluster$DiastCount)
```

```
chisq.test(low.ef.tbl)
```

```
## Warning in chisq.test(low.ef.tbl): Chi-squared approximation may be
## incorrect
```

```
##
```

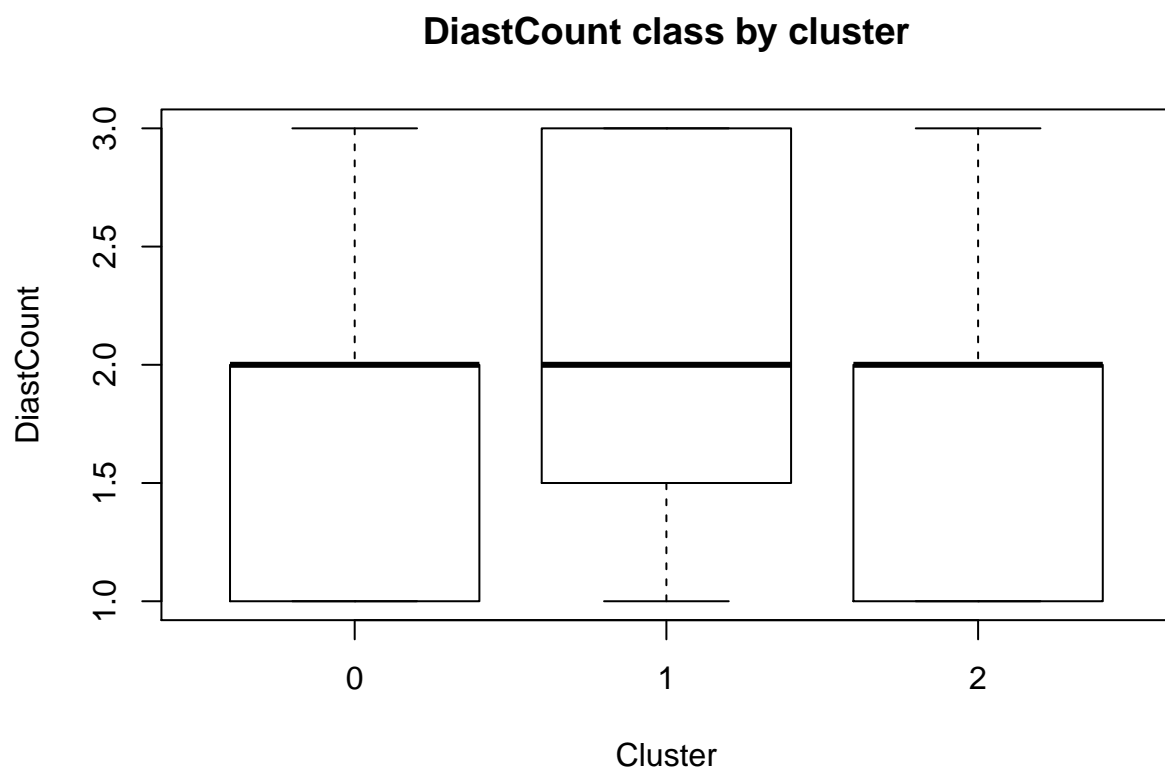
```
## Pearson's Chi-squared test
```

```
##
```

```
## data: low.ef.tbl
```

```
## X-squared = 4.4928, df = 4, p-value = 0.3434
```

```
boxplot(echo.cluster$cluster ~ echo.cluster$DiastCount, xlab = "Cluster", ylab = "DiastCount", main = "Diastolic Count (low EF or 3/4)")
```



## Diastolic Dysfunction ASE (low EF or 3/4)

```
dias.dysfn.ase.tbl <- table(echo.cluster$cluster, echo.cluster$DiastDysfunASE)
```

```
chisq.test(dias.dysfn.ase.tbl)
```

```
##
```

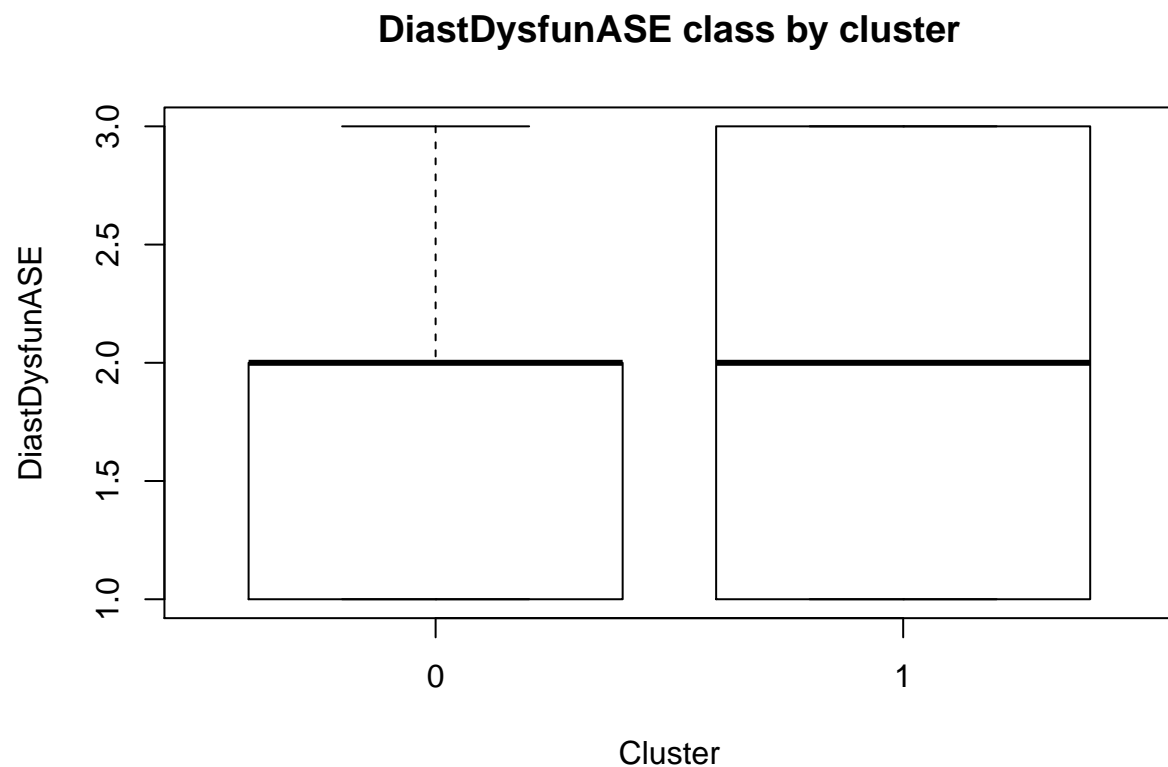
```
## Pearson's Chi-squared test
```

```
##
```

```
## data: dias.dysfn.ase.tbl
```

```
## X-squared = 1.9955, df = 2, p-value = 0.3687
```

```
boxplot(echo.cluster$cluster ~ echo.cluster$DiastDysfunASE, xlab = "Cluster", ylab = "DiastDysfunASE", main = "DiastDysfunASE by Cluster")
```



## Etiology

```
etiology.tbl <- table(echo.cluster$cluster, echo.cluster$Etiology)
```

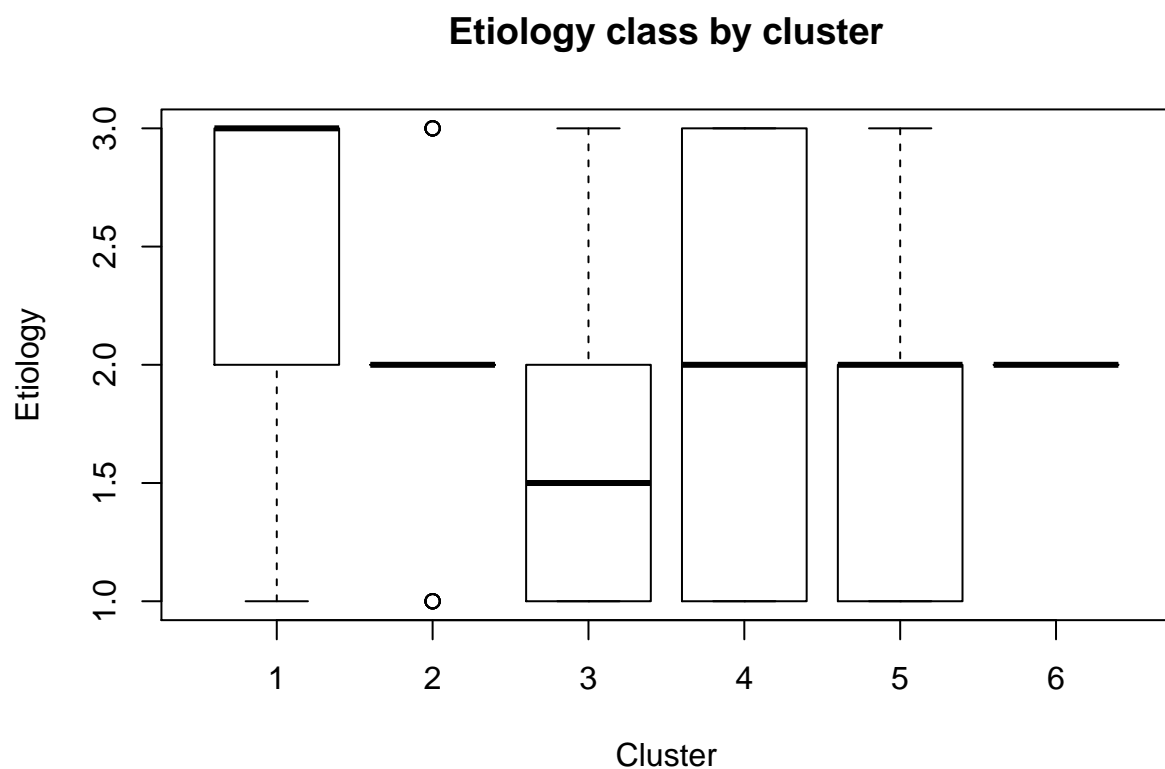
```
chisq.test(etiology.tbl)
```

```
## Warning in chisq.test(etiology.tbl): Chi-squared approximation may be
## incorrect
```

```
##
## Pearson's Chi-squared test
```

```
## data:  etiology.tbl
## X-squared = 13.359, df = 10, p-value = 0.2043
```

```
boxplot(echo.cluster$cluster ~ echo.cluster$Etiology, xlab = "Cluster", ylab = "Etiology", main = "Etiology")
```



## LV Ejection fraction below 40%

```
lv.ejection.tbl <- table(echo.cluster$cluster, echo.cluster$AbnormalEF50)
```

```
chisq.test(lv.ejection.tbl)
```

```
##
## Pearson's Chi-squared test
##
## data: lv.ejection.tbl
## X-squared = 7.452, df = 2, p-value = 0.02409
```

```
boxplot(echo.cluster$cluster ~ echo.cluster$AbnormalEF50, xlab = "Cluster", ylab = "AbnormalEF50", main = "LV Ejection fraction below 40%")
```

**AbnormalEF50 class by cluster**

