



EDA Case Study - Understanding Human Activity with Smart Phones

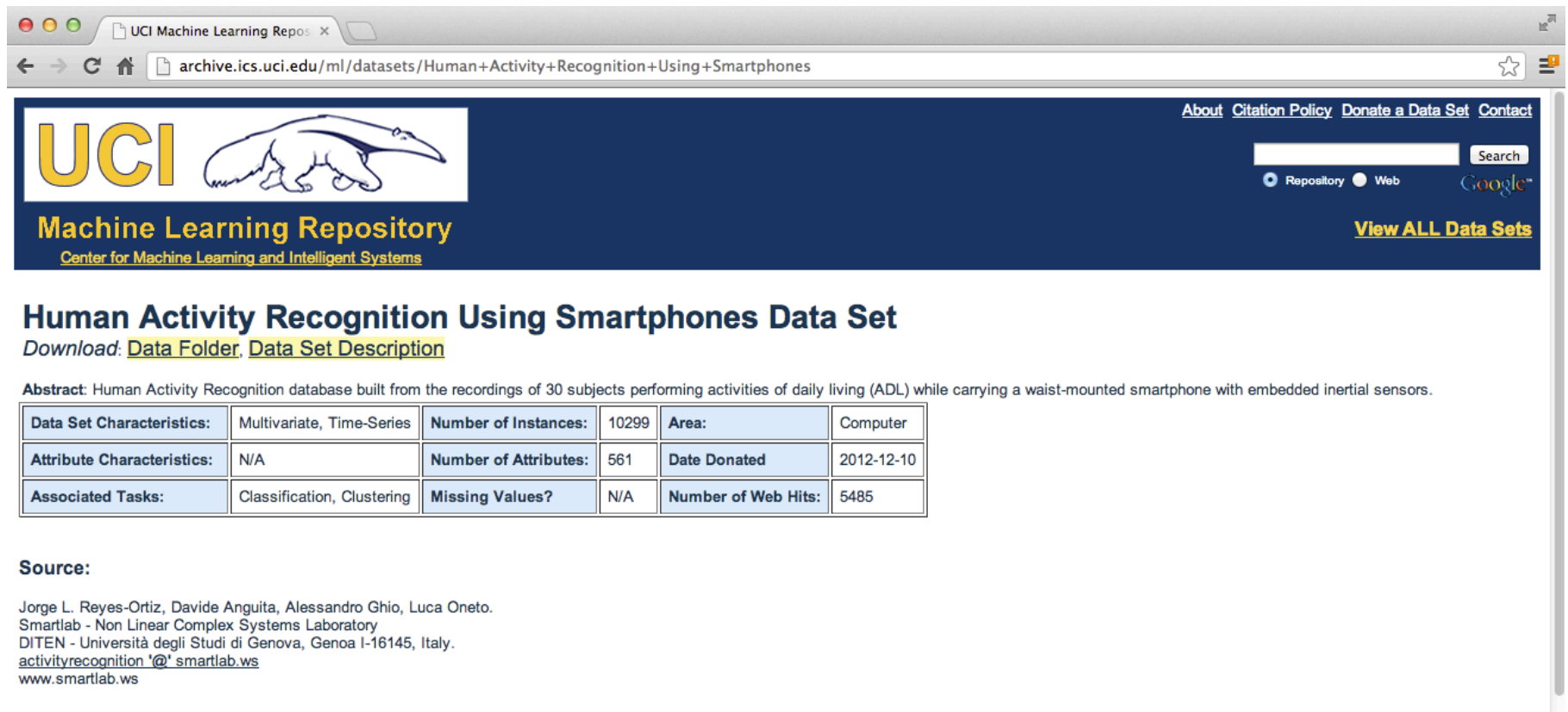
Roger D. Peng, Associate Professor of Biostatistics
Johns Hopkins Bloomberg School of Public Health

Samsung Galaxy S3



<http://www.samsung.com/global/galaxys3/>

Samsung Data



The screenshot shows a web browser window with the address bar displaying `archive.ics.uci.edu/ml/datasets/Human+Activity+Recognition+Using+Smartphones`. The page header features the UCI logo (a sloth) and the text "Machine Learning Repository" and "Center for Machine Learning and Intelligent Systems". Navigation links include "About", "Citation Policy", "Donate a Data Set", and "Contact". A search bar with a "Search" button and a "Google" logo are also present. The main content area is titled "Human Activity Recognition Using Smartphones Data Set" and includes links for "Data Folder" and "Data Set Description". An abstract describes the dataset as a database built from recordings of 30 subjects performing daily living activities while carrying a smartphone. Below the abstract is a table with dataset characteristics.

Human Activity Recognition Using Smartphones Data Set
Download: [Data Folder](#), [Data Set Description](#)

Abstract: Human Activity Recognition database built from the recordings of 30 subjects performing activities of daily living (ADL) while carrying a waist-mounted smartphone with embedded inertial sensors.

Data Set Characteristics:	Multivariate, Time-Series	Number of Instances:	10299	Area:	Computer
Attribute Characteristics:	N/A	Number of Attributes:	561	Date Donated	2012-12-10
Associated Tasks:	Classification, Clustering	Missing Values?	N/A	Number of Web Hits:	5485

Source:
Jorge L. Reyes-Ortiz, Davide Anguita, Alessandro Ghio, Luca Oneto.
Smartlab - Non Linear Complex Systems Laboratory
DITEN - Università degli Studi di Genova, Genoa I-16145, Italy.
activityrecognition '@' smartlab.ws
www.smartlab.ws

<http://archive.ics.uci.edu/ml/datasets/Human+Activity+Recognition+Using+Smartphones>

Slightly processed data

Samsung data file

```
load("data/samsungData.rda")
names(samsungData)[1:12]
```

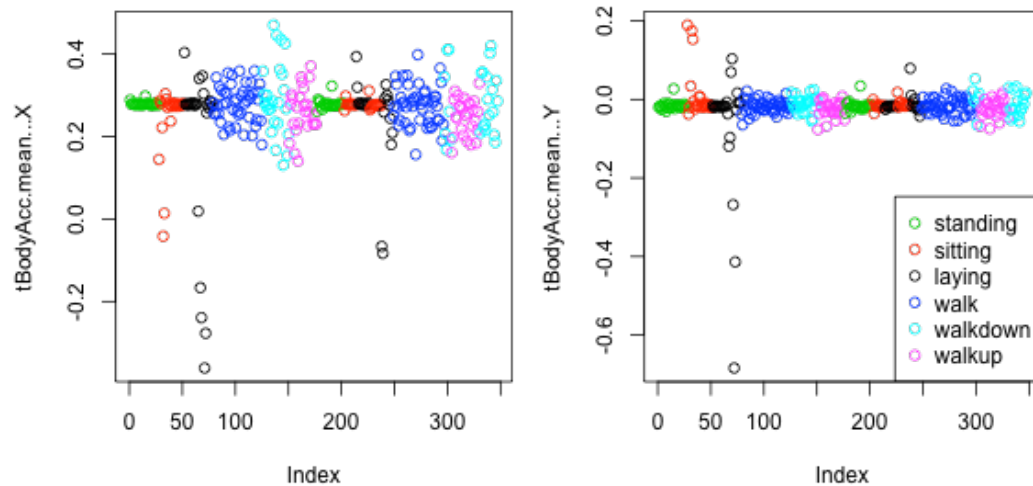
```
## [1] "tBodyAcc-mean()-X" "tBodyAcc-mean()-Y" "tBodyAcc-mean()-Z"
## [4] "tBodyAcc-std()-X"  "tBodyAcc-std()-Y"  "tBodyAcc-std()-Z"
## [7] "tBodyAcc-mad()-X"  "tBodyAcc-mad()-Y"  "tBodyAcc-mad()-Z"
## [10] "tBodyAcc-max()-X"  "tBodyAcc-max()-Y"  "tBodyAcc-max()-Z"
```

```
table(samsungData$activity)
```

```
##
##  laying  sitting standing    walk walkdown  walkup
##    1407    1286    1374    1226     986    1073
```

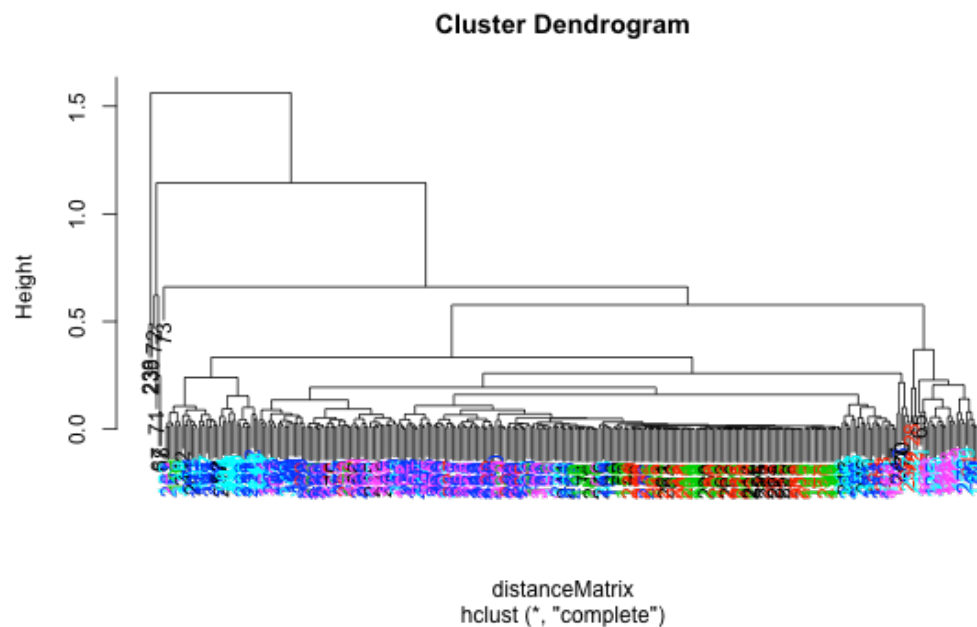
Plotting average acceleration for first subject

```
par(mfrow = c(1, 2), mar = c(5, 4, 1, 1))
samsungData <- transform(samsungData, activity = factor(activity))
sub1 <- subset(samsungData, subject == 1)
plot(sub1[, 1], col = sub1$activity, ylab = names(sub1)[1])
plot(sub1[, 2], col = sub1$activity, ylab = names(sub1)[2])
legend("bottomright", legend = unique(sub1$activity), col = unique(sub1$activity),
      pch = 1)
```



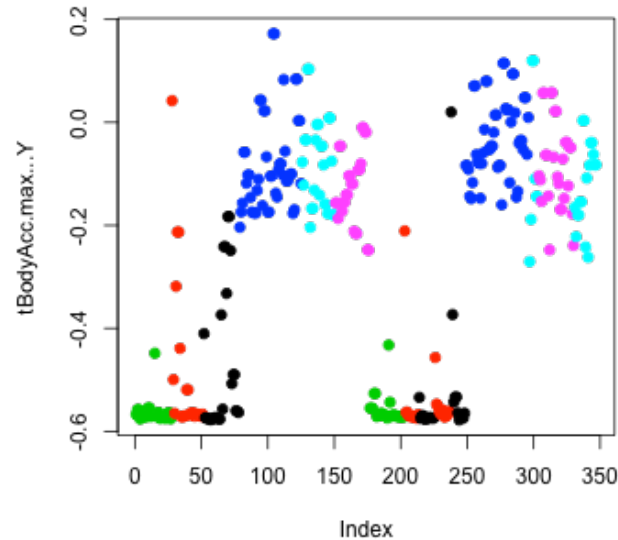
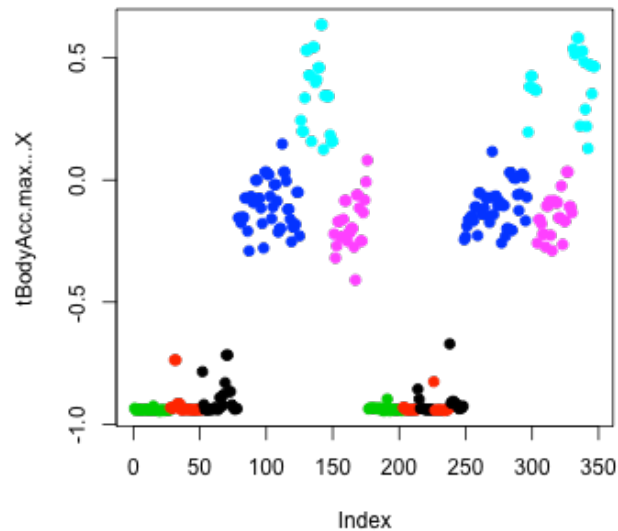
Clustering based just on average acceleration

```
source("myplclust.R")  
distanceMatrix <- dist(sub1[, 1:3])  
hclustering <- hclust(distanceMatrix)  
myplclust(hclustering, lab.col = unclass(sub1$activity))
```



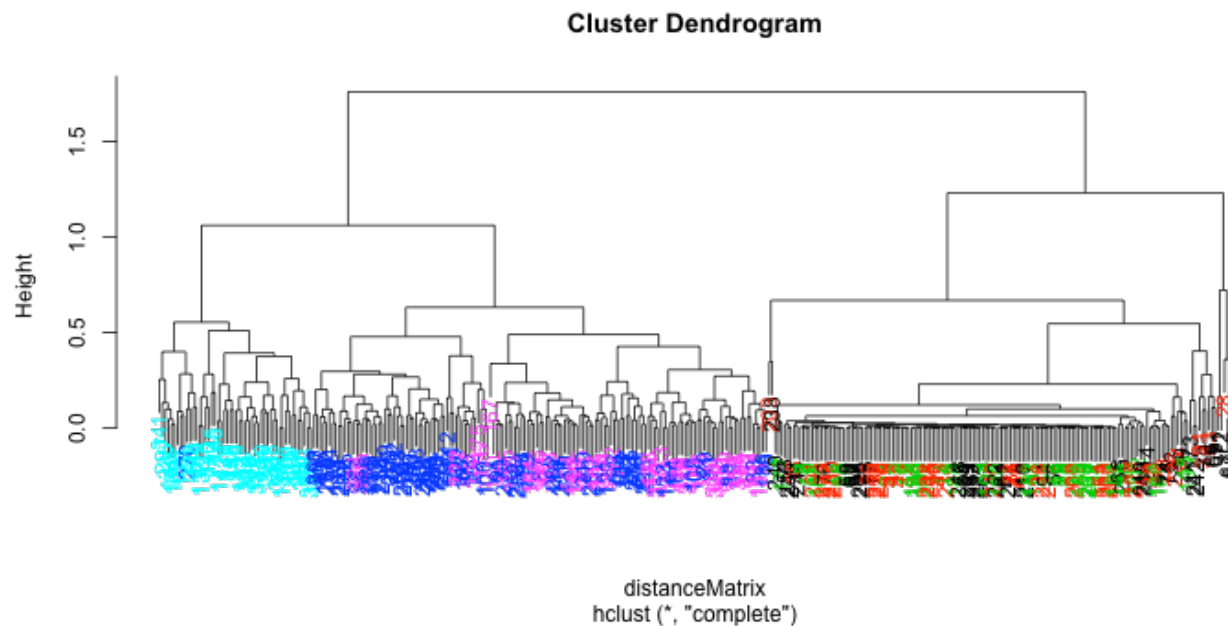
Plotting max acceleration for the first subject

```
par(mfrow = c(1, 2))  
plot(sub1[, 10], pch = 19, col = sub1$activity, ylab = names(sub1)[10])  
plot(sub1[, 11], pch = 19, col = sub1$activity, ylab = names(sub1)[11])
```



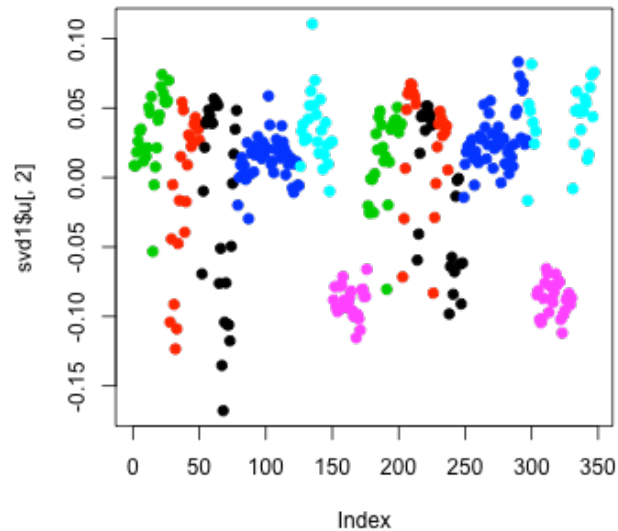
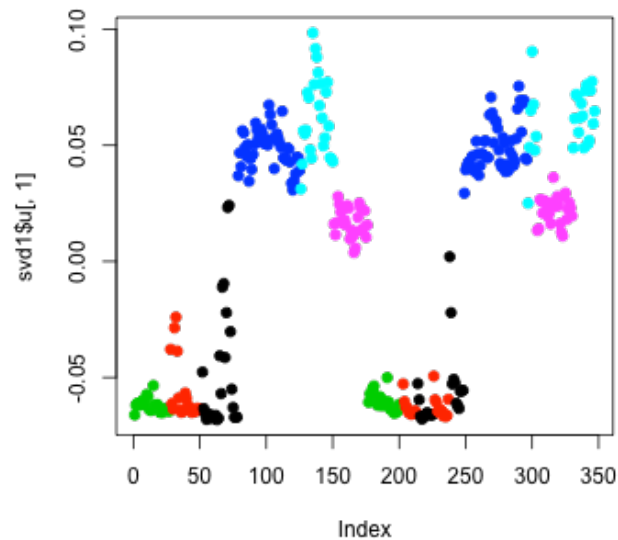
Clustering based on maximum acceleration

```
source("myplclust.R")  
distanceMatrix <- dist(sub1[, 10:12])  
hclustering <- hclust(distanceMatrix)  
myplclust(hclustering, lab.col = unclass(sub1$activity))
```



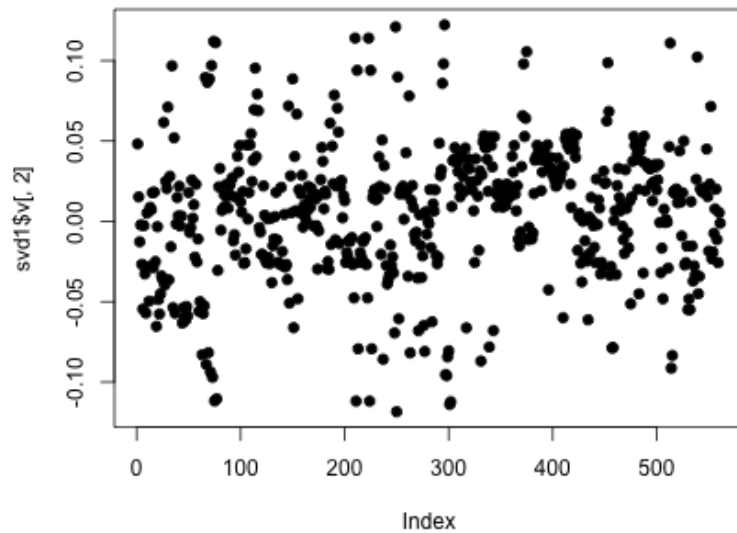
Singular Value Decomposition

```
svd1 = svd(scale(sub1[, -c(562, 563)]))  
par(mfrow = c(1, 2))  
plot(svd1$u[, 1], col = sub1$activity, pch = 19)  
plot(svd1$u[, 2], col = sub1$activity, pch = 19)
```



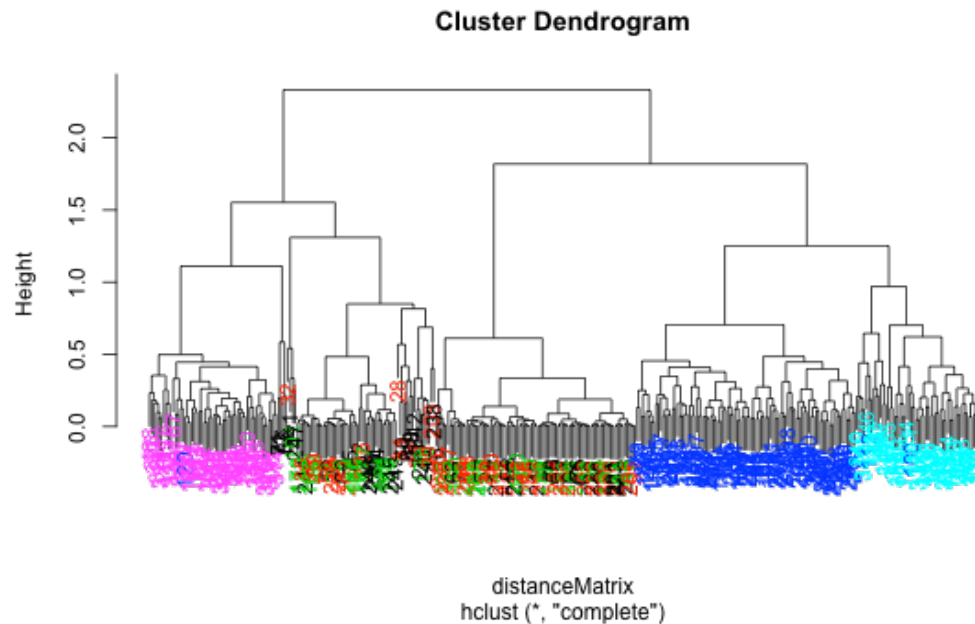
Find maximum contributor

```
plot(svd1$v[, 2], pch = 19)
```



New clustering with maximum contributor

```
maxContrib <- which.max(svd1$v[, 2])  
distanceMatrix <- dist(sub1[, c(10:12, maxContrib)])  
hclustering <- hclust(distanceMatrix)  
myplclust(hclustering, lab.col = unclass(sub1$activity))
```



New clustering with maximum contributor

```
names(samsungData)[maxContrib]
```

```
## [1] "fBodyAcc.meanFreq...Z"
```

K-means clustering (nstart=1, first try)

```
kClust <- kmeans(sub1[, -c(562, 563)], centers = 6)
table(kClust$cluster, sub1$activity)
```

```
##
##      laying sitting standing walk walkdown walkup
##  1         0         0         0   50         1         0
##  2         0         0         0    0         48         0
##  3        27        37        51    0         0         0
##  4         3         0         0    0         0        53
##  5         0         0         0   45         0         0
##  6        20        10         2    0         0         0
```

K-means clustering (nstart=1, second try)

```
kClust <- kmeans(sub1[, -c(562, 563)], centers = 6, nstart = 1)
table(kClust$cluster, sub1$activity)
```

```
##
##      laying sitting standing walk walkdown walkup
##  1         0         0         0    0         49     0
##  2        18        10         2    0         0     0
##  3         0         0         0   95         0     0
##  4        29         0         0    0         0     0
##  5         0        37        51    0         0     0
##  6         3         0         0    0         0    53
```

K-means clustering (nstart=100, first try)

```
kClust <- kmeans(sub1[, -c(562, 563)], centers = 6, nstart = 100)
table(kClust$cluster, sub1$activity)
```

```
##
##      laying sitting standing walk walkdown walkup
##  1      18      10         2    0         0      0
##  2      29       0         0    0         0      0
##  3       0       0         0   95         0      0
##  4       0       0         0    0        49      0
##  5       3       0         0    0         0     53
##  6       0      37        51    0         0      0
```

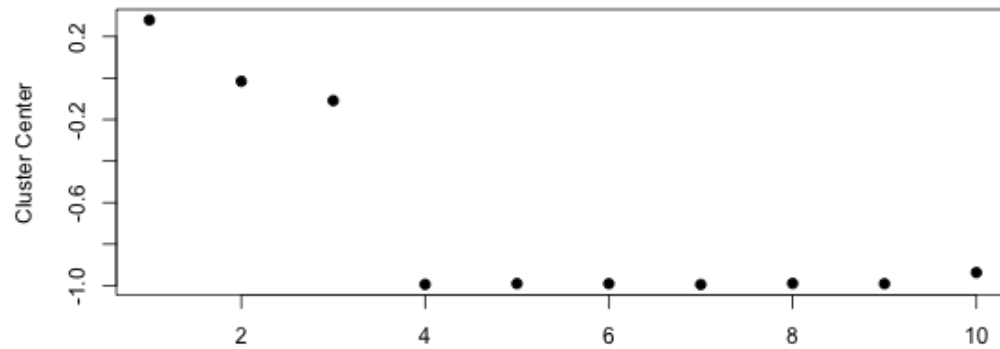
K-means clustering (nstart=100, second try)

```
kClust <- kmeans(sub1[, -c(562, 563)], centers = 6, nstart = 100)
table(kClust$cluster, sub1$activity)
```

```
##
##      laying sitting standing walk walkdown walkup
##  1      29       0        0    0         0      0
##  2       3       0        0    0         0     53
##  3       0       0        0    0        49      0
##  4       0       0        0   95         0      0
##  5       0      37       51    0         0      0
##  6      18      10        2    0         0      0
```


Cluster 1 Variable Centers (Laying)

```
plot(kClust$center[1, 1:10], pch = 19, ylab = "Cluster Center", xlab = "")
```



Cluster 2 Variable Centers (Walking)

```
plot(kClust$center[4, 1:10], pch = 19, ylab = "Cluster Center", xlab = "")
```

