hw7

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Question 1

```
# load the R.matlab package
library(R.matlab)
```

```
## R.matlab v3.6.2 (2018-09-26) successfully loaded. See ?R.matlab for help.

##
## Attaching package: 'R.matlab'

## The following objects are masked from 'package:base':
##
##     getOption, isOpen
```

```
# read the .mat file and store contents in fmri.p1
fmri.p1 <- readMat("data/data-science-P1.mat")
# unlist each element in the dataset and use rbind to combine into a data fram
fmri <- do.call(rbind, lapply(fmri.p1$data, unlist))
# store the coumn names for the fmri data
colnames <- 1:dim(fmri)[2]
```

```
dim(fmri)
```

```
## [1]   360 21764
```

As indicated above, the diminesions are `360 X 21764` as expected.

```
fmri[172, 2014]
```

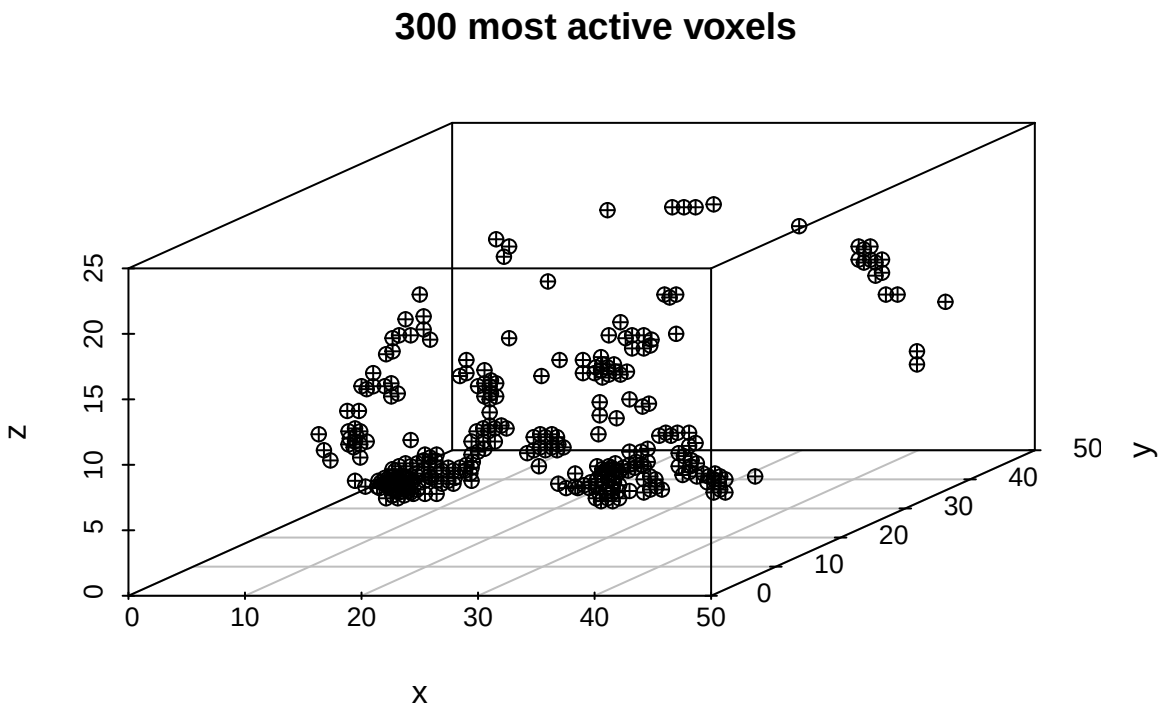
```
##
## -0.06624457
```

As indicated above, the value of `fmri[172,2014]` is ≈ -0.07.

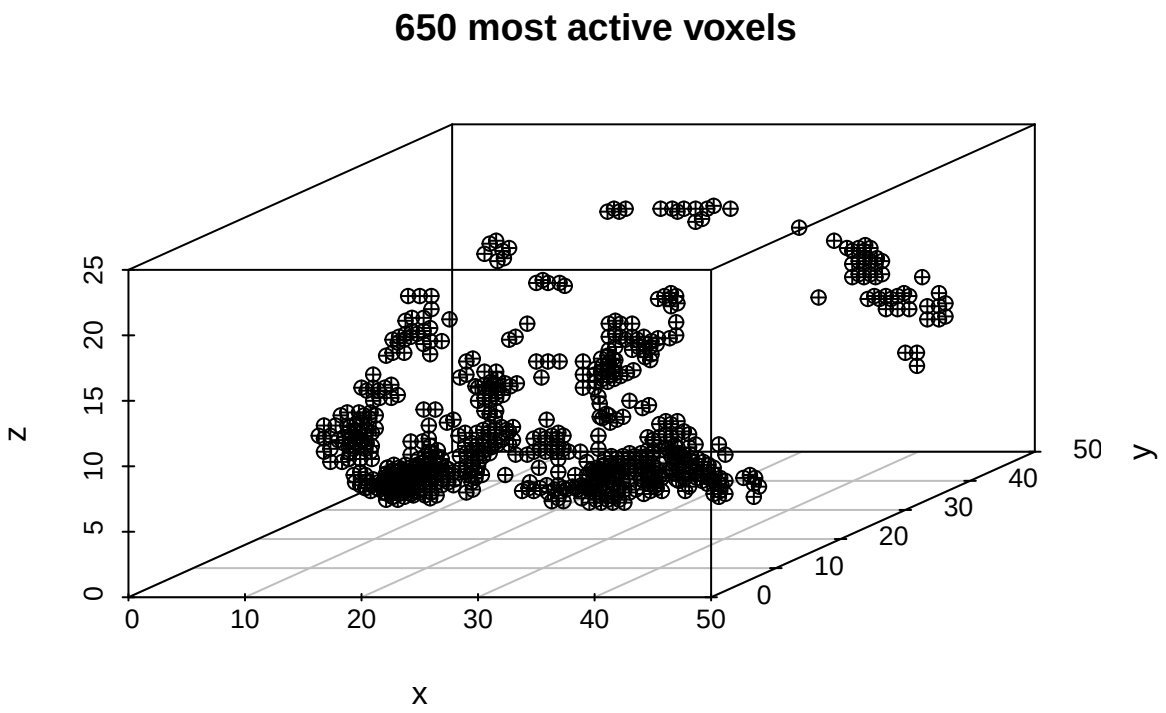
Question 2

```
# load the scatterplot3d package
library(scatterplot3d)
# total number of features
p <- 21764
# store the coordinates needed for the scatterplot in col2coord
col2coord <- fmri.p1$meta[[8]]
```

```r
# compute the means of each column in the fmri data
ave.colMeans <- colMeans(fmri)
# finds the rank of each voxel
rank.fmri <- rank(ave.colMeans)
# we go in reverse order due to the rank() function to get the  300 most active voxels
scatterplot3d(x=col2coord[rank.fmri>(p-300),],pch=10,
  xlab="x", ylab="y", zlab="z", main="300 most active voxels")
```




```r
# repeat as above to plot the 650 most active voxels
scatterplot3d(x=col2coord[rank.fmri>(p-650),],pch=10,
  xlab="x", ylab="y", zlab="z", main="650 most active voxels")
```



Question 3

```
# Doing the PCA
fmri.pca = prcomp(fmri)

# Obtaining the loading vectors for each PCA
fmri.latent.sem = fmri.pca$rotation

# To obtain the variances, we first find the standard deviations for all of the principal components. W
variances = fmri.pca$sdev^2

# To get the fraction of variance for PC1, we divide the variance for PC1 by the sum of variances acros
variances[1]/sum(variances)
```

```
## [1] 0.1284251
```

Question 4

The number of principal components is determined with min(n-1, p). In this case, we need the min of 360-1 and 21764, which is 359.

Question 5

A biplot would be very bad because our data is very high dimensional, so we have a lot of principle components. The vectors representing the principal components would overlap each other and we wouldn't be able to tell what's going on around the source of the vectors.

Question 6

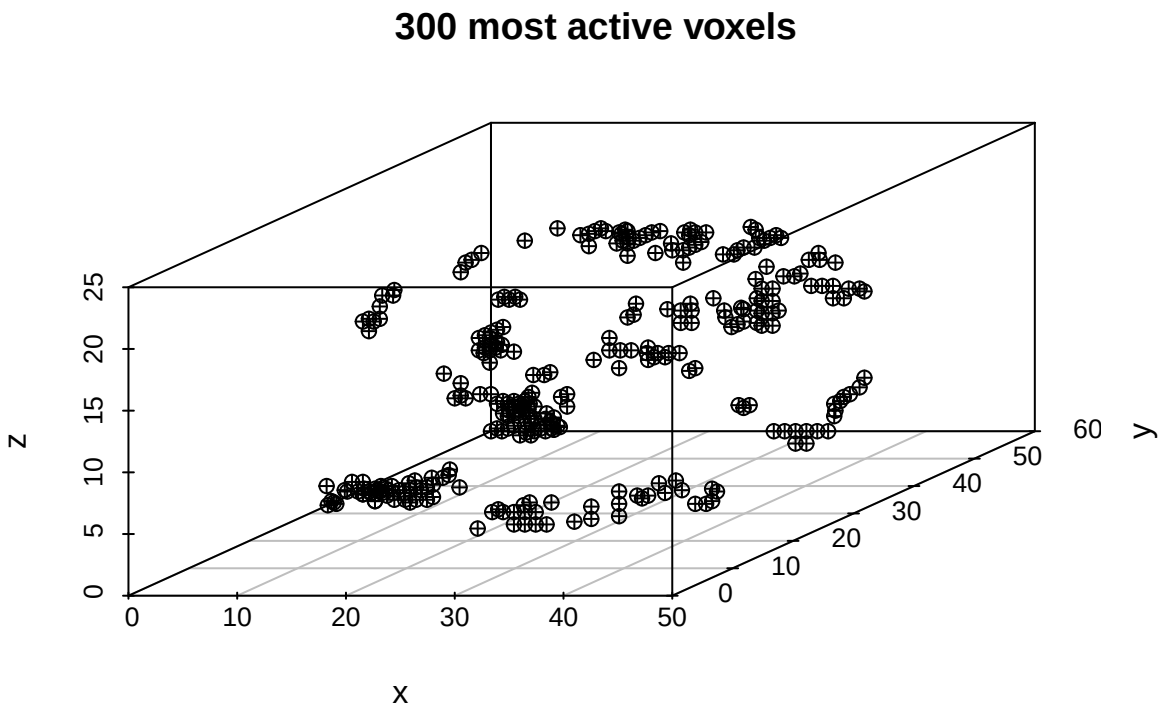
```
# This code is finding the number 300th highest loading value for the first PC. We sort the absolute va

sort(abs(fmri.latent.sem[,1]), decreasing = TRUE)[[300]]
```

```
## [1] 0.01972067
```

```
# We plot the 300 voxel coordinates which have indices matching the top 300 absolute values of the PC1

scatterplot3d(x=col2coord[(abs(fmri.latent.sem[,1]) >= 0.01972066),],pch=10,
  xlab="x", ylab="y", zlab="z", main="300 most active voxels")
```



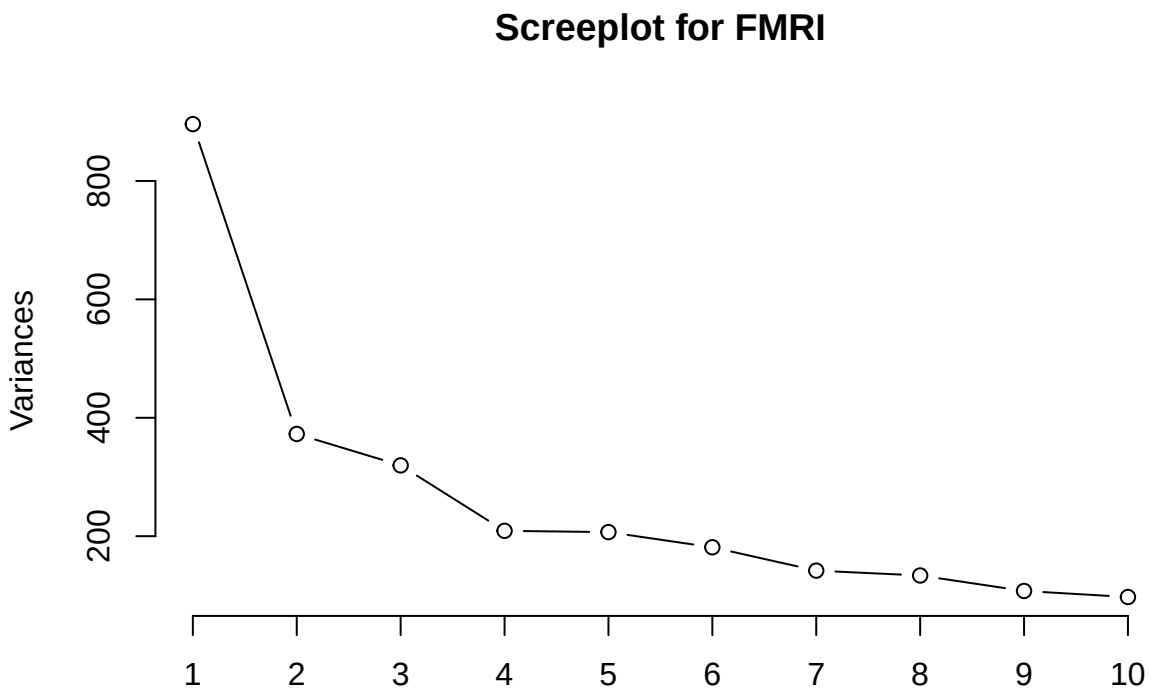
Question 7

The plots from 2 and 6 are different. This is because they are graphing different things. The plot from 2 is simply graphing the voxels that have the 300 top average row values from fmri. The plot from 6 is graphing the voxels with the top 300 most extreme loadings, which relate to the top 300 most correlated coefficients to PC1.

Question 8

The optimal number of principal components is two, since this is the smallest number of principle components at which an adequate amount of variability is explained.

```
screeplot(fmri.pca, type= "lines", main="Screeplot for FMRI") # create a screeplot for FMRI with lines
```



Question 9

```
#scatterplot3d(x=col2coord, pch=6, xlab="x", ylab="y", zlab="z", color=solors)
colors= c("red", "blue", "green", "orange", "purple", "pink", "black", "yellow", "cyan", "powderblue")
#scatterplot3d(x=col2coord, pch=6, xlab="x", ylab="y", zlab="z", color=solors)
bins= cut(fmri.pca$x[,1],10, labels=colors)
bins
```

```
##   [1] blue       orange     purple     orange     orange     cyan
##   [7] pink       orange     orange     black      green      pink
##  [13] black      pink       pink       purple     black      black
##  [19] purple     orange     yellow     purple     orange     green
##  [25] purple     purple     yellow     yellow     green      purple
##  [31] pink       cyan       black      black      purple     pink
##  [37] pink       black      purple     pink       blue       pink
##  [43] pink       pink       black      pink       orange     purple
```

```
##  [49] black      pink       orange     pink       black      black
##  [55] black      black      pink       green      green      pink
##  [61] orange     black      pink       black      purple     orange
##  [67] orange     pink       green      blue       pink       yellow
##  [73] cyan       black      black      pink       black      orange
##  [79] green      orange     pink       purple     purple     purple
##  [85] purple     purple     purple     black      pink       pink
##  [91] yellow     cyan       black      black      blue       green
##  [97] green      orange     pink       orange     pink       black
## [103] purple     pink       orange     purple     black      orange
## [109] yellow     powderblue yellow     orange     green      blue
## [115] blue       pink       black      black      black      black
## [121] blue       black      yellow     green      orange     orange
## [127] yellow     orange     purple     pink       black      pink
## [133] pink       purple     black      yellow     black      purple
## [139] purple     pink       purple     pink       green      black
## [145] orange     purple     pink       pink       pink       black
## [151] purple     black      pink       orange     pink       pink
## [157] yellow     orange     black      pink       orange     pink
## [163] pink       purple     purple     purple     green      green
## [169] pink       pink       black      green      pink       pink
## [175] purple     purple     orange     pink       purple     orange
## [181] orange     purple     orange     purple     purple     black
## [187] black      black      pink       orange     pink       green
## [193] purple     green      orange     pink       pink       pink
## [199] pink       purple     black      yellow     blue       purple
## [205] orange     orange     pink       black      black      pink
## [211] black      purple     purple     orange     black      black
## [217] purple     red        black      black      orange     green
## [223] cyan       pink       pink       purple     purple     orange
## [229] black      blue       pink       pink       green      pink
## [235] green      orange     orange     yellow     cyan       yellow
## [241] orange     purple     purple     black      pink       pink
## [247] pink       pink       pink       pink       black      pink
## [253] green      orange     purple     black      black      black
## [259] purple     red        green      purple     pink       yellow
## [265] cyan       powderblue orange     green      orange     green
## [271] black      pink       pink       purple     orange     purple
## [277] black      pink       orange     purple     black      orange
## [283] pink       black      purple     green      purple     pink
## [289] green      pink       orange     green      orange     orange
## [295] purple     black      yellow     yellow     black      purple
## [301] green      purple     pink       yellow     pink       purple
## [307] green      orange     purple     purple     black      purple
## [313] yellow     pink       purple     pink       purple     blue
## [319] blue       orange     orange     pink       yellow     black
## [325] black      pink       pink       pink       purple     purple
## [331] purple     purple     purple     purple     orange     purple
## [337] pink       purple     pink       pink       yellow     pink
## [343] orange     orange     pink       pink       pink       orange
## [349] green      green      purple     pink       black      pink
## [355] pink       pink       pink       pink       purple     orange
## 10 Levels: red blue green orange purple pink black yellow ... powderblue
```