Lab 13 Part 1

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PCA Demo Using Digits Data

Load Packages

```
library(ggplot2)
library(GGally)
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

Load Digits Data

```
#code for digits - ALL
rm(list=ls())
load("data/digits.Rdata")
```

Create Subset of just 3's and 8's

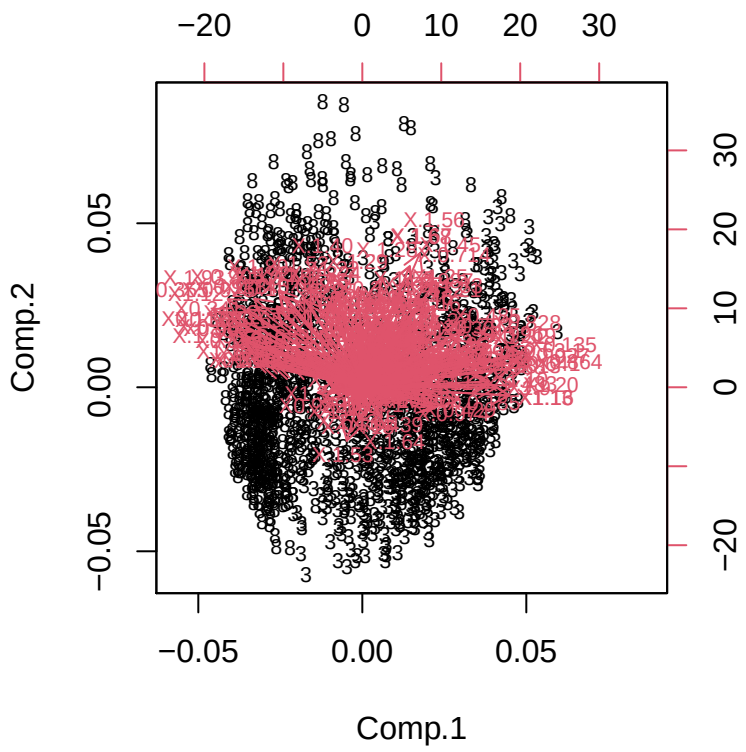
```
dat38 = rbind(digits[which(rownames(digits)==3),],digits[which(rownames(digits)==8),])
```

Try Princomp

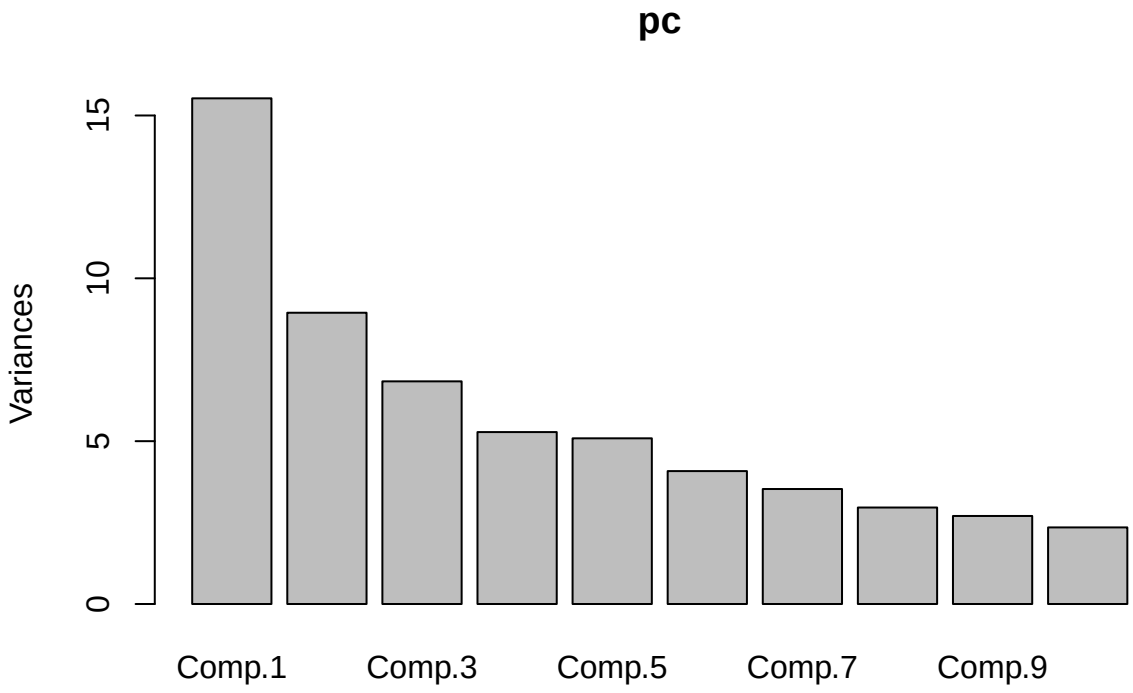
With Centering & Scaling

```
pc = princomp(dat38) #default - centers and scales
biplot(pc,cex=.7)
```

```
## Warning in arrows(0, 0, y[, 1L] * 0.8, y[, 2L] * 0.8, col = col[2L], length =
## arrow.len): zero-length arrow is of indeterminate angle and so skipped
```



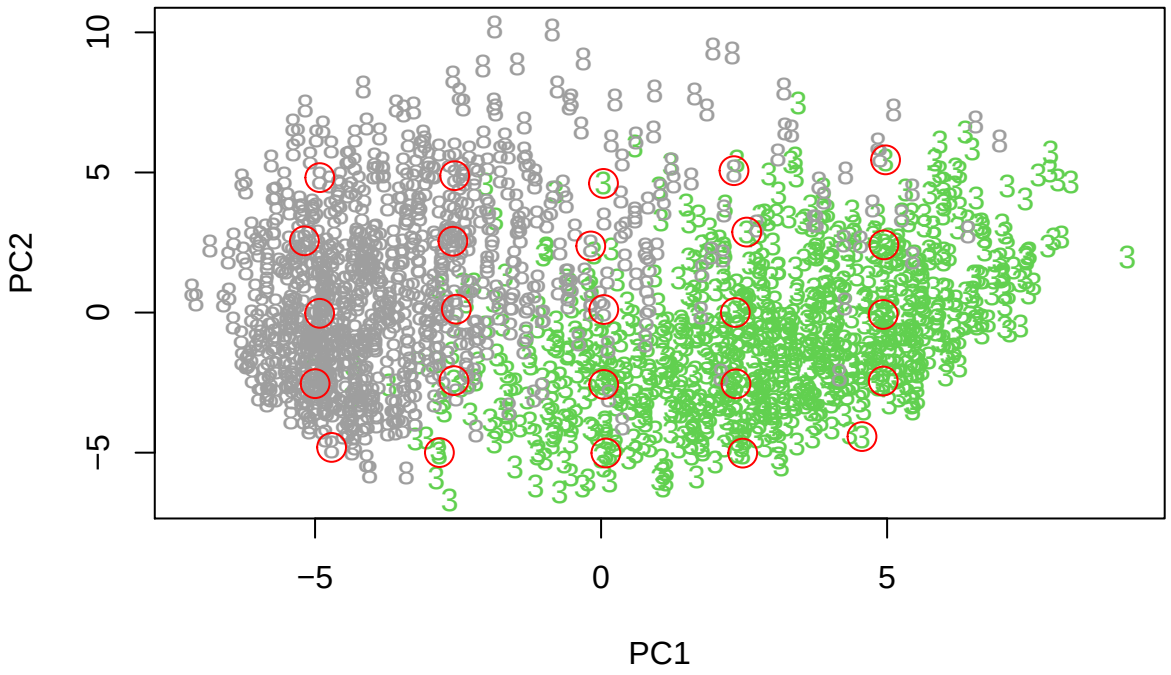

```
screeplot(pc)
```



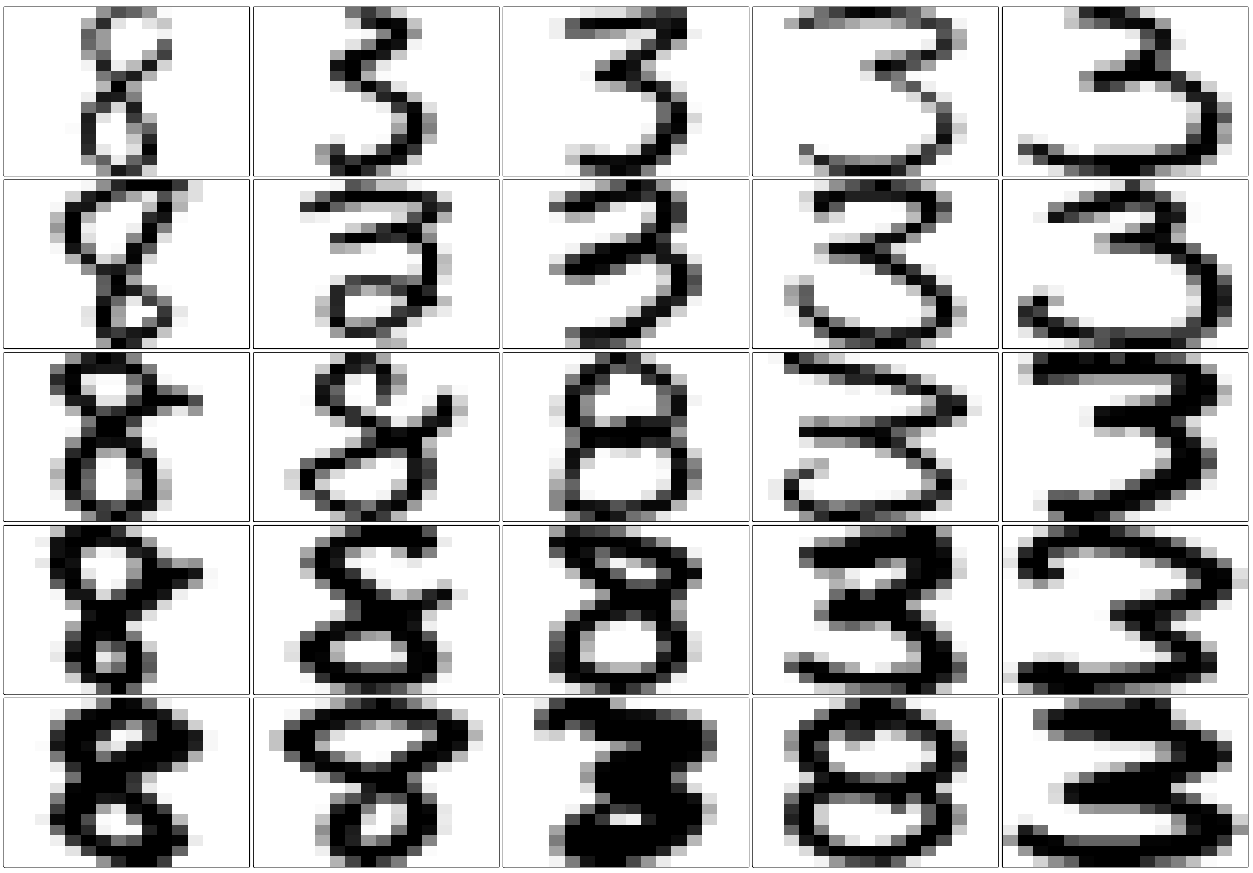
PC Scatterplot

```
PC1 <- as.matrix(x=pc$scores[,1])
PC2 <- as.matrix(pc$scores[,2])
plot(PC1,PC2,type="n",xlab="PC1",ylab="PC2")
text(PC1,PC2,rownames(dat38),col=rownames(dat38))
```

```
select = matrix(nrow=5, ncol=5)
L = seq(-5, 5, 2.5)
for (i in 1:length(L)) {
  for (j in 1:length(L)) {
    d = (PC1 - L[i])^2 + (PC2 - L[j])^2
    select[i, j] = which.min(d)
  }
}
points(PC1[select], PC2[select],type="p",col="red",cex=2)
```




```
latticepoints = dat38[select,]
par(mfrow=c(5,5),mar=c(.1,.1,.1,.1))
for(i in 1:25){
  imagedigit(latticepoints[i,])
}
```



Pairs Plot Using ggpairs

```
PC1 <- as.matrix(x=pc$scores[,1])
PC2 <- as.matrix(pc$scores[,2])
PC3 <- as.matrix(pc$scores[,3])
PC4 <- as.matrix(pc$scores[,4])
PC5<-as.matrix(pc$scores[,5])

pc.df.digits <- data.frame(digit_name = row.names(dat38), PC1, PC2,PC3, PC4, PC5)

ggpairs(pc.df.digits, mapping = aes(color = digit_name))
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
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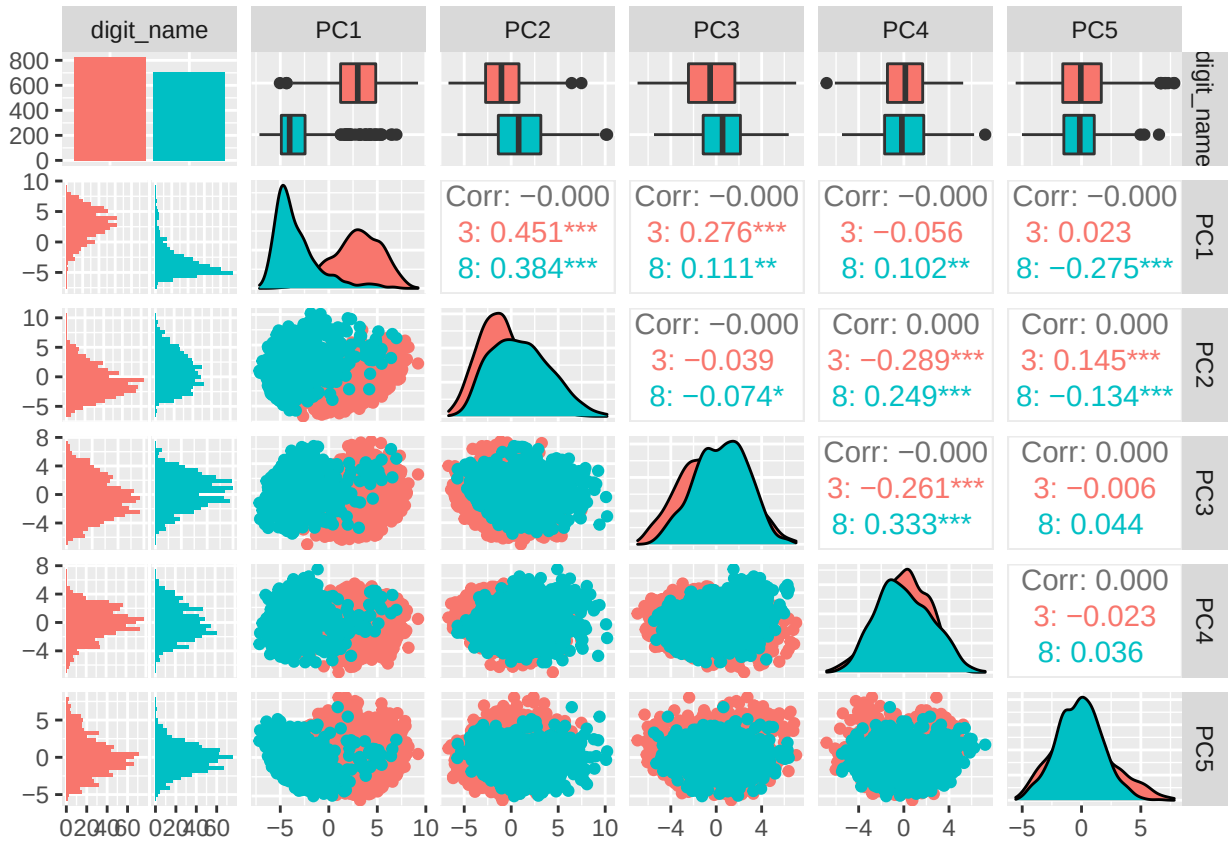
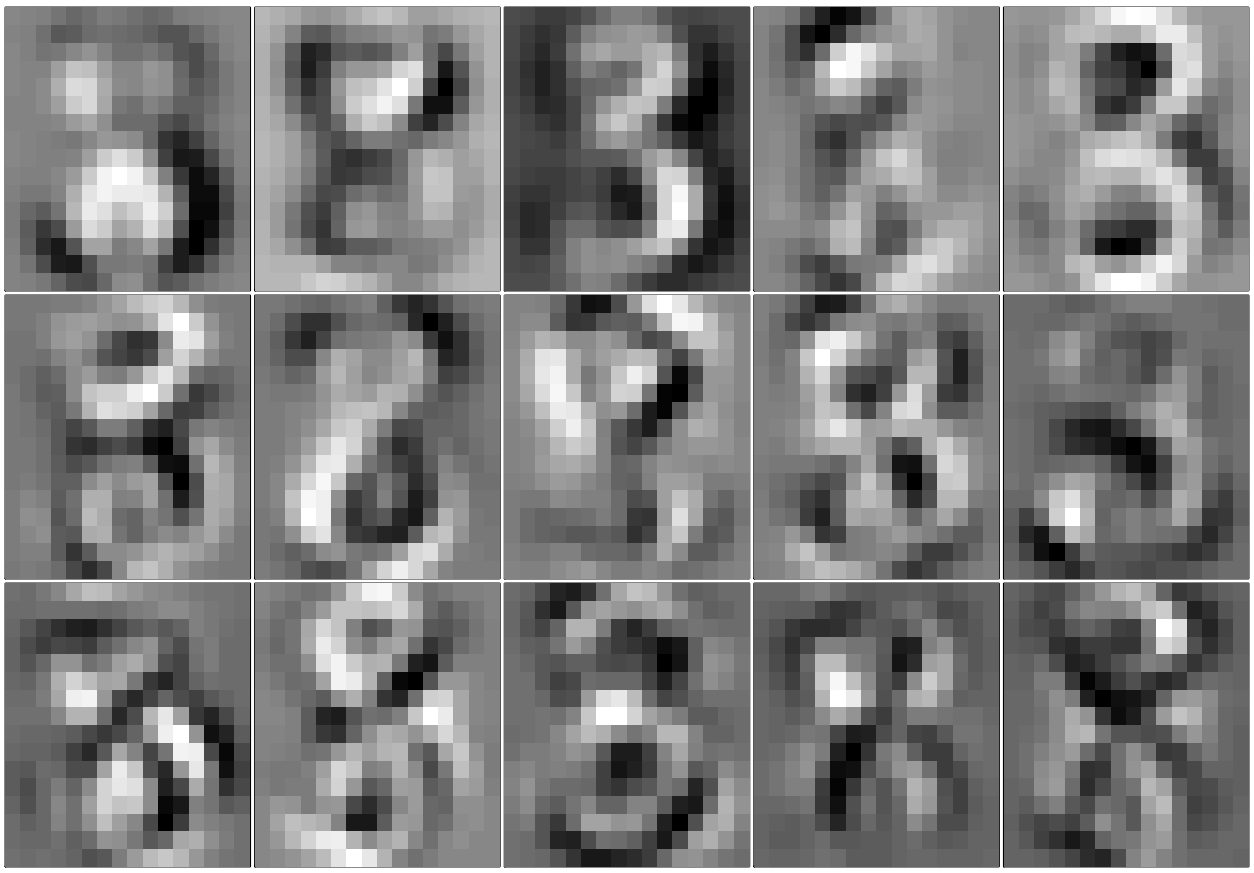
```



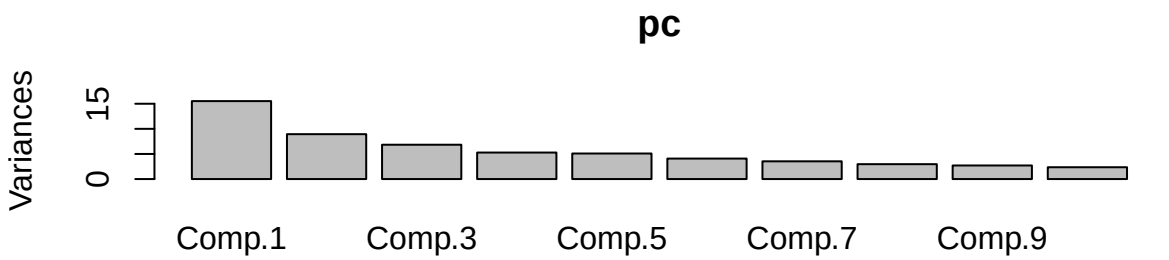
PC Loadings

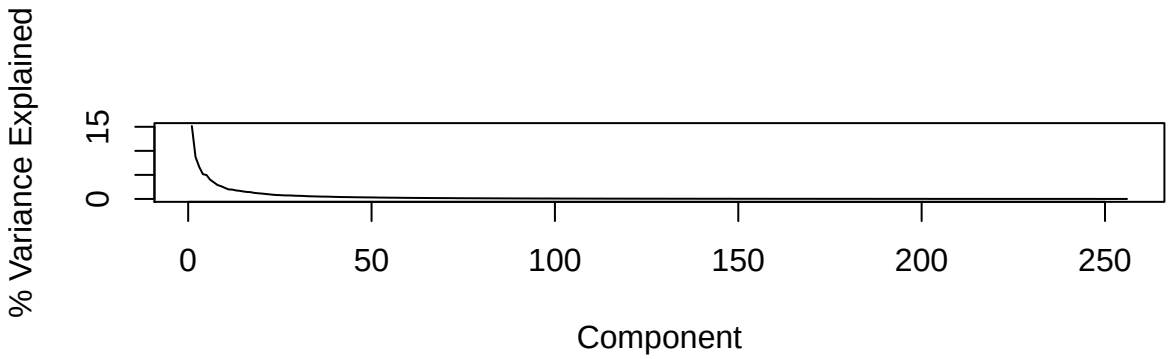
```
par(mfrow=c(3,5),mar=c(.1,.1,.1,.1))
for(i in 1:15){
  imagedigit(pc$loadings[,i])
}
```



Variance explained

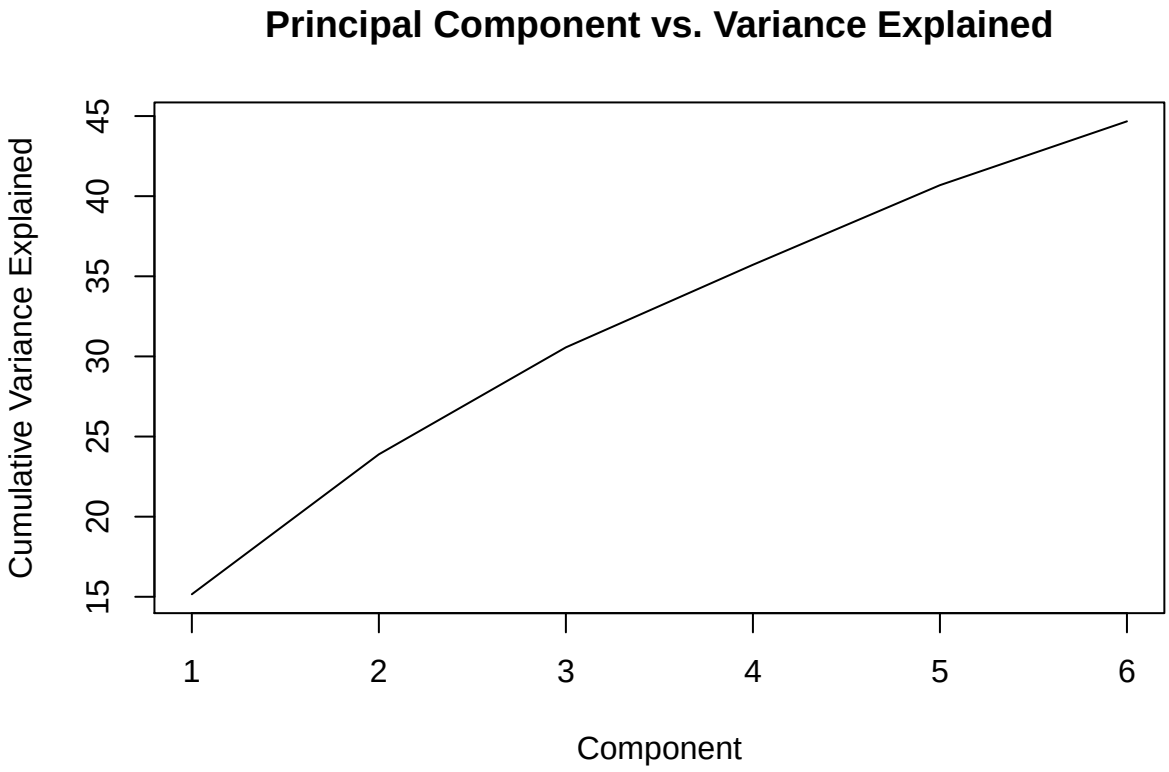
```
varex = 100*pc$sdev^2/sum(pc$sdev^2)
par(mfrow=c(2,1))
screeplot(pc)
plot(varex,type="l",ylab="% Variance Explained",xlab="Component")
```





Cumulative variance explained

```
#cumulative variance explained
cvarex = NULL
for(i in 1:ncol(cdat)){
  cvarex[i] = sum(varex[1:i])
}
plot(cvarex,type="l",ylab="Cumulative Variance Explained",xlab="Component", main = "Principal Component
```



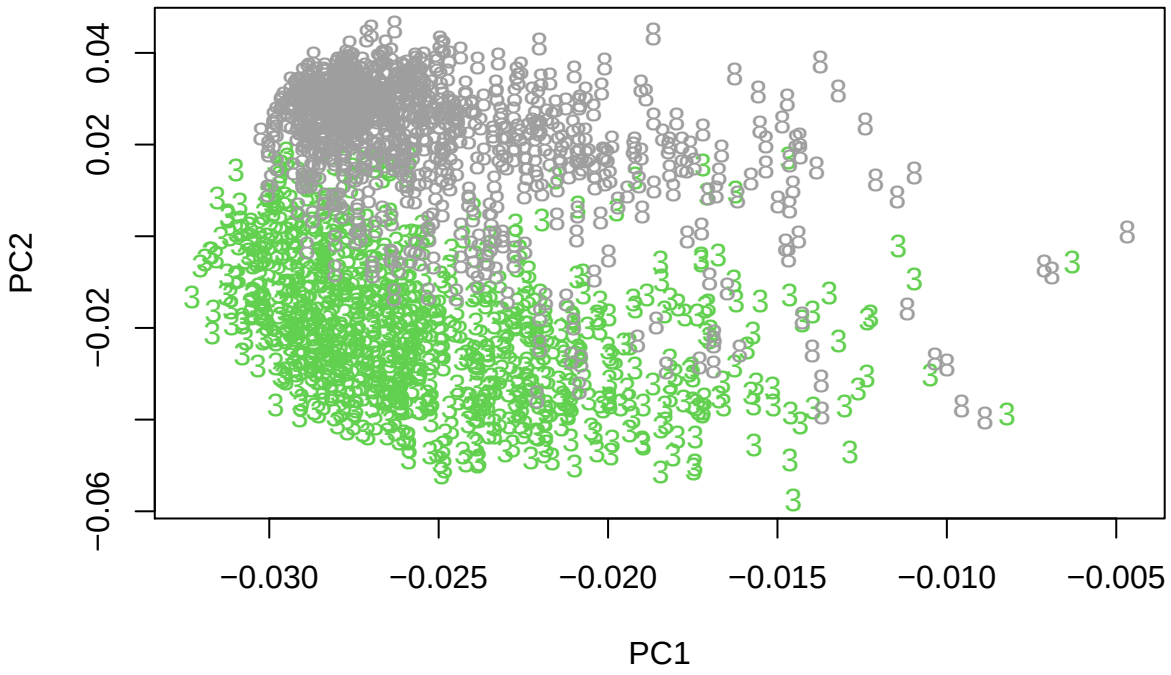
Compare to SVD

Without Centering & Scaling

```
svdd = svd(dat38)
U = svdd$u
V = svdd$v #PC loadings
D = svdd$d
Z = dat38%*%V #PCs
```

PC Scatterplots

```
PC1 <- U[,1]
PC2 <- U[,2]
plot(PC1,PC2,type="n",xlab="PC1",ylab="PC2")
text(PC1,PC2,rownames(dat38),col=rownames(dat38))
```



Pairs Plot Using ggpairs

```
PC1 <- U[,1]
PC2 <- U[,2]
PC3 <- U[,3]
PC4 <- U[,4]
PC5 <- U[,5]

pc.df.digits <- data.frame(digit_name = row.names(dat38), PC1, PC2,PC3, PC4, PC5)

ggpairs(pc.df.digits, mapping = aes(color = digit_name))
```

```
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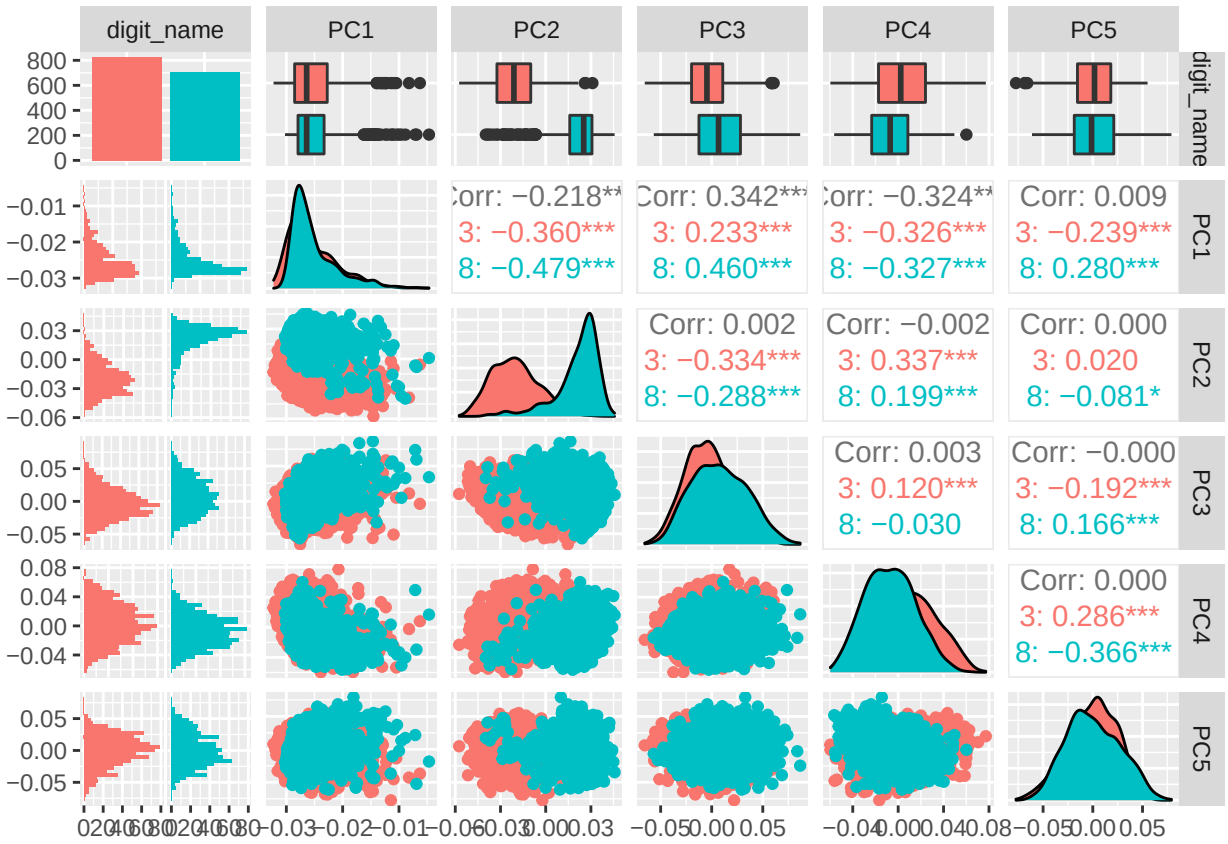
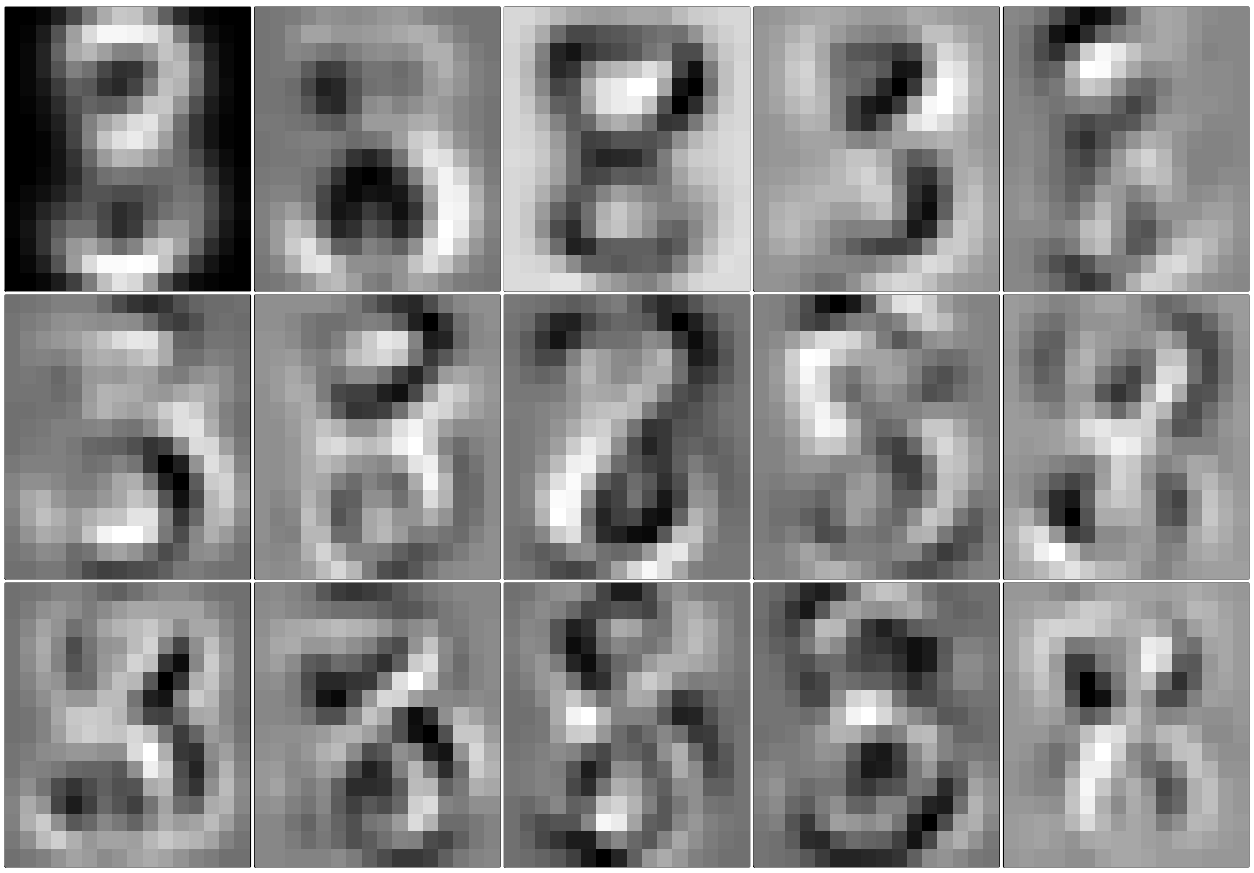


PC Loadings

```
par(mfrow=c(3,5),mar=c(.1,.1,.1,.1))
for(i in 1:15){
  imagedigit(V[,i])
}
```

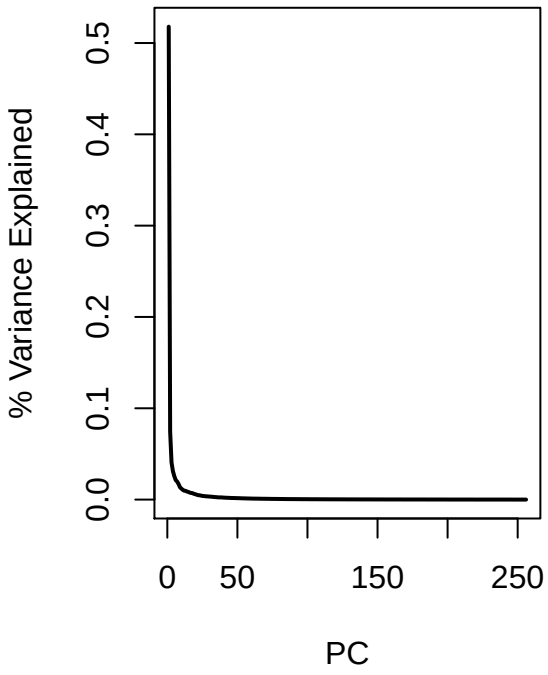


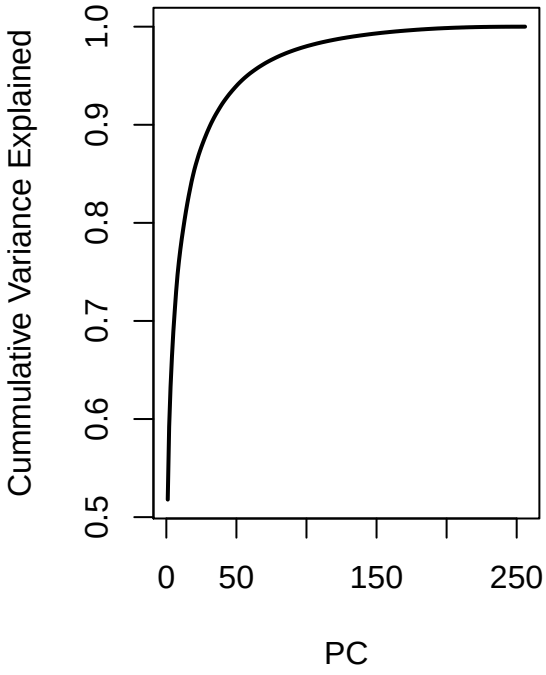
Variance Explained

```
#Variance Explained
varex = 0
cumvar = 0
denom = sum(D^2)
for(i in 1:256){
  varex[i] = D[i]^2/denom
  cumvar[i] = sum(D[1:i]^2)/denom
}
```

Screeplot

```
par(mfrow=c(1,2))
plot(1:256,varex,type="l",lwd=2,xlab="PC",ylab="% Variance Explained")
plot(1:256,cumvar,type="l",lwd=2,xlab="PC",ylab="Cummulative Variance Explained")
```


% Variance Explained
0.0
0.1
0.2
0.3
0.4
0.5
0
50
150
250
PC


Cummulative Variance Explained
0.5
0.6
0.7
0.8
0.9
1.0
0
50
150
250
PC