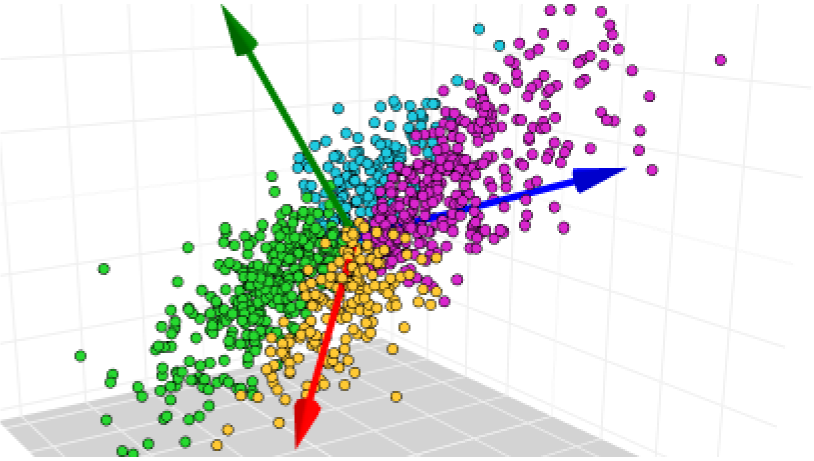
Week 9 - AYUPod - Principal Component Analysis

Contents



(Source: kaggle.com)

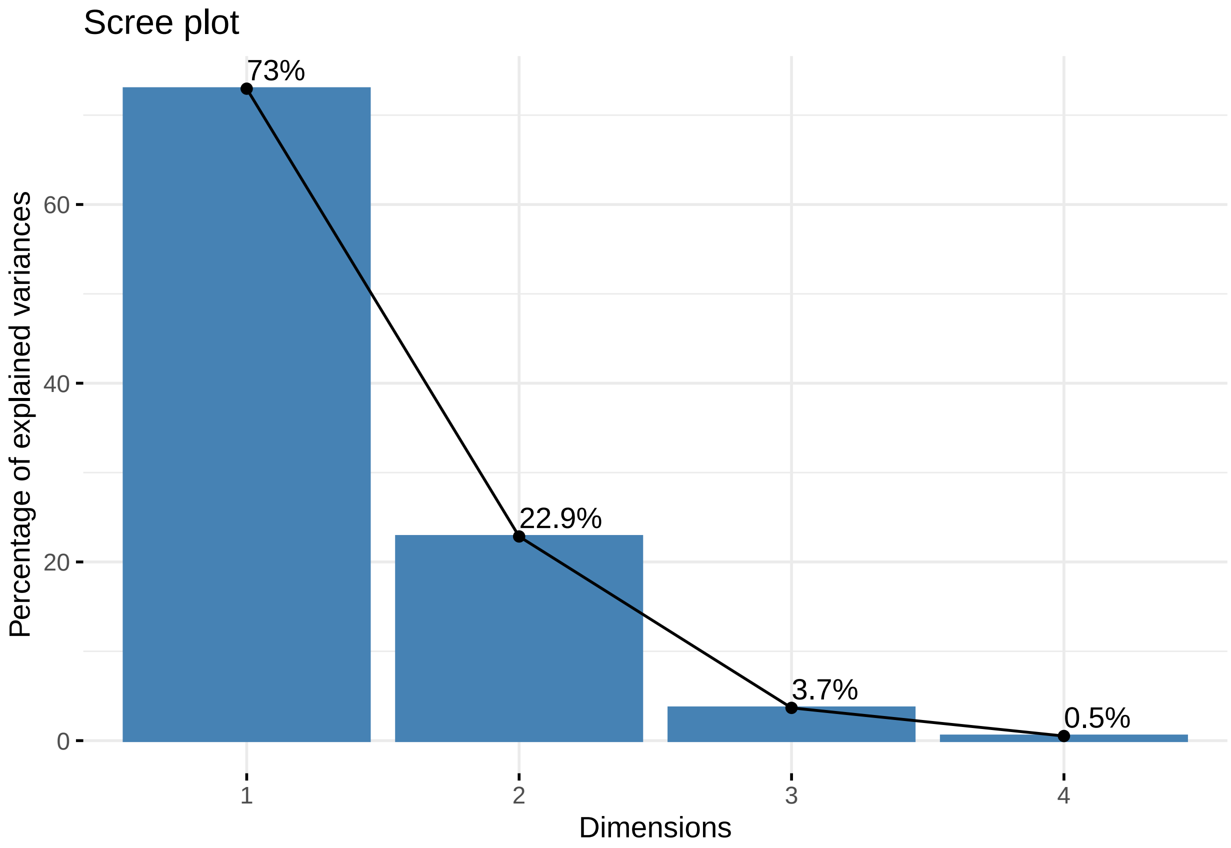
```r
library(factoextra)
library(tidyverse)  # data manipulation and visualization
library(gridExtra)
data(iris)
head(iris)
```

```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1          5.1         3.5          1.4         0.2  setosa
## 2          4.9         3.0          1.4         0.2  setosa
## 3          4.7         3.2          1.3         0.2  setosa
## 4          4.6         3.1          1.5         0.2  setosa
## 5          5.0         3.6          1.4         0.2  setosa
## 6          5.4         3.9          1.7         0.4  setosa
```

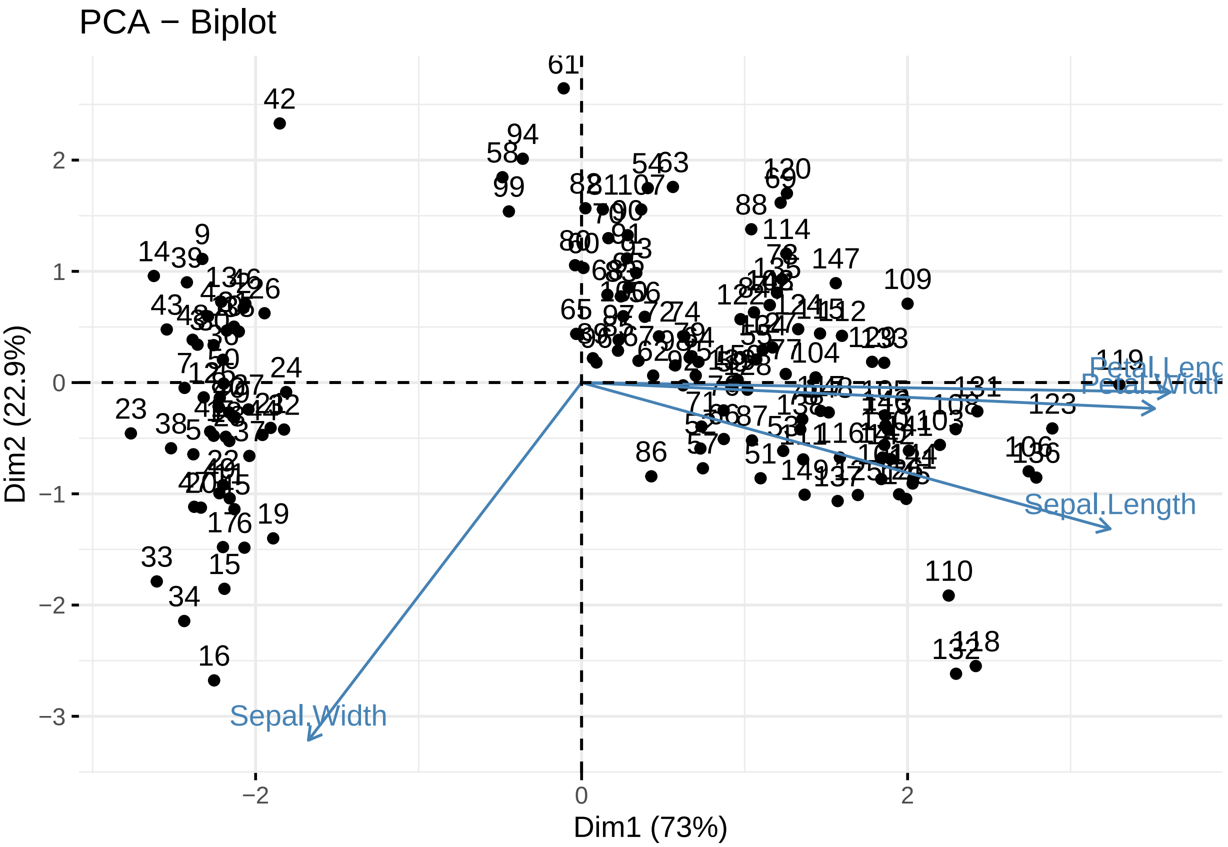
```
# The variable Species (index = 5) is removed
# before the PCA analysis
res.pca <- prcomp(iris[, -5],  scale = TRUE)
# Extract the  eigenvalues/variances
get_eig(res.pca)
```

```
##       eigenvalue variance.percent cumulative.variance.percent
## Dim.1 2.91849782       72.9624454                    72.96245
## Dim.2 0.91403047       22.8507618                    95.81321
## Dim.3 0.14675688        3.6689219                    99.48213
## Dim.4 0.02071484        0.5178709                   100.00000
```

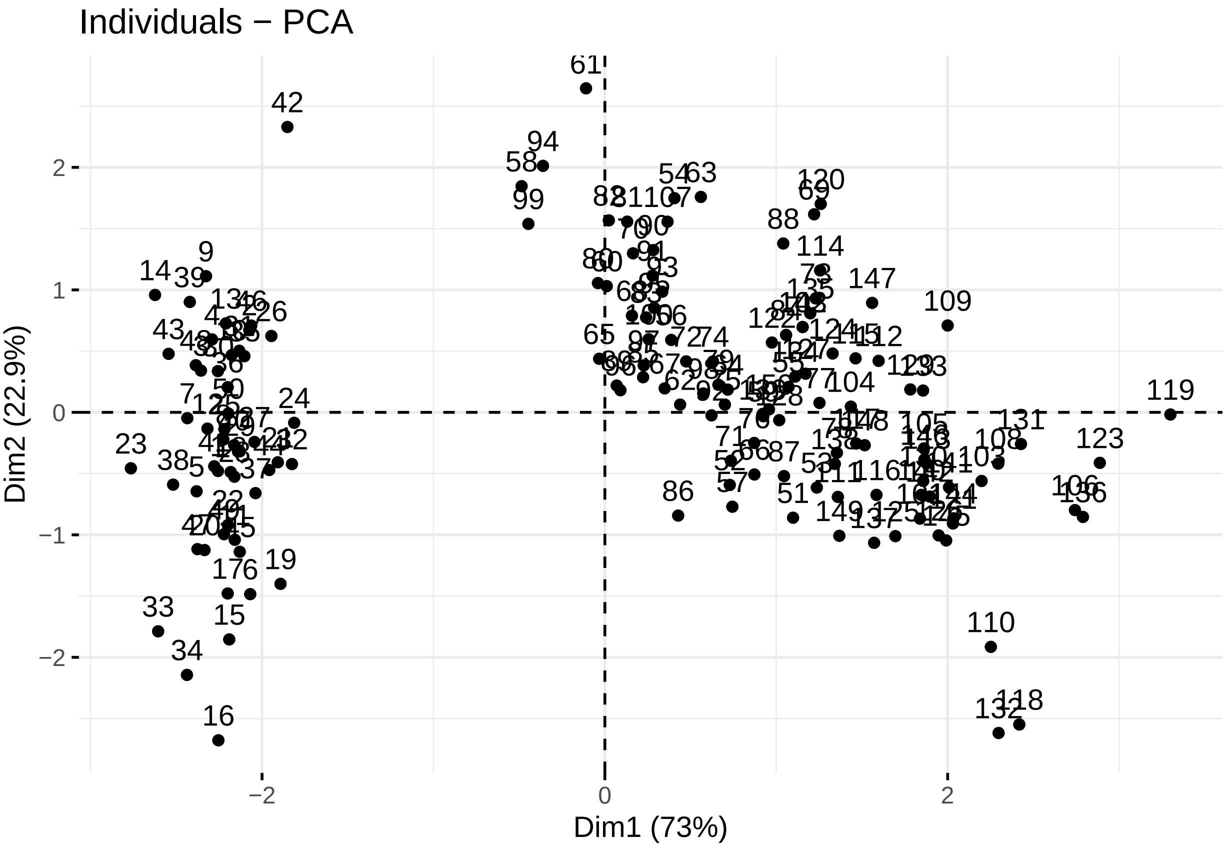
```
# Default plot
fviz_eig(res.pca, addlabels = TRUE)
```



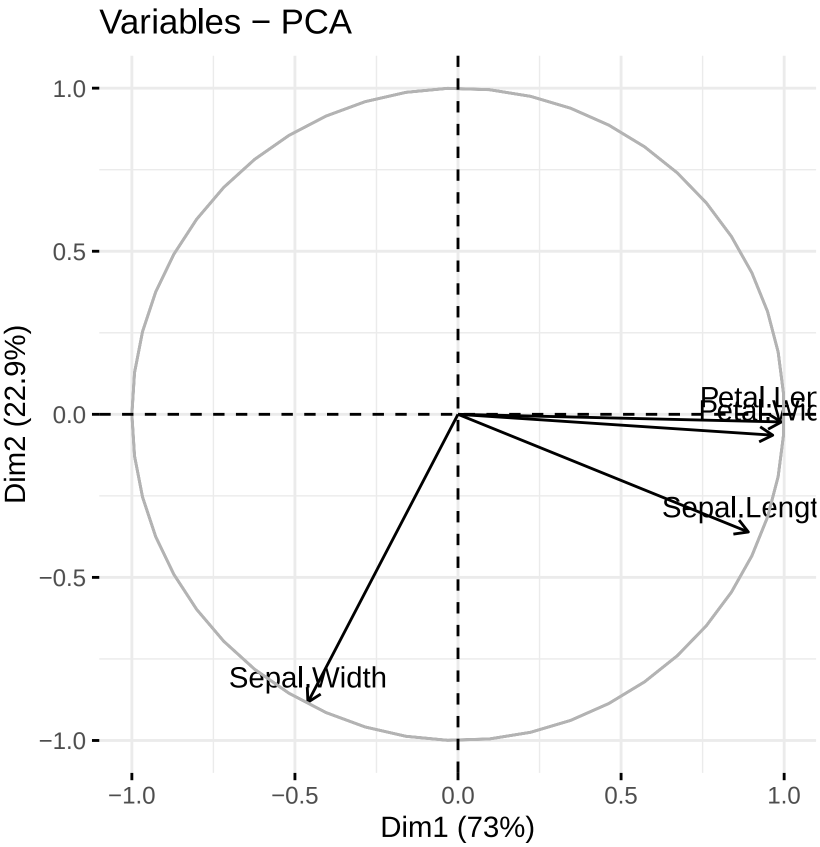
```
fviz_pca(res.pca)
```



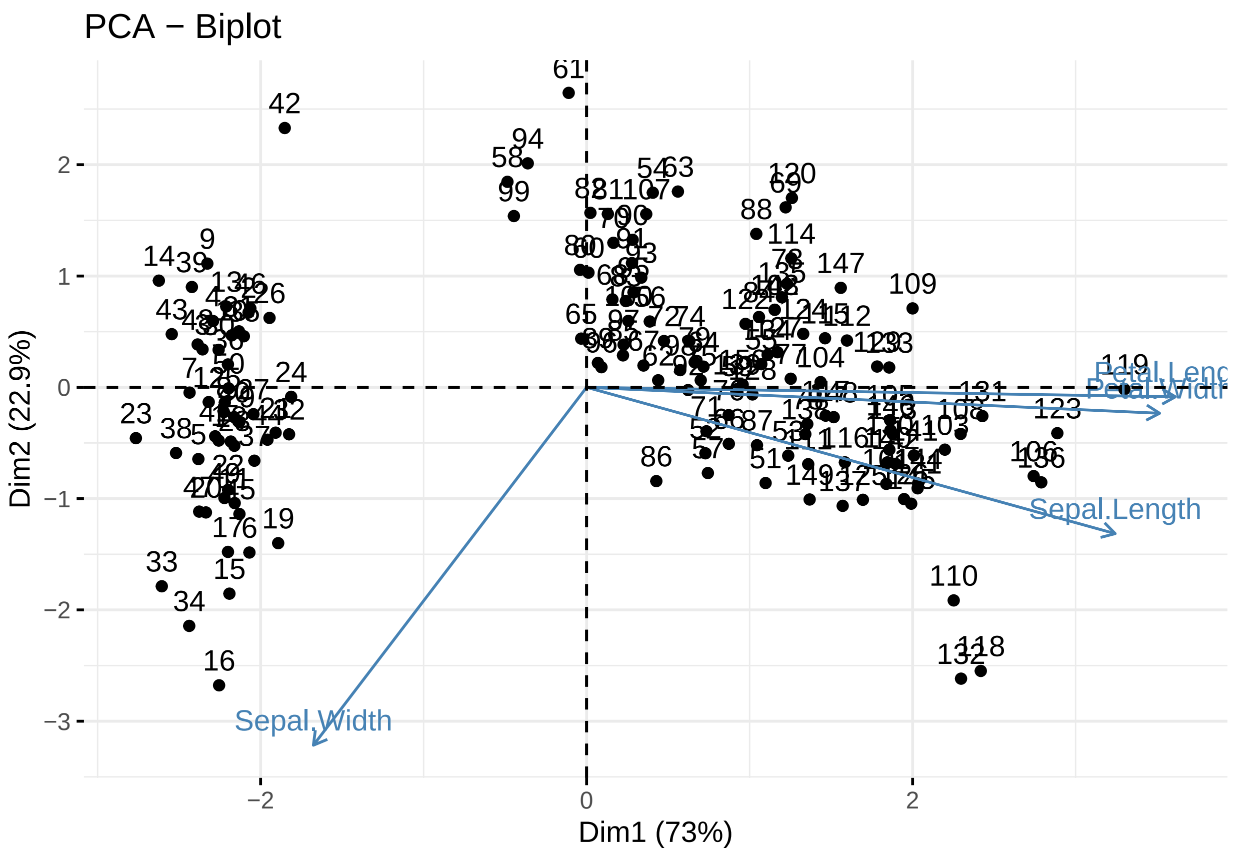
```
fviz_pca_ind(res.pca)
```



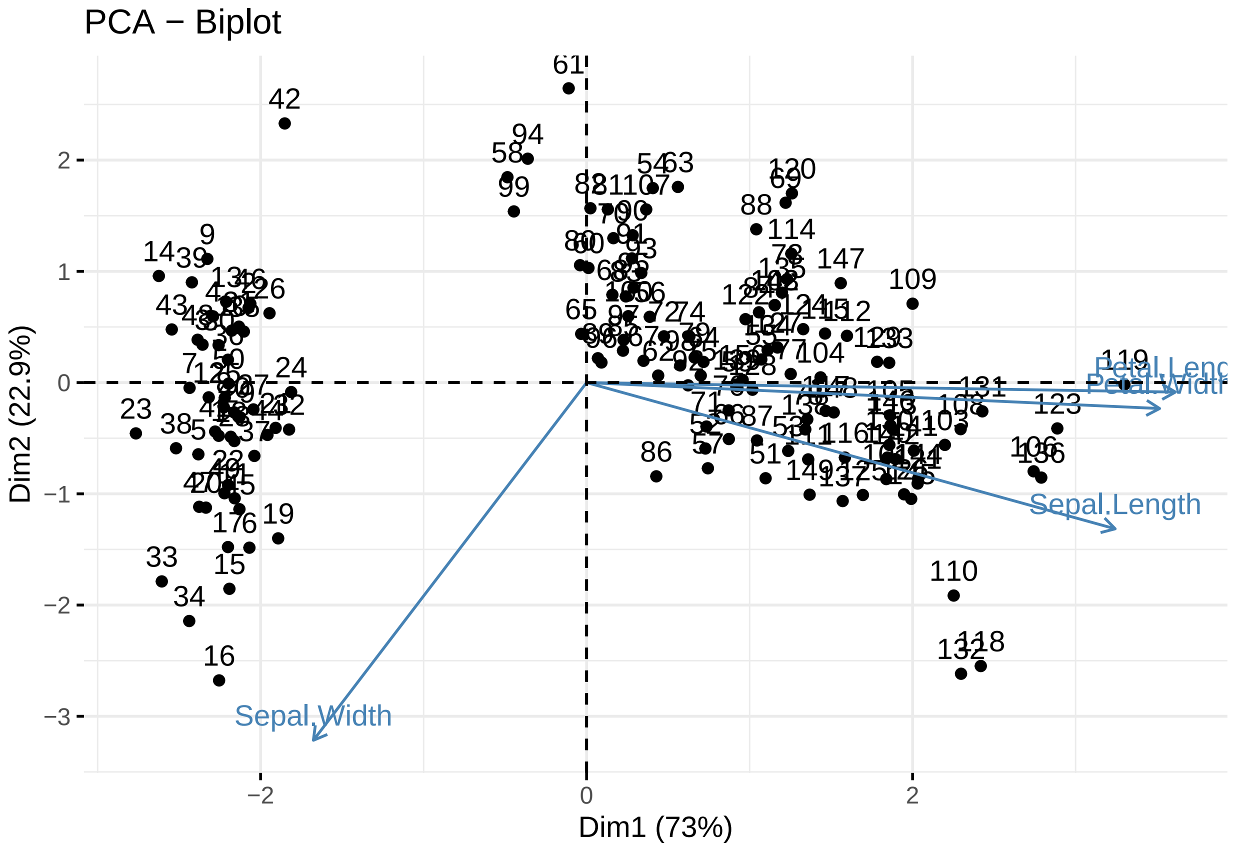
```
fviz_pca_var(res.pca)
```



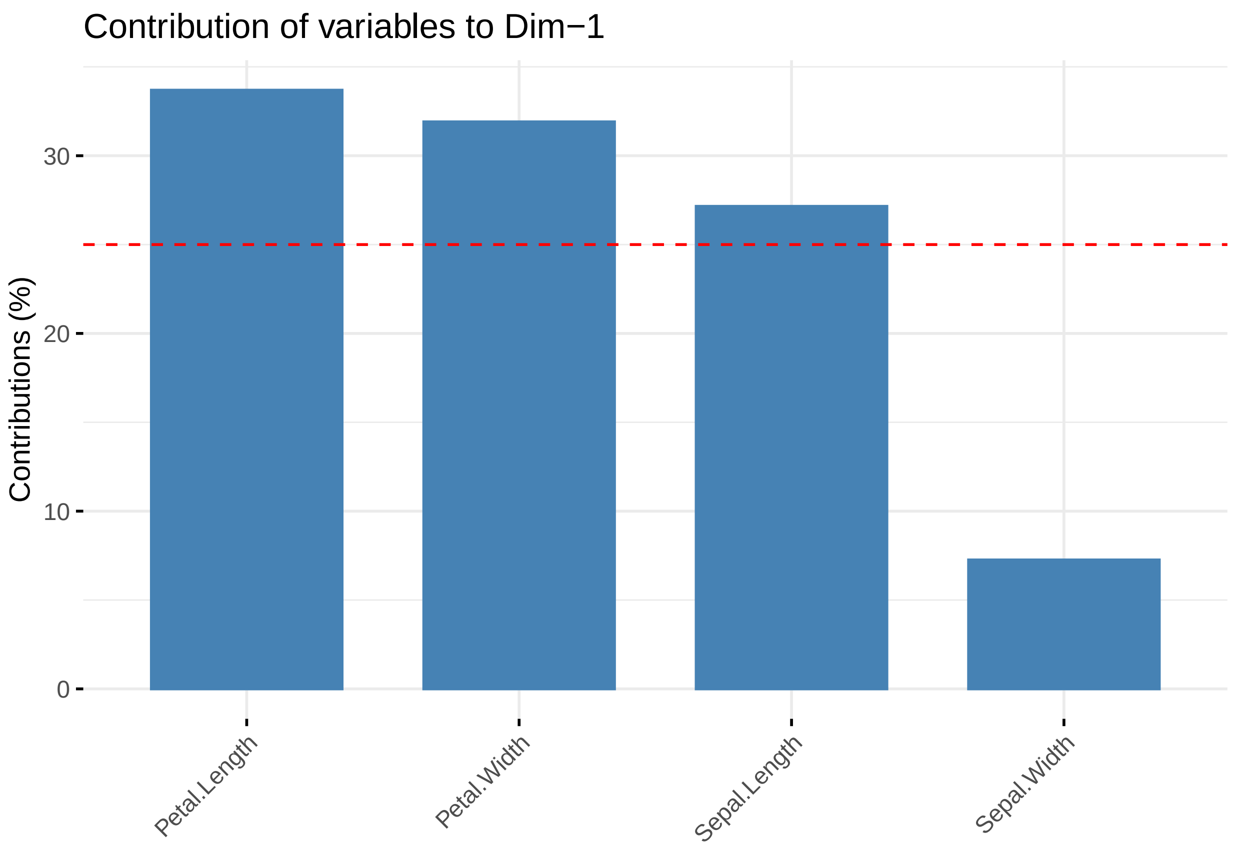
```
fviz_pca_biplot(res.pca)
```



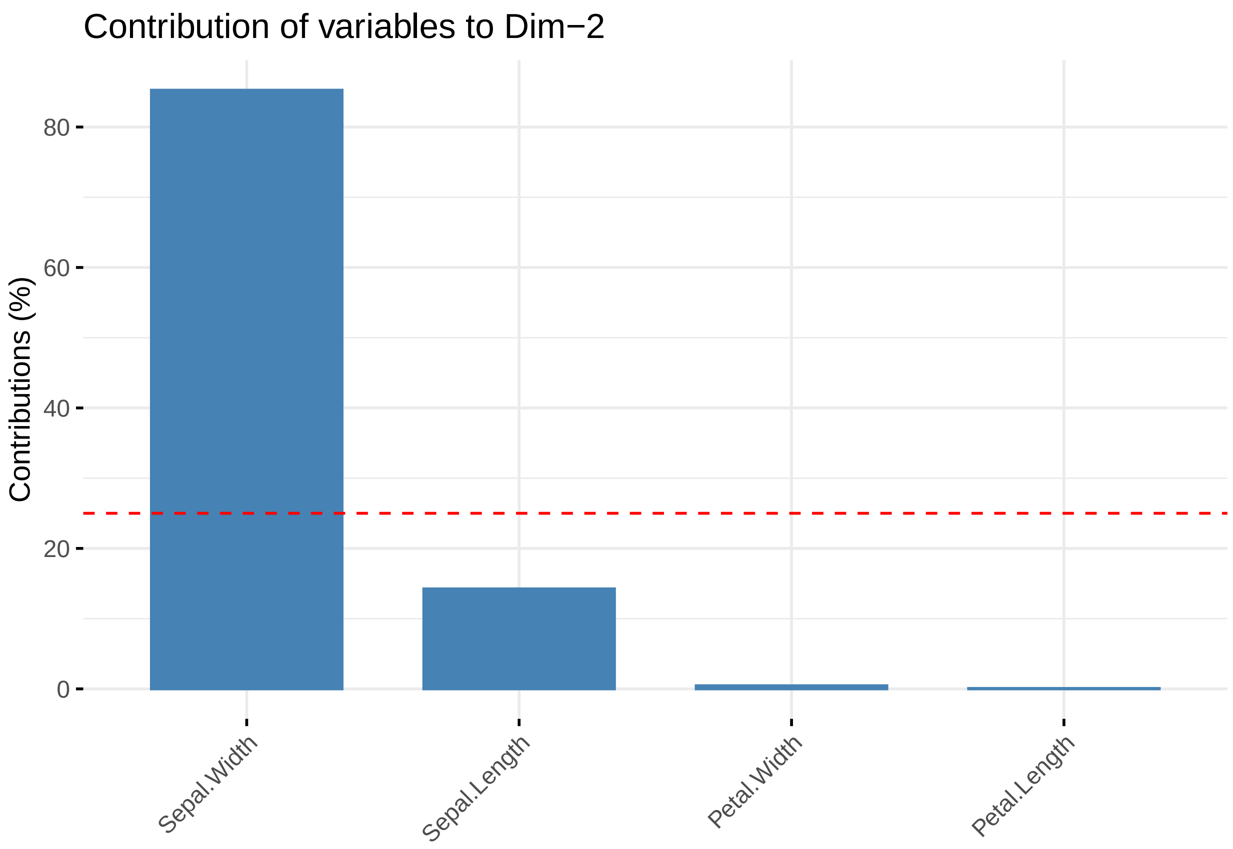
```
fviz_pca(res.pca)
```



```
# Contributions of variables to PC1
fviz_contrib(res.pca, choice = "var", axes = 1, top = 10)
```

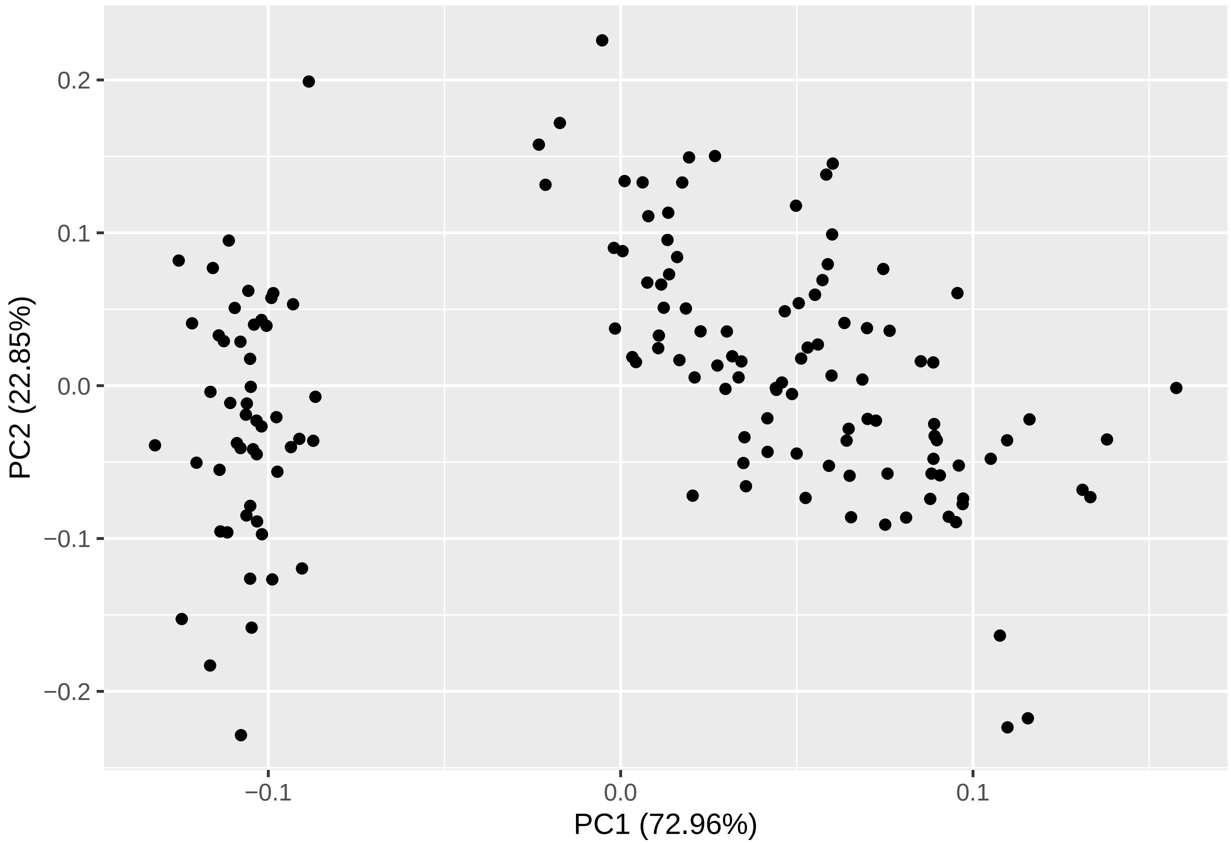


```
# Contributions of variables to PC2
fviz_contrib(res.pca, choice = "var", axes = 2, top = 10)
```

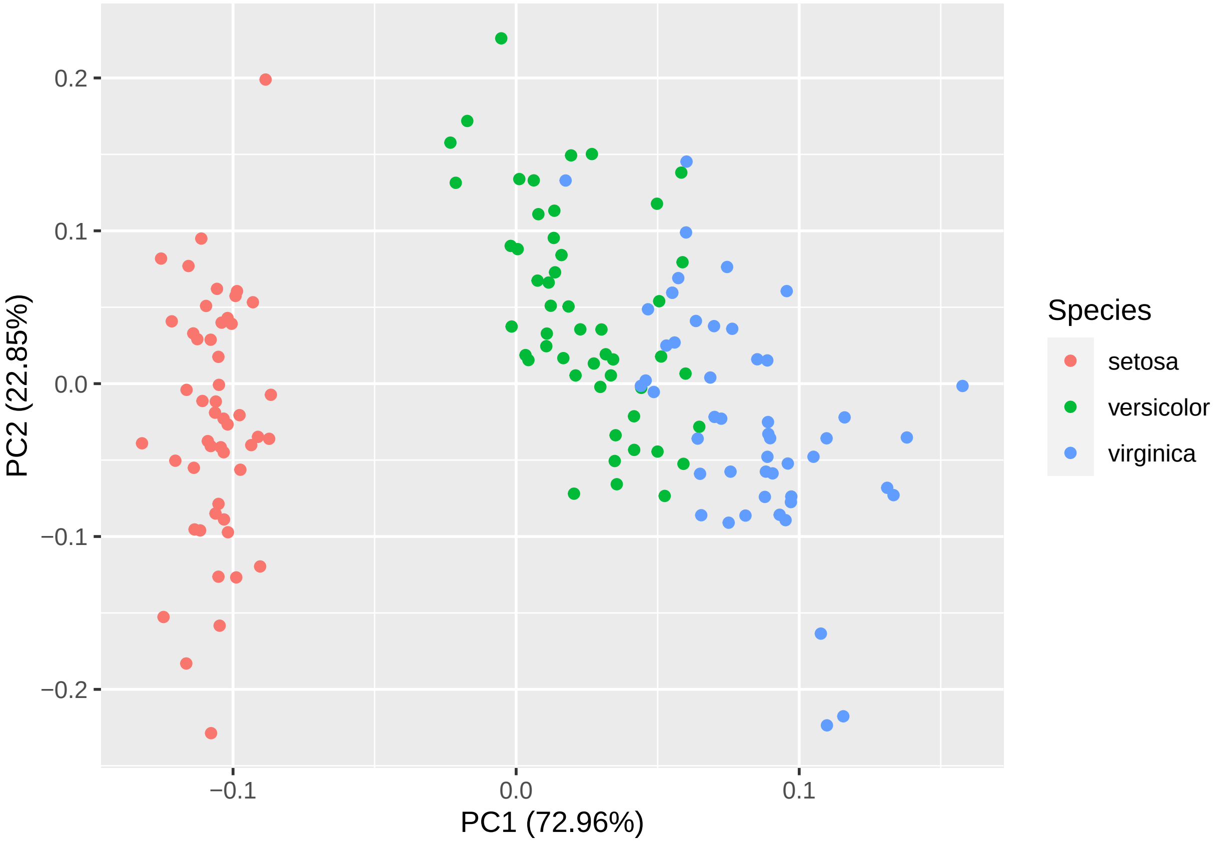


```
# Variable contribution to all components
```

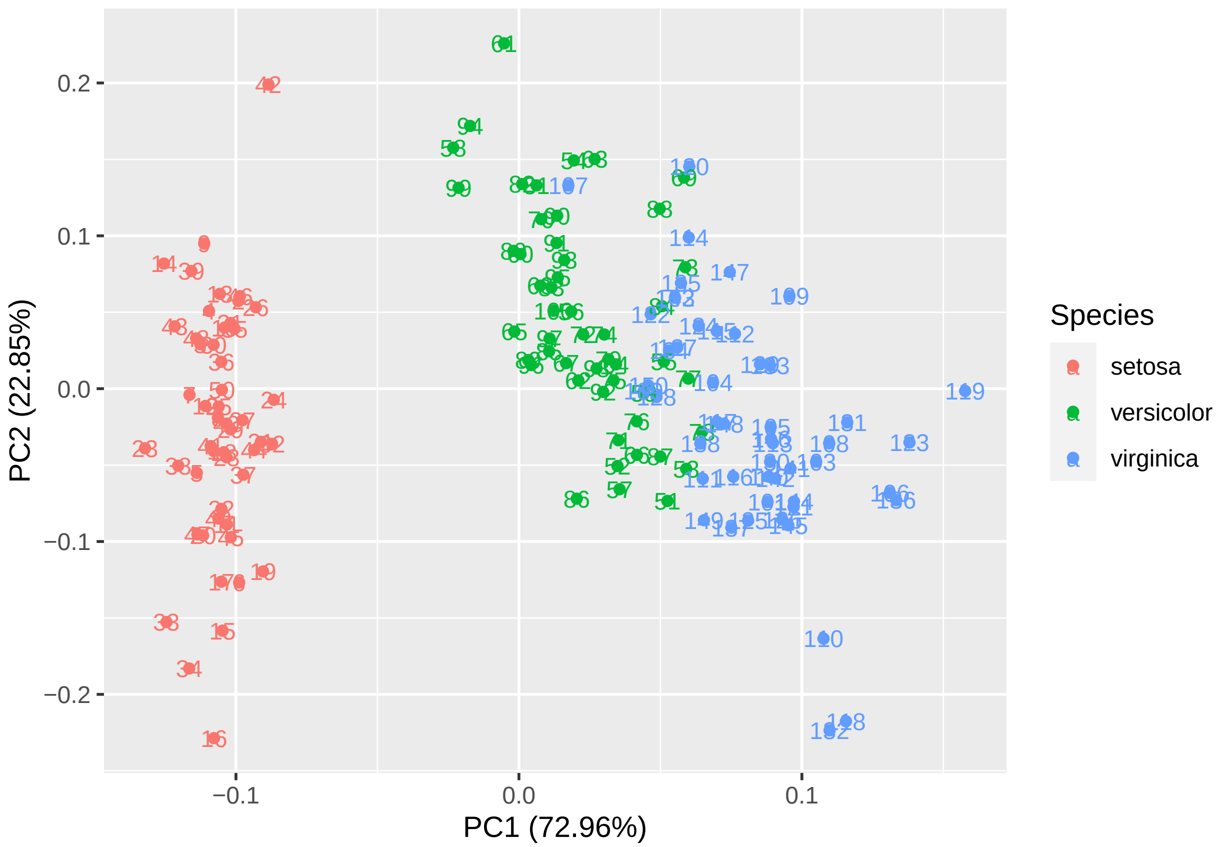
```
library(ggfortify)

autoplot(res.pca)
```



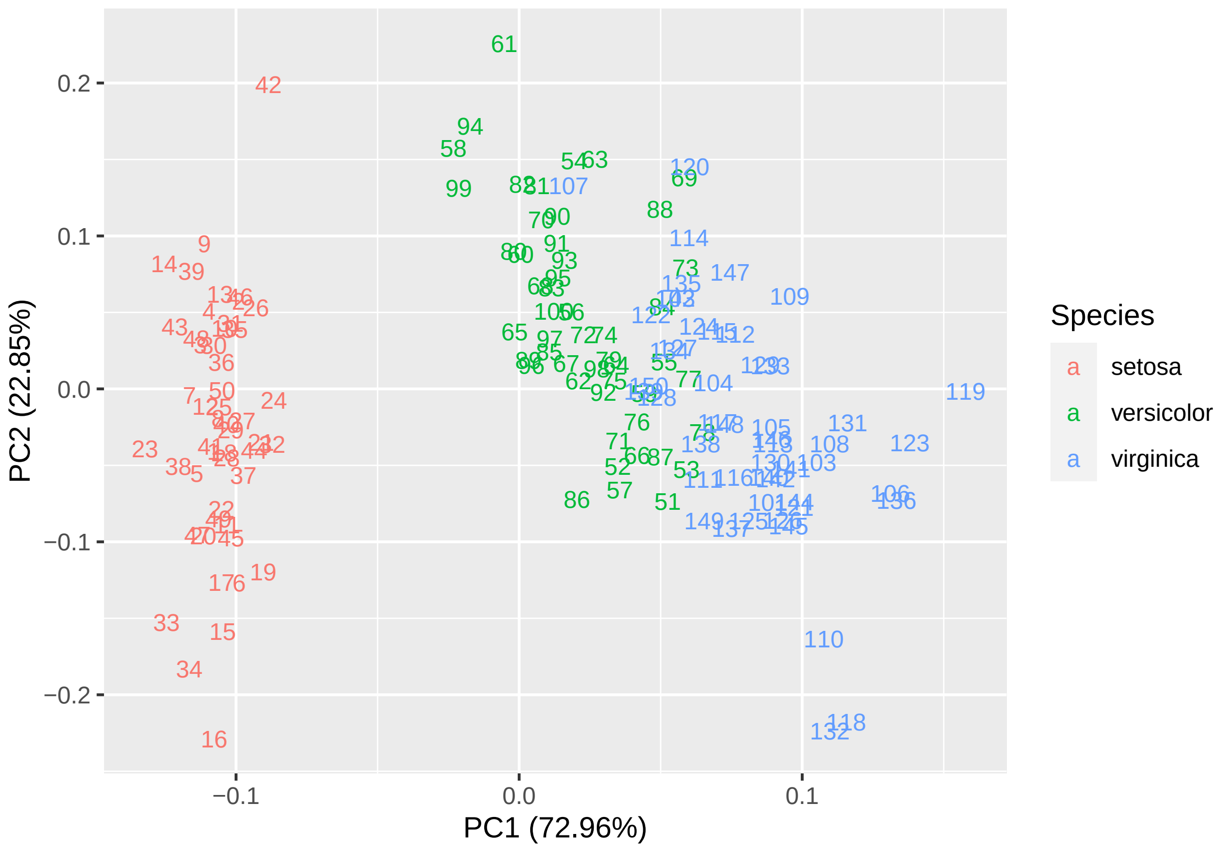
```
autoplot(res.pca, data = iris, colour = 'Species')
```



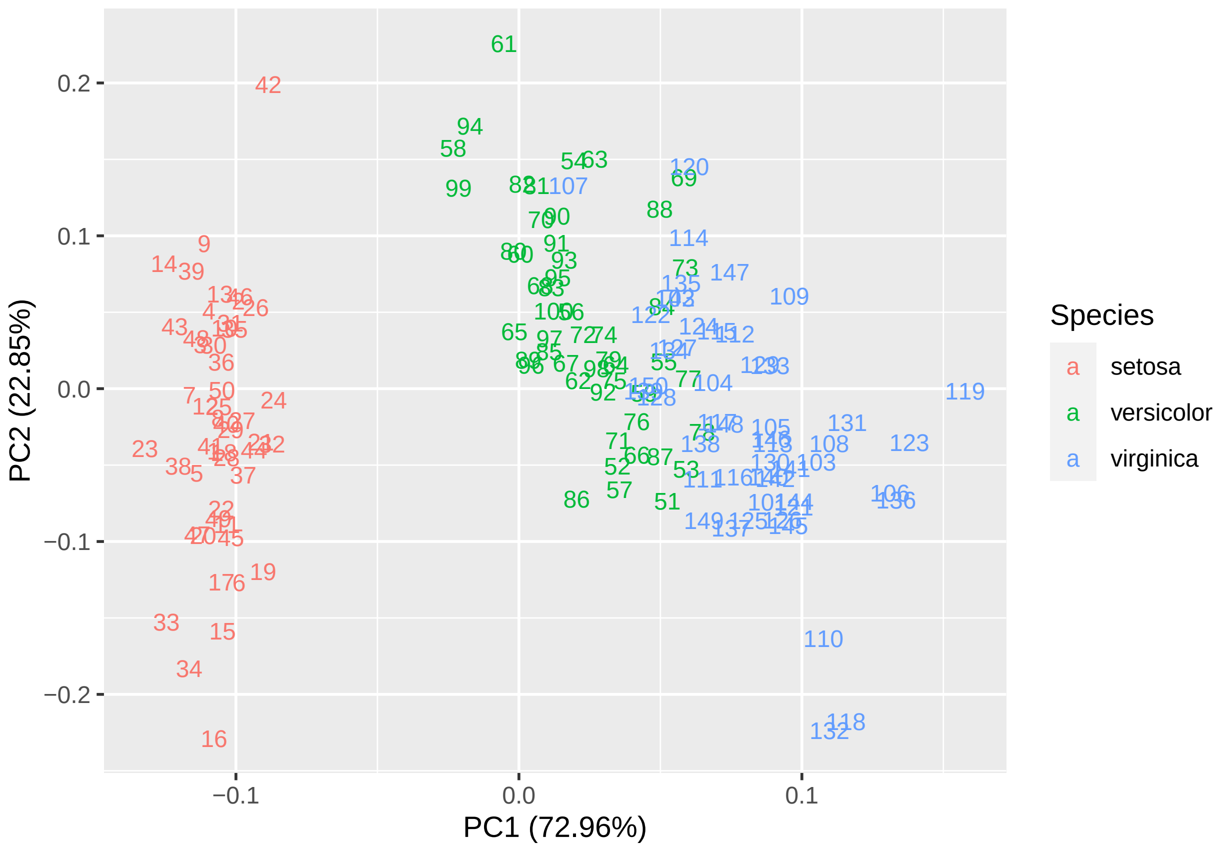
```r
autoplot(res.pca, data = iris, colour = 'Species', label = TRUE, label.size = 3)
```



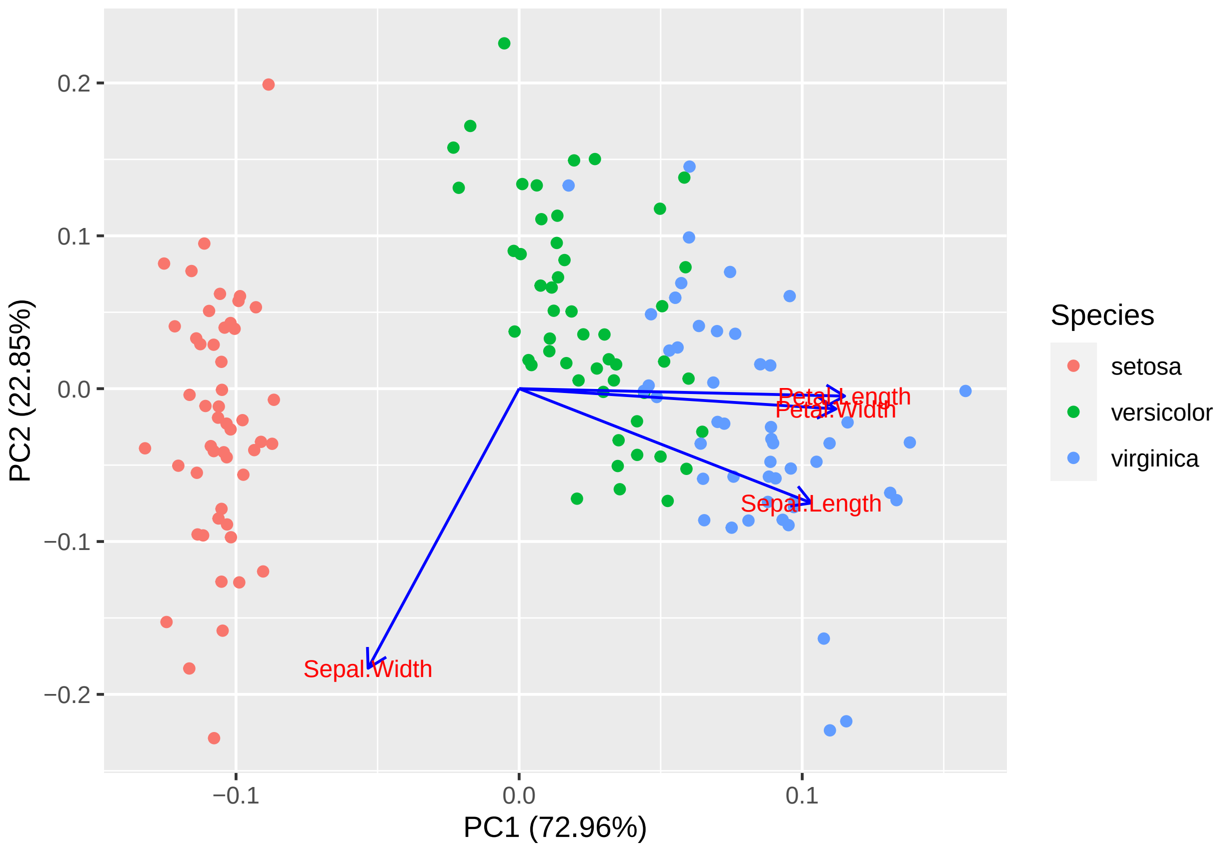
```
autoplot(res.pca, data = iris, colour = 'Species', shape = FALSE, label.size = 3)
```



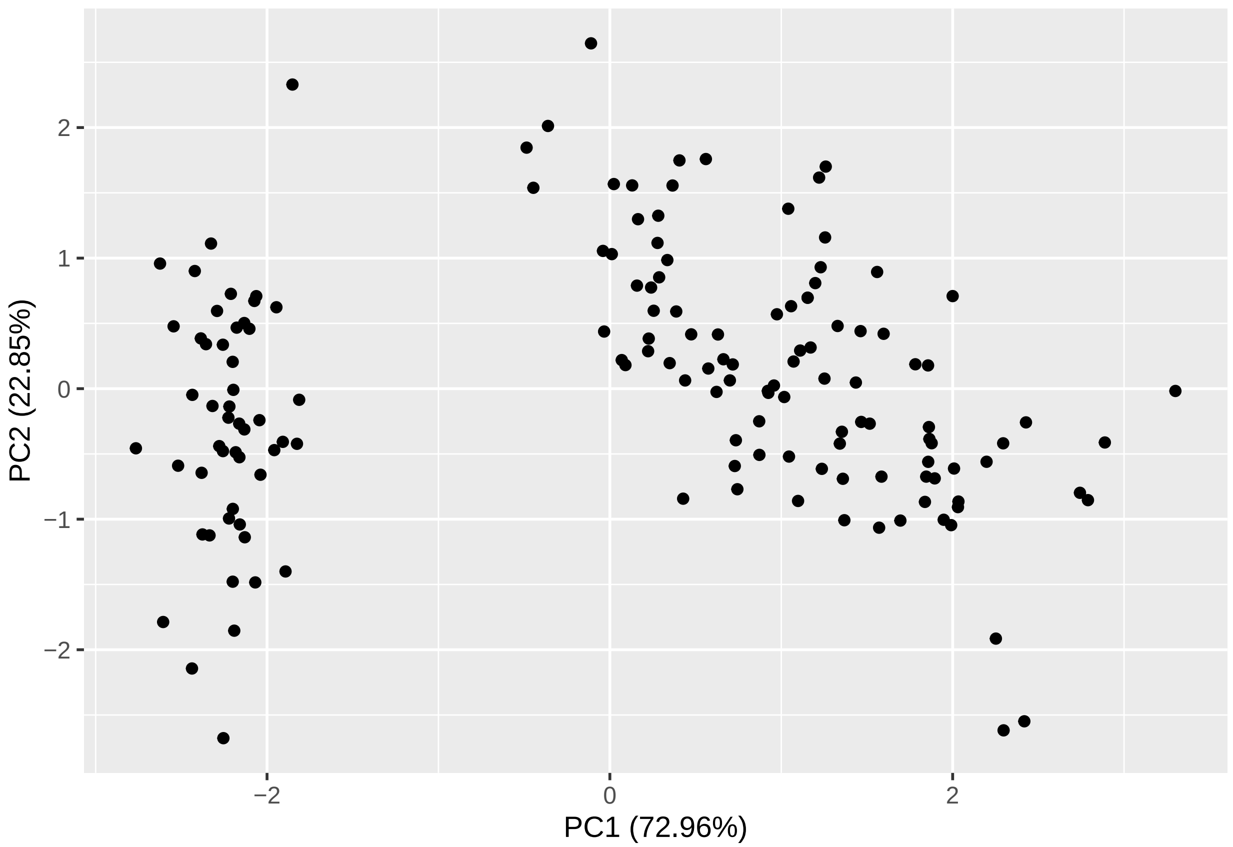
```r
autoplot(res.pca, data = iris, colour = 'Species', shape = FALSE, label.size = 3)
```



```r
autoplot(res.pca, data = iris, colour = 'Species',
         loadings = TRUE, loadings.colour = 'blue',
         loadings.label = TRUE, loadings.label.size = 3)
```

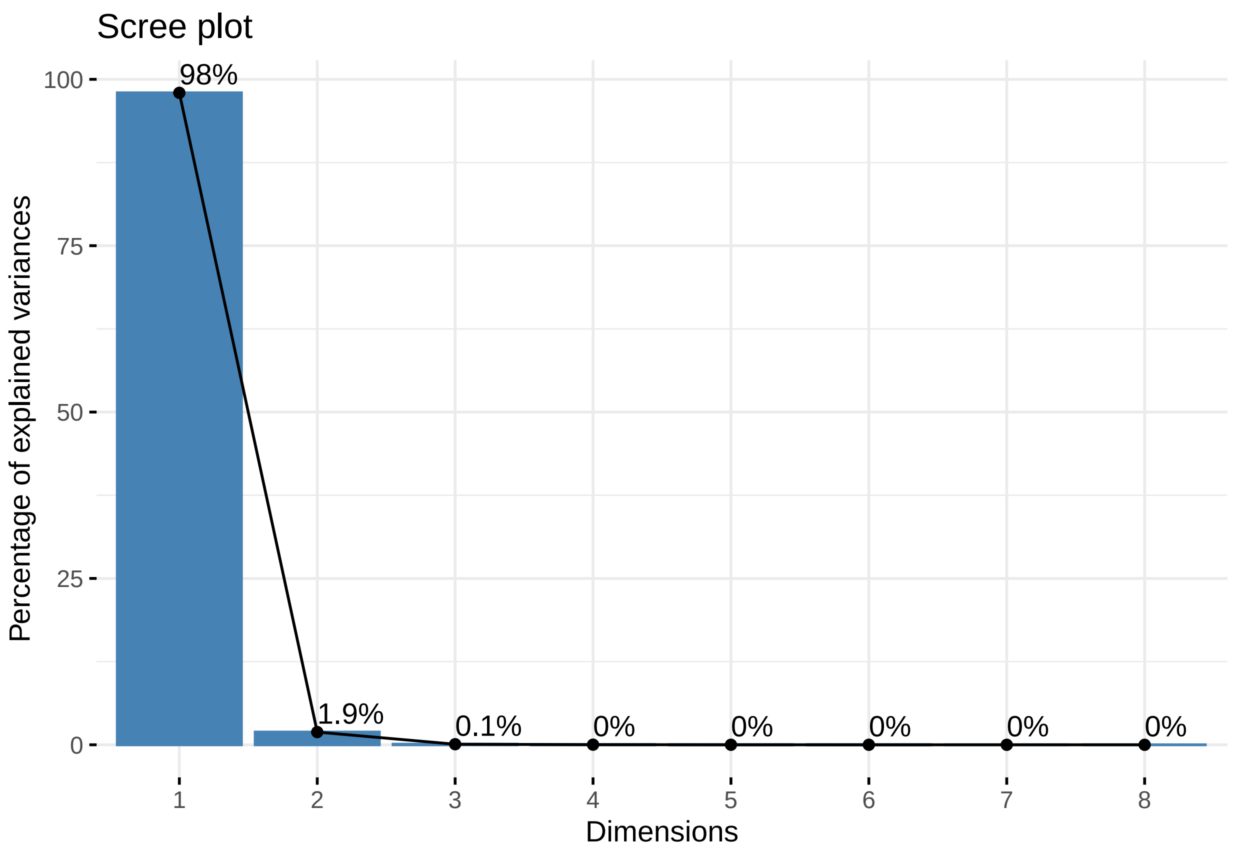


```
autoplot(res.pca, scale = 0)
```

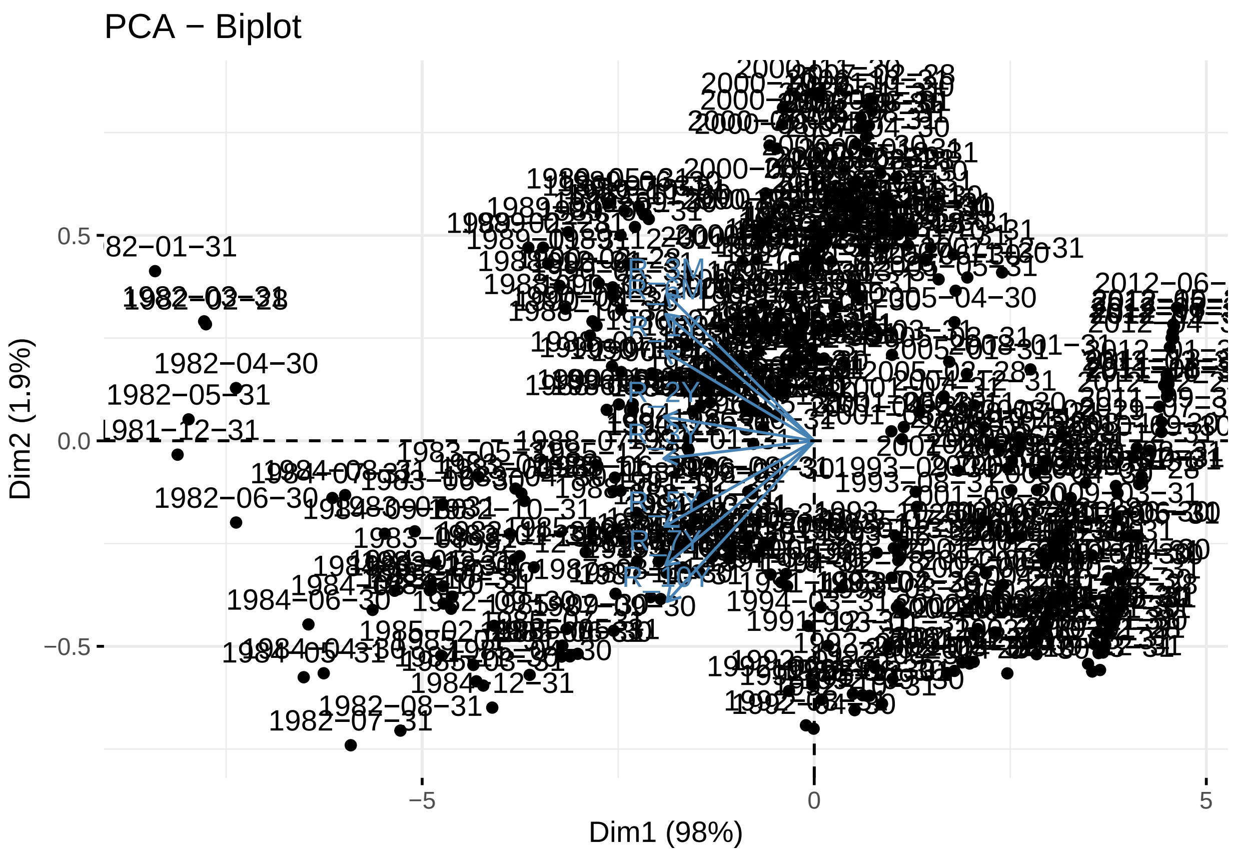


-

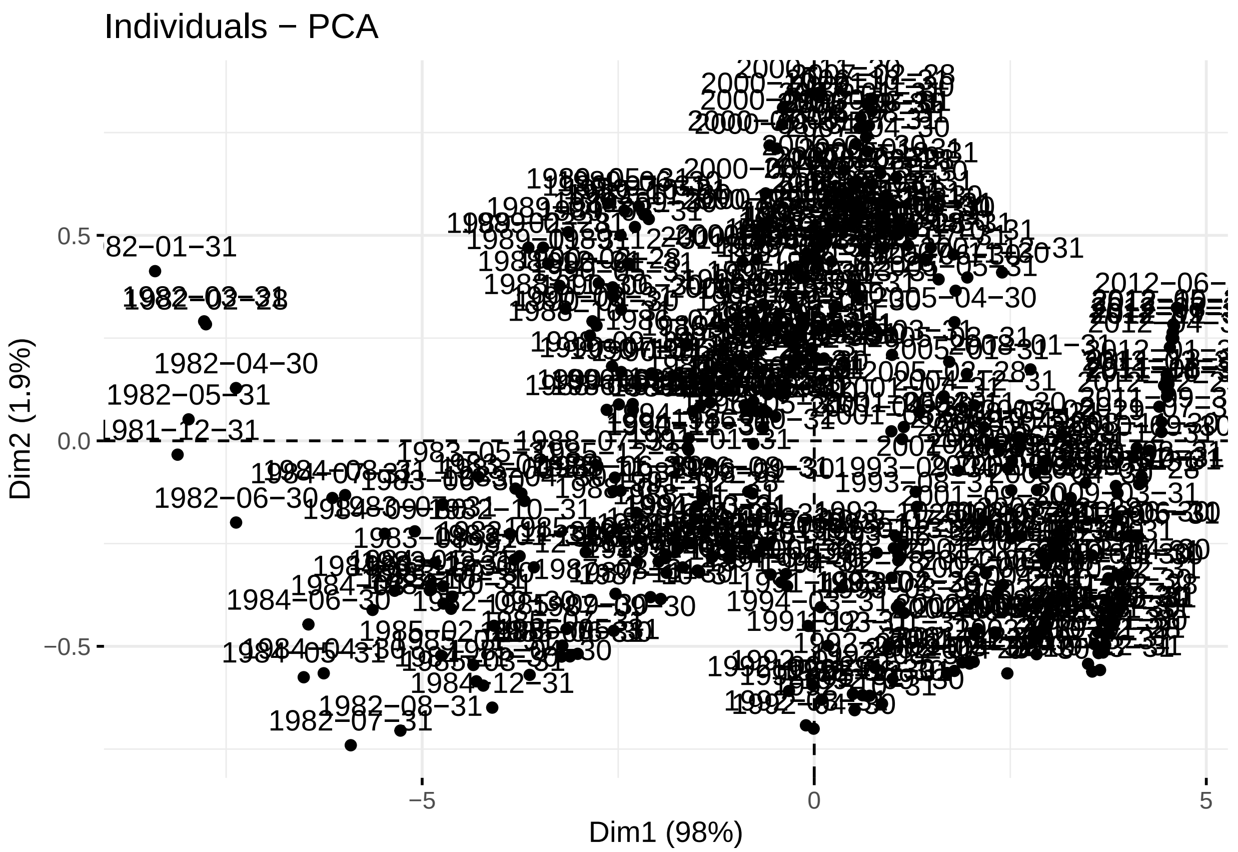
```
library(YieldCurve)
data(FedYieldCurve)

M <- as.matrix(FedYieldCurve)


res.pca = prcomp(M,  scale = TRUE)

fviz_eig(res.pca, addlabels = TRUE)
```



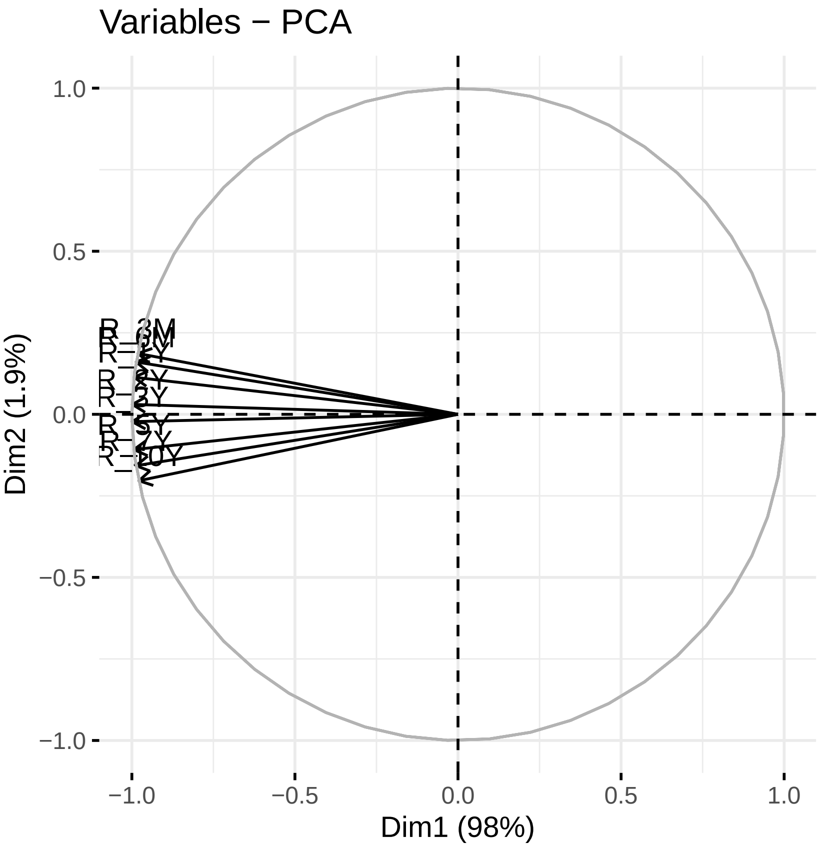
```
fviz_pca(res.pca)
```



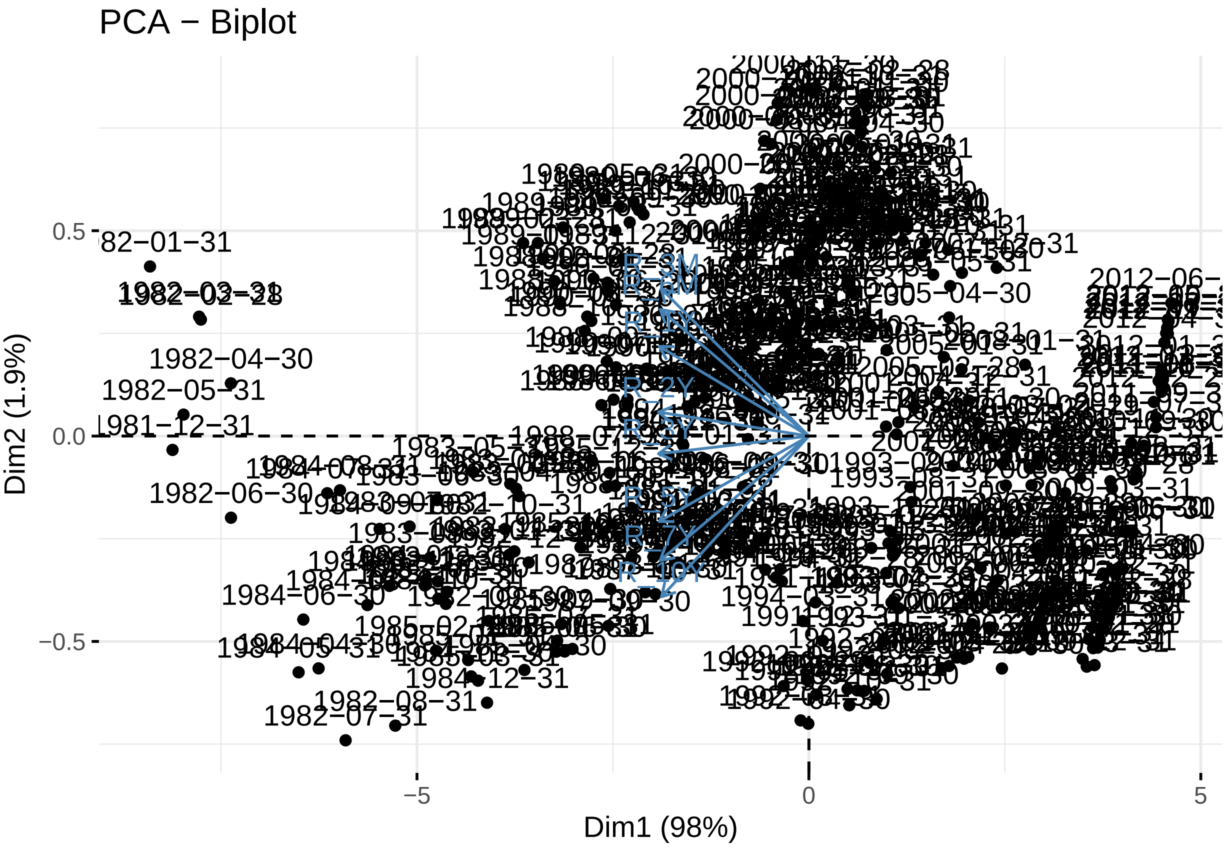
```
fviz_pca_ind(res.pca)
```



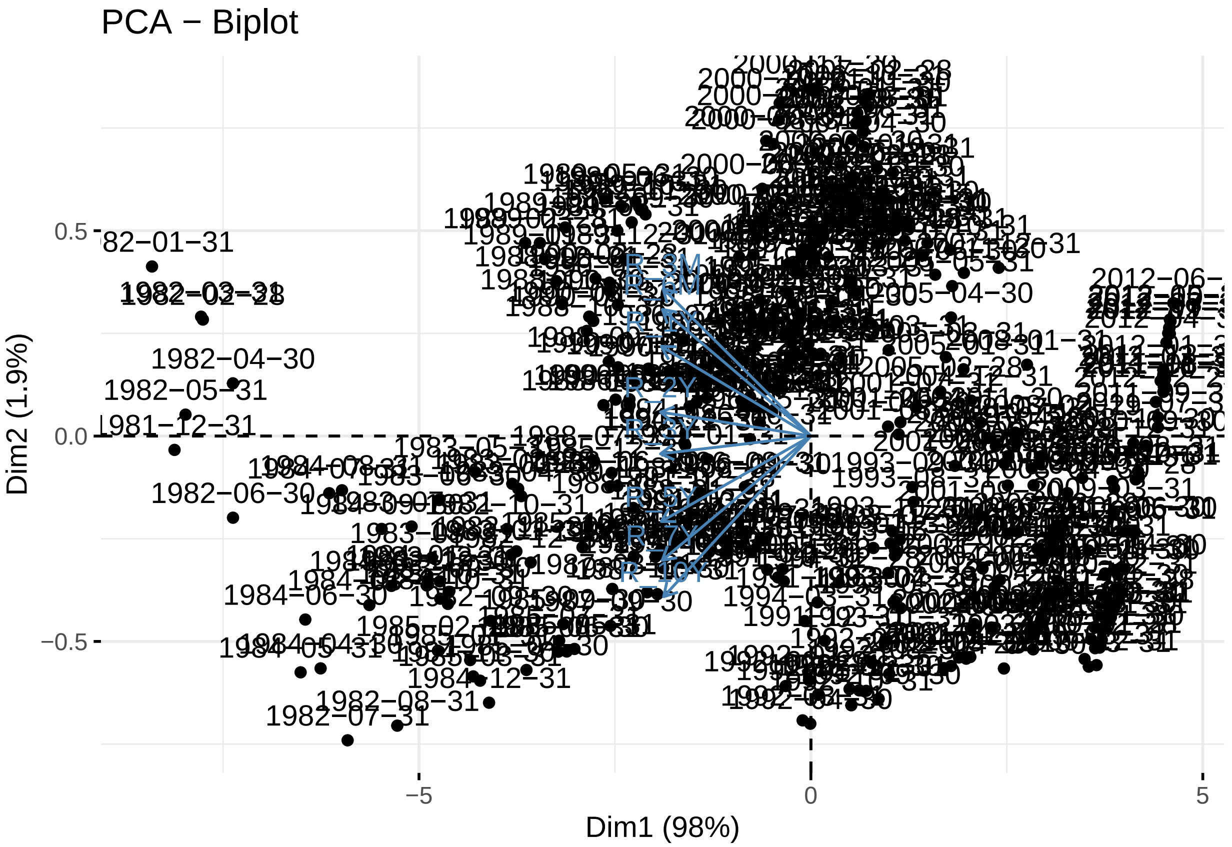
```
fviz_pca_var(res.pca)
```



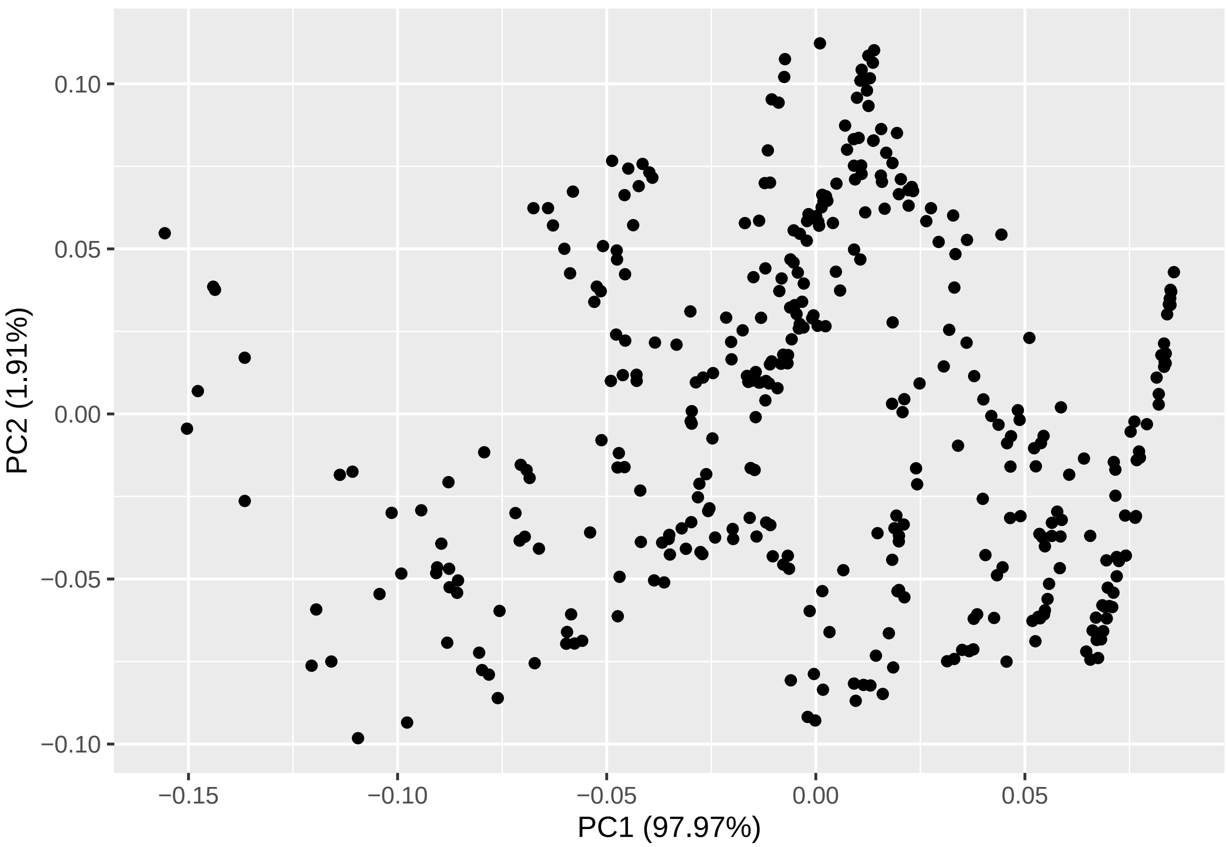
```
fviz_pca_biplot(res.pca)
```



```
fviz_pca(res.pca)
```



```
library(ggfortify)

autoplot(res.pca)
```



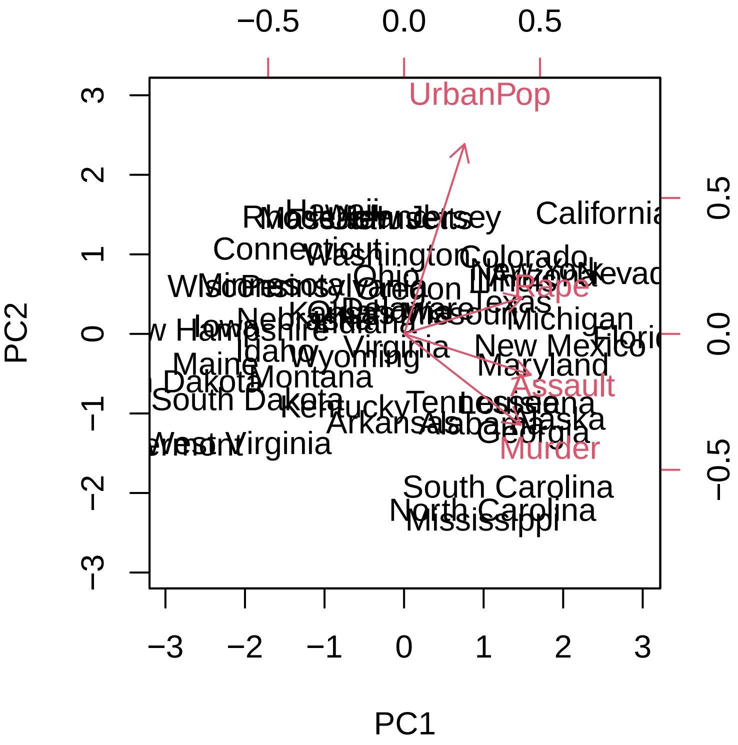
```
  # plot arrangement
data("USArrests")
results <- prcomp(USArrests, scale = TRUE)
results$rotation <- -results$rotation
results$rotation
```

```
##                PC1        PC2        PC3         PC4
## Murder   0.5358995 -0.4181809  0.3412327 -0.64922780
## Assault  0.5831836 -0.1879856  0.2681484  0.74340748
## UrbanPop 0.2781909  0.8728062  0.3780158 -0.13387773
## Rape     0.5434321  0.1673186 -0.8177779 -0.08902432
```

```
#reverse the signs of the scores
results$x <- -1*results$x

#display the first six scores
head(results$x)
```

```
##                   PC1        PC2         PC3          PC4
## Alabama     0.9756604 -1.1220012  0.43980366 -0.154696581
## Alaska      1.9305379 -1.0624269 -2.01950027  0.434175454
## Arizona     1.7454429  0.7384595 -0.05423025  0.826264240
## Arkansas   -0.1399989 -1.1085423 -0.11342217  0.180973554
## California  2.4986128  1.5274267 -0.59254100  0.338559240
## Colorado    1.4993407  0.9776297 -1.08400162 -0.001450164
```

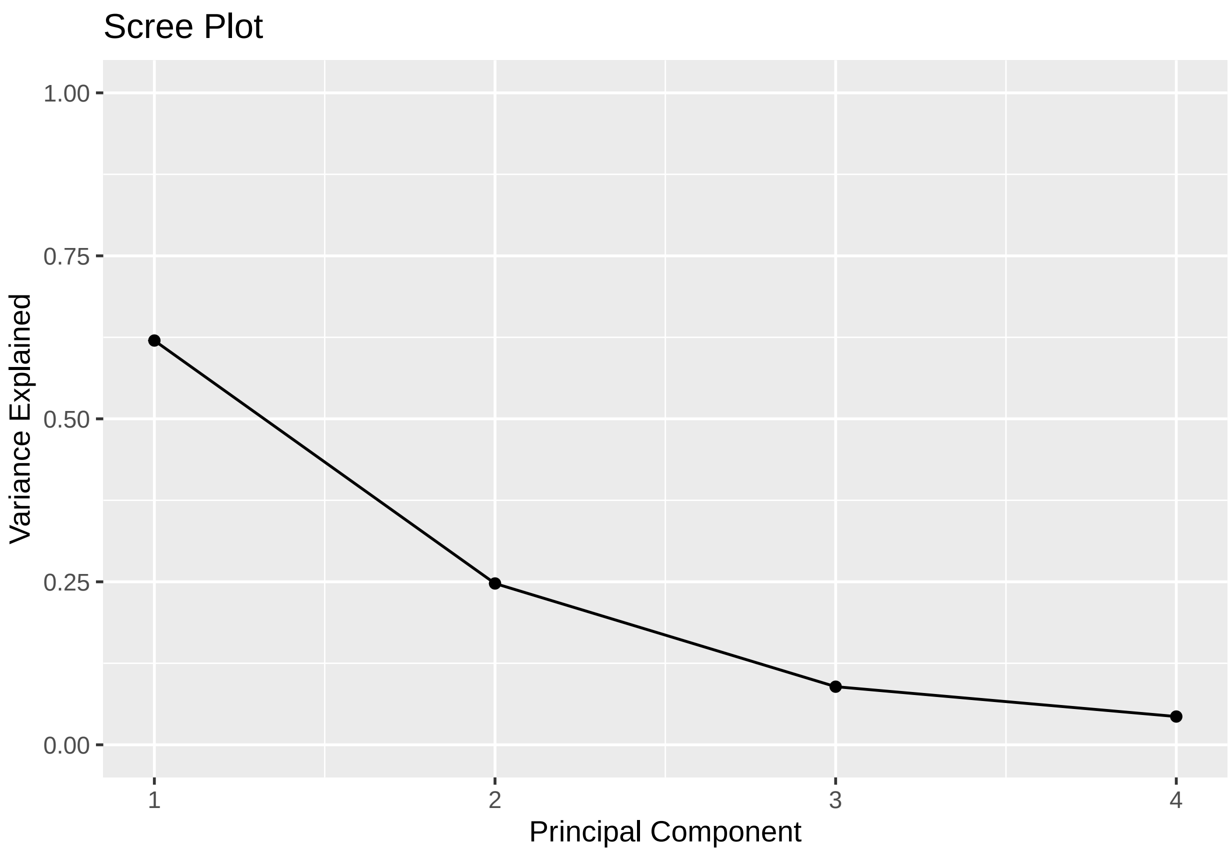
```r
biplot(results, scale = 0)
```



```r
#calculate total variance explained by each principal component
results$sdev^2 / sum(results$sdev^2)
```

```
## [1] 0.62006039 0.24744129 0.08914080 0.04335752
```

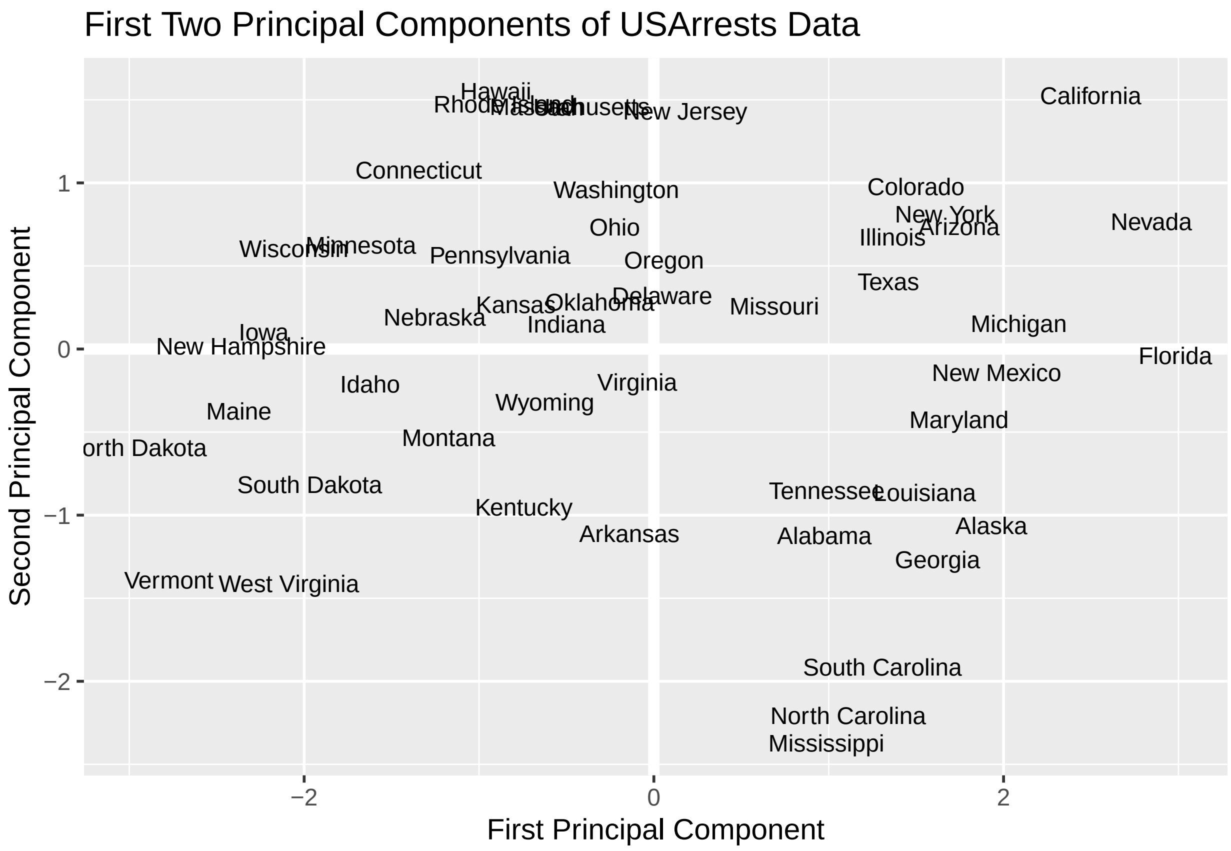
```r
#calculate total variance explained by each principal component
var_explained = results$sdev^2 / sum(results$sdev^2)

#create scree plot
qplot(c(1:4), var_explained) +
  geom_line() +
  xlab("Principal Component") +
  ylab("Variance Explained") +
  ggtitle("Scree Plot") +
  ylim(0, 1)
```



```r
library(tidyverse)  # data manipulation and visualization
library(gridExtra)  # plot arrangement
data("USArrests")
apply(USArrests, 2, var)
```

```
##     Murder    Assault   UrbanPop       Rape
##   18.97047 6945.16571  209.51878   87.72916
```

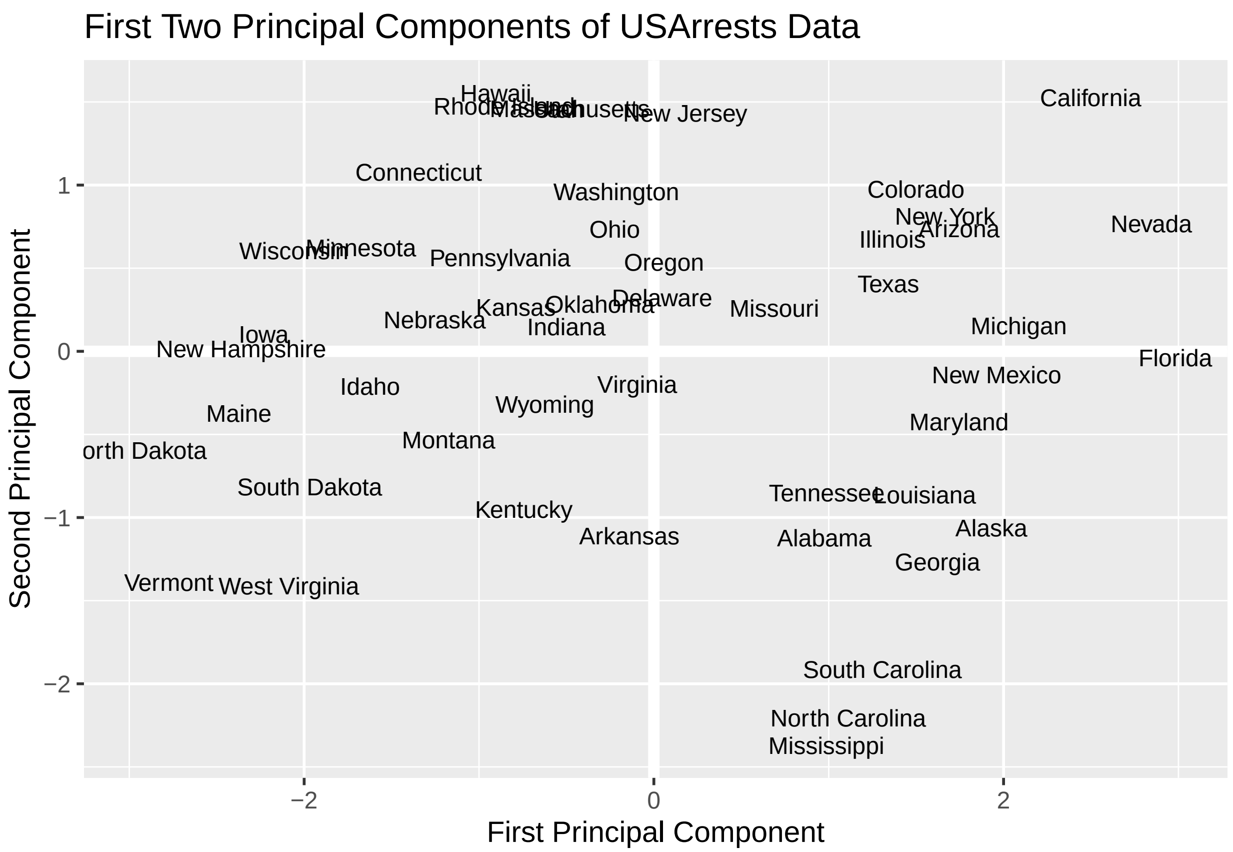
```r
scaled_df <- apply(USArrests, 2, scale)
arrests.cov <- cov(scaled_df)
arrests.eigen <- eigen(arrests.cov)

phi <- arrests.eigen$vectors[,1:2]

phi <- -phi
row.names(phi) <- c("Murder", "Assault", "UrbanPop", "Rape")
colnames(phi) <- c("PC1", "PC2")
PC1 <- as.matrix(scaled_df) %*% phi[,1]
PC2 <- as.matrix(scaled_df) %*% phi[,2]

# Create data frame with Principal Components scores
PC <- data.frame(State = row.names(USArrests), PC1, PC2)
ggplot(PC, aes(PC1, PC2)) +
  modelr::geom_ref_line(h = 0) +
  modelr::geom_ref_line(v = 0) +
  geom_text(aes(label = State), size = 3) +
  xlab("First Principal Component") +
  ylab("Second Principal Component") +
  ggtitle("First Two Principal Components of USArrests Data")
```



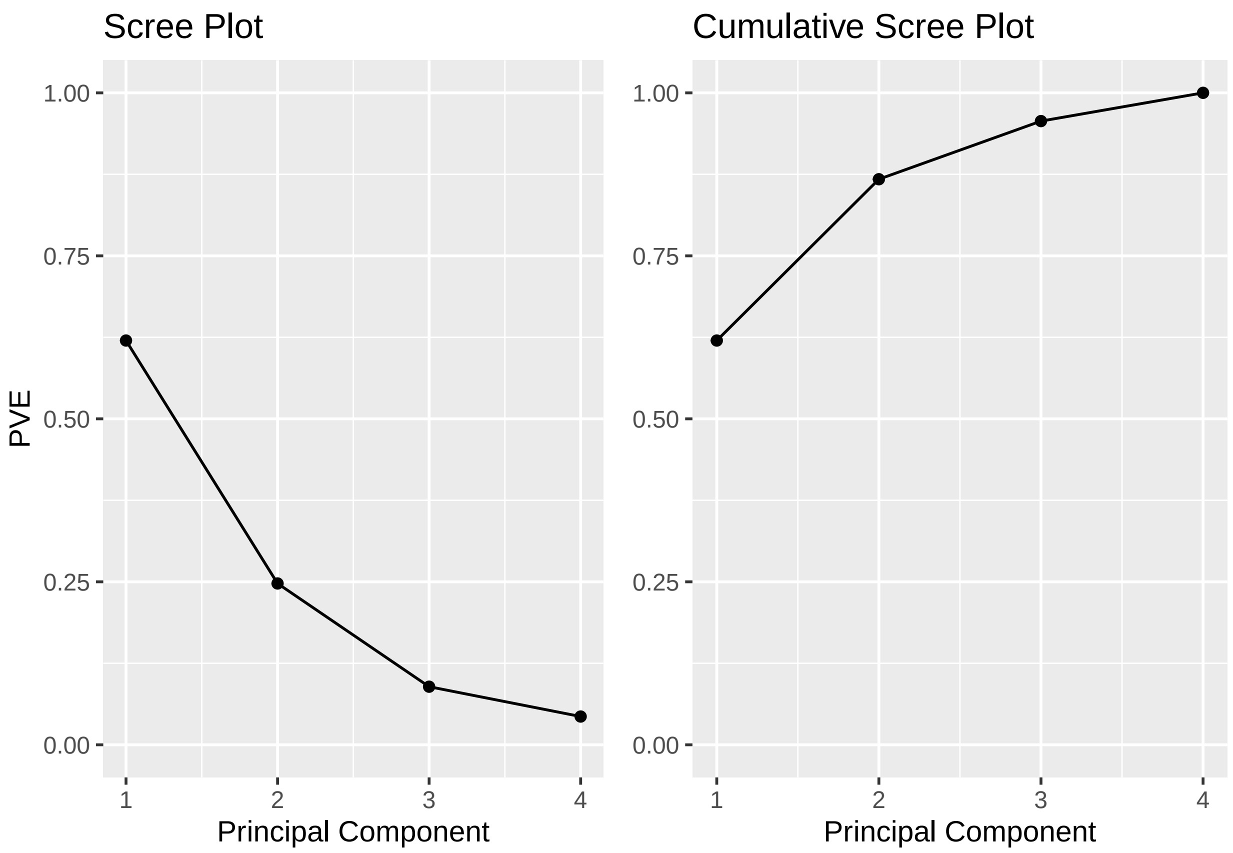
```
PVE <- arrests.eigen$values / sum(arrests.eigen$values)
round(PVE, 2)
```

```
## [1] 0.62 0.25 0.09 0.04
```

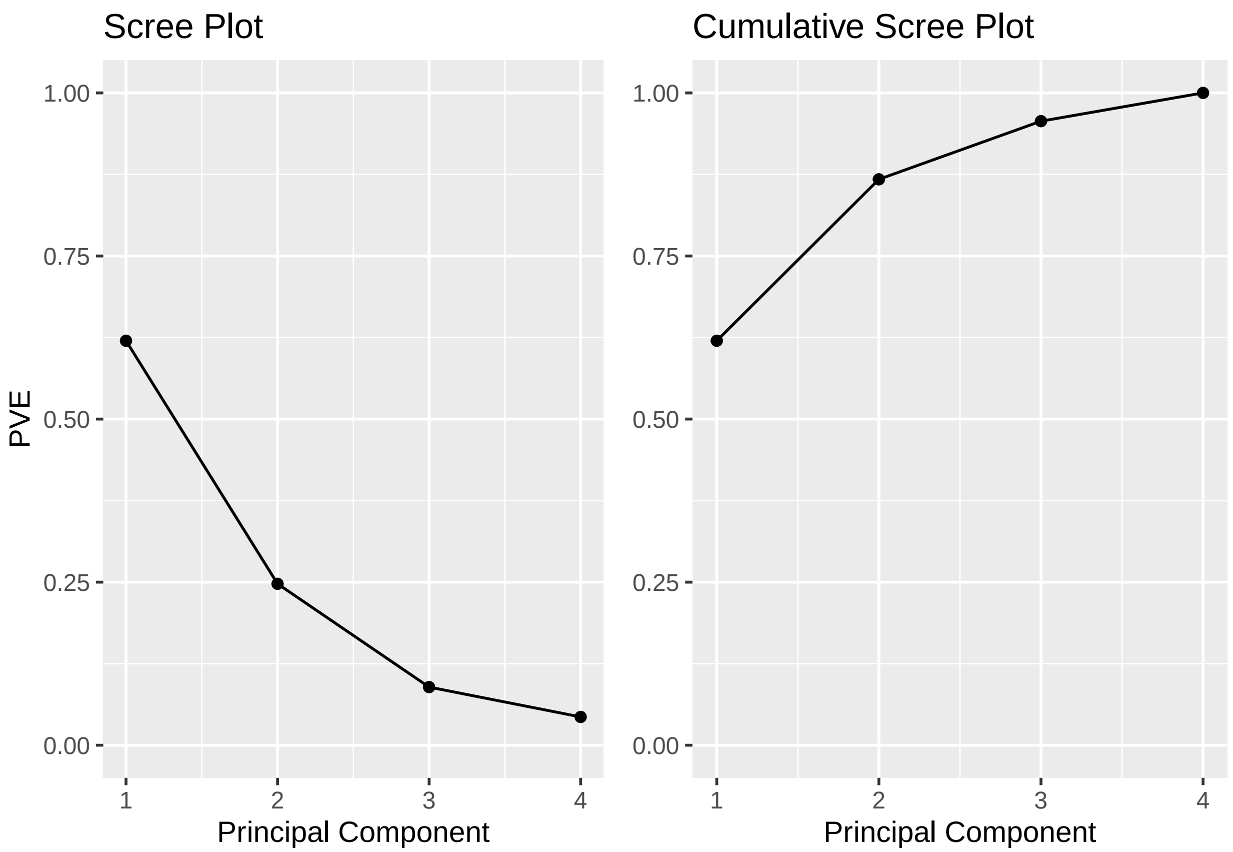
```
# Calculate Principal Components scores
PC1 <- as.matrix(scaled_df) %*% phi[,1]
PC2 <- as.matrix(scaled_df) %*% phi[,2]
PC <- data.frame(State = row.names(USArrests), PC1, PC2)
# Plot Principal Components for each State
ggplot(PC, aes(PC1, PC2)) +
  modelr::geom_ref_line(h = 0) +
  modelr::geom_ref_line(v = 0) +
  geom_text(aes(label = State), size = 3) +
  xlab("First Principal Component") +
  ylab("Second Principal Component") +
  ggtitle("First Two Principal Components of USArrests Data")
```



```r
PVE <- arrests.eigen$values / sum(arrests.eigen$values)
# PVE (aka scree) plot
PVEplot <- qplot(c(1:4), PVE) +
  geom_line() +
  xlab("Principal Component") +
  ylab("PVE") +
  ggtitle("Scree Plot") +
  ylim(0, 1)

# Cumulative PVE plot
cumPVE <- qplot(c(1:4), cumsum(PVE)) +
  geom_line() +
  xlab("Principal Component") +
  ylab(NULL) +
  ggtitle("Cumulative Scree Plot") +
  ylim(0,1)

grid.arrange(PVEplot, cumPVE, ncol = 2)
```



```
# PVE (aka scree) plot
PVEplot <- qplot(c(1:4), PVE) +
  geom_line() +
  xlab("Principal Component") +
  ylab("PVE") +
  ggtitle("Scree Plot") +
  ylim(0, 1)

# Cumulative PVE plot
cumPVE <- qplot(c(1:4), cumsum(PVE)) +
  geom_line() +
  xlab("Principal Component") +
  ylab(NULL) +
  ggtitle("Cumulative Scree Plot") +
  ylim(0,1)

grid.arrange(PVEplot, cumPVE, ncol = 2)
```



For Modeling (PC Regression)

```
library(tidyverse)
d <- read_csv("data/TermLife.csv")
d1 <- d[d$FACE>0, ]
```