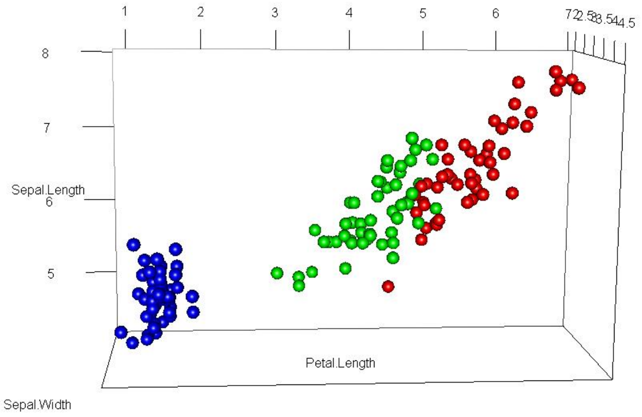

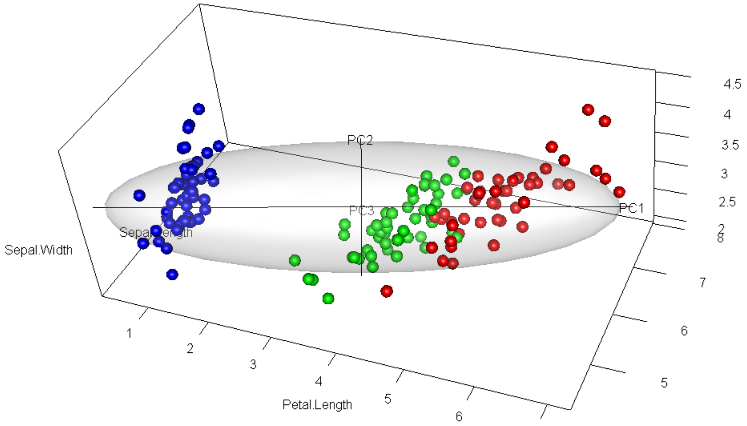

Travels in 3D space

Data ellipsoids, biplots, and rgl movies

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Prelude

- Multivariate data often needs > 2D
  - Usually reduced to multiple 2D views (scatplot matrix)
- Static 3D visualization often
  - Badly rendered
  - Lacks control of perspective
  - Lacks direct manipulation of viewpoint
- Dynamic 3D visualization
  - ggobi / rggobi – powerful dynamic graphics, but crummy rendering
  - rgl – beautiful rendering, good interactive control of perspective, viewpoint, etc., weak 3D “tours”
- Goal: Explore 3D vis & animation with rgl

PCA animation: 2D + time

PCA:

- PC1 is the direction along which points have max. variance
- Equivalently, the perp. deviations from the line have min. residual SS

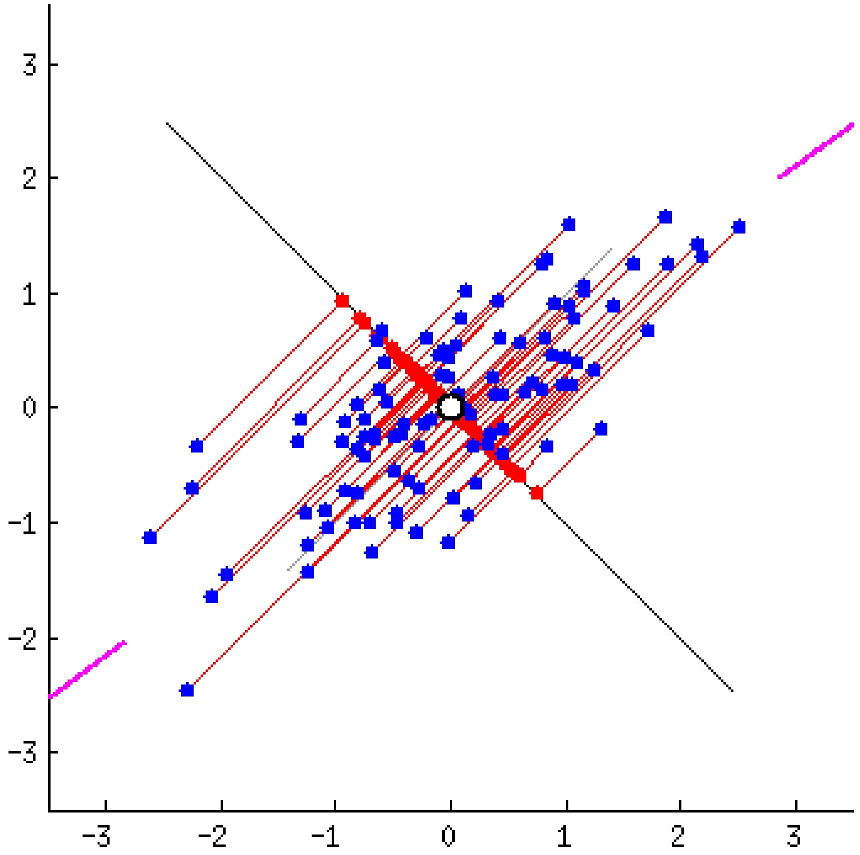
PCA by springs

- Imagine each pt connected to a possible PC1 line by springs
- Force ~ deviation^2

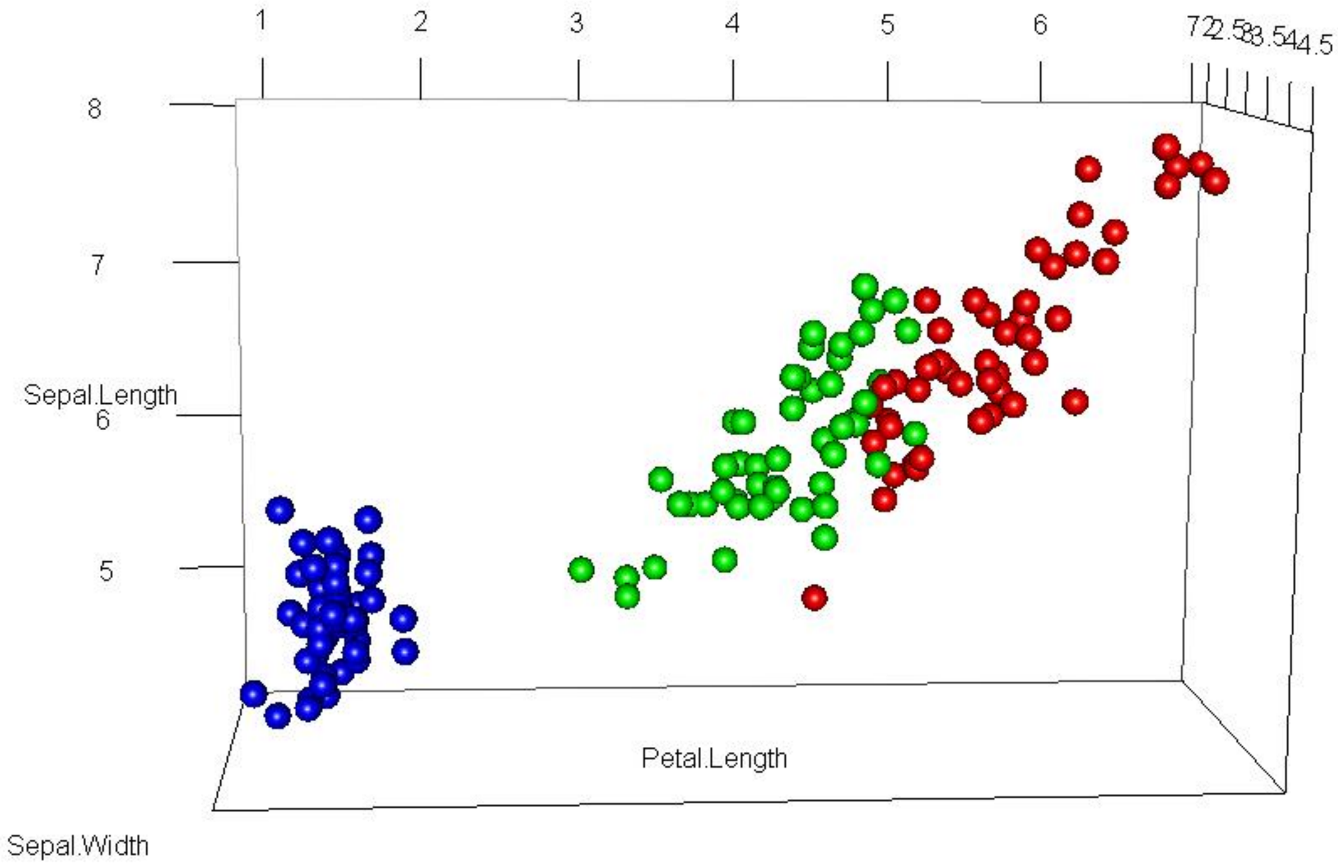
Forces balance, naturally seek the min. residual SS position.

Voila, QED!

- A visual proof

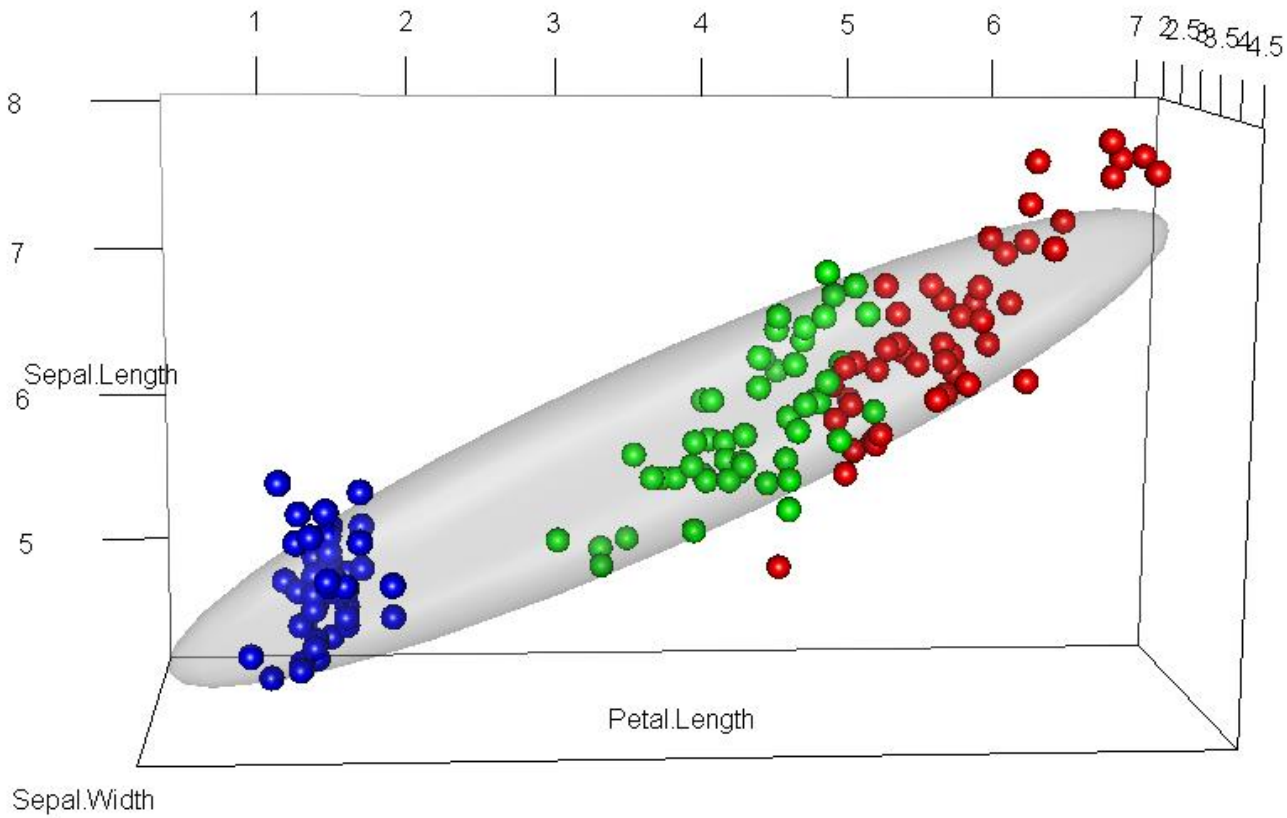


Iris data: rgl:::plot3d()



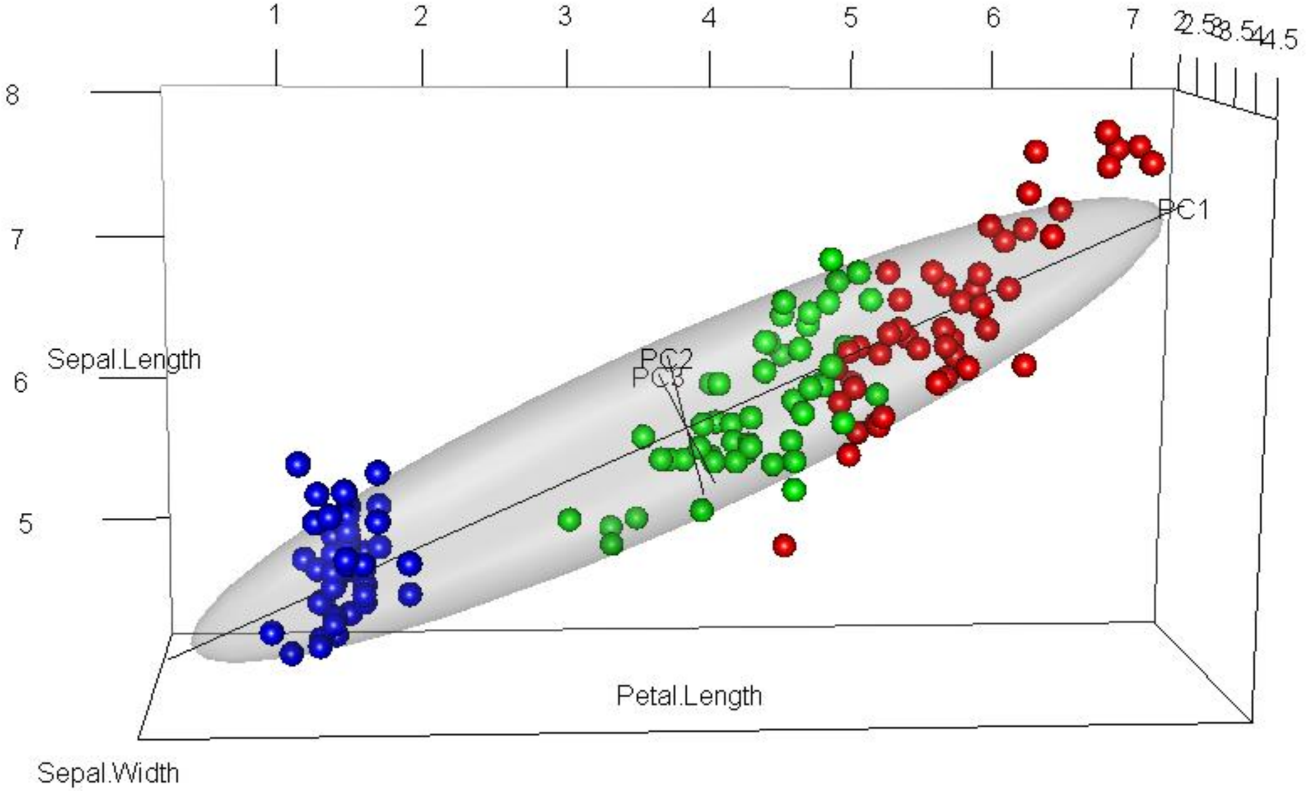
```
data(iris); library(rgl)
col <-c("blue", "green", "red")[iris$Species]
plot3d(iris, type="s", size=0.4, col=col, cex=2, box=FALSE, aspect="iso")
```

Add data ellipse



```
cov <- cov(iris); mu <- mean(iris)
plot3d( ellipse3d(cov, centre=mu, level=0.68), col="gray", alpha=0.2,  add = TRUE)
```

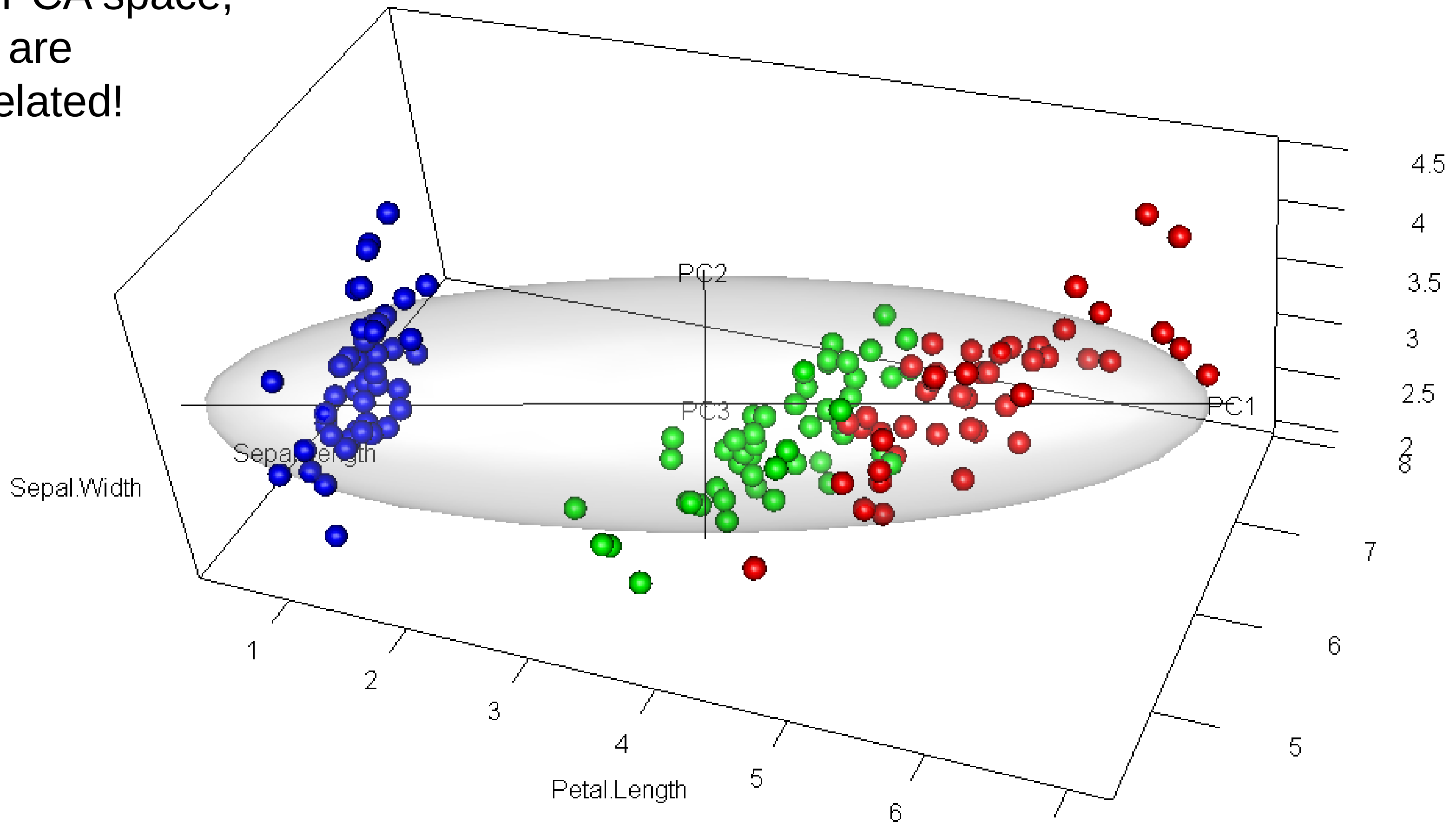
Add PC axes



```
source("c:/R/functions/ellipse3d.axes.R")
axes <- ellipse3d.axes(cov, centre=mu, level=0.72, labels=TRUE)
M1 <- par3d("userMatrix")
```

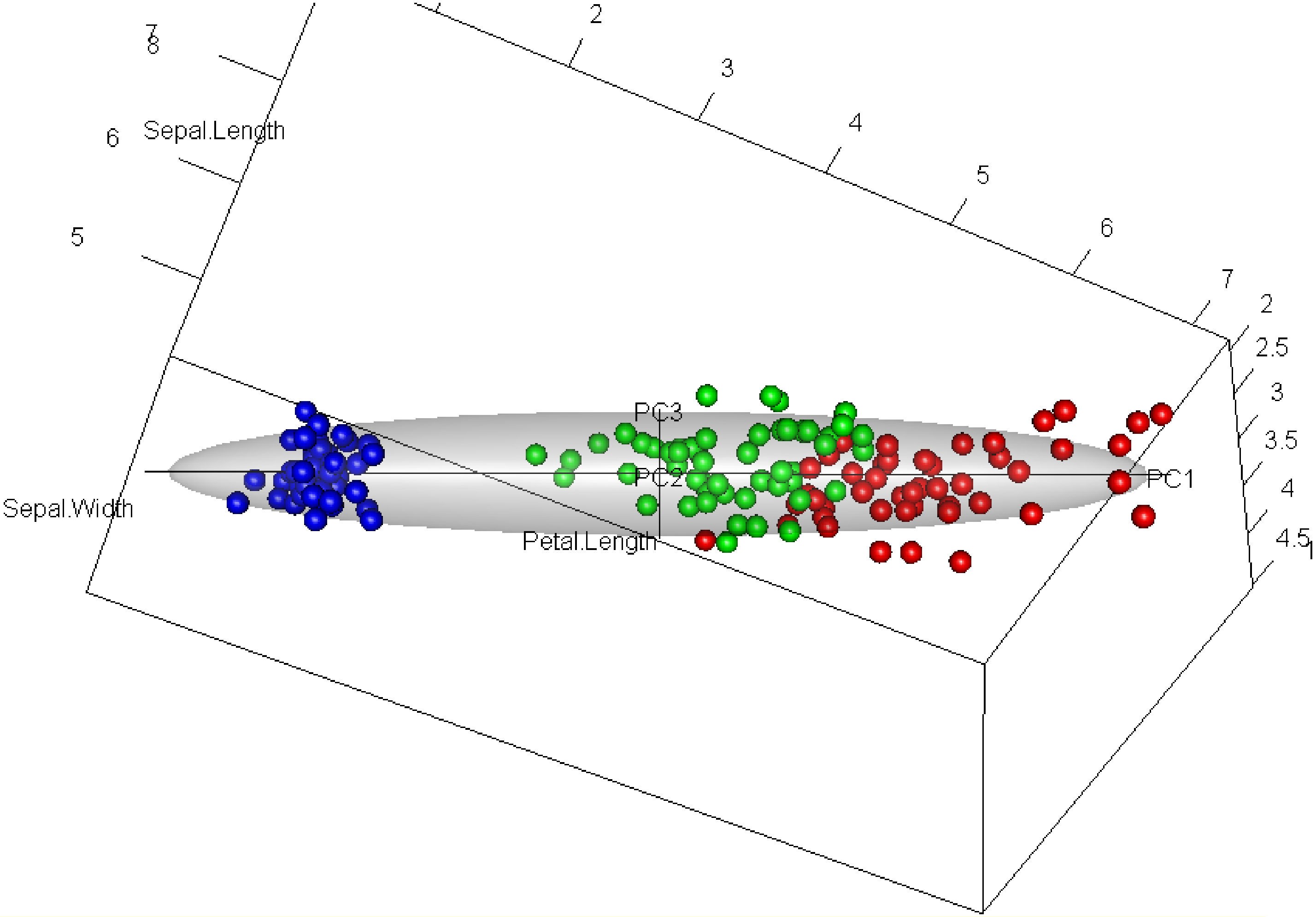
Rotate to show PC1 & PC2: Biplot view

NB: In PCA space, scores are uncorrelated!



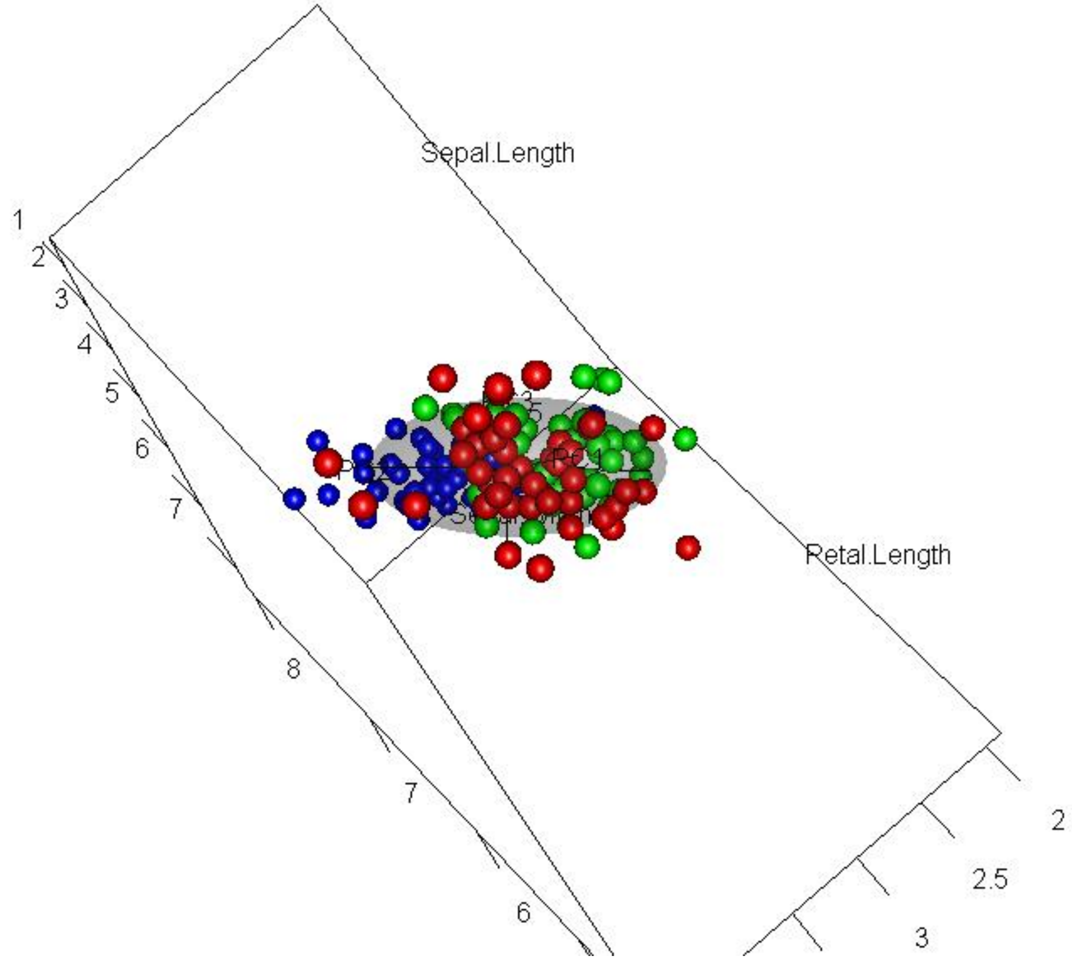
```
# hand rotate / zoom, then save current position
M2 <- par3d("userMatrix")
```

Rotate to show PC1 & PC3



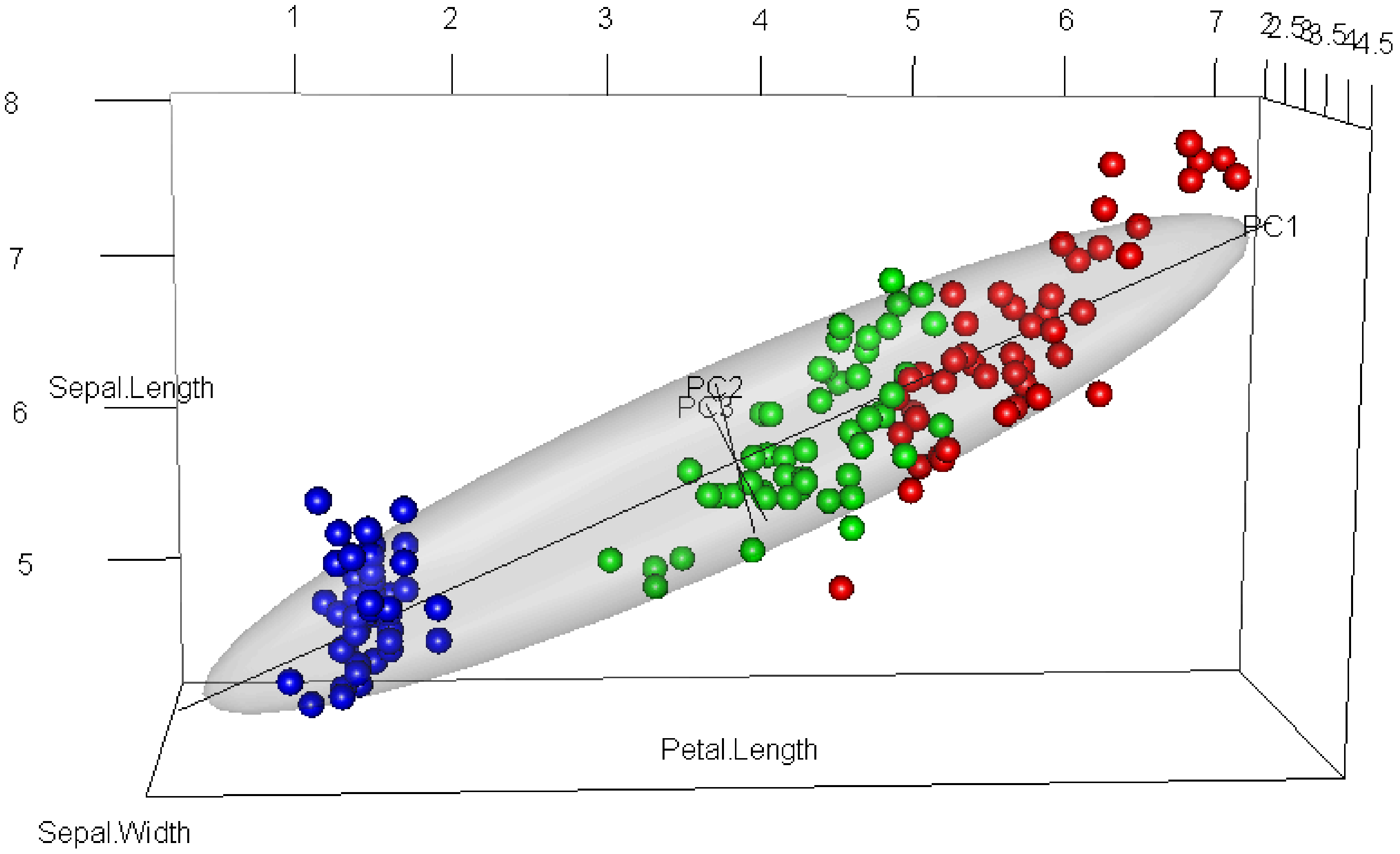
```
M3 <- par3d("userMatrix")
```

Rotate to show PC2 & PC3



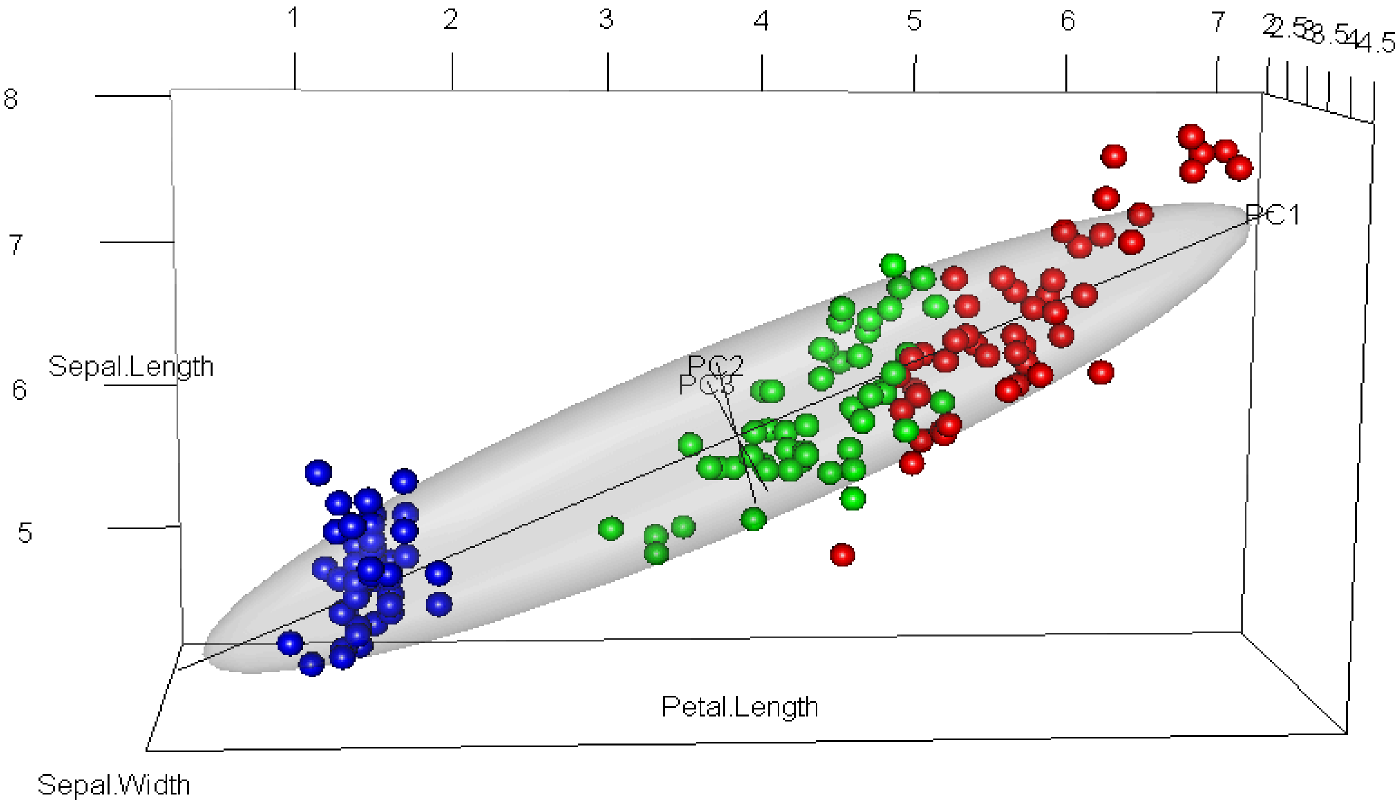
```
M4 <- par3d("userMatrix")
```

Biplot movie: rotation to PC coordinates



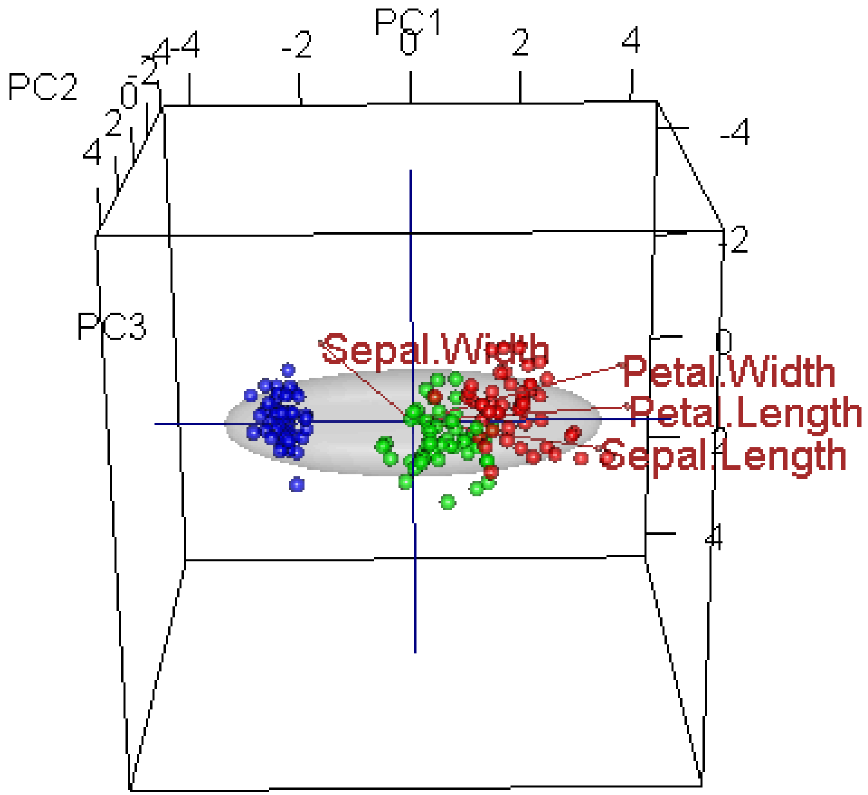
```
interp <-par3dinterp( userMatrix=list(M1, M2),
                      extrapolate="constant", method="linear")
movie3d(interp, duration=4, fps=8, movie="biplot3d-iris")
```

Grand tour: Interpolation thru multiple views



```
interp3 <-par3dinterp(userMatrix=list(M1, M2, M3, M4, M3, M2, M1),
                      extrapolate="constant", method="linear" )
movie3d(interp3, duration=6, fps=8, movie="biplot3d-iris3", dir="../anim")
```

View in PCA space: bpca package


PC1
PC2
PC3
Sepal.Width
Petal.Width
Petal.Length
Sepal.Length