456F

```r
w = read.table("wine.txt",sep = ",")
head(w)
```

```
##   V1    V2   V3   V4   V5  V6   V7   V8   V9  V10  V11  V12  V13  V14
## 1  1 14.23 1.71 2.43 15.6 127 2.80 3.06 0.28 2.29 5.64 1.04 3.92 1065
## 2  1 13.20 1.78 2.14 11.2 100 2.65 2.76 0.26 1.28 4.38 1.05 3.40 1050
## 3  1 13.16 2.36 2.67 18.6 101 2.80 3.24 0.30 2.81 5.68 1.03 3.17 1185
## 4  1 14.37 1.95 2.50 16.8 113 3.85 3.49 0.24 2.18 7.80 0.86 3.45 1480
## 5  1 13.24 2.59 2.87 21.0 118 2.80 2.69 0.39 1.82 4.32 1.04 2.93  735
## 6  1 14.20 1.76 2.45 15.2 112 3.27 3.39 0.34 1.97 6.75 1.05 2.85 1450
```

```r
#a Covariance matrix

sigma = cov(w)
round(sigma,2)
```

```
##          V1     V2     V3    V4      V5      V6    V7     V8     V9   V10
## V1     0.60  -0.21   0.38 -0.01    1.34   -2.32 -0.35  -0.66   0.05 -0.22
## V2    -0.21   0.66   0.09  0.05   -0.84    3.14  0.15   0.19  -0.02  0.06
## V3     0.38   0.09   1.25  0.05    1.08   -0.87 -0.23  -0.46   0.04 -0.14
## V4    -0.01   0.05   0.05  0.08    0.41    1.12  0.02   0.03   0.01  0.00
## V5     1.34  -0.84   1.08  0.41   11.15   -3.97 -0.67  -1.17   0.15 -0.38
## V6    -2.32   3.14  -0.87  1.12   -3.97  203.99  1.92   2.79  -0.46  1.93
## V7    -0.35   0.15  -0.23  0.02   -0.67    1.92  0.39   0.54  -0.04  0.22
## V8    -0.66   0.19  -0.46  0.03   -1.17    2.79  0.54   1.00  -0.07  0.37
## V9     0.05  -0.02   0.04  0.01    0.15   -0.46 -0.04  -0.07   0.02 -0.03
## V10   -0.22   0.06  -0.14  0.00   -0.38    1.93  0.22   0.37  -0.03  0.33
## V11    0.48   1.03   0.64  0.16    0.15    6.62 -0.08  -0.40   0.04 -0.03
## V12   -0.11  -0.01  -0.14  0.00   -0.21    0.18  0.06   0.12  -0.01  0.04
## V13   -0.43   0.04  -0.29  0.00   -0.66    0.67  0.31   0.56  -0.04  0.21
## V14 -154.67 164.57 -67.55 19.32 -463.36 1769.16 98.17 155.45 -12.20 59.55
##        V11   V12   V13      V14
## V1    0.48 -0.11 -0.43  -154.67
## V2    1.03 -0.01  0.04   164.57
## V3    0.64 -0.14 -0.29   -67.55
## V4    0.16  0.00  0.00    19.32
## V5    0.15 -0.21 -0.66  -463.36
## V6    6.62  0.18  0.67  1769.16
## V7   -0.08  0.06  0.31    98.17
## V8   -0.40  0.12  0.56   155.45
## V9    0.04 -0.01 -0.04   -12.20
## V10  -0.03  0.04  0.21    59.55
## V11   5.37 -0.28 -0.71   230.77
## V12  -0.28  0.05  0.09    17.00
## V13  -0.71  0.09  0.50    69.93
## V14 230.77 17.00 69.93 99166.72
```

```r
#b
sigma.eval = eigen(sigma)$values
sigma.evec = eigen(sigma)$vectors
round(sigma.eval,2)
```

```
## [1] 99202.03   172.54     9.53     5.10     1.29     0.87     0.29
## [8]     0.16     0.11     0.09     0.05     0.03     0.02     0.01
```

```r
round(sigma.evec ,2)
```

```
##        [,1]  [,2]  [,3]  [,4]  [,5]  [,6]  [,7]  [,8]  [,9] [,10] [,11]
##  [1,]  0.00  0.00 -0.10  0.15 -0.22  0.17 -0.18 -0.19 -0.17  0.51 -0.62
##  [2,]  0.00  0.00 -0.02  0.14  0.05 -0.20  0.89 -0.35 -0.10  0.06 -0.09
##  [3,]  0.00  0.00 -0.12  0.16 -0.53 -0.80 -0.15  0.08 -0.01 -0.03  0.01
##  [4,]  0.00  0.00 -0.05 -0.01  0.03 -0.04  0.05  0.15 -0.07 -0.11  0.35
##  [5,]  0.00 -0.03 -0.93 -0.36  0.07  0.02  0.04 -0.01  0.00 -0.01  0.00
##  [6,] -0.02 -1.00  0.03  0.00 -0.01  0.00  0.00  0.00  0.00  0.00  0.00
##  [7,]  0.00  0.00  0.04 -0.08  0.32 -0.23 -0.07  0.09 -0.36  0.72  0.39
##  [8,]  0.00  0.00  0.09 -0.17  0.54 -0.36 -0.08  0.20 -0.38 -0.32 -0.49
##  [9,]  0.00  0.00 -0.01  0.01 -0.03  0.02  0.00  0.00 -0.03 -0.02  0.18
## [10,]  0.00 -0.01  0.03 -0.05  0.25 -0.20 -0.35 -0.85  0.12 -0.10  0.13
## [11,]  0.00 -0.02 -0.30  0.86  0.37  0.01 -0.09  0.11  0.11 -0.04  0.04
## [12,]  0.00  0.00  0.03 -0.06  0.05  0.03  0.03  0.00 -0.03 -0.05  0.08
## [13,]  0.00  0.00  0.07 -0.18  0.27 -0.25  0.08  0.18  0.80  0.30 -0.18
## [14,] -1.00  0.02  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
##       [,12] [,13] [,14]
##  [1,] -0.37 -0.10  0.05
##  [2,] -0.03  0.00  0.01
##  [3,]  0.04 -0.06 -0.01
##  [4,] -0.89  0.09 -0.16
##  [5,]  0.06  0.00  0.00
##  [6,]  0.00  0.00  0.00
##  [7,]  0.14  0.02 -0.03
##  [8,] -0.08  0.00  0.09
##  [9,] -0.12 -0.13  0.97
## [10,] -0.09  0.02 -0.02
## [11,]  0.04 -0.04 -0.01
## [12,] -0.02 -0.98 -0.15
## [13,] -0.13 -0.04  0.06
## [14,]  0.00  0.00  0.00
```

```r
#(c) Perform principle component analysis on raw data??? scale choose
#true or false?
w.pca = prcomp(w,center=T,scale=F)
print(w.pca)
```

```
## Standard deviations (1, .., p=14):
##  [1] 314.96353873  13.13531864   3.08726351   2.25849728   1.13392604
##  [6]   0.93175457   0.53573032   0.39405452   0.33724371   0.29390207
## [11]   0.21494794   0.18688848   0.14409259   0.08995921
##
## Rotation (n x k) = (14 x 14):
##               PC1           PC2         PC3          PC4          PC5
## V1   0.0015593428 -2.778618e-03 -0.10091996 -0.147645845  0.219197410
## V2  -0.0016592619 -1.204267e-03 -0.01830354 -0.136988601 -0.048932608
## V3   0.0006810190 -2.159531e-03 -0.12455946 -0.156739376  0.528930958
## V4  -0.0001949052 -4.593996e-03 -0.05129289  0.012047122 -0.025845659
## V5   0.0046713046 -2.646070e-02 -0.92809986  0.356990103 -0.069611267
## V6  -0.0178679787 -9.993399e-01  0.02998454  0.004754117  0.006452123
## V7  -0.0009898316 -8.747309e-04  0.04276110  0.076452064 -0.320080904
```

```
## V8  -0.0015672929  5.865826e-05  0.09026712  0.172191025 -0.535695633
## V9   0.0001230870  1.353994e-03 -0.01372151 -0.010593546  0.029288874
## V10 -0.0006006091 -5.002227e-03  0.02623713  0.051606406 -0.253787072
## V11 -0.0023271272 -1.511422e-02 -0.30320298 -0.856516199 -0.367299181
## V12 -0.0001713811  7.640425e-04  0.02699227  0.059055310 -0.045942828
## V13 -0.0007049359  3.500684e-03  0.07436620  0.178526137 -0.269296632
## V14 -0.9998217211  1.776936e-02 -0.00462656  0.002950572  0.002713180
##              PC6           PC7           PC8           PC9          PC10
## V1   0.168685378 -1.788007e-01 -1.909952e-01 -1.658280e-01 -0.5109932771
## V2  -0.202080449  8.901163e-01 -3.490280e-01 -1.042972e-01 -0.0575902207
## V3  -0.803839930 -1.468581e-01  7.552074e-02 -1.022552e-02  0.0336100827
## V4  -0.041693904  5.034930e-02  1.505281e-01 -6.888147e-02  0.1071613371
## V5   0.023859516  3.593720e-02 -1.139207e-02  2.441283e-03  0.0099803583
## V6   0.001349008  2.065027e-03  3.568638e-03  1.632307e-03 -0.0008647093
## V7  -0.228319660 -6.567984e-02  8.990297e-02 -3.642319e-01 -0.7196957875
## V8  -0.357645070 -7.945528e-02  2.049005e-01 -3.849304e-01  0.3184589500
## V9   0.016951591 -5.403887e-05 -9.899527e-04 -2.887276e-02  0.0177935045
## V10 -0.197181268 -3.517404e-01 -8.477276e-01  1.212945e-01  0.1040244264
## V11  0.005507929 -9.328967e-02  1.083719e-01  1.108008e-01  0.0445052328
## V12  0.030413173  2.958250e-02  2.816679e-03 -2.708614e-02  0.0519432038
## V13 -0.249150932  7.998405e-02  1.809240e-01  8.045947e-01 -0.2960758515
## V14  0.001211259 -1.178372e-03 -9.491742e-05 -2.980272e-05 -0.0003880366
##              PC11          PC12          PC13          PC14
## V1  -0.6235291164  3.663543e-01  9.598765e-02 -4.715808e-02
## V2  -0.0890749178  3.477671e-02 -4.240326e-03 -1.342199e-02
## V3   0.0077436199 -3.573628e-02  6.323570e-02  1.205487e-02
## V4   0.3532557832  8.914869e-01 -8.648809e-02  1.623446e-01
## V5  -0.0026586178 -5.931059e-02  2.694858e-04  6.483270e-05
## V6  -0.0016384061 -2.620277e-03  5.009661e-04 -2.271269e-03
## V7   0.3933791381 -1.356768e-01 -1.908158e-02  3.464768e-02
## V8  -0.4852223379  8.051266e-02 -1.971202e-04 -8.667150e-02
## V9   0.1750692832  1.164653e-01  1.329541e-01 -9.672182e-01
## V10  0.1313895856  8.704446e-02 -1.502505e-02  1.929259e-02
## V11  0.0357823455 -3.763496e-02  4.256684e-02  7.836890e-03
## V12  0.0827103412  2.479200e-02  9.786547e-01  1.523550e-01
## V13 -0.1794317102  1.302390e-01  3.801870e-02 -5.675071e-02
## V14 -0.0005285291  4.693355e-05 -4.006096e-05 -6.726096e-05
```

```r
#above code returns 14 principle components as rotation
#  Compute principal components from the covariance matrix.
# sdev:  standard deviations of the component scores (
# square roots of eigenvalues of the covariance matrix)
#  rotation:  The coefficients needed to compute the scores
#  (elements of eigenvectors)

#  Print the results
round(w.pca$sdev,2)
```

```
##  [1] 314.96  13.14   3.09   2.26   1.13   0.93   0.54   0.39   0.34   0.29
## [11]   0.21   0.19   0.14   0.09
```

```r
round(w.pca$rotation,2)
```

```
##       PC1   PC2   PC3   PC4   PC5   PC6   PC7   PC8   PC9  PC10  PC11
## V1   0.00  0.00 -0.10 -0.15  0.22  0.17 -0.18 -0.19 -0.17 -0.51 -0.62
```

```
## V2   0.00  0.00 -0.02 -0.14 -0.05 -0.20  0.89 -0.35 -0.10 -0.06 -0.09
## V3   0.00  0.00 -0.12 -0.16  0.53 -0.80 -0.15  0.08 -0.01  0.03  0.01
## V4   0.00  0.00 -0.05  0.01 -0.03 -0.04  0.05  0.15 -0.07  0.11  0.35
## V5   0.00 -0.03 -0.93  0.36 -0.07  0.02  0.04 -0.01  0.00  0.01  0.00
## V6  -0.02 -1.00  0.03  0.00  0.01  0.00  0.00  0.00  0.00  0.00  0.00
## V7   0.00  0.00  0.04  0.08 -0.32 -0.23 -0.07  0.09 -0.36 -0.72  0.39
## V8   0.00  0.00  0.09  0.17 -0.54 -0.36 -0.08  0.20 -0.38  0.32 -0.49
## V9   0.00  0.00 -0.01 -0.01  0.03  0.02  0.00  0.00 -0.03  0.02  0.18
## V10  0.00 -0.01  0.03  0.05 -0.25 -0.20 -0.35 -0.85  0.12  0.10  0.13
## V11  0.00 -0.02 -0.30 -0.86 -0.37  0.01 -0.09  0.11  0.11  0.04  0.04
## V12  0.00  0.00  0.03  0.06 -0.05  0.03  0.03  0.00 -0.03  0.05  0.08
## V13  0.00  0.00  0.07  0.18 -0.27 -0.25  0.08  0.18  0.80 -0.30 -0.18
## V14 -1.00  0.02  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
##      PC12  PC13  PC14
## V1   0.37  0.10 -0.05
## V2   0.03  0.00 -0.01
## V3  -0.04  0.06  0.01
## V4   0.89 -0.09  0.16
## V5  -0.06  0.00  0.00
## V6   0.00  0.00  0.00
## V7  -0.14 -0.02  0.03
## V8   0.08  0.00 -0.09
## V9   0.12  0.13 -0.97
## V10  0.09 -0.02  0.02
## V11 -0.04  0.04  0.01
## V12  0.02  0.98  0.15
## V13  0.13  0.04 -0.06
## V14  0.00  0.00  0.00
```

```r
#d
s = w.pca$sdev^2
pvar = s/sum(s)
cpvar = cumsum(s) / sum(s)
cat("Cumulative proportion of the total variance explained by each component: ", cpvar, fill = T)
```

```
## Cumulative proportion of the total variance explained by each component:
## 0.9980876 0.9998235 0.9999194 0.9999708 0.9999837 0.9999924 0.9999953
## 0.9999969 0.999998 0.9999989 0.9999994 0.9999997 0.9999999 1
```

```r
#second way to confirm this:
summary(w.pca)
```

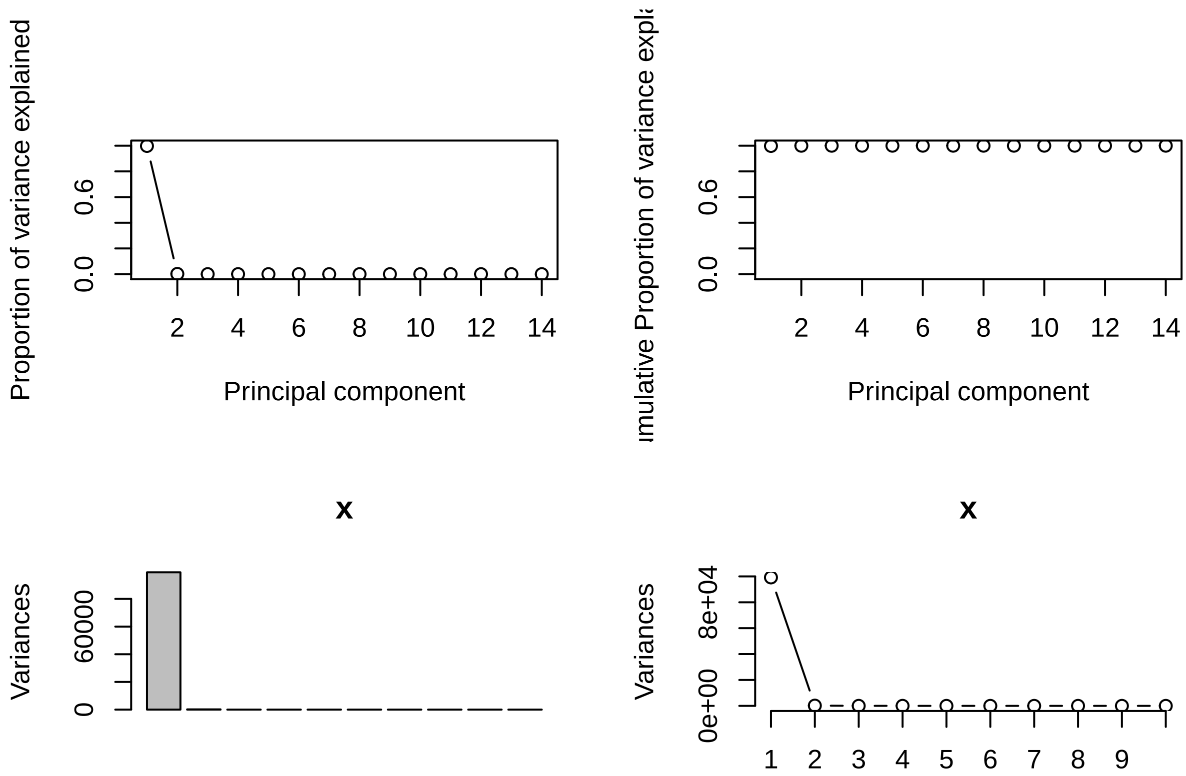
```
## Importance of components%s:
##                             PC1      PC2    PC3     PC4     PC5     PC6
## Standard deviation     314.9635 13.13532 3.0873 2.25850 1.13393 0.93175
## Proportion of Variance   0.9981  0.00174 0.0001 0.00005 0.00001 0.00001
## Cumulative Proportion    0.9981  0.99982 0.9999 0.99997 0.99998 0.99999
##                           PC7    PC8    PC9   PC10   PC11   PC12   PC13
## Standard deviation     0.5357 0.3941 0.3372 0.2939 0.2149 0.1869 0.1441
## Proportion of Variance 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
## Cumulative Proportion  1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
##                           PC14
## Standard deviation     0.08996
## Proportion of Variance 0.00000
## Cumulative Proportion  1.00000
```

```r
#use summary to compute the total variance explained by each component

#e
#It appears that 5 components needed to explain 75 percents

#(f)    For the number of components in part e, give the formula for each component
#and a brief interpretation.
#Provide formula for each component???
#PC1 = 0.393669533 * V1 - 0.136325011 * V2 + ...
#PC2 = ...

#g
# 7 components are needed in this case
```

```r
#Give the four plots that helps explain
pcaCharts <- function(x) {
    x.var <- x$sdev ^ 2
    x.pvar <- x.var/sum(x.var)
    print("proportions of variance:")
    print(x.pvar)

    par(mfrow=c(2,2))
    plot(x.pvar,xlab="Principal component", ylab="Proportion of variance explained", ylim=c(0,1), type=
    plot(cumsum(x.pvar),xlab="Principal component", ylab="Cumulative Proportion of variance explained",
    screeplot(x)
    screeplot(x,type="l")
    par(mfrow=c(1,1))
}
```

```r
pcaCharts(w.pca)
```

```
## [1] "proportions of variance:"
##  [1] 9.980876e-01 1.735919e-03 9.589490e-05 5.132007e-05 1.293652e-05
##  [6] 8.734764e-06 2.887623e-06 1.562287e-06 1.144289e-06 8.690673e-07
## [11] 4.648520e-07 3.514092e-07 2.088966e-07 8.142155e-08
```




```r
#h
w.pca0 = princomp(w,cor=TRUE)
head(w.pca0$scores)
```

```
##          Comp.1     Comp.2     Comp.3      Comp.4     Comp.5     Comp.6
## [1,] -3.522934 -1.4530984  0.1647955  0.01327282  0.7373454 -0.3007162
## [2,] -2.528858  0.3300193  2.0267067  0.41714436 -0.2832137 -0.8843094
## [3,] -2.785029 -1.0369360 -0.9832377 -0.66423241 -0.3875650  0.4688416
## [4,] -3.922588 -2.7682103  0.1749682 -0.56508782 -0.3243597  0.2626164
## [5,] -1.407511 -0.8677731 -2.0258295  0.44090580  0.2279492 -0.5937621
## [6,] -3.288130 -2.1301751  0.6289923  0.60537190 -0.4096264  0.2582760
##           Comp.7      Comp.8      Comp.9     Comp.10    Comp.11
## [1,]  0.57387557  0.05563728  0.45876506  1.06556955 -0.4204939
## [2,] -0.02971648  1.01037189 -0.21880609 -0.02018203 -0.1300196
## [3,]  0.48830540 -0.26895705 -1.22276949 -0.10624913 -0.2790741
## [4,] -0.39836411  0.61884369  0.11465832  0.10767113  0.7738658
## [5,]  0.44787555  0.43493730  0.26154774  0.11243432 -0.5379312
## [6,]  0.37857594  0.36682547 -0.04491229 -0.21796620  0.4077854
##           Comp.12     Comp.13     Comp.14
## [1,] -0.552927766  0.30297818  0.20085745
## [2,] -0.394971160  0.14664531  0.12640235
## [3,] -0.001897993 -0.02127802 -0.05575152
## [4,]  0.230929232  0.50127681  0.01990285
## [5,]  0.226686179 -0.27410891 -0.51749790
## [6,]  0.376715445  0.01744264  0.23956231
```

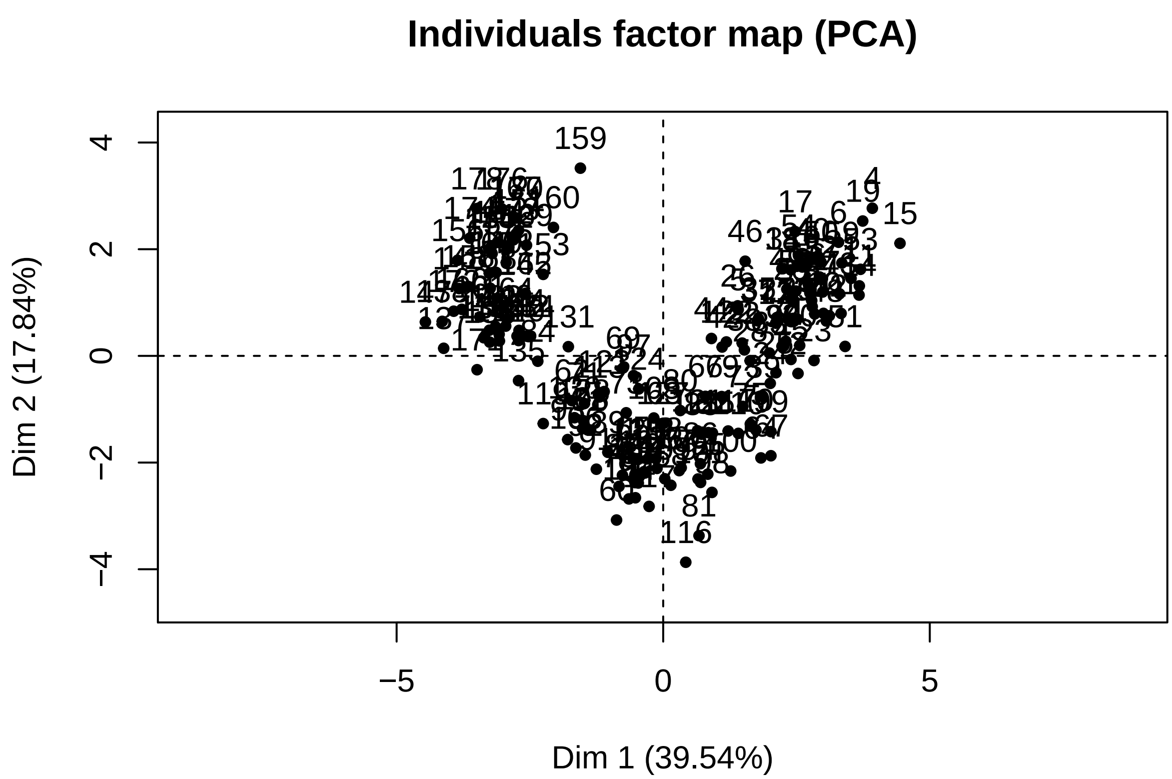
```r
#(h)
#  plot component scores????????????
component_scores = w.pca$x[,c(1,2,3,5,6,7)]
head(component_scores)
```

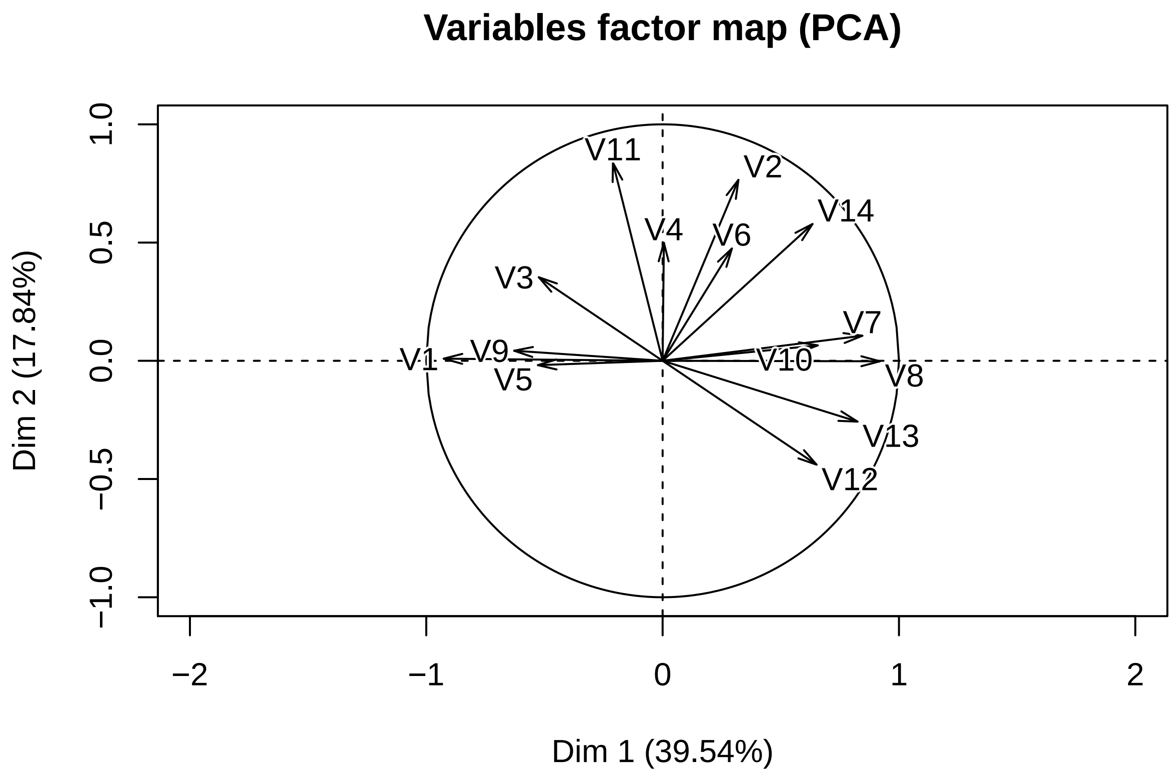
```
##             PC1         PC2        PC3        PC5          PC6         PC7
## [1,] -318.56405 -21.4907729  3.1646131 -0.7520919 -0.520108716  0.59053749
## [2,] -303.09851   5.3660827  6.8169925  0.5010454 -0.052439234 -0.08217096
## [3,] -438.06206   6.5379861 -1.0667167 -0.4532081 -0.634321618 -0.79376803
## [4,] -733.24071  -0.1933200 -0.9383123 -0.8799180 -0.480809678 -0.10023671
## [5,]   11.56995 -18.4872549 -0.4249173 -0.5067331 -0.862531264  0.40524787
## [6,] -703.23180   0.3317232  0.9229641 -0.1133199 -0.006724859 -0.07490001
```

```r
#(h)
library(FactoMineR)
```

```
## Warning: package 'FactoMineR' was built under R version 3.4.2
```

```r
w.pca1 = PCA(w)
```






```
w.pca1$var$coord
```

```
##            Dim.1        Dim.2        Dim.3       Dim.4       Dim.5
## V1  -0.926249119  0.008992068  0.001464623  0.11796747 -0.14761693
## V2   0.320753602  0.765077776 -0.249405338 -0.07891083  0.23502535
## V3  -0.523926254  0.353321542  0.106779776  0.45263625  0.17667138
## V4   0.005312596  0.499119886  0.752905787 -0.24066828  0.08760833
## V5  -0.527742841 -0.018355351  0.735934791  0.06934999 -0.04362215
## V6   0.293237259  0.474935577  0.157512659 -0.15722170 -0.72910189
## V7   0.845297832  0.106063692  0.176179709  0.18397317  0.13551568
## V8   0.919289787 -0.002075539  0.181536969  0.13930706  0.10492129
## V9  -0.628216328  0.042647926  0.204400357 -0.31596971  0.40521898
## V10  0.656594877  0.065140471  0.180234438  0.44576752 -0.08579534
## V11 -0.210153399  0.837170096 -0.165066603  0.06946486  0.04334310
## V12  0.651324814 -0.439153088  0.102609980 -0.41870738  0.02797754
## V13  0.824738871 -0.257221308  0.199865440  0.15096930  0.13507348
## V14  0.634131533  0.578451334 -0.152344513 -0.24640337  0.07906923
```

```
#On the second output table, Dim1 symbolizes the first principle component :
#same for rest to interpert.

#Using 0.5 as threshhold:

###there are only 5 dims but to explain 90 percent, there needs about 7??

#The first principle component: V1 has highest and V4 has the lowest
#The second principle component:...
```

```r
#...
```

```r
#i. Give the correlation between Alcohol and the first principal component
pca.out = prcomp(w)
round(cor(pca.out$x,w),2)
```

```
##          V1    V2    V3    V4    V5    V6    V7    V8    V9   V10   V11
## PC1    0.63 -0.64  0.19 -0.22  0.44 -0.39 -0.50 -0.49  0.31 -0.33 -0.32
## PC2   -0.05 -0.02 -0.03 -0.22 -0.10 -0.92 -0.02  0.00  0.14 -0.11 -0.09
## PC3   -0.40 -0.07 -0.34 -0.58 -0.86  0.01  0.21  0.28 -0.34  0.14 -0.40
## PC4   -0.43 -0.38 -0.32  0.10  0.24  0.00  0.28  0.39 -0.19  0.20 -0.83
## PC5    0.32 -0.07  0.54 -0.11 -0.02  0.00 -0.58 -0.61  0.27 -0.50 -0.18
## PC6    0.20 -0.23 -0.67 -0.14  0.01  0.00 -0.34 -0.33  0.13 -0.32  0.00
## PC7   -0.12  0.59 -0.07  0.10  0.01  0.00 -0.06 -0.04  0.00 -0.33 -0.02
## PC8   -0.10 -0.17  0.03  0.22  0.00  0.00  0.06  0.08  0.00 -0.58  0.02
## PC9   -0.07 -0.04  0.00 -0.08  0.00  0.00 -0.20 -0.13 -0.08  0.07  0.02
## PC10  -0.19 -0.02  0.01  0.11  0.00  0.00 -0.34  0.09  0.04  0.05  0.01
## PC11  -0.17 -0.02  0.00  0.28  0.00  0.00  0.14 -0.10  0.30  0.05  0.00
## PC12   0.09  0.01 -0.01  0.61  0.00  0.00 -0.04  0.02  0.17  0.03  0.00
## PC13   0.02  0.00  0.01 -0.05  0.00  0.00  0.00  0.00  0.15  0.00  0.00
## PC14  -0.01  0.00  0.00  0.05  0.00  0.00  0.00 -0.01 -0.70  0.00  0.00
##         V12   V13 V14
## PC1   -0.24 -0.31  -1
## PC2    0.04  0.06   0
## PC3    0.36  0.32   0
## PC4    0.58  0.57   0
## PC5   -0.23 -0.43   0
## PC6    0.12 -0.33   0
## PC7    0.07  0.06   0
## PC8    0.00  0.10   0
## PC9   -0.04  0.38   0
## PC10   0.07 -0.12   0
## PC11   0.08 -0.05   0
## PC12   0.02  0.03   0
## PC13   0.62  0.01   0
## PC14   0.06 -0.01   0
```

```r
#correlation between Alcohol and the first principal component is 0.63, which
#suggests those 2 are highly correlated
```

```r
##########################
######### PART2
##########################
# To compute principal components from a correlation matrix, I first
#standardize the data aka change the scale to true.
ws = scale(w,center=T,scale = T)
ws.cor = var(ws)
cat("covariance matrix:", fill=T)
```

```
## covariance matrix:
```

```r
round(ws.cor,2)
```

```
##        V1    V2    V3    V4    V5    V6    V7    V8    V9   V10   V11
## V1   1.00 -0.33  0.44 -0.05  0.52 -0.21 -0.72 -0.85  0.49 -0.50  0.27
## V2  -0.33  1.00  0.09  0.21 -0.31  0.27  0.29  0.24 -0.16  0.14  0.55
```

```
## V3   0.44  0.09  1.00  0.16  0.29 -0.05 -0.34 -0.41  0.29 -0.22  0.25
## V4  -0.05  0.21  0.16  1.00  0.44  0.29  0.13  0.12  0.19  0.01  0.26
## V5   0.52 -0.31  0.29  0.44  1.00 -0.08 -0.32 -0.35  0.36 -0.20  0.02
## V6  -0.21  0.27 -0.05  0.29 -0.08  1.00  0.21  0.20 -0.26  0.24  0.20
## V7  -0.72  0.29 -0.34  0.13 -0.32  0.21  1.00  0.86 -0.45  0.61 -0.06
## V8  -0.85  0.24 -0.41  0.12 -0.35  0.20  0.86  1.00 -0.54  0.65 -0.17
## V9   0.49 -0.16  0.29  0.19  0.36 -0.26 -0.45 -0.54  1.00 -0.37  0.14
## V10 -0.50  0.14 -0.22  0.01 -0.20  0.24  0.61  0.65 -0.37  1.00 -0.03
## V11  0.27  0.55  0.25  0.26  0.02  0.20 -0.06 -0.17  0.14 -0.03  1.00
## V12 -0.62 -0.07 -0.56 -0.07 -0.27  0.06  0.43  0.54 -0.26  0.30 -0.52
## V13 -0.79  0.07 -0.37  0.00 -0.28  0.07  0.70  0.79 -0.50  0.52 -0.43
## V14 -0.63  0.64 -0.19  0.22 -0.44  0.39  0.50  0.49 -0.31  0.33  0.32
##       V12   V13   V14
## V1  -0.62 -0.79 -0.63
## V2  -0.07  0.07  0.64
## V3  -0.56 -0.37 -0.19
## V4  -0.07  0.00  0.22
## V5  -0.27 -0.28 -0.44
## V6   0.06  0.07  0.39
## V7   0.43  0.70  0.50
## V8   0.54  0.79  0.49
## V9  -0.26 -0.50 -0.31
## V10  0.30  0.52  0.33
## V11 -0.52 -0.43  0.32
## V12  1.00  0.57  0.24
## V13  0.57  1.00  0.31
## V14  0.24  0.31  1.00
```

```r
#Start repeating from the first step
#a Covariance matrix
sigma = var(ws)
round(sigma,2)
```

```
##        V1    V2    V3    V4    V5    V6    V7    V8    V9   V10   V11
## V1   1.00 -0.33  0.44 -0.05  0.52 -0.21 -0.72 -0.85  0.49 -0.50  0.27
## V2  -0.33  1.00  0.09  0.21 -0.31  0.27  0.29  0.24 -0.16  0.14  0.55
## V3   0.44  0.09  1.00  0.16  0.29 -0.05 -0.34 -0.41  0.29 -0.22  0.25
## V4  -0.05  0.21  0.16  1.00  0.44  0.29  0.13  0.12  0.19  0.01  0.26
## V5   0.52 -0.31  0.29  0.44  1.00 -0.08 -0.32 -0.35  0.36 -0.20  0.02
## V6  -0.21  0.27 -0.05  0.29 -0.08  1.00  0.21  0.20 -0.26  0.24  0.20
## V7  -0.72  0.29 -0.34  0.13 -0.32  0.21  1.00  0.86 -0.45  0.61 -0.06
## V8  -0.85  0.24 -0.41  0.12 -0.35  0.20  0.86  1.00 -0.54  0.65 -0.17
## V9   0.49 -0.16  0.29  0.19  0.36 -0.26 -0.45 -0.54  1.00 -0.37  0.14
## V10 -0.50  0.14 -0.22  0.01 -0.20  0.24  0.61  0.65 -0.37  1.00 -0.03
## V11  0.27  0.55  0.25  0.26  0.02  0.20 -0.06 -0.17  0.14 -0.03  1.00
## V12 -0.62 -0.07 -0.56 -0.07 -0.27  0.06  0.43  0.54 -0.26  0.30 -0.52
## V13 -0.79  0.07 -0.37  0.00 -0.28  0.07  0.70  0.79 -0.50  0.52 -0.43
## V14 -0.63  0.64 -0.19  0.22 -0.44  0.39  0.50  0.49 -0.31  0.33  0.32
##       V12   V13   V14
## V1  -0.62 -0.79 -0.63
## V2  -0.07  0.07  0.64
## V3  -0.56 -0.37 -0.19
## V4  -0.07  0.00  0.22
## V5  -0.27 -0.28 -0.44
## V6   0.06  0.07  0.39
```

```
## V7   0.43  0.70  0.50
## V8   0.54  0.79  0.49
## V9  -0.26 -0.50 -0.31
## V10  0.30  0.52  0.33
## V11 -0.52 -0.43  0.32
## V12  1.00  0.57  0.24
## V13  0.57  1.00  0.31
## V14  0.24  0.31  1.00
```

```r
#why same results??
```

```r
#should I put true or false?
ws.pca = prcomp(ws,center=T,scale=F)
print(ws.pca)
```

```
## Standard deviations (1, .., p=14):
##  [1] 2.3528595 1.5802140 1.2025283 0.9632849 0.9367510 0.8202307 0.7441767
##  [8] 0.5916369 0.5427172 0.5121583 0.4752351 0.4108488 0.3599502 0.2404419
##
## Rotation (n x k) = (14 x 14):
##              PC1          PC2          PC3         PC4         PC5
## V1   0.393669533 -0.005690412  0.001217953 -0.12246373  0.15758395
## V2  -0.136325011 -0.484160868 -0.207400812  0.08191848 -0.25089415
## V3   0.222676383 -0.223590947  0.088796064 -0.46988824 -0.18860015
## V4  -0.002257932 -0.315855884  0.626102363  0.24984122 -0.09352360
## V5   0.224298489  0.011615737  0.611989600 -0.07199322  0.04656750
## V6  -0.124630159 -0.300551432  0.130984580  0.16321412  0.77833048
## V7  -0.359264042 -0.067119829  0.146507749 -0.19098521 -0.14466563
## V8  -0.390711715  0.001313454  0.150962746 -0.14461667 -0.11200553
## V9   0.267001203 -0.026988703  0.169975512  0.32801272 -0.43257916
## V10 -0.279062504 -0.041222563  0.149879586 -0.46275771  0.09158820
## V11  0.089318293 -0.529782740 -0.137266298 -0.07211248 -0.04626960
## V12 -0.276822650  0.277907354  0.085328539  0.43466618 -0.02986657
## V13 -0.350526181  0.162776250  0.166204360 -0.15672341 -0.14419358
## V14 -0.269515252 -0.366058862 -0.126686846  0.25579490 -0.08440794
##             PC6         PC7         PC8          PC9        PC10
## V1  -0.20033864  0.05938234 -0.07179553 -0.162368819  0.19899373
## V2   0.13517139  0.09269887 -0.42154435 -0.450190708 -0.31127983
## V3   0.59841948 -0.37436980 -0.08757556 -0.006025687  0.32592413
## V4   0.10799983  0.16708856  0.17208034  0.262494455  0.12452347
## V5  -0.08811224  0.26872469 -0.41324857 -0.118633417 -0.15716811
## V6   0.14483831 -0.32957951  0.14881189 -0.252536278 -0.12773363
## V7  -0.14809748  0.03789829  0.36343884 -0.406373544  0.30772263
## V8  -0.06247252  0.06773223  0.17540500 -0.090919334  0.14044000
## V9  -0.25868639 -0.61111195  0.23075135 -0.159122818 -0.24054263
## V10 -0.46627764 -0.42292282 -0.34373920  0.265786794 -0.10869629
## V11 -0.42525454  0.18613617  0.04069617 -0.075264592  0.21704255
## V12  0.01565089 -0.19204101 -0.48362564 -0.212416815  0.50966073
## V13  0.21770365  0.07850980  0.06865116 -0.084264837 -0.45570504
## V14  0.06656550 -0.05420370 -0.11146671  0.544905394  0.04620802
##            PC11        PC12        PC13         PC14
## V1  -0.01444169  0.01575769 -0.49224318 -0.669045280
## V2   0.22154641 -0.26411262 -0.05610645 -0.090626055
## V3  -0.06839251  0.11921210  0.06675544  0.025225306
## V4   0.49452428 -0.04502305 -0.19201787  0.001635816
```

```
## V5  -0.47461722 -0.06131271  0.20007784  0.095361066
## V6  -0.07119731  0.06116074  0.05829909 -0.022300745
## V7  -0.29740957 -0.30087591 -0.35952714  0.253037788
## V8   0.03219187 -0.05001396  0.59834288 -0.601909165
## V9  -0.12200984  0.04266558  0.06403952 -0.082230935
## V10  0.23292405 -0.09334264 -0.11013538  0.058641979
## V11 -0.01972448  0.59795428  0.15917751  0.178821145
## V12  0.06140493  0.25774292 -0.04923091  0.022582562
## V13 -0.06646166  0.61109218 -0.32941979 -0.135092159
## V14 -0.55130818 -0.07268036 -0.17322892 -0.216043617
```