lab07

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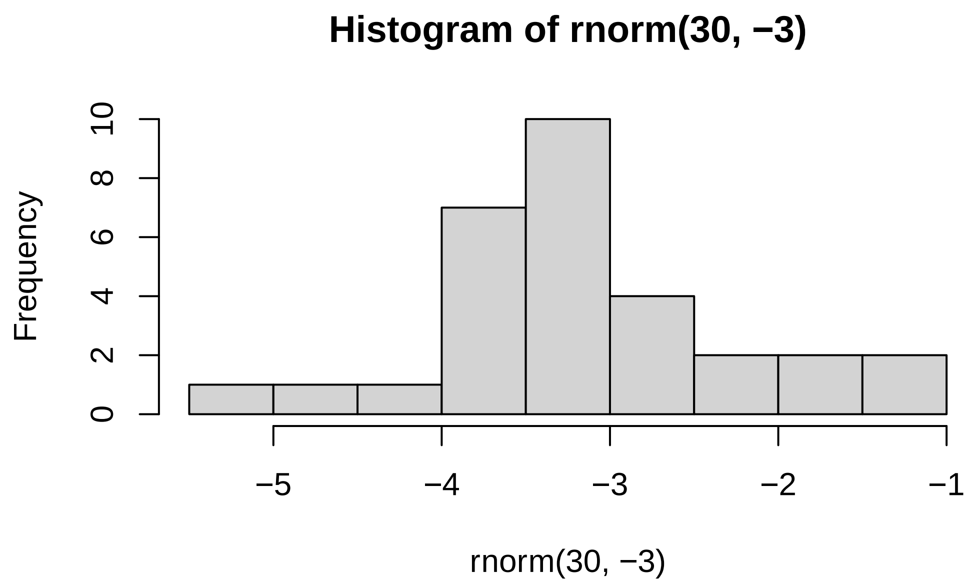
kmeans

```r
hist(rnorm(30, -3))
```

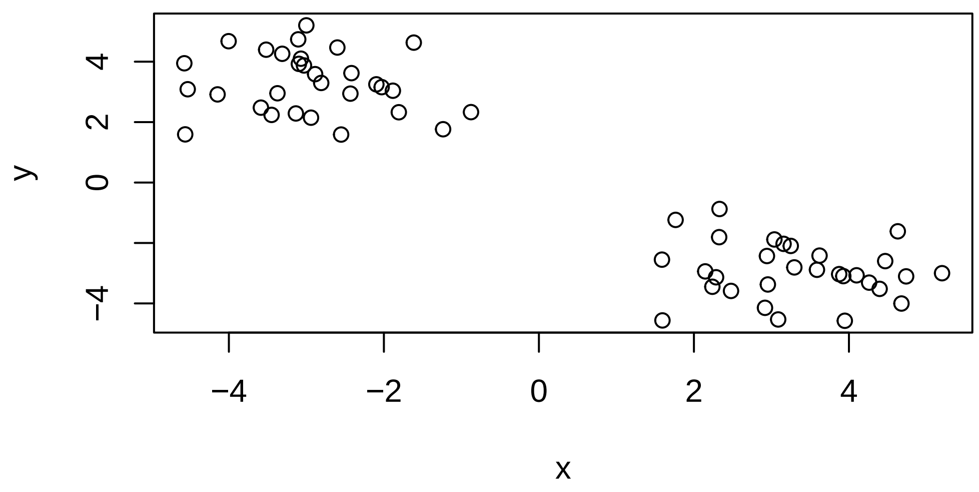


```r
tmp <- c(rnorm(30, -3), rnorm(30, +3))
x <- cbind(x=tmp, y=rev(tmp))
head(x)
```

```
             x        y
[1,] -2.028778 3.156471
```

```
[2,] -3.096753 3.927053
[3,] -4.574697 3.946691
[4,] -2.940199 2.145891
[5,] -3.000527 5.201289
[6,] -3.373100 2.953791
```

```
plot(x)
```

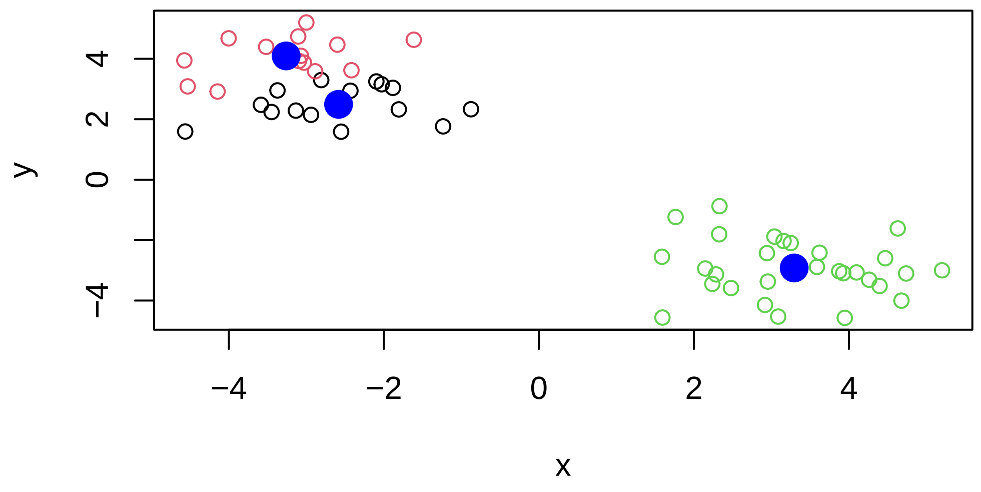


Use the kmeans function

```
km <- kmeans(x, centers=2, nstart=20)
km
```

```
K-means clustering with 2 clusters of sizes 30, 30

Cluster means:
          x         y
1  3.293751 -2.922612
2 -2.922612  3.293751

Clustering vector:
 [1] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1
[39] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Within cluster sum of squares by cluster:
[1] 55.13581 55.13581
 (between_SS / total_SS =  91.3 %)

Available components:

[1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
[6] "betweenss"    "size"         "iter"         "ifault"
```

```
# play with kmeans and ask for different number of clusters

km <- kmeans(x, centers=3, nstart=20)
plot(x, col=km$cluster)
points(km$centers, col="blue", pch=16, cex=2)
```



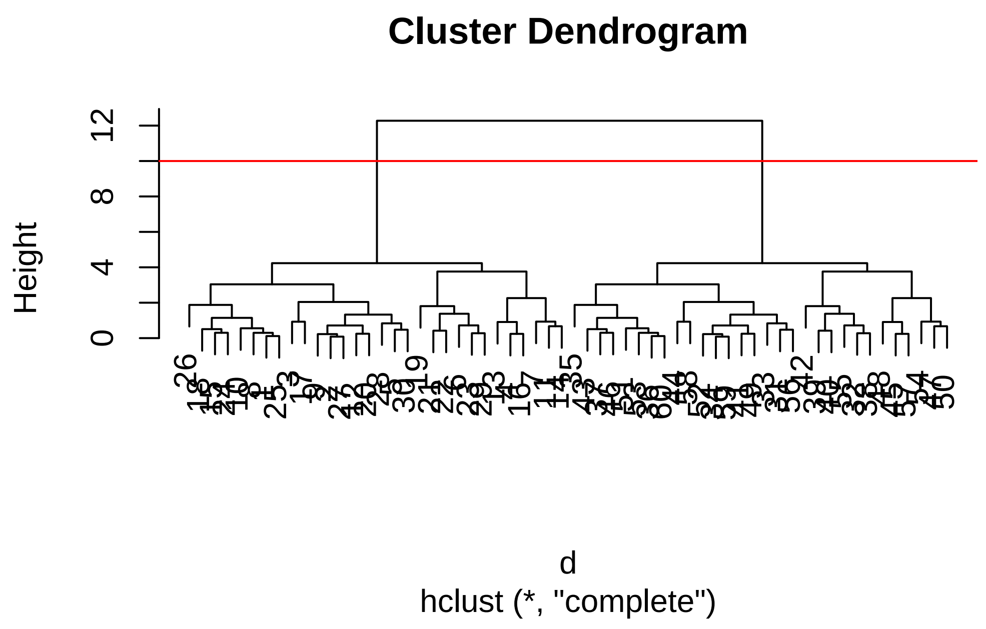
Hierarchical clustering

```r
d <- dist(x)
hc <- hclust(d)

hc
```

```
Call:
hclust(d = d)

Cluster method   : complete
Distance         : euclidean
Number of objects: 60
```

There is a plot method for hclust result.

```r
plot(hc)
abline(h=10, col='red')
```

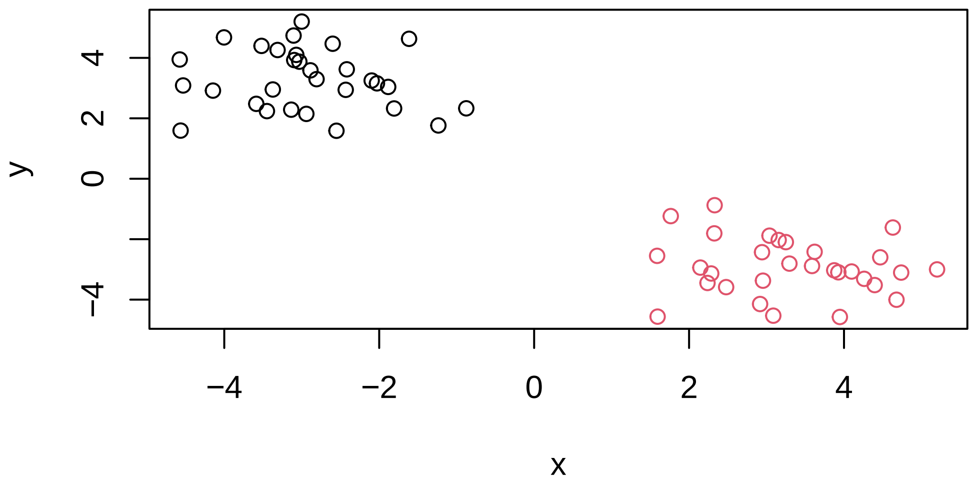


To get all the members of a given cluster residing in the same cut branch.

```r
cut_hc <- cutree(hc, h=10)
cut_hc
```

```
 [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2
[39] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
```

```r
plot(x, col=cut_hc)
```



It is often helpful to use "k" instead of "h=" in cutree.

```r
cutree(hc, k=4)
```

```
 [1] 1 1 1 2 1 2 2 1 1 1 2 1 2 2 1 2 1 1 2 1 2 2 2 1 1 1 1 1 2 1 3 4 3 3 3 3 3 4
[39] 4 4 3 4 3 3 4 3 4 4 3 4 3 3 3 4 4 3 4 3 3 3
```

PCA

```
url <- "https://tinyurl.com/UK-foods"
x <- read.csv(url)
```

```
ncol(x)
```

```
[1] 5
```

```
nrow(x)
```

```
[1] 17
```

Q1. 5 columns 17 rows.

```
#View(head(x, 6))
head(x,6)
```

```
               X England Wales Scotland N.Ireland
1         Cheese     105   103      103        66
2  Carcass_meat      245   227      242       267
3    Other_meat      685   803      750       586
4           Fish     147   160      122        93
5 Fats_and_oils      193   235      184       209
6         Sugars     156   175      147       139
```

```
# change the index to first column

rownames(x) <- x[,1]
x <- x[,-1]
head(x)
```

```
               England Wales Scotland N.Ireland
Cheese             105   103      103        66
Carcass_meat       245   227      242       267
Other_meat         685   803      750       586
Fish               147   160      122        93
Fats_and_oils      193   235      184       209
Sugars             156   175      147       139
```

```r
dim(x)
```

```
[1] 17  4
```

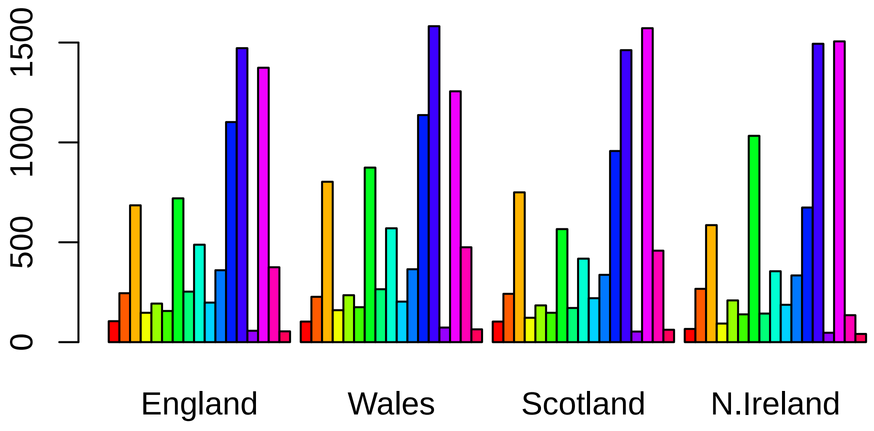
```r
x <- read.csv(url, row.names=1)
head(x)
```

```
               England Wales Scotland N.Ireland
Cheese             105   103      103        66
Carcass_meat       245   227      242       267
Other_meat         685   803      750       586
Fish               147   160      122        93
Fats_and_oils      193   235      184       209
Sugars             156   175      147       139
```

> Q2. the second approach is more robust. Since we don't need to reassign x. And we can have two dataset from the same url but with different columns as rownames.

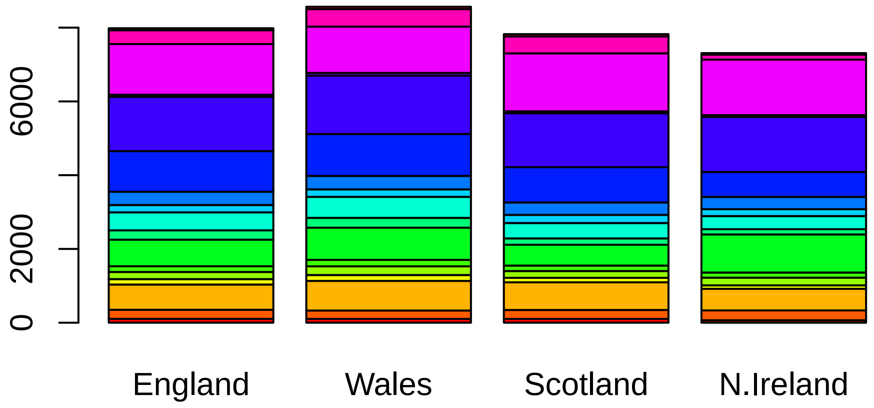
Visualize the data

```r
barplot(as.matrix(x), beside=T, col=rainbow(nrow(x)))
```

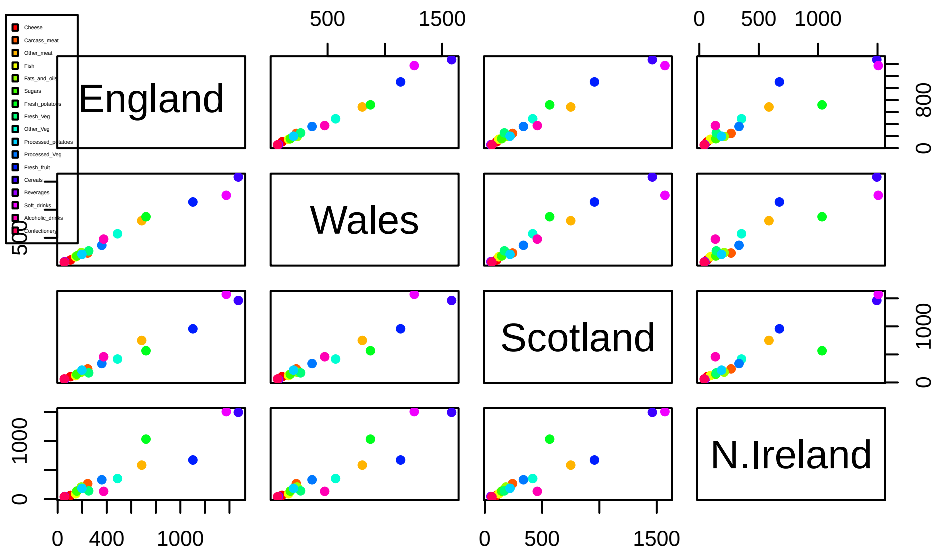


Q3. # change the beside to False to get a stacked barplot

```
barplot(as.matrix(x), beside=F, col=rainbow(nrow(x)))
```



```
x$color <- rainbow(nrow(x))

pairs(x[, 1:4], col=x$color, pch=16)
par(xpd=TRUE)
legend("topleft", fill = unique(x$color), legend = c( rownames(x) ), cex=0.2)
```



Q5. It makes pairwise comparison of each combination. plot(2,3) is comparing Wales and Scotland for the prize of each different food type. Points on diagonal mean the prize of that specific food cost the same in the two countries in comparison.

Q6. Certain food is higher in N. Ireland. But it's generally hard to compare.

Use the PCA on the dataset

```
x <- x[, 1:4]

pca <- prcomp(t(x))
summary(pca)
```

```
Importance of components:
                            PC1      PC2      PC3       PC4
Standard deviation     324.1502 212.7478 73.87622 5.552e-14
Proportion of Variance   0.6744   0.2905  0.03503 0.000e+00
Cumulative Proportion    0.6744   0.9650  1.00000 1.000e+00
```

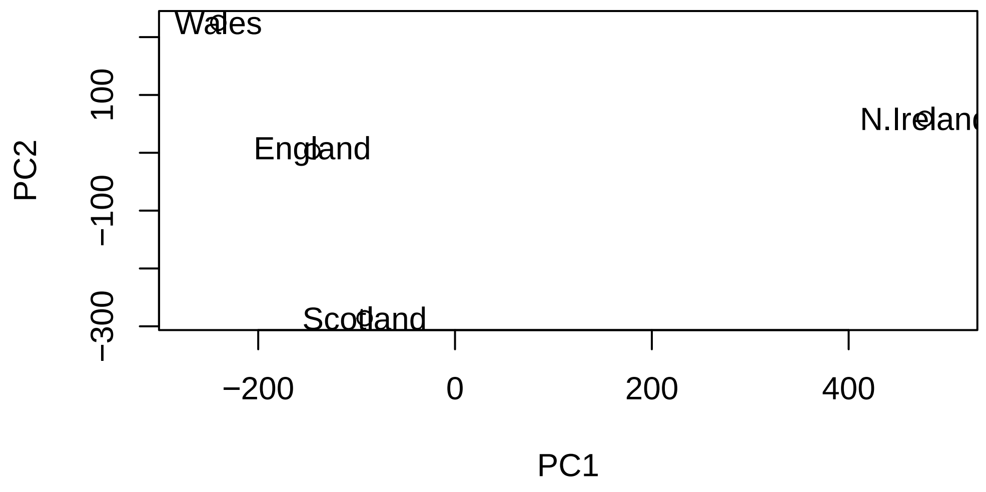
```
head(pca)
```

```
$sdev
[1] 3.241502e+02 2.127478e+02 7.387622e+01 5.551558e-14

$rotation
                            PC1          PC2         PC3          PC4
Cheese             -0.056955380 -0.016012850 -0.02394295 -0.537717586
Carcass_meat        0.047927628 -0.013915823 -0.06367111  0.827327785
Other_meat         -0.258916658  0.015331138  0.55384854 -0.054885657
Fish               -0.084414983  0.050754947 -0.03906481 -0.017195729
Fats_and_oils      -0.005193623  0.095388656  0.12522257  0.039441462
Sugars             -0.037620983  0.043021699  0.03605745  0.002788534
Fresh_potatoes      0.401402060  0.715017078  0.20668248 -0.030319813
Fresh_Veg          -0.151849942  0.144900268 -0.21382237 -0.051070911
Other_Veg          -0.243593729  0.225450923  0.05332841  0.060355222
Processed_potatoes -0.026886233 -0.042850761  0.07364902  0.003645959
Processed_Veg      -0.036488269  0.045451802 -0.05289191 -0.003672450
Fresh_fruit        -0.632640898  0.177740743 -0.40012865  0.031359988
Cereals            -0.047702858  0.212599678  0.35884921  0.073618516
Beverages          -0.026187756  0.030560542  0.04135860 -0.005163295
Soft_drinks         0.232244140 -0.555124311  0.16942648 -0.009904437
Alcoholic_drinks   -0.463968168 -0.113536523  0.49858320  0.088180533
Confectionery      -0.029650201 -0.005949921  0.05232164  0.004029923

$center
            Cheese       Carcass_meat         Other_meat               Fish
             94.25             245.25             706.00             130.50
     Fats_and_oils             Sugars     Fresh_potatoes          Fresh_Veg
            205.25             154.25             798.25             208.00
         Other_Veg Processed_potatoes      Processed_Veg        Fresh_fruit
            457.75             202.00             349.00             967.50
           Cereals          Beverages        Soft_drinks   Alcoholic_drinks
           1502.50              57.50            1427.00             360.75
     Confectionery
             55.25

$scale
[1] FALSE

$x
                PC1        PC2         PC3           PC4
England  -144.99315   2.532999 -105.768945  1.042460e-14
Wales    -240.52915 224.646925   56.475555  9.556806e-13
Scotland  -91.86934 -286.081786   44.415495 -1.257152e-12
```

```
N.Ireland  477.39164   58.901862    4.877895  2.872787e-13
```

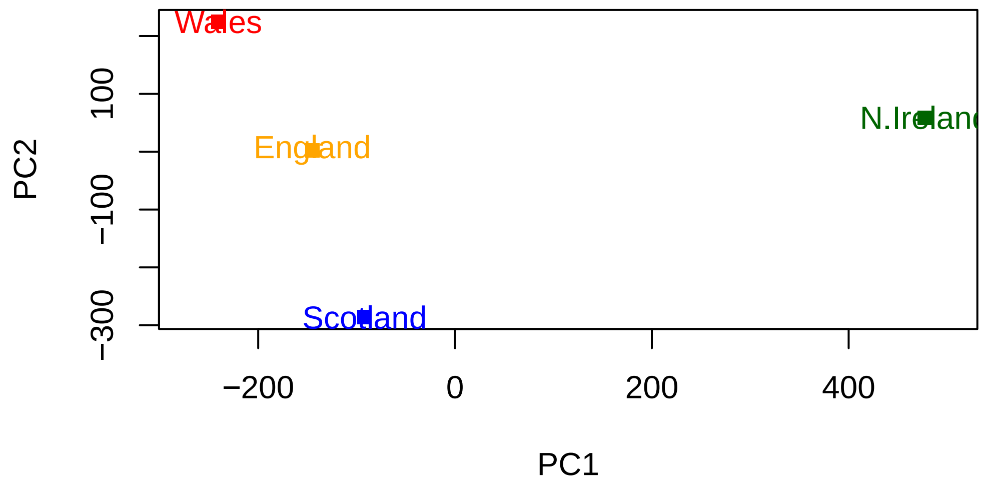
Q7

```
plot(pca$x[,1], pca$x[,2], xlab="PC1", ylab="PC2", xlim=c(-270,500))
text(pca$x[,1], pca$x[,2], colnames(x))
```



Q8.

```
plot(pca$x[,1], pca$x[,2], xlab="PC1", ylab="PC2", xlim=c(-270,500), pch=15,
     col=c('orange', 'red', 'blue', 'darkgreen'))
text(pca$x[,1], pca$x[,2], colnames(x), col=c('orange', 'red', 'blue', 'darkgreen'))
```



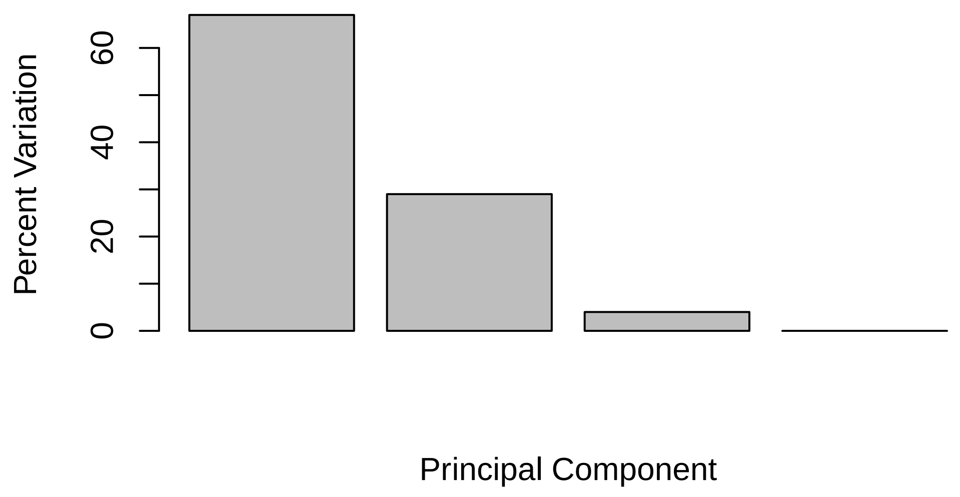
```
v <- round( pca$sdev^2/sum(pca$sdev^2) * 100 )
v
```

```
[1] 67 29  4  0
```

```
z <- summary(pca)
z$importance
```

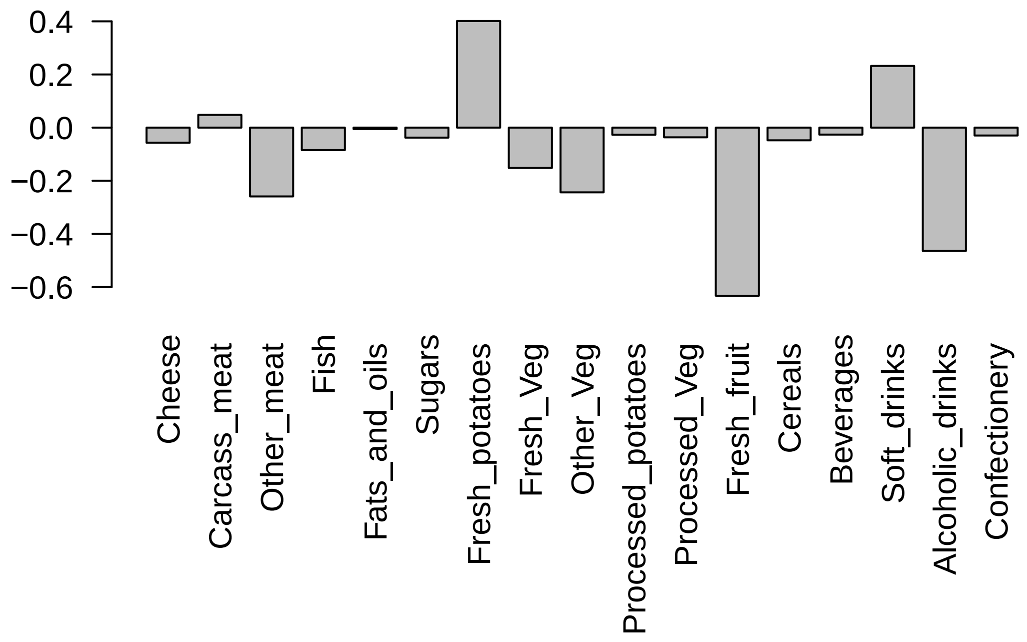
```
                             PC1       PC2      PC3          PC4
Standard deviation     324.15019 212.74780 73.87622 5.551558e-14
Proportion of Variance   0.67444   0.29052  0.03503 0.000000e+00
Cumulative Proportion    0.67444   0.96497  1.00000 1.000000e+00
```

```
barplot(v, xlab="Principal Component", ylab="Percent Variation")
```



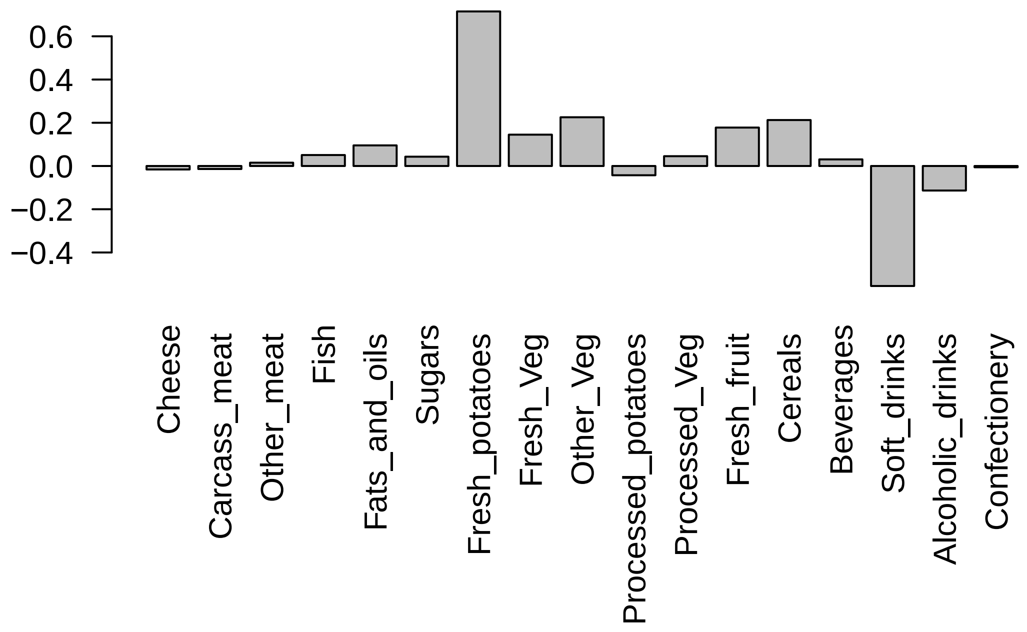
The first two PCs capture most of the variance.

```r
# visualize the loading for each variables in PC1.
par(mar=c(10, 3, 0.35, 0))
barplot( pca$rotation[,1], las=2 )
```



Q9

```
# loading in second PC
par(mar=c(10, 3, 0.35, 0))
barplot( pca$rotation[,2], las=2 )
```


0.6
0.4
0.2
0.0
−0.2
−0.4
Cheese
Carcass_meat
Other_meat
Fish
Fats_and_oils
Sugars
Fresh_potatoes
Fresh_Veg
Other_Veg
Processed_potatoes
Processed_Veg
Fresh_fruit
Cereals
Beverages
Soft_drinks
Alcoholic_drinks
Confectionery