Math 5772 practical

Utkarsh Balooni (201792310)

Summary:

The aim of this report is to analyse the average dietary intake for women in the age group of 25-50 years using multivariate analysis. We will consider the intake of 5 nutrients: Calcium, Iron, Protein, Vitamin A, and Vitamin C for a sample of 737 women.

We perform exploratory analysis on the data and find that there are a few women who are consuming as low as 0 units of nutrients from their diet while some are over consuming (outliers). On performing the statistical analysis, we conclude that on an average, women are not getting the recommended amount of nutrients from their diet. The consumption of Vitamin A and Vitamin C is in accordance with the RDA but intake of Calcium and Iron is in deficit. Protein intake for an average woman is higher than the RDA value.

A profile hypothesis test is also conducted to check if the proportion of nutrients consumed is equal. We find that on an average, women consume proportionally equal amounts of Protein, Vitamin A and Vitamin C. To ensure a balanced diet, more Calcium and Iron sources should be included in the diet.

We also propose a better way of defining the RDA in the form of intervals. This would account for the variability in the population and provide a more flexible approach to dietary standards.

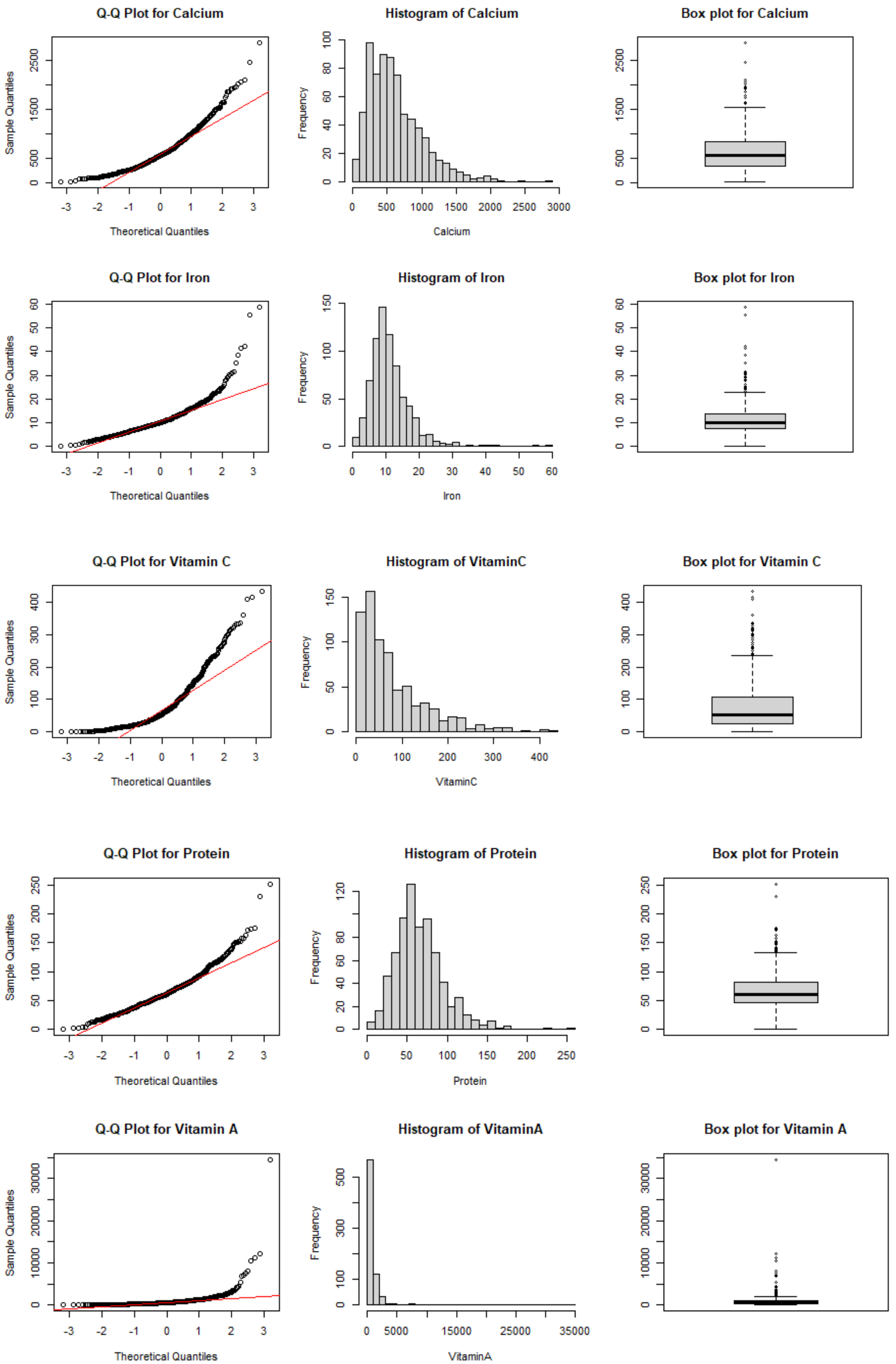
Finally, we cluster the women into 2 groups, and find that all women need to up their Calcium intake. We conclude our report by examining the appropriateness of the techniques used.

Objective-1: Exploratory Data Analysis

We start by examining the nature of the variables present in the dataset with the help of various plots.

Univariate plots:

The Quantile-Quantile plot, histogram, and box plot for all the variables is shown below.

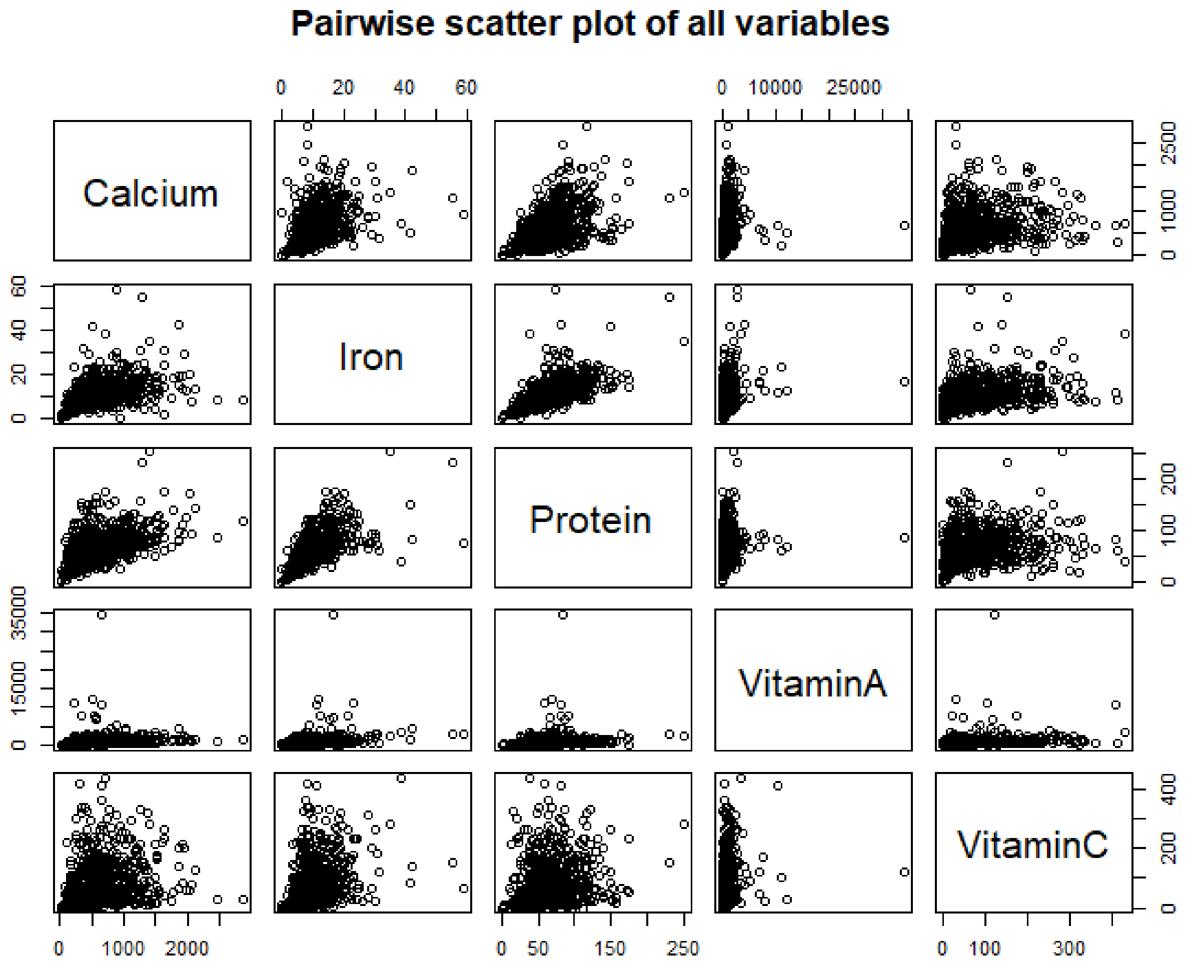

Q-Q Plot for Calcium
Sample Quantiles
Theoretical Quantiles
Histogram of Calcium
Frequency
Calcium
Box plot for Calcium
Q-Q Plot for Iron
Sample Quantiles
Theoretical Quantiles
Histogram of Iron
Frequency
Iron
Box plot for Iron
Q-Q Plot for Vitamin C
Sample Quantiles
Theoretical Quantiles
Histogram of VitaminC
Frequency
VitaminC
Box plot for Vitamin C
Q-Q Plot for Protein
Sample Quantiles
Theoretical Quantiles
Histogram of Protein
Frequency
Protein
Box plot for Protein
Q-Q Plot for Vitamin A
Sample Quantiles
Theoretical Quantiles
Histogram of VitaminA
Frequency
VitaminA
Box plot for Vitamin A

The histogram of Iron and Protein follows the normal distribution apart from some outliers present.

The distribution for Calcium and Vitamin C is skewed to the right which is evident from the histogram and q-q plot.

Vitamin A contains extreme outliers due to which its histogram becomes unreliable. The box plot and q-q plot for Vitamin A reveals that it is also skewed to the right.

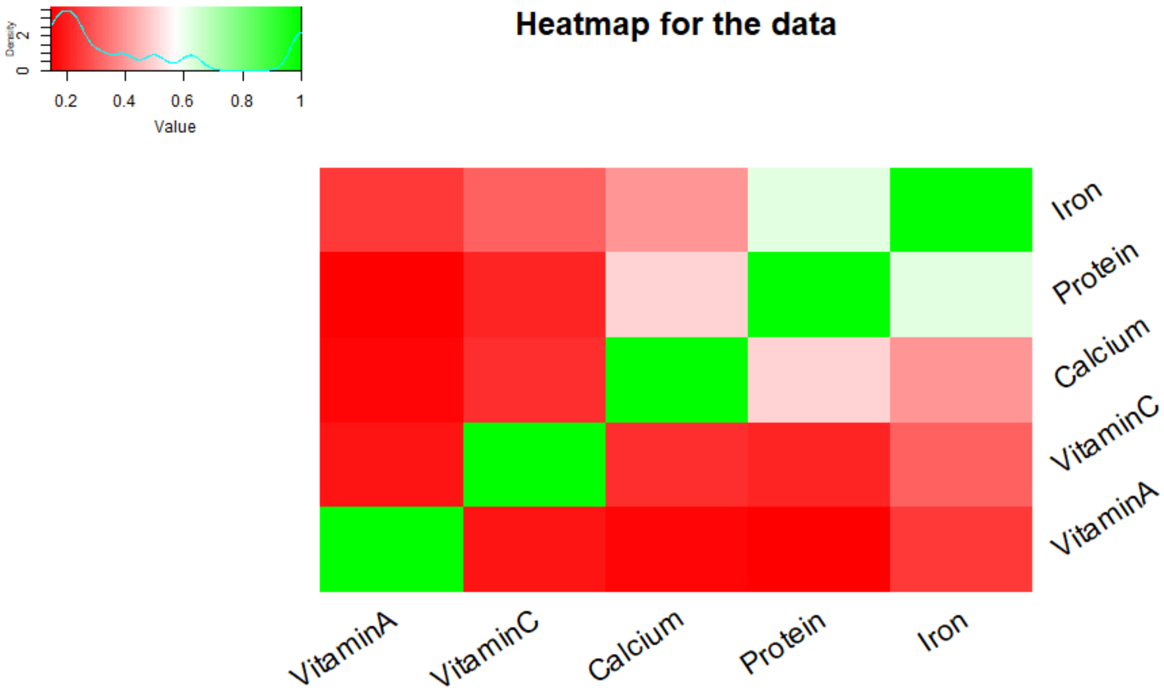
Bivariate plots:



Most of the points in all scatter plots are in the bottom left corner because of the skewness in the data. The plots seem to follow an elliptical pattern with positive correlation which suggests bivariate normality.

Correlation:

Heatmap describing the correlations among variables is shown below.



Protein is positively correlated with Iron (0.62) and Calcium (0.50).

Objective-2: Hotelling's T^2 test for checking RDA

Next, we check if the average nutrient intake for women is consistent with the Recommended Daily Allowance using Hotelling's T^2 test.

If $\bar{x}$ is the mean vector of the sample, then

H_0 : $\bar{x}$ = RDA values,

H_A : $\bar{x} \neq$ RDA values

The T^2 statistic comes out to be 1758.5 and the p-value is 2.99×10^{-191}.

Hence, we can reject the null hypothesis and conclude that <u>on an average, women are not getting the recommended level of nutrients</u>.

We can further elaborate on our conclusion by calculating the appropriate simultaneous confidence intervals.

The SCIs at a 5% significance level take the form

$$a^T\bar{x} \pm \sqrt{a^T S a \times T^2(5,736,0.95) \times 737^{-1}} = a^T\bar{x} \pm 0.123\sqrt{a^T S a}$$

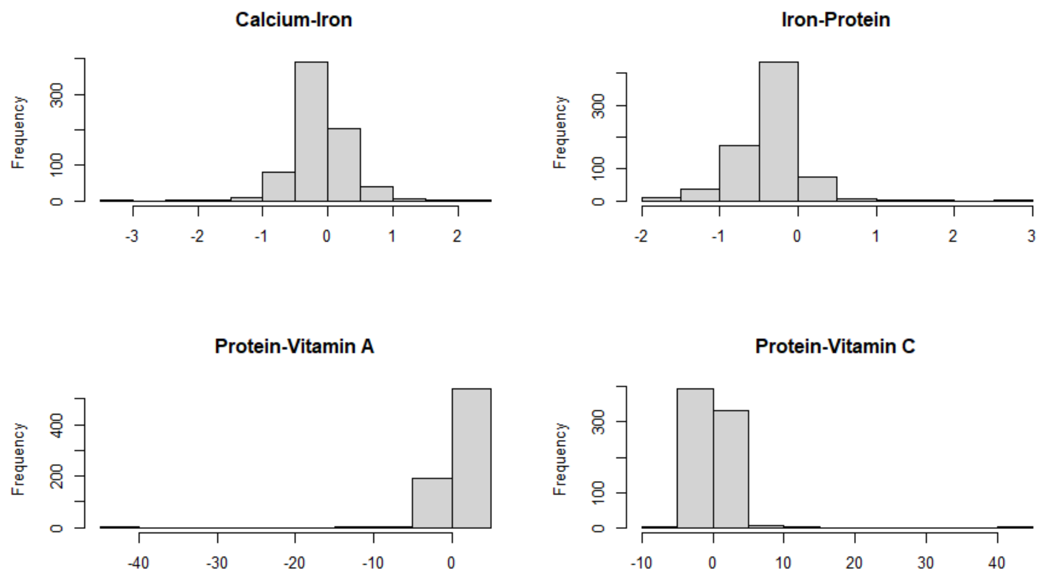
Considering a as the coefficient vectors for the co-ordinate axes, we get the following SCIs:

$RDA_{Calcium}$ = 1000,	SCI : [575.09 , 673.01]
RDA_{Iron} = 15,	SCI : [10.39, 11.87]
$RDA_{Protein}$ = 60,	SCI : [62.03, 69.57]
$RDA_{Vitamin\ A}$ = 800,	SCI : [638.33, 1040.94]
$RDA_{Vitamin\ C}$ = 75,	SCI : [69.86, 87.99]

RDA for Vitamin A and Vitamin C lie in the SCI range. Thus, we can say (with 95% certainty) that women are consuming appropriate amount of Vitamin A and C in their diets. However, the nutrient intake for Calcium and Iron is in deficit and that of protein is in surplus which is why the null hypothesis gets rejected.

Assumption used for Hotelling's T^2 test:

- Multivariate normality: The T^2 test assumes that the data is normally distributed in the multivariate setting. The plots in the pairwise plot for the dataset seem to follow an elliptical pattern indicating normality. We also plot the histogram of differences between the variables as shown below.



The plots seem to be normally distributed with a few outliers.

- Independence: The samples drawn should be independent of one another. The scatterplot for the data suggests correlation between variables. Chi-Square test of independence is performed on the data and a p-value of "< 2.2e-16" is obtained suggesting that the variables are associated. Since mild deviation from the assumptions are acceptable, we would consider the test valid for this case.

Objective-3: Testing the profile hypothesis

The profile hypothesis compares the standardized mean (by RDA) across all nutrients. This is helpful to understand the proportion of nutrients consumed by a person and could also give insights about over and under consumption of certain nutrients. It would help assess if a person is consuming a balanced diet with equal recommended proportion of nutrients.

For testing this hypothesis, we create independent linear combinations of the variables using a matrix of contrasts A.

$$A = \begin{pmatrix} 1 & -1 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 1 & -1 \end{pmatrix} \text{ and Combinations Matrix} = XA^T$$

On performing the matrix multiplication, we get the linear combinations: "Calcium-Iron", "Iron-Protein", "Protein-VitaminA", and "VitaminA-VitaminC".

We now perform Hotelling's T^2 test on the combinations matrix obtained.

If $\bar{y}$ is the mean vector of the columns of the combinations matrix, then

$H_0 : \bar{y} = 0,$

$H_A : \bar{y} \neq 0$

The T^2 statistic comes out to be 1033.03 and the p-value is 5.59×10^{-138}.

Hence we can reject the null hypothesis and <u>conclude that $\bar{y} \neq 0$ which implies that the standardized mean across all nutrients is not equal</u>. The average nutrient consumption is not proportionate for all nutrients.

The SCIs at a 5% significance level take the form

$$a^T\bar{x} \pm \sqrt{a^T S a \times T^2(4,736,0.95) \times 737^{-1}} = a^T\bar{x} \pm 0.114\sqrt{a^T S a}$$

Considering a as the coefficient vectors for the co-ordinate axes, we get the following SCIs:

$\mu_{0(\text{Calcium-Iron})} = 0$, SCI : [-0.168, -0.068]

$\mu_{0(\text{Iron-Protein})} = 0$, SCI : [-0.401, -0.308]

$\mu_{0(\text{Protein-Vitamin A})} = 0$, SCI : [-0.184, 0.279]

$\mu_{0(\text{Vitamin A-Vitamin C})} = 0$, SCI : [-0.242, 0.236]

μ_0 for "Protein-Vitamin A" and "Vitamin A-Vitamin C" lie in the SCI range. This implies (with 95% confidence) that the standardized average intake for Protein, Vitamin A, and Vitamin C are equal. It also means that an average woman's diet does not contain appropriate proportions of Calcium and Iron.

Objective-4: Redefining the RDA

Instead of defining RDA as a single number, it would be more suitable to describe it as an interval. This would account for the variability in the population with regards to age, gender, genetics, and underlying health conditions. Providing a range of values for RDA would ensure that people are flexible with their diets and would encourage them to follow a balanced diet rather than pursue numerical targets.

Objective-5: Clustering the data

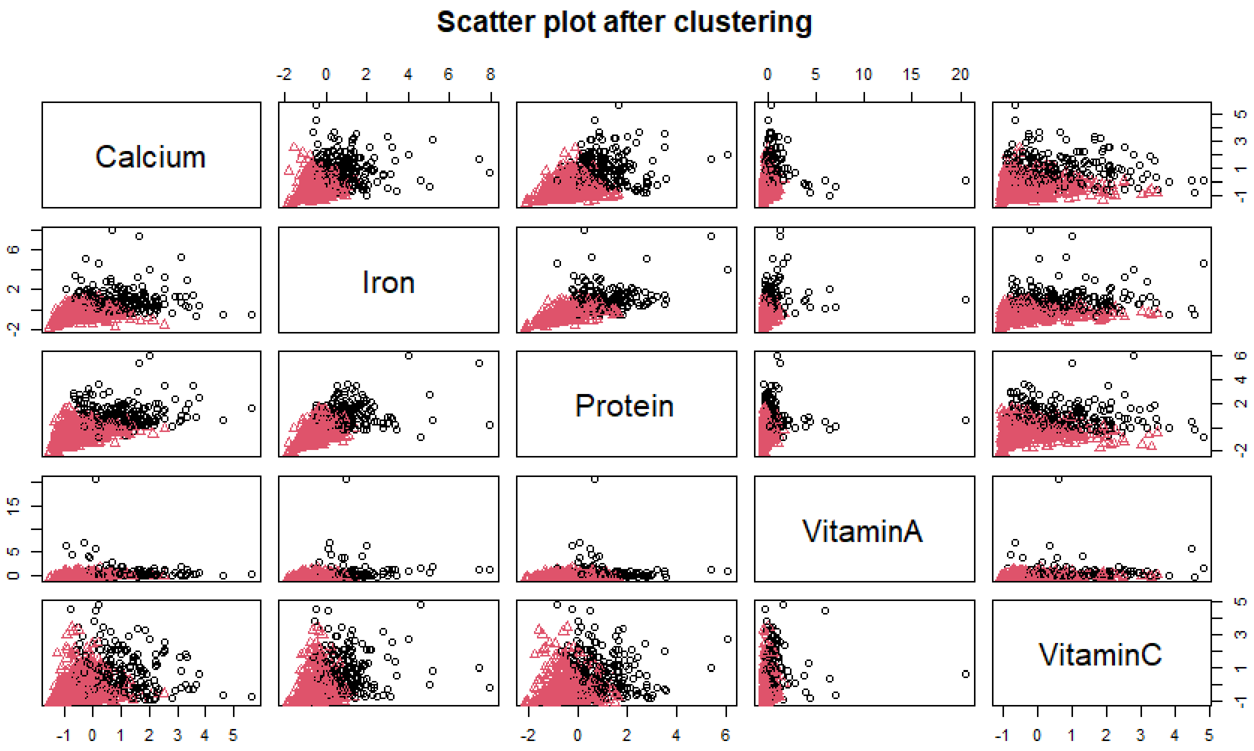
For applying k-means clustering to the dataset, we need to normalize the variables since they are not on the same scale.

We apply the following normalization technique to the data:

$$x_{norm} = \frac{x-\bar{x}}{\sigma_x},$$

where $\bar{x}$=mean of x and

σ_x=standard deviation of x

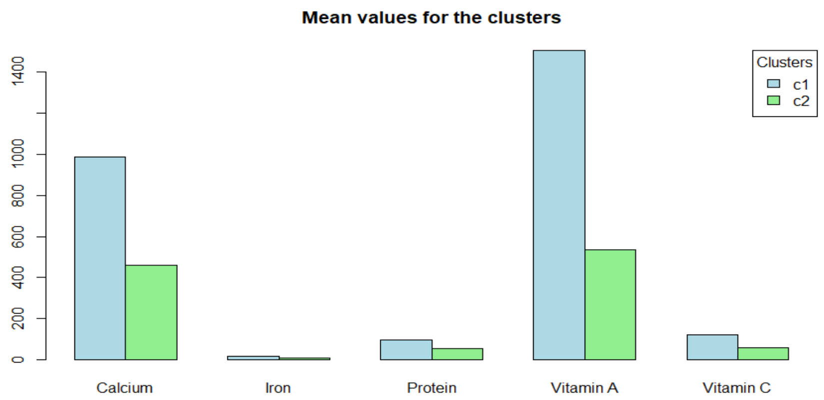


The pairs plot for the 2 clusters is shown below.

The ratio of data points in the first and second cluster are 231:506.

The mean value for all 5 nutrients (in original units) in the 2 clusters are:

Cluster	Calcium	Iron	Protein	VitaminA	VitaminC
1	985.106	16.494	94.922	1504.656	122.649
2	459.219	8.680	52.510	536.039	58.969



On examining the clusters formed, we find that women in the first cluster consume higher amount of nutrients.

1. Women in Cluster 1 overconsume the nutrients which is not considered healthy in general. This suggests that women in cluster 1 overeat and should cut down on their diet.
2. Women in Cluster 2 under consume the nutrients and must up their intake to account for a balanced diet.
3. Women in both the clusters do not consume the required amount of Calcium.

Discussion:

- While examining univariate normality most of the plots did not look linear. To tackle this issue, the outliers can be removed from the data and a suitable power transformation can be applied to stabilize the variance.
- The variance for Calcium and Vitamin A is relatively higher than others which might impact the results of the Hotelling's T^2 test in Q2.
- Tests for multivariate normality (using the mvn library in R) are carried out on the nutrients dataset and they suggest that the data is not normally distributed.
- The dataset contains some extreme values which impact the normality and sanity of the data. Overall analysis could be improved by removing the outliers.

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I declare that the attached submission is my own work.

Where the work of others has contributed to my work, I have given full acknowledgement using the appropriate referencing conventions for my programme of study.

I confirm that the attached submission has not been submitted for marks or credits in a different module or for a different qualification or completed prior to entry to the University.

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Student Signature:  **Student Number:** 201792310

Student Name: Utkarsh Balooni **Date:** 2023/11/30

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Appendix (R code)

A Report Generated by knitr

November 30, 2023

The results below are generated from an R script.

```
#install.pac
kages("gplo
ts")
#install.pac
kages("fact
oextra")
#install.pack
ages("MVN"
)

#library(gpl
ots)
#library(fact
oextra)
#library(MV
N)

#source(
#     "http://www1.maths.leeds.ac.uk/~john/3772/clusterings.r")



nutrients =
read.csv("http://www1.maths.leeds.ac.uk/~john/3772/nutrients.csv
") nutrients = nutrients[,2:6]

head(nutrients)

##     Calcium    Iron   Protein  VitaminA  VitaminC
## 1   522.29 10.188  42.561    349.13    54.141
## 2   343.32   4.113  67.793    266.99    24.839
## 3   858.26 13.741  59.933    667.90   155.455
## 4   575.98 13.245  42.215    792.23   224.688
## 5          18.919 111.316    740.27    80.961
1927.50
## 6   607.58   6.800  45.785    165.68    13.050

attach(nutrients)
```

The following objects are masked from st.nut (pos = 3):

Calcium, Iron, Protein, VitaminA, VitaminC

The following objects are masked from nutrients (pos = 4):

Calcium, Iron, Protein, VitaminA, VitaminC

The following objects are masked from st.nut (pos = 5):

Calcium, Iron, Protein, VitaminA, VitaminC

The following objects are masked from nutrients (pos = 6):

Calcium, Iron, Protein, VitaminA, VitaminC

The following objects are masked from st.nut (pos = 7):

Calcium, Iron, Protein, VitaminA, VitaminC

```
## The following objects are masked from nutrients (pos =
8): ##

##        Calcium, Iron, Protein, VitaminA, VitaminC

#testing independence

chisq.test(nutrients)

## Warning in chisq.test(nutrients):        Chi-squared approximation may be incorrect ##

##   Pearson's Chi-squared test ##

## data:    nutrients

## X-squared = 275592, df = 2944, p-value < 2.2e-16

summary(nutrients)
```

##	Calcium	Iron	Protein	VitaminA	VitaminC
##	Min. : 7.44	Min. : 0.00	Min. : 0.00	Min. : 0.0	Min. : 0.00
##	1st Qu.: 326.54	1st Qu.: 7.46	1st Qu.: 45.52	1st Qu.: 276.3	1st Qu.: 24.94
##	Median : 548.29	Median :10.03	Median : 61.07	Median : 524.0	Median : 53.59
##	Mean : 624.05	Mean :11.13	Mean : 65.80	Mean : 839.6	Mean : 78.93
##	3rd Qu.: 826.51	3rd Qu.:13.71	3rd Qu.: 80.77	3rd Qu.: 943.2	3rd Qu.:108.67
##	Max. :2866.44	Max. :58.67	Max. :251.01	Max. :34434.3	Max. :433.34

```
#inspecting          normality
univarate

# par(mfrow=c(2,3))

# qqnorm(Calcium, main = "Q-Q Plot for Calcium")
# qqline(Calcium, col = "red")

# hist(Calcium,breaks=30)

# boxplot(Calcium, main = "Box plot for
Calcium") #

# qqnorm(Iron, main = "Q-Q Plot for Iron")
# qqline(Iron, col = "red")

# hist(Iron,breaks=30)

# boxplot(Iron, main = "Box plot for Iron")
#

# qqnorm(Protein, main = "Q-Q Plot for
Protein") # qqline(Protein, col = "red")

# hist(Protein,breaks=30)

# boxplot(Protein, main = "Box plot for
Protein") #

# qqnorm(VitaminA, main = "Q-Q Plot for Vitamin A")
# qqline(VitaminA, col = "red")
```

```
# hist(VitaminA,breaks=30)

# boxplot(VitaminA, main = "Box plot for Vitamin
A") #

# qqnorm(VitaminC, main = "Q-Q Plot for Vitamin C")
# qqline(VitaminC, col = "red")

# hist(VitaminC,breaks=30)

# boxplot(VitaminC, main = "Box plot for Vitamin C")

#inspecting bivariate normality
#mvn(data=nutrients, mvnTest="mardia")
```

```
# pairs(nutrients, main="Pairwise scatter plot of all
variables") #

# cor(nutrients)

# heatmap.2(cor(nutrients),

#              col = colorRampPalette(c("red", "white",
"green"))(100), #      key = TRUE,

#              srtRow=34,

#              srtCol = 34,

#              density.info = "density",

#              trace = "none",

#              dendrogram = "none",

#              key.title="",

#              margins = c(5, 10),

#              main="Heatmap for the data"

#              )


#hotellings t2 test

n = nrow(nutrients)

rda = c(Cal=1000, Iro=15, Pro=60, VitA=800, VitC=75)
xbar = colMeans(nutrients)

diff = xbar - rda

S = round(cov(nutrients),3)

tsq = n*t(diff)%*%solve(S)%*%diff tsq

##           [,1]

## [1,] 1758.526

p=5
m=n-1

fstat = tsq*(m-p+1)/(m*p)
fstat

##           [,1]

## [1,] 349.7938


pf(fstat, df1=p, df2=m-p+1, lower.tail=FALSE) ##

                   [,1]

## [1,] 2.995284e-191

xbar
```

```
##     Calcium        Iron     Protein   VitaminA   VitaminC
## 624.04925   11.12990   65.80344  839.63535   78.92845
```

```
#calculating sci

inv.tsq = qf(0.95, df1=p, df2=m-p+1) * (p*m)/(m-p+1) inv.tsq
```

```
## [1] 11.19253

sci1 = sqrt(S[1,1] * inv.tsq/n)

c(xbar[1]-sci1,xbar[1]+sci1)

##   Calcium   Calcium
## 575.0912 673.0073

rda[1]

##  Cal
## 1000

sci2 = sqrt(S[2,2] * inv.tsq/n)

c(xbar[2]-sci2,xbar[2]+sci2)

##      Iron      Iron
## 10.39244 11.86736

rda[2]

## Iro
##  15

sci3 = sqrt(S[3,3] * inv.tsq/n)

c(xbar[3]-sci3,xbar[3]+sci3)

##  Protein  Protein
## 62.03547 69.57141

rda[3]

## Pro
##  60

sci4 = sqrt(S[4,4] * inv.tsq/n)

c(xbar[4]-sci4,xbar[4]+sci4)

##  VitaminA  VitaminA
##  638.3278 1040.9429

rda[4]

## VitA
##  800

sci5 = sqrt(S[5,5] * inv.tsq/n)

c(xbar[5]-sci5,xbar[5]+sci5)

## VitaminC VitaminC ##
69.85901 87.99788

rda[5]

## VitC
##   75
```

```r
#var high for cal, vit C
#vit A and vit C not significant diff
#asssumptions: multivariate normality, independence

#testing equality of means

st.nut = data.frame(mapply("/",nutrients,rda)) st.nut
```

```
##      Calcium      Iron   Protein  VitaminA    VitaminC
## 1    0.52229 0.6792000 0.7093500 0.4364125 0.721880000
## 2    0.34332 0.2742000 1.1298833 0.3337375 0.331186667
## 3    0.85826 0.9160667 0.9988833 0.8348750 2.072733333
## 4    0.57598 0.8830000 0.7035833 0.9902875 2.995840000
## 5    1.92750 1.2612667 1.8552667 0.9253375 1.079480000
## 6    0.60758 0.4533333 0.7630833 0.2071000 0.174000000
## 7    1.04619 1.2288667 1.9403000 1.3994875 2.119813333
## 8    0.18121 0.8508000 1.0692667 0.0981125 0.359226667
## 9    0.32708 0.5795333 0.8193500 0.7104750 0.666360000
## 10   0.38309 0.9111333 1.7307333 1.2865000 0.112053333
## 11   1.22758 1.1206667 1.7949667 0.7791500 0.494173333
## 12   0.84544 0.4944667 0.9419833 0.3414500 0.289226667
## 13   0.46052 0.8250000 0.8687667 0.2550250 1.860200000
## 14   0.34956 1.0716000 0.8446500 0.7470875 0.714346667
## 15   0.07446 0.4558667 1.2979667 0.0081000 0.929520000
## 16   0.28031 0.9698667 1.4799667 0.6953375 1.345600000
## 17   0.42236 1.4425333 2.4785500 0.5225375 3.507186667
## 18   0.55290 1.4344667 1.5180500 9.5269250 2.304053333
## 19   0.58877 0.5966667 1.2415500 0.7088125 0.047853333
## 20   0.25465 0.3200667 0.4716500 0.2425875 0.459400000
```

## 44	0.50687	0.7479333	1.4683500	1.0170875	0.871200000
## 45	0.97562	0.8982667	1.2882167	1.2700125	0.496080000
## 46	0.69327	1.1473333	1.4791833	1.0695000	1.911986667
## 47	0.70391	1.1696667	2.9194000	0.1629125	0.675266667
## 48	0.41926	0.7408000	1.2250333	0.2244500	1.500053333
## 49	0.16579	0.3578667	0.5657667	0.2503500	0.361280000
## 50	0.58068	0.9975333	2.5266833	0.9542125	0.270933333
## 51	0.26610	0.5488667	0.4691000	0.1879500	0.191213333
## 52	0.14771	0.2446000	0.5819833	0.2648625	0.791760000
## 53	1.08924	0.8640667	1.5853167	0.9510125	0.491280000
## 54	0.14066	0.2547333	0.4862833	0.0691500	0.060773333
## 55	0.23043	1.5484000	0.9769000	14.0762875	1.390866667
## 56	0.55424	0.5003333	0.9489500	1.8570625	1.185240000
## 57	0.06934	0.1355333	0.2715667	0.0151000	0.048066667
## 58	0.20556	0.6512667	1.6440000	0.2620125	0.785186667
## 59	0.59893	0.5774667	0.8741000	0.2379250	0.176533333
## 60	0.25311	0.2117333	0.4322167	0.1305875	0.091146667
## 61	0.92992	0.5887333	1.0620333	0.7078875	0.525866667
## 62	0.67565	1.0204667	0.9614167	2.9823500	0.391346667
## 63	0.11718	0.2275333	0.3287833	0.0242250	0.166400000
## 64	0.70291	0.5896667	0.4117667	1.2612000	2.109533333
## 65	1.07344	1.3376667	2.1285500	0.9717500	1.929733333
## 66	0.61803	0.4886000	0.9749833	0.3401750	0.635453333
## 67	0.63008	0.9369333	1.4001333	1.3472250	1.041653333
## 68	0.40165	0.3235333	0.5276667	0.3862125	0.111400000
## 69	0.22863	0.5749333	0.5120167	0.8809875	0.00985333

3

## 70	1.26304	2.0719333	1.1756333	3.3795250	2.405106667
## 71	0.75193	0.3358667	0.6562500	0.4463375	0.315453333
## 72	0.87763	0.7035333	1.2629000	0.9421625	3.111493333
## 73	1.40364	0.4227333	1.1200667	0.5530875	0.139906667
## 74	0.15509	0.5233333	0.9835500	0.6600125	0.750066667
## 75	0.26972	0.6507333	0.7549000	0.7236500	0.162026667
## 76	0.90157	1.0662667	1.4993167	0.6488125	0.357360000
## 77	1.33062	1.3915333	1.9159333	1.2027500	1.008773333
## 78	0.73618	0.5835333	0.9795000	4.3759625	1.141186667
## 79	0.28623	0.6980667	0.5704500	0.0329250	0.217560000
## 80	1.02847	1.4920667	1.2257500	5.1255375	1.018680000
## 81	0.67847	0.7539333	1.0606833	1.1137000	0.219253333
## 82	0.73250	1.2311333	1.2973167	1.5278000	4.019986667
## 83	0.25296	0.7530000	1.0057667	0.2370500	0.197093333
## 84	1.35499	1.3486000	1.1838667	1.4289750	1.072253333
## 85	0.44290	0.4757333	0.9491500	0.2645500	0.846226667
## 86	0.32487	0.5814667	0.8411333	0.2934000	0.968133333
## 87	0.47860	0.6050667	1.2261333	0.4628125	0.225946667
## 88	0.88935	0.3631333	0.7410333	1.7567625	1.196333333
## 89	0.48772	0.6398667	0.6441833	1.8596875	0.179626667
## 90	0.62799	0.7944000	1.0635500	0.5635375	1.488093333
## 91	2.07256	0.4809333	1.5248000	1.3101000	1.074466667
## 92	0.23978	0.5671333	0.9946667	0.3772875	0.942493333
## 93	1.04312	0.7838667	1.8061667	0.7890000	1.317106667
## 94	0.20250	0.6196667	0.9383833	0.4857125	0.06001333

```
                                                    3
## 95   0.36943 0.5828000 0.4039500  1.2985500 3.19417333
                                                    3
## 96   0.56865 0.6008000 0.5151667  0.1201500 0.42701333
                                                    3
## 97   1.33458 1.4292000 1.5679167  2.5296375 1.86548000
                                                    0

##  98  0.47510 0.728800  1.3839167 0.2744875 0.43653333
                  0                                 3
##  99  0.60465 0.763466  0.9850000 0.8924125 0.29406666
                  7                                 7
##  10  0.44960 0.665266  0.7312833 0.5733375 0.22128000
     0            7                                 0
##  10  0.46260 0.586400  0.4227167 0.6932375 0.92460000
     1            0                                 0
##  10  0.55975 0.479000  0.6478500 0.6663875 2.30454666
     2            0                                 7
##  10  0.42133 0.848533  0.9919667 1.7268750 1.41621333
     3            3                                 3
##  10  0.46437 0.766733  1.2620333 0.8770250 0.62222666
     4            3                                 7
##  10  0.71070 0.501266  0.7484667 0.4103125 0.38620000
     5            7                                 0
##  10  0.87736 2.002133  1.5374667 2.3582500 0.32909333
     6            3                                 3
##  10  0.31306 0.380333  0.3721667 0.2086625 0.47485333
     7            3                                 3
##  10  0.25082 0.579200  0.8929500 0.2843625 0.39368000
     8            0                                 0
##  10  1.06769 0.767733  1.5533167 0.7329875 1.26894666
     9            3                                 7
##  11  0.64659 0.350666  0.6754500 3.0136500 0.62916000
     0            7                                 0
##  11  1.30109 0.273933  0.9079833 0.4736125 0.40481333
     1            3                                 3
##  11  0.79008 0.812200  1.3670000 1.4345625 0.60644000
     2            0                                 0
##  11  0.85441 0.947200  1.5527833 0.9222125 2.11110666
     3            0                                 7
##  11  0.31857 0.466866  0.6497667 0.3080250 2.07294666
     4            7                                 7
##  11  0.55723 0.754200  0.9320333 0.9813875 1.86862666
     5            0                                 7
##  11  0.15208 0.319933  0.5709333 0.9798750 1.11144000
     6            3                                 0
##  11  0.17176 0.282066  0.4971000 0.2565875 0.64921333
     7            7                                 3
##  11  0.79995 0.393733  0.7587167 0.7454875 0.78220000
     8            3                                 0
##  11  0.81847 0.560533  1.0549333 0.4756625 0.15846666
```

```
     9            3                              7
##  12  0.54872  0.524266   0.8089667  0.6720625 0.61418666
     0            7                              7
##  12  0.57027  0.554066   0.8163667  0.3228000 0.39901333
     1            7                              3
##  12  0.53057  0.617733   0.9271667  0.4346125 0.75845333
     2            3                              3
##  12  0.55649  0.698600   0.9373667  0.5486375 0.13373333
     3            0                              3
##  12  0.32152  0.456200   1.0846667  0.1862125 2.90674666
     4            0                              7
##  12  0.98790  1.031800   1.7976500  0.9699250 0.80270666
     5            0                              7
##  12  1.21130  0.570533   1.4249000  0.7487250 1.02790666
     6            3                              7
##  12  0.57931  0.679733   1.0731833  0.3751625 0.44365333
     7            3                              3
##  12  0.86537  0.597800   0.9415000  0.6258500 2.91726666
     8            0                              7
##  12  0.76831  1.049866   1.4359833  1.9420375 4.42858666
     9            7                              7
##  13  0.33782  0.609266   0.7939667  0.3931875 4.19937333
     0            7                              3
##  13  0.54829  0.884133   1.2913167  0.4031000 0.50582666
     1            3                              7
##  13  1.15533  0.685933   1.6018000  0.9664125 2.10557333
     2            3                              3
##  13  0.47016  0.869333   1.7053833  0.8740625 1.60306666
     3            3                              7
##  13  0.27517  0.644333   1.0034833  0.3456750 0.66070666
     4            3                              7
##  13  0.16522  0.253333   0.5116500  0.2909625 1.93268000
     5            3                              0
##  13  1.10117  1.094066   1.2034500  2.4527000 3.08788000
     6            7                              0
##  13  0.26176  0.835533   1.3022833  0.6440125 0.29733333
     7            3                              3
##  13  0.15146  0.432400   1.0638167  0.1886250 1.46176000
     8            0                              0
##  13  0.95582  0.680666   0.8615000  0.5687875 0.25348000
     9            7                              0
##  14  0.92013  0.483666   1.0632000  0.7311625 1.82990666
     0            7                              7
##  14  0.26031  0.195800   0.5764833  0.1526000 0.11102666
     1            0                              7
##  14  1.19343  1.624066   1.8023333  0.7938750 0.87374666
     2            7                              7
##  14  0.41922  0.436066   0.6379167  0.3750000 2.75132000
     3            7                              0
##  14  0.80779  0.600733   1.1087000  0.5805750 0.57062666
```

```
##  4            3                                  7
## 14  0.36551 0.560066  0.7271000 2.1869250 0.82761333
    5           7                                  3
## 14  0.76573 1.048466  1.2824167 1.2603875 2.79116000
    6           7                                  0
## 14  0.66873 1.519733  1.9317500 0.8023750 2.17733333
    7           3                                  3
## 14  0.28405 0.479600  0.8167667 0.3579750 0.25522666
    8           0                                  7
## 14  0.52308 0.919266  0.7651833 0.4694250 0.28314666
    9           7                                  7
## 15  0.15985 0.341533  0.4318667 0.1471375 0.58145333
    0           3                                  3
## 15  0.78802 0.537866  0.6040333 0.9653125 0.61884000
    1           7                                  0

## 152 0.67879 0.498400  0.9288167 1.7302000 1.08428000
                0                                  0
## 153 0.95835 1.029133  1.6450167 0.9412125 0.20040000
                3                                  0
## 154 0.77457 0.409933  0.8598833 1.6877375 1.16376000
                3                                  0
## 155 0.58328 1.358400  1.4446833 0.3612000 1.44888000
                0                                  0
## 156 1.49807 0.877800  1.3841500 0.8606875 2.87069333
                0                                  3
## 157 1.15971 0.691333  1.7185667 0.9114000 0.22188000
                3                                  0
## 158 1.54899 0.880733  2.1152000 1.0812500 0.82241333
                3                                  3
## 159 0.68902 0.480866  1.4728833 0.3235875 0.81824000
                7                                  0
## 160 0.26539 0.443400  0.7413333 0.3812125 0.27498666
                0                                  7
## 161 0.06952 0.141000  0.1598500 0.0049500 0.01033333
                0                                  3
## 162 1.64299 0.950000  2.8939833 2.6056625 3.05301333
                0                                  3
## 163 0.46982 0.489266  0.6725667 0.4419125 0.35160000
                7                                  0
## 164 0.22367 0.454200  0.9315167 0.2690375 0.27698666
                0                                  7
## 165 0.54312 0.630400  0.5806500 2.1172500 1.80296000
                0                                  0
## 166 0.87510 1.269266  1.8255500 1.2719500 2.26089333
                7                                  3
## 167 1.49406 0.760600  1.3221500 0.9383750 0.71096000
                0                                  0
## 168 0.46796 0.396666  0.4708167 0.2362000 0.03261333
                7                                  3
## 169 0.91372 0.920600  1.2816500 1.3499000 0.91069333
```

```
                 0                                 3
## 170 0.99586 0.717533   1.0469000  1.6476125 1.93484000
                 3                                 0
## 171 0.10049 0.385133   0.2689000  0.7294750 0.27258666
                 3                                 7
## 172 0.27082 0.637866   1.2077000  0.5015000 1.89346666
                 7                                 7
## 173 0.42921 0.569733   0.6962000  0.8126625 2.07422666
                 3                                 7
## 174 0.41714 0.410066   0.6139500  0.1253375 0.83920000
                 7                                 0
## 175 1.07588 0.736000   0.7394333  1.2225000 3.06252000
                 0                                 0
## 176 0.92845 0.681333   1.1100167  1.5169375 0.93461333
                 3                                 3
## 177 0.21026 0.249466   0.7768167  2.4013250 0.68380000
                 7                                 0
## 178 0.47667 0.766800   1.2085333  0.9137875 1.53153333
                 0                                 3
## 179 0.82213 1.070800   1.5278833  1.1405000 1.61398666
                 0                                 7
## 180 0.24841 0.778200   1.3483500  1.4449250 2.56222666
                 0                                 7
## 181 0.63367 1.251000   1.4981500  0.8735625 0.61280000
                 0                                 0
## 182 0.58953 1.104266   1.6005833  0.5522875 1.70893333
                 7                                 3
## 183 0.27922 0.641266   1.1601000  0.9550875 0.72362666
                 7                                 7
## 184 1.02266 0.640933   0.8502500  0.6052500 2.80658666
                 3                                 7
## 185 0.48686 0.778333   0.9899667  0.4180750 1.07641333
                 3                                 3
## 186 0.23319 0.639733   1.5242667  0.5561250 0.18172000
                 3                                 0
## 187 0.57418 0.434266   0.4195833  0.3558125 1.33726666
                 7                                 7
## 188 1.11733 0.954400   1.8701667  2.3041500 3.94246666
                 0                                 7
## 189 0.78066 0.707066   1.9005000  0.6753000 0.47281333
                 7                                 3
## 190 0.83371 1.084200   1.9586000  1.1332000 0.99238666
                 0                                 7
## 191 0.75917 1.102666   2.5002000  1.0869500 1.57017333
                 7                                 3
## 192 1.18402 1.200066   2.1708833  2.5474000 2.49932000
                 7                                 0
## 193 0.38637 1.245600   1.3698667  0.5601500 3.07402666
                 0                                 7
## 194 1.86624 2.811066   1.3606167  5.0666000 1.86534666
                 7                                 7
## 195 0.57334 1.051733   1.4496333  8.6844875 1.57841333
```

```
                  3                                   3
## 196 0.36064 0.667000  0.7543333 0.3715375 0.21205333
                  0                                   3
## 197 0.55055 0.459666  0.6343667 0.6314000 2.50665333
                  7                                   3
## 198 0.91480 0.860400  1.2597500 0.8203750 0.82522666
                  0                                   7
## 199 1.01264 1.207333  1.2363000 2.5021000 1.72169333
                  3                                   3
## 200 0.65029 1.299133  1.0574000 2.8277375 3.67805333
                  3                                   3
##  [ reached 'max' / getOption("max.print") -- omitted 537 rows ]
```

```r
attach(st.nut)
```

The following objects are masked from nutrients (pos = 3):

```
##
## Calcium, Iron, Protein, VitaminA, VitaminC
## The following objects are masked from st.nut (pos = 4):
##
## Calcium, Iron, Protein, VitaminA, VitaminC
## The following objects are masked from nutrients (pos = 5):
##
## Calcium, Iron, Protein, VitaminA, VitaminC
## The following objects are masked from st.nut (pos = 6):
##
## Calcium, Iron, Protein, VitaminA, VitaminC
## The following objects are masked from nutrients (pos = 7):
##
## Calcium, Iron, Protein, VitaminA, VitaminC
## The following objects are masked from st.nut (pos = 8):
##
## Calcium, Iron, Protein, VitaminA, VitaminC
## The following objects are masked from nutrients (pos = 9):
##
## Calcium, Iron, Protein, VitaminA, VitaminC
A = matrix(c(1,-1,0,0,0,0,1,-1,0,0,0,0,1,-1,0,0,0,0,1,-1),nrow=4,byrow=T) A
```

```
dif.nut = data.frame(as.matrix(st.nut)%*%t(A))
colnames(dif.nut) = c("Calcium-Iron","Iron-Protein","Protein-VitaminA","VitaminA-VitaminC") dif.nut
```

## 21	-0.850740000	-0.695216667	1.596991667	-0.371175000
## 22	-0.137090000	-0.227950000	0.451150000	-0.201773333
## 23	-0.150676667	-0.039833333	0.239175000	-0.106208333
## 24	-0.413610000	-0.672633333	1.537120833	-0.731580833
## 25	0.038086667	-0.281516667	0.231287500	0.050295833
## 26	-0.148710000	-0.133233333	-0.262854167	-0.142992500
## 27	0.363570000	-0.207950000	0.145737500	0.127692500
## 28	0.419223333	-0.056750000	-0.498558333	-0.304878333
## 29	-0.044453333	-0.397350000	-0.672141667	-1.459521667
## 30	0.479490000	-1.237633333	0.435220833	-2.776694167
## 31	0.119730000	-0.113800000	0.064400000	-1.847666667
## 32	-0.313490000	-0.185150000	0.334912500	0.247504167
## 33	0.104500000	-0.202783333	0.532558333	-0.024241667
## 34	-0.033746667	-0.267866667	-0.125579167	0.458779167
## 35	-1.052120000	-0.779700000	1.724075000	-1.676761667
## 36	-0.072890000	-0.554966667	0.590366667	-0.538786667
## 37	-0.643410000	-0.559116667	1.305141667	-2.240451667
## 38	-0.304126667	-0.556733333	0.717650000	-1.002596667
## 39	-0.612453333	0.419016667	-0.983208333	1.026178333
## 40	-0.802696667	-0.730083333	1.684862500	-1.553392500
## 41	0.146570000	-0.667000000	0.914975000	-0.159095000
## 42	-0.251096667	-0.546116667	0.804008333	-0.171638333
## 43	-0.037610000	0.103533333	0.042366667	0.365180000
## 44	-0.241063333	-0.720416667	0.451262500	0.145887500
## 45	0.077353333	-0.389950000	0.018204167	0.773932500
## 46	-	-0.331850000	0.409683333	-0.842486667

	0.454063333			
## 47	-0.465756667	-1.749733333	2.756487500	-0.512354167
## 48	-0.321540000	-0.484233333	1.000583333	-1.275603333
## 49	-0.192076667	-0.207900000	0.315416667	-0.110930000
## 50	-0.416853333	-1.529150000	1.572470833	0.683279167
## 51	-0.282766667	0.079766667	0.281150000	-0.003263333
## 52	-0.096890000	-0.337383333	0.317120833	-0.526897500
## 53	0.225173333	-0.721250000	0.634304167	0.459732500
## 54	-0.114073333	-0.231550000	0.417133333	0.008376667
## 55	-1.317970000	0.571500000	-13.099387500	12.685420833
## 56	0.053906667	-0.448616667	-0.908112500	0.671822500
## 57	-0.066193333	-0.136033333	0.256466667	-0.032966667
## 58	-0.445706667	-0.992733333	1.381987500	-0.523174167
## 59	0.021463333	-0.296633333	0.636175000	0.061391667
## 60	0.041376667	-0.220483333	0.301629167	0.039440833
## 61	0.341186667	-0.473300000	0.354145833	0.182020833
## 62	-0.344816667	0.059050000	-2.020933333	2.591003333
## 63	-0.110353333	-0.101250000	0.304558333	-0.142175000
## 64	0.113243333	0.177900000	-0.849433333	-0.848333333
## 65	-0.264226667	-0.790883333	1.156800000	-0.957983333
## 66	0.129430000	-0.486383333	0.634808333	-0.295278333
## 67	-0.306853333	-0.463200000	0.052908333	0.305571667
## 68	0.078116667	-0.204133333	0.141454167	0.274812500
## 69	-0.346303333	0.062916667	-0.368970833	0.871134167
## 70	-0.808893333	0.896300000	-2.203891667	0.974418333
## 71	0.41606333	-0.320383333	0.209912500	0.130884167

	3			
## 72	0.174096667	-0.559366667	0.320737500	-2.169330833
## 73	0.980906667	-0.697333333	0.566979167	0.413180833
## 74	-0.368243333	-0.460216667	0.323537500	-0.090054167
## 75	-0.381013333	-0.104166667	0.031250000	0.561623333
## 76	-0.164696667	-0.433050000	0.850504167	0.291452500
## 77	-0.060913333	-0.524400000	0.713183333	0.193976667
## 78	0.152646667	-0.395966667	-3.396462500	3.234775833
## 79	-0.411836667	0.127616667	0.537525000	-0.184635000
## 80	-0.463596667	0.266316667	-3.899787500	4.106857500
## 81	-0.075463333	-0.306750000	-0.053016667	0.894446667
## 82	-0.498633333	-0.066183333	-0.230483333	-2.492186667
## 83	-0.500040000	-0.252766667	0.768716667	0.039956667
## 84	0.006390000	0.164733333	-0.245108333	0.356721667
## 85	-0.032833333	-0.473416667	0.684600000	-0.581676667
## 86	-0.256596667	-0.259666667	0.547733333	-0.674733333
## 87	-0.126466667	-0.621066667	0.763320833	0.236865833
## 88	0.526216667	-0.377900000	-1.015729167	0.560429167
## 89	-0.152146667	-0.004316667	-1.215504167	1.680060833
## 90	-0.166410000	-0.269150000	0.500012500	-0.924555833
## 91	1.591626667	-1.043866667	0.214700000	0.235633333
## 92	-0.327353333	-0.427533333	0.617379167	-0.565205833
## 93	0.259253333	-1.022300000	1.017166667	-0.528106667
## 94	-0.417166667	-0.318716667	0.452670833	0.425699167
## 95	-0.213370000	0.178850000	-0.894600000	-1.895623333
## 96	-	0.085633333	0.395016667	-0.306863333

		0.032150000			
##	97	-0.094620000	-0.138716667	-0.961720833	0.664157500
##	98	-0.253700000	-0.655116667	1.109429167	-0.162045833
##	99	-0.158816667	-0.221533333	0.092587500	0.598345833
##	100	-0.215666667	-0.066016667	0.157945833	0.352057500
##	101	-0.123800000	0.163683333	-0.270520833	-0.231362500
##	102	0.080750000	-0.168850000	-0.018537500	-1.638159167
##	103	-0.427203333	-0.143433333	-0.734908333	0.310661667
##	104	-0.302363333	-0.495300000	0.385008333	0.254798333
##	105	0.209433333	-0.247200000	0.338154167	0.024112500
##	106	-1.124773333	0.464666667	-0.820783333	2.029156667
##	107	-0.067273333	0.008166667	0.163504167	-0.266190833
##	108	-0.328380000	-0.313750000	0.608587500	-0.109317500
##	109	0.299956667	-0.785583333	0.820329167	-0.535959167
##	110	0.295923333	-0.324783333	-2.338200000	2.384490000
##	111	1.027156667	-0.634050000	0.434370833	0.068799167
##	112	-0.022120000	-0.554800000	-0.067562500	0.828122500
##	113	-0.092790000	-0.605583333	0.630570833	-1.188894167
##	114	-0.148296667	-0.182900000	0.341741667	-1.764921667
##	115	-0.196970000	-0.177833333	-0.049354167	-0.887239167
##	116	-0.167853333	-0.251000000	-0.408941667	-0.131565000
##	117	-0.110306667	-0.215033333	0.240512500	-0.392625833
##	118	0.406216667	-0.364983333	0.013229167	-0.036712500
##	119	0.257936667	-0.494400000	0.579270833	0.317195833
##	120	0.024453333	-0.284700000	0.136904167	0.057875833
##	12	0.01620333	-	0.493566667	-0.076213333

1	3	0.262300000		
## 122	-0.087163333	-0.309433333	0.492554167	-0.323840833
## 123	-0.142110000	-0.238766667	0.388729167	0.414904167
## 124	-0.134680000	-0.628466667	0.898454167	-2.720534167
## 125	-0.043900000	-0.765850000	0.827725000	0.167218333
## 126	0.640766667	-0.854366667	0.676175000	-0.279181667
## 127	-0.100423333	-0.393450000	0.698020833	-0.068490833
## 128	0.267570000	-0.343700000	0.315650000	-2.291416667
## 129	-0.281556667	-0.386116667	-0.506054167	-2.486549167
## 130	-0.271446667	-0.184700000	0.400779167	-3.806185833
## 131	-0.335843333	-0.407183333	0.888216667	-0.102726667
## 132	0.469396667	-0.915866667	0.635387500	-1.139160833
## 133	-0.399173333	-0.836050000	0.831320833	-0.729004167
## 134	-0.369163333	-0.359150000	0.657808333	-0.315031667
## 135	-0.088113333	-0.258316667	0.220687500	-1.641717500
## 136	0.007103333	-0.109383333	-1.249250000	-0.635180000
## 137	-0.573773333	-0.466750000	0.658270833	0.346679167
## 138	-0.280940000	-0.631416667	0.875191667	-1.273135000
## 139	0.275153333	-0.180833333	0.292712500	0.315307500
## 140	0.436463333	-0.579533333	0.332037500	-1.098744167
## 141	0.064510000	-0.380683333	0.423883333	0.041573333
## 142	-0.430636667	-0.178266667	1.008458333	-0.079871667
## 143	-0.016846667	-0.201850000	0.262916667	-2.376320000
## 144	0.207056667	-0.507966667	0.528125000	0.009948333
## 145	-0.194556667	-0.167033333	-1.459825000	1.359311667
## 146	-	-	0.022029167	-1.530772500

	0.282736667	0.233950000		
## 147	- 0.851003333	- 0.412016667	1.129375000	-1.374958333
## 148	- 0.195550000	- 0.337166667	0.458791667	0.102748333
## 149	- 0.396186667	0.154083333	0.295758333	0.186278333
## 150	- 0.181683333	- 0.090333333	0.284729167	-0.434315833
## 151	0.25015333 3	- 0.066166667	-0.361279167	0.346472500
## 152	0.18039000 0	- 0.430416667	-0.801383333	0.645920000
## 153	- 0.070783333	- 0.615883333	0.703804167	0.740812500
## 154	0.36463666 7	- 0.449950000	-0.827854167	0.523977500
## 155	- 0.775120000	- 0.086283333	1.083483333	-1.087680000
## 156	0.62027000 0	- 0.506350000	0.523462500	-2.010005833
## 157	0.46837666 7	- 1.027233333	0.807166667	0.689520000
## 158	0.66825666 7	- 1.234466667	1.033950000	0.258836667
## 159	0.20815333 3	- 0.992016667	1.149295833	-0.494652500
## 160	- 0.178010000	- 0.297933333	0.360120833	0.106225833
## 161	- 0.071480000	- 0.018850000	0.154900000	-0.005383333
## 162	0.69299000 0	- 1.943983333	0.288320833	-0.447350833
## 163	- 0.019446667	- 0.183300000	0.230654167	0.090312500
## 164	- 0.230530000	- 0.477316667	0.662479167	-0.007949167
## 165	- 0.087280000	0.049750000	-1.536600000	0.314290000
## 166	- 0.394166667	- 0.556283333	0.553600000	-0.988943333
## 167	0.73346000 0	- 0.561550000	0.383775000	0.227415000
## 168	0.07129333 3	- 0.074150000	0.234616667	0.203586667
## 169	- 0.006880000	- 0.361050000	-0.068250000	0.439206667
## 170	0.27832666 7	- 0.329366667	-0.600712500	-0.287227500
## 171	-	0.116233333	-0.460575000	0.456888333

		0.284643333			
##	172	-0.367046667	-0.569833333	0.706200000	-1.391966667
##	173	-0.140523333	-0.126466667	-0.116462500	-1.261564167
##	174	0.007073333	-0.203883333	0.488612500	-0.713862500
##	175	0.339880000	-0.003433333	-0.483066667	-1.840020000
##	176	0.247116667	-0.428683333	-0.406920833	0.582324167
##	177	-0.039206667	-0.527350000	-1.624508333	1.717525000
##	178	-0.290130000	-0.441733333	0.294745833	-0.617745833
##	179	-0.248670000	-0.457083333	0.387383333	-0.473486667
##	180	-0.529790000	-0.570150000	-0.096575000	-1.117301667
##	181	-0.617330000	-0.247150000	0.624587500	0.260762500
##	182	-0.514736667	-0.496316667	1.048295833	-1.156645833
##	183	-0.362046667	-0.518833333	0.205012500	0.231460833
##	184	0.381726667	-0.209316667	0.245000000	-2.201336667
##	185	-0.291473333	-0.211633333	0.571891667	-0.658338333
##	186	-0.406543333	-0.884533333	0.968141667	0.374405000
##	187	0.139913333	0.014683333	0.063770833	-0.981454167
##	188	0.162930000	-0.915766667	-0.433983333	-1.638316667
##	189	0.073593333	-1.193433333	1.225200000	0.202486667
##	190	-0.250490000	-0.874400000	0.825400000	0.140813333
##	191	-0.343496667	-1.397533333	1.413250000	-0.483223333
##	192	-0.016046667	-0.970816667	-0.376516667	0.048080000
##	193	-0.859230000	-0.124266667	0.809716667	-2.513876667
##	194	-0.944826667	1.450450000	-3.705983333	3.201253333
##	195	-0.478393333	-0.397900000	-7.234854167	7.106074167
##	196	-	-	0.382795833	0.159484167

	0.306360000	0.087333333		
## 197	0.090883333	-0.174700000	0.002966667	-1.875253333
## 198	0.054400000	-0.399350000	0.439375000	-0.004851667
## 199	-0.194693333	-0.028966667	-1.265800000	0.780406667
## 200	-0.648843333	0.241733333	-1.770337500	-0.850315833
## 201	-0.032916667	0.003750000	-0.087570833	-0.705552500
## 202	-0.049163333	-0.285100000	-0.700204167	-0.251309167
## 203	0.057156667	-0.910533333	0.913929167	-0.997062500
## 204	-0.115283333	-1.283183333	1.442854167	-1.145190833
## 205	-0.152470000	-0.189266667	-0.218808333	-1.089165000
## 206	-0.171543333	-0.562583333	0.729691667	-0.433388333
## 207	-0.278266667	-0.314033333	0.739162500	-0.770409167
## 208	0.256753333	-0.312983333	0.206987500	0.001329167
## 209	0.077293333	-0.260733333	0.378162500	-0.044629167
## 210	0.200253333	-0.715333333	0.616650000	0.184683333
## 211	-0.144996667	-0.519050000	0.860691667	0.053038333
## 212	-0.177773333	-0.083450000	0.351908333	0.016621667
## 213	0.069356667	-0.366716667	0.218725000	0.243445000
## 214	0.174476667	-0.483883333	0.604129167	-1.206379167
## 215	0.694316667	-1.527216667	1.057550000	1.019933333
## 216	0.504306667	-0.389450000	-1.365416667	1.741826667
## 217	-0.255980000	-0.203483333	0.395045833	0.277757500
## 218	0.146620000	-0.527933333	0.390058333	-0.443378333
## 219	0.200360000	-0.645000000	0.784812500	0.104960833
## 220	-0.207716667	-0.431600000	0.194354167	-2.074487500
## 221	-	-	0.738241667	-0.385958333

	0.525056667	0.364150000		
## 222	-0.466426667	-0.229616667	0.547908333	-0.067838333
## 223	-0.880273333	-0.057033333	0.766354167	-0.240307500
## 224	-0.546750000	0.010666667	-7.813066667	8.303173333
## 225	-0.145570000	-0.631333333	0.809020833	-0.359407500
## 226	-0.039470000	-0.720133333	0.667058333	-0.234111667
## 227	-0.267446667	0.024216667	0.306500000	-0.078263333
## 228	0.183120000	-0.412416667	0.378916667	0.465753333
## 229	-0.736423333	-0.358783333	0.829529167	-0.248465833
## 230	0.149060000	-0.268950000	0.368900000	-1.202016667
## 231	-0.205126667	-0.325883333	0.555425000	-0.545528333
## 232	-0.530300000	-0.589266667	1.227291667	-0.732025000
## 233	-0.207293333	-0.265216667	0.369362500	-0.197532500
## 234	-0.210553333	-0.098066667	0.604275000	-0.001048333
## 235	0.120883333	-0.235583333	-0.624837500	0.940834167
## 236	-0.612106667	-0.625450000	0.536279167	-0.853509167
## 237	-0.046976667	0.043000000	-0.217645833	0.403739167
## 238	-0.371023333	-0.265650000	0.225308333	-0.458285000
## 239	-0.379026667	-1.237100000	1.709241667	0.068631667
## 240	-0.462720000	-0.365466667	0.702291667	-0.445331667
## 241	-0.125353333	-0.851383333	0.192554167	1.001642500
## 242	0.109060000	-0.312483333	0.493770833	-0.212514167
## 243	-0.145573333	-0.481716667	0.527687500	0.306109167
## 244	-0.422023333	0.316650000	-0.418229167	-3.225674167
## 245	-0.693000000	0.429733333	-0.459470833	0.280644167
## 246	-	0.204383333	0.316241667	0.244321667

```
         0.239080000
## 247 -                                  -       0.198608333       -3.509388333
         0.177050000  0.576633333
## 248 -                                  -      -0.001191667        0.078008333
         0.042000000  0.321283333
## 249 -                                  -      -0.678395833        1.418759167
         0.084666667  0.656150000
## 250   0.58597333                       -       0.898879167        0.239410833
          3           0.689250000
## [ reached 'max' / getOption("max.print") -- omitted 487 rows ]

#bivariate plot for
normality # par(mfrow =
c(2,2))

# hist(dif.nut[,1], main="Calcium-
Iron",xlab="") # hist(dif.nut[,2], main="Iron-
Protein",xlab="")

# hist(dif.nut[,3], main="Protein-Vitamin A",xlab="")
# hist(dif.nut[,4], main="Protein-Vitamin C",xlab="")

xbar.s = colMeans(dif.nut) mu0
= rep(0,4)

dif.s = xbar.s-mu0

S.s = round(cov(dif.nut),3)

tsq.s = n*t(dif.s)%*%solve(S.s)%*%dif.s tsq.s

##          [,1]

## [1,] 1033.033

p.s = 4

fstat.s = tsq.s*(m-p.s+1)/(m*p.s)
fstat.s

##          [,1]

## [1,] 257.2055

pf(fstat.s, df1=p.s, df2=m-p.s+1, lower.tail=FALSE) ##

                 [,1]

## [1,] 5.597653e-138

#sci

inv.tsq.s = qf(0.95, df1=p.s, df2=m-p.s+1) * (p.s*m)/(m-p.s+1)
inv.tsq.s

## [1] 9.575357

sci1.s = sqrt(S.s[1,1] * inv.tsq.s/n)
```

```
c(xbar.s[1]-sci1.s,xbar.s[1]+sci1.s)
```

```
## Calcium-Iron Calcium-Iron ##
      -0.16788932     -0.06799878

sci2.s = sqrt(S.s[2,2] * inv.tsq.s/n)

c(xbar.s[2]-sci2.s,xbar.s[2]+sci2.s)

## Iron-Protein Iron-Protein ##
      -0.4010312     -0.3084302

sci3.s = sqrt(S.s[3,3] * inv.tsq.s/n)

c(xbar.s[3]-sci3.s,xbar.s[3]+sci3.s)

## Protein-VitaminA Protein-VitaminA ##
      -0.1842946            0.2786543

sci4.s = sqrt(S.s[4,4] * inv.tsq.s/n)

c(xbar.s[4]-sci4.s,xbar.s[4]+sci4.s)

## VitaminA-VitaminC VitaminA-VitaminC

##          -0.2418483          0.2361781

#kmeans

sc.data = scale(nutrients)
sc.data
```

##		Calcium	Iron	Protein	VitaminA	VitaminC
##	[1,]	-0.2561414715	-0.1573979969	-0.7601591486	-3.002714e-01	-0.3368075923
##	[2,]	-0.7066325815	-1.1725729032	0.0650698218	-3.505549e-01	-0.7349581685
##	[3,]	0.5895393588	0.4363331047	-0.1919965902	-1.051308e-01	1.0398297526
##	[4,]	-0.1209966557	0.3534480424	-0.7714753036	-2.902001e-02	1.9805559433
##	[5,]	3.2809575541	1.3016130496	1.4885178434	-6.082824e-02	0.0276179914
##	[6,]	-0.0414552852	-0.7235564467	-0.6547161318	-4.125736e-01	-0.8951450889
##	[7,]	1.0625839713	1.2203990571	1.6553820716	1.713791e-01	1.0878083781
##	[8,]	-1.1146848463	0.2727353708	-0.0538806286	-4.659484e-01	-0.7063829633
##	[9,]	-0.7475108048	-0.4072229327	-0.5443018561	-1.660537e-01	-0.3933873138
##	[10,]	-0.6065262428	0.4239671882	1.2441412237	1.160453e-01	-0.9582741442

##	[29,]	-0.6719968455	-0.8533985705	-0.5844643948	2.064135e-01	1.9140163429
##	[30,]	1.6080464707	0.1037902136	1.8138082421	2.626288e-01	3.3733084538
##	[31,]	-0.2374140096	-0.8321759840	-1.1242711543	-2.890137e-01	1.2786358537
##	[32,]	-0.3341222202	0.1574315543	-0.2095268188	-1.932033e-01	-0.6571542575
##	[33,]	0.0202647909	-0.5373992705	-0.7188846178	-4.171158e-01	-0.8461609640
##	[34,]	-0.1256785212	-0.3362024660	-0.4336586408	-2.362069e-02	-0.5195774851
##	[35,]	-0.5265066172	1.8173051913	2.2566427482	-2.580502e-01	1.1689005437
##	[36,]	-0.7408907477	-0.8507248588	-0.2730738975	-3.341671e-01	-0.1491868443
##	[37,]	0.9105491999	2.2238764748	2.1420748550	-8.147665e-02	2.1107817000
##	[38,]	-0.7488700561	-0.2790518787	0.1779370213	-2.839449e-01	0.4279833838
##	[39,]	-0.3180880895	0.9227815249	-0.7959391301	3.059764e-01	-0.4119482887
##	[40,]	-0.5554788063	1.1632484698	1.6472383647	-3.909334e-01	0.7666600309
##	[41,]	0.1030029190	-0.5604600338	0.1740123432	-3.815612e-01	-0.6347479269
##	[42,]	-1.1938234757	-0.8550696403	-0.2938419855	-4.439778e-01	-0.7518478404
##	[43,]	0.5224074490	0.3188568975	-0.6496467560	-1.597729e-01	-0.7075107531
##	[44,]	-0.2949556466	0.0148893000	0.7292561698	-1.589514e-02	-0.1846374911
##	[45,]	0.8849499677	0.3917155409	0.3757735004	1.079708e-01	-0.5669174827
##	[46,]	0.1742377539	1.0160272200	0.7505148425	9.773042e-03	0.8760148817
##	[47,]	0.2010200382	1.0720080584	3.5767082089	-4.342137e-01	-0.3843106437
##	[48,]	-0.5154815791	-0.0029911469	0.2517863799	-4.040767e-01	0.4562188933
##	[49,]	-1.1534990214	-0.9628536427	-1.0419183266	-3.913926e-01	-0.7042904376
##	[50,]	-0.1091661354	0.6405378349	2.8060649690	-4.668717e-02	-0.7963615694
##	[51,]	-0.9010055128	-0.4840921437	-1.2316110989	-4.219520e-01	-0.8776032012
##	[52,]	-1.1990087675	-1.2467684025	-1.0100957288	-3.842853e-01	-0.2655937785
##	[53,]	1.1709465029	0.3059896600	0.9587844242	-4.825432e-02	-0.5718091012

##	[54,]	-1.2167545480	-1.2213681415	-1.1978915733	-4.801324e-01	-1.0105329359
##	[55,]	-0.9907916104	2.0213428145	-0.2351353430	6.379639e+00	0.3449481586
##	[56,]	-0.1757191049	-0.6057460255	-0.2899827187	3.954692e-01	0.1353966540
##	[57,]	-1.3962764006	-1.5201554226	-1.6192384672	-5.066025e-01	-1.0234821373
##	[58,]	-1.0533926827	-0.2274158217	1.0739410191	-3.856810e-01	-0.2722925784
##	[59,]	-0.0632284768	-0.4124032491	-0.4368637946	-3.974775e-01	-0.8925634013
##	[60,]	-0.9337030571	-1.3291521439	-1.3039887032	-4.500443e-01	-0.9795798606
##	[61,]	0.7699170363	-0.3841621694	-0.0680748809	-1.673209e-01	-0.5365622718
##	[62,]	0.1298858885	0.6980226361	-0.2655188922	9.465607e-01	-0.6736498824
##	[63,]	-1.2758568068	-1.2895477895	-1.5069599694	-5.021337e-01	-0.9028901517
##	[64,]	0.1985029062	-0.3818226716	-1.3441185362	1.036551e-01	1.0773321616
##	[65,]	1.1311758177	1.4931176492	2.0247923927	-3.809846e-02	0.8941002826
##	[66,]	-0.0151512560	-0.6351568540	-0.2388964928	-3.474022e-01	-0.4248839022
##	[67,]	0.0151801843	0.4886375896	0.5953919428	1.457844e-01	-0.0109306805
##	[68,]	-0.5598082733	-1.0489137377	-1.1166834434	-3.248561e-01	-0.9589399478
##	[69,]	-0.9953224480	-0.4187533143	-1.1473940491	-8.254794e-02	-1.0624248563
##	[70,]	1.6084240405	3.3336339321	0.1548468321	1.141071e+00	1.3785471631
##	[71,]	0.3218927157	-1.0179989463	-0.8643593507	-2.954108e-01	-0.7509918071
##	[72,]	0.6382962052	-0.0964039490	0.3260936175	-5.258846e-02	2.0984167753
##	[73,]	1.9623327965	-0.8002585507	0.0458061937	-2.431317e-01	-0.9298891686
##	[74,]	-1.1804323336	-0.5480941172	-0.2220857885	-1.907669e-01	-0.3080829210
##	[75,]	-0.8918934950	-0.2287526775	-0.6707746061	-1.596015e-01	-0.9073469597
##	[76,]	0.6985563448	0.8128251317	0.7900232682	-1.962519e-01	-0.7082852594
##	[77,]	1.7785318196	1.6281400894	1.6075664108	7.503010e-02	-0.0444382677
##	[78,]	0.282247887	-0.3971965139	-	1.629060e+0	0.090502465

		1		0.2300332616	0	8
##	[79,]	-0.8503356461	-0.1101067214	-1.0327280389	-4.978730e-01	-0.8507536504
##	[80,]	1.0179803927	1.8801374160	0.2531927228	1.996153e+00	-0.0343425105
##	[81,]	0.1369842007	0.0299289282	-0.0707240386	3.141929e-02	-0.8490279960
##	[82,]	0.2729848414	1.2260806944	0.3936307856	2.342181e-01	3.0242507051
##	[83,]	-0.9340806269	0.0275894305	-0.1784891566	-3.979060e-01	-0.8716109685
##	[84,]	1.8398743258	1.5205231940	0.1710034234	1.858202e-01	0.0202533879
##	[85,]	-0.4559765792	-0.6674085013	-0.2895902509	-3.844383e-01	-0.2100874956
##	[86,]	-0.7530736665	-0.4023768302	-0.5015555710	-3.703095e-01	-0.0858539716
##	[87,]	-0.3661149676	-0.3432209592	0.2539449528	-2.873425e-01	-0.8422069057
##	[88,]	0.6677969920	-0.9496521913	-0.6979857072	3.463489e-01	0.1467017280
##	[89,]	-0.3431587240	-0.2559911154	-0.8880382416	3.967547e-01	-0.8894110249
##	[90,]	0.0099193784	0.1313628654	-0.0650986667	-2.380140e-01	0.4440306103
##	[91,]	3.6460927187	-0.6543741568	0.8400302076	1.276030e-01	0.0225089676
##	[92,]	-0.9672564264	-0.4383048310	-0.2002711197	-3.292270e-01	-0.1119833675
##	[93,]	1.0548563761	0.1049599625	1.3921669974	-1.275973e-01	0.2697802865
##	[94,]	-1.0610951065	-0.3066245304	-0.3107181011	-2.761275e-01	-1.0113074422
##	[95,]	-0.6409102656	-0.3990346906	-1.3594574862	1.219466e-01	2.1826749052
##	[96,]	-0.1394472331	-0.3539158059	-1.1412126812	-4.551559e-01	-0.6373024388
##	[97,]	1.7884996622	1.7225555334	0.9246397252	7.248520e-01	0.8286205328
##	[98,]	-0.3749249295	-0.0330704034	0.5635693449	-3.795716e-01	-0.6276007286
##	[99,]	-0.0488304819	0.0538252264	-0.2192403969	-7.695273e-02	-0.7727866854
##	[100,]	-0.4391117950	-0.1923233558	-0.7171185127	-2.332146e-01	-0.8469626460
##	[101,]	-0.4063890793	-0.3900109137	-1.3226309239	-1.744955e-01	-0.1302182345
##	[102,]	-0.1618497077	-0.6592202592	-0.8808429985	-1.876449e-01	1.2760677540

## [103,]	-0.5102711160	0.2670537335	-0.2055694351	3.317119e-01	0.3707786222
## [104,]	-0.4019337557	0.0620134685	0.3243929237	-8.448851e-02	-0.4383630290
## [105,]	0.2181113643	-0.6034065277	-0.6833989872	-3.130535e-01	-0.6788947845
## [106,]	0.6376165796	3.1586729235	0.8648865019	6.409177e-01	-0.7370914577
## [107,]	-0.7828009951	-0.9065385903	-1.4218271615	-4.118084e-01	-0.5885493070
## [108,]	-0.9394672894	-0.4080584676	-0.3998737040	-3.747355e-01	-0.6712720122
## [109,]	1.1167023088	0.0645200732	0.8959895754	-1.550286e-01	0.2207010468
## [110,]	0.0567380332	-0.9809011966	-0.8266824415	9.618894e-01	-0.4312973577
## [111,]	1.7042009123	-1.1732413311	-0.3703732074	-2.820533e-01	-0.6599261747
## [112,]	0.4179213006	0.1759804292	0.5303731098	1.885566e-01	-0.4544510190
## [113,]	0.5798484007	0.5143720646	0.8949429946	-6.235865e-02	1.0789355255
## [114,]	-0.7689315979	-0.6896337297	-0.8770818487	-3.631472e-01	1.0400471578
## [115,]	-0.1681928803	0.0305973561	-0.3231789539	-3.337864e-02	0.8318272606
## [116,]	-1.1880089008	-1.0579375146	-1.0317795750	-3.411937e-02	0.0601880184
## [117,]	-1.1384717435	-1.1528542795	-1.1766656062	-3.883379e-01	-0.4108612623
## [118,]	0.4427653932	-0.8729500872	-0.6632850122	-1.489069e-01	-0.2753362522
## [119,]	0.4893826775	-0.4548484221	-0.0820074879	-2.810494e-01	-0.9109749101
## [120,]	-0.1896136734	-0.5457546195	-0.5646774763	-1.848656e-01	-0.4465564901
## [121,]	-0.1353694793	-0.4710577992	-0.5501561675	-3.559113e-01	-0.6658368805
## [122,]	-0.2352996188	-0.3114706329	-0.3327290038	-3.011530e-01	-0.2995361763
## [123,]	-0.1700555579	-0.1087698656	-0.3127131457	-2.453110e-01	-0.9361803336
## [124,]	-0.7615060586	-0.7163708465	-0.0236606077	-4.228029e-01	1.8897620675
## [125,]	0.9158603483	0.7264308228	1.3754544100	-3.899222e-02	-0.2544381706
## [126,]	1.4781876320	-0.4297823750	0.6439925392	-1.473214e-01	-0.0249397326
## [127,]	-0.1126146062	-0.1560611410	-	-3.302676e-	-0.6203448277

			0.0461948008	01	
## [128,]	0.6074361672	-0.3614356200	-0.3046021444	-2.074974e-01	1.9004828649
## [129,]	0.3631233375	0.7717168145	0.6657417967	4.370843e-01	3.4406497362
## [130,]	-0.7204768074	-0.3326932194	-0.5941125616	-3.214402e-01	3.2070613614
## [131,]	-0.1906960401	0.3562888611	0.3818567514	-3.165857e-01	-0.5569847794
## [132,]	1.3373037553	-0.1405201919	0.9911303124	-4.071241e-02	1.0732965763
## [133,]	-0.3873595615	0.3191911114	1.1943959295	-8.593935e-02	0.5611984630
## [134,]	-0.8781751257	-0.2447949477	-0.1829698307	-3.447087e-01	-0.3991485534
## [135,]	-1.1549337866	-1.2248773881	-1.1481135734	-3.715032e-01	0.8971031928
## [136,]	1.2009758874	0.8825087426	0.2094325626	6.871731e-01	2.0743527295
## [137,]	-0.9119298655	0.2344678723	0.4033770694	-1.986027e-01	-0.7694576672
## [138,]	-1.1895695226	-0.7760280386	-0.0645753763	-4.216214e-01	0.4171946473
## [139,]	0.8351107545	-0.1537216433	-0.4615892663	-2.354429e-01	-0.8141480380
## [140,]	0.7452743143	-0.6475227706	-0.0657854854	-1.559223e-01	0.7923682041
## [141,]	-0.9155797069	-1.3690907123	-1.0208885935	-4.392641e-01	-0.9593204070
## [142,]	1.4332064836	2.2110092373	1.3846446978	-1.252099e-01	-0.1820422157
## [143,]	-0.5155822644	-0.7668371546	-0.9003355661	-3.303472e-01	1.7313687405
## [144,]	0.4624997079	-0.3540829129	0.0235009402	-2.296702e-01	-0.4909479286
## [145,]	-0.6507774229	-0.4560181710	-0.7253276310	5.570141e-01	-0.2290561054
## [146,]	0.3566291370	0.7682075679	0.3643919341	1.032571e-01	1.7719691747
## [147,]	0.1124673352	1.9494868129	1.6386040730	-1.210472e-01	1.1464262740
## [148,]	-0.8558229938	-0.6577162964	-0.5493712319	-3.386849e-01	-0.8123680324
## [149,]	-0.2541529373	0.4443542398	-0.6505952198	-2.841041e-01	-0.7839151177
## [150,]	-1.1684507853	-1.0037948529	-1.3046755218	-4.419392e-01	-0.4799146112
## [151,]	0.4127360088	-0.5116647955	-0.9668261534	-4.125112e-02	-0.4418143376

## [152,]	0.1377896829	-0.6105921279	-0.3294911444	3.333403e-01	0.0325096100
## [153,]	0.8414790984	0.7197465436	1.0759360638	-5.305371e-02	-0.8682411868
## [154,]	0.3788805837	-0.8323430910	-0.4647617144	3.125450e-01	0.1135066609
## [155,]	-0.1026215923	1.5450879201	0.6828141462	-3.371056e-01	0.4040688041
## [156,]	2.2000255691	0.3404136979	0.5640272240	-9.248954e-02	1.8530205769
## [157,]	1.3483287933	-0.1269845264	1.2202660990	-6.765390e-02	-0.8463511937
## [158,]	2.3281979294	0.3477664051	1.9985951667	1.552742e-02	-0.2343553588
## [159,]	0.1635399430	-0.6545412638	0.7381521067	-3.555257e-01	-0.2386083494
## [160,]	-0.9027926765	-0.7484553868	-0.6973970055	-3.273048e-01	-0.7922308693
## [161,]	-1.3958233168	-1.5064526502	-1.8384644417	-5.115733e-01	-1.0619356944
## [162,]	2.5648083353	0.5213905578	3.5268320921	7.620841e-01	2.0388205557
## [163,]	-0.3882153864	-0.6334857842	-0.8323405190	-2.975779e-01	-0.7141552017
## [164,]	-1.0078074226	-0.7213840560	-0.3241928290	-3.822407e-01	-0.7901926949
## [165,]	-0.2037096125	-0.2797203066	-1.0127121809	5.228918e-01	0.7649072009
## [166,]	0.6319278613	1.3216658872	1.4302036688	1.089197e-01	1.2315812006
## [167,]	2.1899318699	0.0466396263	0.4423622046	-5.444333e-02	-0.3479360245
## [168,]	-0.3928972519	-0.8655973801	-1.2282424169	-3.983223e-01	-1.0392304316
## [169,]	0.7291394983	0.4476963794	0.3628874742	1.470945e-01	-0.1443903406
## [170,]	0.9358967189	-0.0613114831	-0.0977716114	2.928944e-01	0.8993044212
## [171,]	-1.3178677395	-0.8945068877	-1.6244713712	-1.567488e-01	-0.7946766786
## [172,]	-0.8891246498	-0.2610043248	0.2177725035	-2.683959e-01	0.8571413867
## [173,]	-0.4904361160	-0.4317876588	-0.7859639068	-1.160090e-01	1.0413515894
## [174,]	-0.5208178989	-0.8320088770	-0.9473662914	-4.526154e-01	-0.2172482816
## [175,]	1.1373176197	-0.0150228495	-0.7011254497	8.470234e-02	2.0485086780
## [176,]	0.766216852	-0.1520505735	0.0260846866	2.288984e-01	-0.1200137747

	3				
## [177,]	-1.0415621624	-1.2345695930	-0.6277666759	6.620130e-01	-0.3756144329
## [178,]	-0.3709730323	0.0621805755	0.2194077860	-6.648466e-02	0.4882997584
## [179,]	0.4985953805	0.8241884064	0.8460807529	4.454416e-02	0.5723268952
## [180,]	-0.9455335774	0.0907558691	0.4937754870	1.936314e-01	1.5386661444
## [181,]	0.0242166881	1.2758785746	0.7877338727	-8.618421e-02	-0.4479696243
## [182,]	-0.0868895174	0.9080761106	0.9887427999	-2.435235e-01	0.6690858282
## [183,]	-0.8679807412	-0.2524818688	0.1243651660	-4.625865e-02	-0.3350275866
## [184,]	1.0033558559	-0.2533174037	-0.4836655803	-2.175860e-01	1.7876902933
## [185,]	-0.3453234575	0.0910900831	-0.2094941131	-3.092519e-01	0.0244927907
## [186,]	-0.9838443261	-0.2563253293	0.8389836268	-2.416442e-01	-0.8872777357
## [187,]	-0.1255274932	-0.7713490431	-1.3287795861	-3.397440e-01	0.2903250845
## [188,]	1.2416527401	0.5324196185	1.5177566948	6.144231e-01	2.9452510651
## [189,]	0.3942099174	-0.0875472790	1.5772809785	-1.832801e-01	-0.5906282449
## [190,]	0.5277437688	0.8577769095	1.6912928757	4.096910e-02	-0.0611377100
## [191,]	0.3401167512	0.9040655431	2.7540956906	1.831890e-02	0.5276772879
## [192,]	1.4095202717	1.1482088415	2.1078647447	7.335509e-01	1.4745587654
## [193,]	-0.5982700499	1.2623429092	0.5359984817	-2.396730e-01	2.0602349748
## [194,]	3.1267580492	5.1863490245	0.5178468457	1.967289e+00	0.8284846545
## [195,]	-0.1276418841	0.7763958100	0.6925277244	3.739091e+00	0.5360745665
## [196,]	-0.6630358556	-0.1879785743	-0.6718865982	-3.320429e-01	-0.8563654239
## [197,]	-0.1850073219	-0.7076812836	-0.9073018697	-2.047794e-01	1.4820320716
## [198,]	0.7318580008	0.2967987760	0.3199122496	-1.122319e-01	-0.2314883268
## [199,]	0.9781341935	1.1664235024	0.2738953995	7.113660e-01	0.6820893809
## [200,]	0.0660514215	1.3965298145	-0.0771670517	8.708417e-01	2.6757908209

```
##   [ reached getOption("max.print") -- omitted 537 rows ] ##
attr(,"scaled:center")

##     Calcium        Iron     Protein   VitaminA   VitaminC
## 624.04925   11.12990   65.80344  839.63535   78.92845

## attr(,"scaled:scale")

##      Calcium         Iron      Protein     VitaminA     VitaminC
##   397.27754      5.98419     30.57576  1633.53983     73.59527
```

```
#x.cl = clustering(sc.data,"kmeans",k=2)

# fviz_cluster(kmeans(sc.data, centers =
2),data=sc.data) #

# plot(sc.data, col = kmeans(sc.data, centers = 2)$cluster, pch = 16, main = "K-Means
Clusters") # points(kmeans(sc.data, centers = 2)$means, col = 1:2, pch = 8, cex = 4)



# cal.m =
x.cl$means[,1]*sd(nutrients$Calcium)+mean(nutrients$Calcium) # ir.m
= x.cl$means[,2]*sd(nutrients$Iron)+mean(nutrients$Iron)

#  pr.m  =  x.cl$means[,3]*sd(nutrients$Protein)+mean(nutrients$Protein)

# va.m =
x.cl$means[,4]*sd(nutrients$VitaminA)+mean(nutrients$VitaminA) # vc.m
= x.cl$means[,5]*sd(nutrients$VitaminC)+mean(nutrients$VitaminC)

# barplot(matrix(c(cal.m,ir.m,pr.m,va.m,vc.m),nrow=2,byrow=F), beside=T, col = c("lightblue",
"lightgre # legend("topright", legend = c("c1", "c2"), fill = c("lightblue", "lightgreen"), title =
"Clusters")
```

```
#knitr::stitch_rhtml('prac.r')
knitr::stitch('myscript.r')

## Warning in file(con, "r"):   cannot open file 'myscript.r':   No such file or directory

## Error in file(con, "r"):  cannot open the connection
```

The R session information (including the OS info, R version and all packages used):

```
sessionInfo()

## R version 4.3.1 (2023-06-16 ucrt)

## Platform: x86_64-w64-mingw32/x64 (64-bit) ##
Running under: Windows 11 x64 (build 22621)
```

```
##

## Matrix products: default ##

##

## locale:

## [1] LC_COLLATE=English_India.utf8 LC_CTYPE=English_India.utf8 ## [3]
LC_MONETARY=English_India.utf8 LC_NUMERIC=C

## [5] LC_TIME=English_India.utf8 ##

## time zone: Europe/London
## tzcode source: internal ##

## attached base packages:

## [1] stats graphics grDevices utils datasets methods base
## other attached packages:

## [1] mclust_6.0.0
##

## loaded via a namespace (and not attached): ## knitr_1.45 xfun_0.41
[1] compiler_4.3.1 tools_4.3.1 highr_0.10
## [6] evaluate_0.23

Sys.time()

## [1] "2023-11-30 16:43:55 GMT"
```