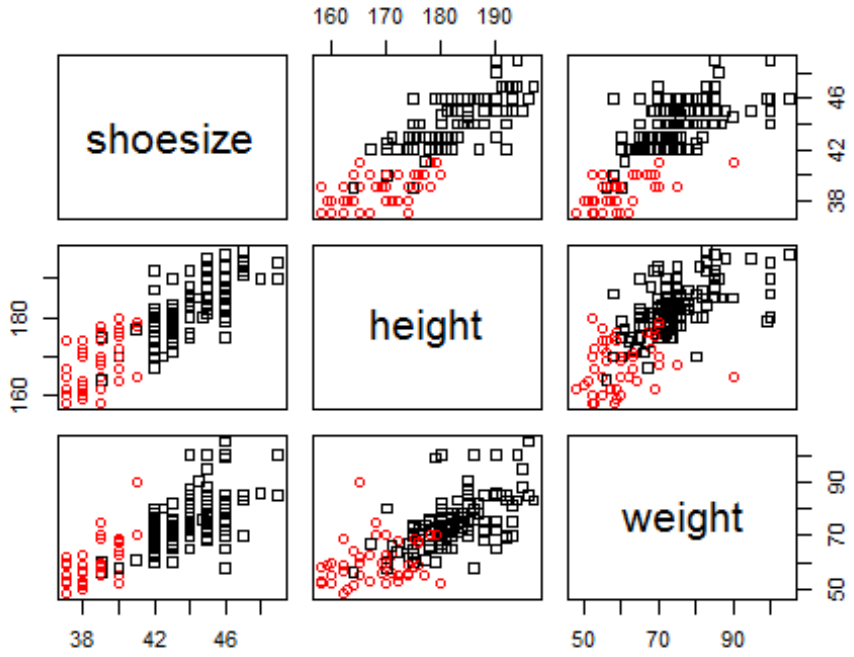
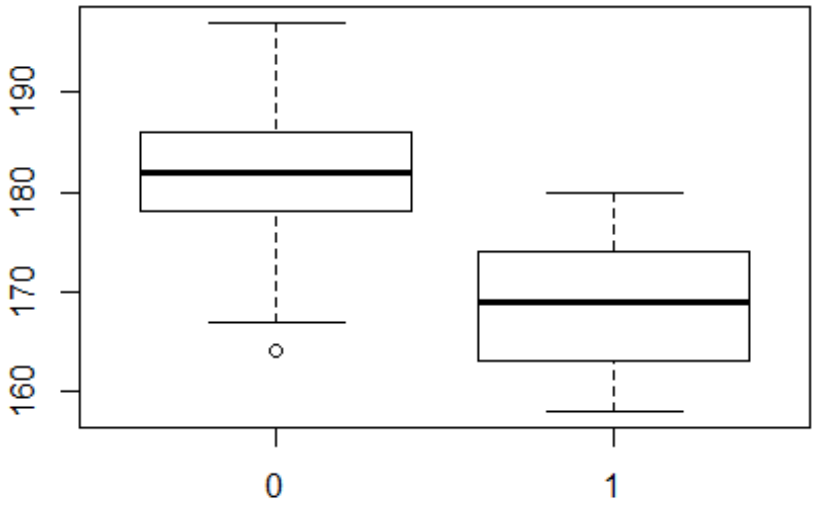
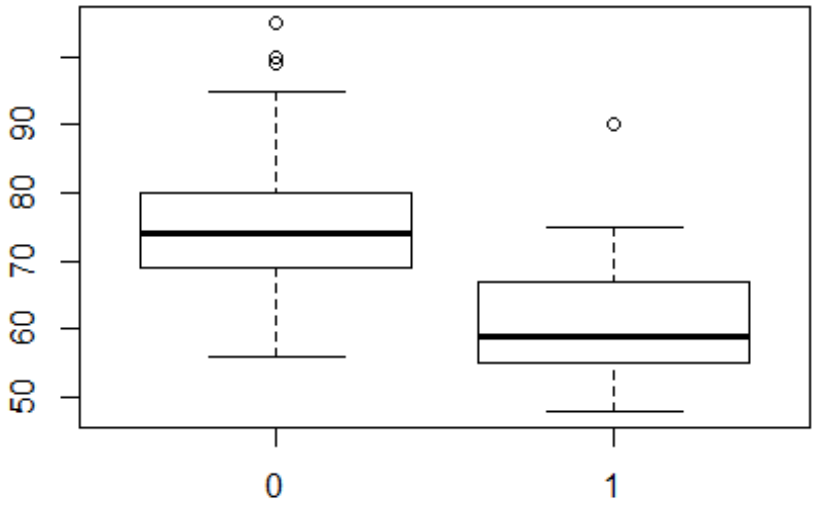
```
### Exercise 1

remove(list = ls())

students2008 = read.table("students2008.txt", header = TRUE, dec = ",")
students2008 = students2008[c(1,4,35,36)]
students2008 = na.omit(students2008)
attach(students2008)

# a)

pairs(students2008[,2:4], col = sex+1, pch = sex)
```



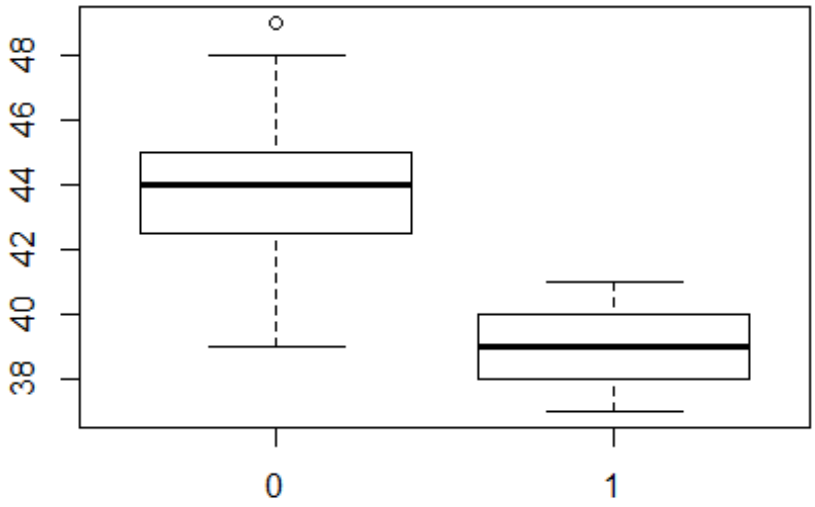

```
# b)

boxplot(height ~ sex)
```




```
boxplot(weight ~ sex)
```



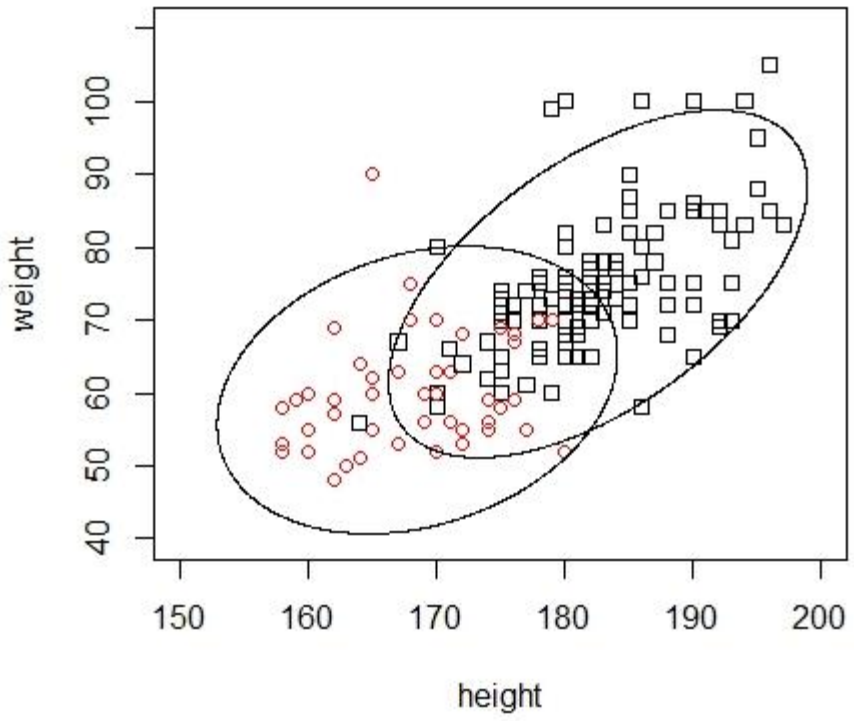

```
boxplot(shoesize ~ sex)
```




```
female = subset(students2008, sex == 1)
male = subset(students2008, sex == 0)

# c)

colMeans(male)

##       sex  shoesize    height    weight
##   0.00000  43.97000 182.57273  74.98182

colMeans(female)

##       sex  shoesize    height    weight
##   1.00000  38.76087 168.47826  60.41304

cov(male[,2:4])

##           shoesize    height   weight
## shoesize  3.521936  8.614587 10.40954
## height    8.614587 44.485488 37.01968
## weight   10.409541 37.019683 94.93545

cov(female[,2:4])

##           shoesize    height   weight
## shoesize 1.474879  4.383575  5.63430
## height   4.383575 40.655072 12.57585
## weight   5.634300 12.575845 65.00338
```

```
# d)

percMale = (dim(male)[1])/(dim(students2008)[1])
percMale

## [1] 0.7051282

percFem = (dim(female)[1])/(dim(students2008)[1])
percFem

## [1] 0.2948718

# e)

plot(height, weight, col = sex+1, pch = sex, xlim = c(150,200), ylim = c(40,1
10) )
c2 = qchisq(0.95,2)
meanmalehei= colMeans(male)[3]
meanmalewei = colMeans(male)[4]
meanfemalehei = colMeans(female)[3]
meanfemalewei = colMeans(female)[4]

Smale = cov(male[,3:4])
Sfemale = cov(female[,3:4])

SmaleInv = solve(Smale)
aSM11 = SmaleInv[1,1]
aSM22 = SmaleInv[2,2]
aSM12 = SmaleInv[1,2]
SfemaleInv = solve(Sfemale)
aSF11 = SfemaleInv[1,1]
aSF22 = SfemaleInv[2,2]
aSF12 = SfemaleInv[1,2]

x1 = seq(150,210, le = 1000)
x2 = seq(40,110, le = 1000)
f = function(x1, x2)
{
  aSM11*(x1-meanmalehei)^2+aSM22*(x2-meanmalewei)^2+2*aSM12*(x1-meanmalehei)*
(x2-meanmalewei)
}
z = outer(x1,x2,f)
contour(x1, x2, z, asp = 1, levels = c2, add = TRUE, drawlabels = FALSE)

ff = function(x1,x2)
{
  aSF11*(x1-meanfemalehei)^2+aSF22*(x2-meanfemalewei)^2+2*aSF12*(x1-meanfemal
ehei)*(x2-meanfemalewei)
}
```

```
y = outer(x1,x2,ff)
contour(x1, x2, y, asp = 1, levels = c2, add = TRUE, drawlabels = FALSE)
```




```
m = c(meanmalehei,meanmalewei)
n = length(male[,3])
sum(mahalanobis(male[,3:4],m,Smale)<=c2)/n

## [1] 0.9181818

# ~91,82%

mf = c(meanfemalehei,meanfemalewei)
nf = length(female[,3])
sum(mahalanobis(female[,3:4],mf,Sfemale)<=c2)/nf

## [1] 0.9782609

# ~97,83%

# f)
X = as.matrix(students2008[,3:4])
Sp = ((109)/(154))*Smale+((45)/(154))*Sfemale
x1bar = matrix(mf,2,1)
x2bar = matrix(m,2,1)

lhs = X%*%solve(Sp)%*%(x1bar-x2bar)-(0.5*t(x1bar-x2bar)%*%solve(Sp)%*%(x1bar+
```

```
x2bar))[1,1]
rhs = log(percMale/percFem)
pi1 = c(lhs>=rhs)

countFemasMale = c(students2008[1] == 1 & pi1 == FALSE)
countFemasFemale = c(students2008[1] == 1 & pi1 == TRUE)
countMaleasFem = c(students2008[1] == 0 & pi1 == TRUE)
countMaleasMale = c(students2008[1] == 0 & pi1 == FALSE)

sum(countMaleasFem)

## [1] 6

sum(countMaleasMale)

## [1] 104

sum(countFemasFemale)

## [1] 36

sum(countFemasMale)

## [1] 10

APER = ((sum(countFemasMale)+sum(countMaleasFem))/dim(students2008)[1])
APER

## [1] 0.1025641

# ~ 10.26%
```

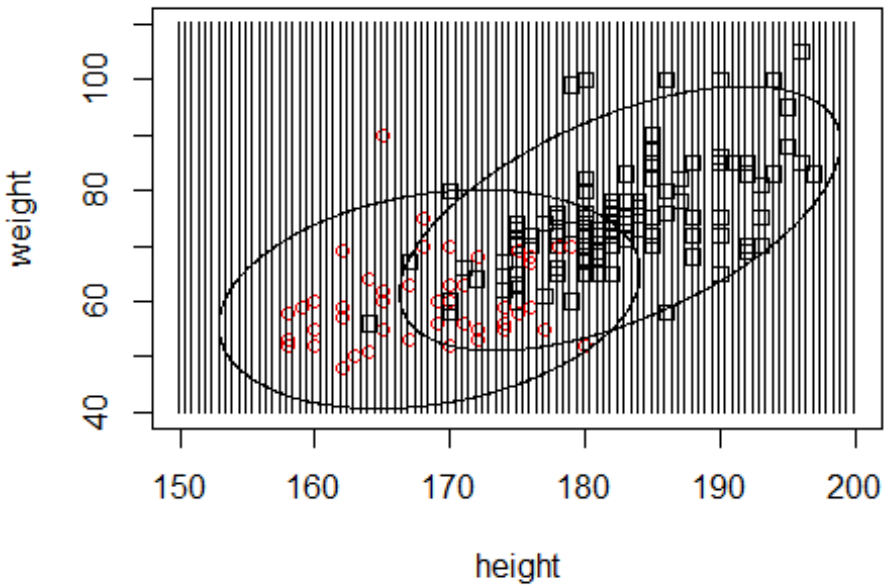
		Predicted Sex		
		π1: Female	π2: Male	
Actual Sex	π1: Female	36	10	46
	π2: Male	6	104	110
				156
	APER = 10.10%			

```
# g)
X2 = as.matrix(students2008[,2:4])
Smale2 = cov(male[,2:4])
Sfemale2 = cov(female[,2:4])
meanfemalesho = colMeans(female)[2]
meanmalesho = colMeans(male)[2]
m2 = c(meanmalesho,meanmalehei,meanmalewei)
mf2 = c(meanfemalesho,meanfemalehei,meanfemalewei)
```

```
x1bar2 = matrix(mf2,3,1)
x2bar2 = matrix(m2,3,1)
Sp2 = ((109)/(154))*Smale2+((45)/(154))*Sfemale2
lhs2 = X2%*%solve(Sp2)%*%(x1bar2-x2bar2)-(0.5*t(x1bar2-x2bar2)%*%solve(Sp2)%*
%(x1bar2+x2bar2))[1,1]
rhs = log(percMale/percFem)

pi12 = c(lhs2<=rhs)

countFemasMale2 = c(students2008[1] == 1 & pi12 == FALSE)
countFemasFemale2 = c(students2008[1] == 1 & pi12 == TRUE)
countMaleasFem2 = c(students2008[1] == 0 & pi12 == TRUE)
countMaleasMale2 = c(students2008[1] == 0 & pi12 == FALSE)

sum(countMaleasFem2)

## [1] 107

sum(countMaleasMale2)

## [1] 3

sum(countFemasFemale2)

## [1] 2

sum(countFemasMale2)

## [1] 44

APER2 = (2+10)/dim(students2008)[1]
APER2

## [1] 0.07692308

# ~ 7,69%
```

		Predicted Sex		
		π1: Female	π2: Male	
Actual Sex	π1: Female	44	2	46
	π2: Male	10	100	110
				156
	APER = 7.69%			

```
### Exercise 2

require(utils)
points(expand.grid(height = seq(150,200, 0.5), weigth = seq(40, 110, 0.5)), c
ex = 0.1)
```




```
### Exercise 3

# f)

students2009 = read.table("students2009.txt", header = TRUE, dec = ",")
students2009 = students2009[c(1,4,35,36)]
students2009 = na.omit(students2009)
X3 = as.matrix(students2009[,3:4])
X3 = matrix(as.numeric(X3), 130,2)

lhs3 = X3%*%solve(Sp)%*%(x1bar-x2bar)-(0.5*t(x1bar-x2bar)%*%solve(Sp)%*%(x1ba
r+x2bar))[1,1]
rhs = log(percMale/percFem)
pi3 = c(lhs3>=rhs)

countFemasMale3 = c(students2009[1] == 1 & pi3 == FALSE)
countFemasFemale3 = c(students2009[1] == 1 & pi3 == TRUE)
countMaleasFem3 = c(students2009[1] == 0 & pi3 == TRUE)
countMaleasMale3 = c(students2009[1] == 0 & pi3 == FALSE)

sum(countMaleasFem3)

## [1] 7
```

```
# Anzahl der Männer die Frauen zugeordnet wurden: 7
sum(countMaleasMale3)

## [1] 93

# Anzahl der Männer die Männern zugeordnet wurden: 93
sum(countFemasFemale3)

## [1] 20

# Anzahl der Frauen die Frauen zugeordnet wurden: 20
sum(countFemasMale3)

## [1] 10

# Anzahl der Frauen die Männern zugeordnet wurden: 10
APER3 = ((sum(countFemasMale3)+sum(countMaleasFem3))/dim(students2009)[1])
APER3

## [1] 0.1307692

# g)

X4 = as.matrix(students2009[,2:4])
X4 = matrix(as.numeric(X3), 130,3)

## Warning in matrix(as.numeric(X3), 130, 3): Datenlänge [260] ist kein Teile
r
## oder Vielfaches der Anzahl der Spalten [3]

lhs4 = X4%*%solve(Sp2)%*%(x1bar2-x2bar2)-(0.5*t(x1bar2-x2bar2)%*%solve(Sp2)%*
%(x1bar2+x2bar2))[1,1]
pi4 = c(lhs4>=rhs)

countFemasMale4 = c(students2009[1] == 1 & pi4 == FALSE)
countFemasFemale4 = c(students2009[1] == 1 & pi4 == TRUE)
countMaleasFem4 = c(students2009[1] == 0 & pi4 == TRUE)
countMaleasMale4 = c(students2009[1] == 0 & pi4 == FALSE)

sum(countMaleasFem4)

## [1] 0

sum(countMaleasMale4)

## [1] 100

sum(countFemasFemale4)

## [1] 0

sum(countFemasMale4)
```

```
## [1] 30

APER4 = ((sum(countFemasMale4)+sum(countMaleasFem4))/dim(students2009)[1])
APER4

## [1] 0.2307692
```