HW2

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Chapter 4

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```r
#a
mu<-c(3,1,4)
SIGMA <-rbind(c(6,1,-2),c(1,13,4),c(-2,4,4))
c<-c(2,-1,3)
(zmu<-c%*%mu)
```

```
##      [,1]
## [1,]   17
```

```r
(zSIGMA<-t(c)%*%SIGMA%*%c)
```

```
##      [,1]
## [1,]   21
```

```r
# z~(17,21)

#b
cb<-rbind(c(1,1,1),c(1,-1,2))
(zbmu<-cb%*%mu)
```

```
##      [,1]
## [1,]    8
## [2,]   10
```

```r
(zbSIGMA<-cb%*%SIGMA%*%t(cb))
```

```
##      [,1] [,2]
## [1,]   29   -1
## [2,]   -1    9
```

```r
# z1,z2~N2((8,10),[(29,-1),(-1,9)])

#c
# y2~N(1,13)

#d
# y1,y3~N2((3,4),[(6,-2),(-2,4)])

#e
C<-rbind(c(1,0,0),c(0,0,1),c(.5,.5,0))
(cmu<-C%*%mu)
```

```
##      [,1]
## [1,]    3
## [2,]    4
```

```
## [3,]    2
```

```
(cSIGMA<-C%*%SIGMA%*%t(C))
```

```
##      [,1] [,2] [,3]
## [1,]  6.0   -2 3.50
## [2,] -2.0    4 1.00
## [3,]  3.5    1 5.25
```

```
# y1,y3,.5(y1+y2)~N3((3,4,2),[(6,-2,3.5),(-2,4,1),(3.5,1,5.25)])
```

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```
#b
SIGMARoot <- eigen(SIGMA)$vectors%*%diag(sqrt(eigen(SIGMA)$values))%*%t(eigen(SIGMA)$vectors)
(SIGMARootInverse<-solve(SIGMARoot))
```

```
##             [,1]        [,2]       [,3]
## [1,]  0.46496849 -0.06966936  0.1701484
## [2,] -0.06966936  0.32645938 -0.1657086
## [3,]  0.17014841 -0.16570861  0.6916013
```

```
# z=SIGMARootInverse%*%c(y-3,y-1,y-4)

#c
# Distributed chi-square(3) because statistical distance is distributed chi-square(p)
```

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```
#a
mu<-c(2,-3,4)
(SIGMA<-rbind(c(4,-3,0),c(-3,6,0),c(0,0,5)))
```

```
##      [,1] [,2] [,3]
## [1,]    4   -3    0
## [2,]   -3    6    0
## [3,]    0    0    5
```

```
# Dependent due to covariance not equal to 0

#b
# Independent due to covariance equal to 0

#c
# Independent due to covariance equal to 0

#d
c<-rbind(c(1,1,0),c(0,0,1))
(dSIGMA<-c%*%SIGMA%*%t(c))
```

```
##      [,1] [,2]
## [1,]    4    0
## [2,]    0    5
```

```r
# Independent due to covariance equal to 0

#e
c<-rbind(c(1,0,1),c(0,1,0))
(eSIGMA<-c%*%SIGMA%*%t(c))
```

```
##      [,1] [,2]
## [1,]    9   -3
## [2,]   -3    6
```

```r
# Dependent due to covariance not equal to 0
```

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```r
#a
mu<-c(2,-1,3,1)
SIGMA<-rbind(c(7,3,-3,2),c(3,6,0,4),c(-3,0,5,-2),c(2,4,-2,4))
(n<-mu[1:2])
```

```
## [1]  2 -1
```

```r
(z<-SIGMA[1:2,3:4]%*%solve(SIGMA[3:4,3:4]))
```

```
##      [,1] [,2]
## [1,] -0.5 0.25
## [2,]  0.5 1.25
```

```r
# n+z%*%c(x1-3,x2-1)

#b
(SIGMA[1:2,1:2]-SIGMA[1:2,3:4]%*%solve(SIGMA[3:4,3:4])%*%SIGMA[3:4,1:2])
```

```
##      [,1] [,2]
## [1,]    5    2
## [2,]    2    1
```

Chapter 5

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```r
nullvec<-c(6,11)
Y<-cbind(c(3,6,5,10),c(10,12,14,9))
meanvec<-colMeans(Y)
varmat<-var(Y)
n=nrow(Y)
p=ncol(Y)
(T2 <- n*t(meanvec-nullvec)%*%solve(varmat)%*%(meanvec-nullvec))
```

```
##            [,1]
## [1,] 0.06103286
```

```r
(critval <- (n-1)*p/(n-p)*qf(.95,p,n-p))
```

```
## [1] 57
```

```r
(T2>critval)
```

```
##       [,1]
## [1,] FALSE
```

```r
# Fail to reject H0
```

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```r
probe <- read.table("T3_6_PROBE.dat")
probe<-probe[,-1]
#a
nullvec<-c(30,25,40,25,30)
meanvec <- colMeans(probe)
varmat <- var(probe)
n=nrow(probe)
p=ncol(probe)
(T2 <- n*t(meanvec-nullvec)%*%solve(varmat)%*%(meanvec-nullvec))
```

```
##         [,1]
## [1,] 85.3327
```

```r
(critval <- (n-1)*p/(n-p)*qf(.95,p,n-p))
```

```
## [1] 36.56145
```

```r
(T2>critval)
```

```
##      [,1]
## [1,] TRUE
```

```r
# reject H0

#b
t.test(probe$V2,mu=nullvec[1])
```

```
##
##  One Sample t-test
##
## data:  probe$V2
## t = 2.5039, df = 10, p-value = 0.03124
## alternative hypothesis: true mean is not equal to 30
## 95 percent confidence interval:
##  30.67082 41.51099
## sample estimates:
## mean of x
##  36.09091
```

```r
# reject H0, true mean not equal to 30
t.test(probe$V3,mu=nullvec[2])
```

```
##
##  One Sample t-test
##
## data:  probe$V3
## t = 0.26652, df = 10, p-value = 0.7953
```

```
## alternative hypothesis: true mean is not equal to 25
## 95 percent confidence interval:
##  20.98542 30.10549
## sample estimates:
## mean of x
##  25.54545
```

```r
# Fail to reject H0, true mean equal to 25
t.test(probe$V4,mu=nullvec[3])
```

```
##
##  One Sample t-test
##
## data:  probe$V4
## t = -2.5157, df = 10, p-value = 0.03061
## alternative hypothesis: true mean is not equal to 40
## 95 percent confidence interval:
##  28.85722 39.32460
## sample estimates:
## mean of x
##  34.09091
```

```r
# reject H0, true mean not equal to 40
t.test(probe$V5,mu=nullvec[4])
```

```
##
##  One Sample t-test
##
## data:  probe$V5
## t = 0.95104, df = 10, p-value = 0.364
## alternative hypothesis: true mean is not equal to 25
## 95 percent confidence interval:
##  21.94811 32.59735
## sample estimates:
## mean of x
##  27.27273
```

```r
# Fail to reject H0, true mean equal to 25
t.test(probe$V6,mu=nullvec[5])
```

```
##
##  One Sample t-test
##
## data:  probe$V6
## t = 0.31613, df = 10, p-value = 0.7584
## alternative hypothesis: true mean is not equal to 30
## 95 percent confidence interval:
##  25.60131 35.85323
## sample estimates:
## mean of x
##  30.72727
```

```r
# Fail to reject H0, true mean equal to 30
```

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```r
fBeetles <- read.table("T5_5_FBEETLES.dat")
fBeetles<-fBeetles[,-1]

#a
g1<- subset(fBeetles,V2==1)[,-1]
g2<- subset(fBeetles,V2==2)[,-1]
p <- ncol(g1)
n1 <- nrow(g1)
n2 <- nrow(g2)
mean1 <- colMeans(g1)
mean2 <- colMeans(g2)
S1 <- var(g1)
S2 <- var(g2)
Sg <- ((n1-1)*S1+(n2-1)*S2)/(n1+n2-2)
(T2 <- n1*n2/(n1+n2)*t(mean1-mean2)%*%solve(Sg)%*%(mean1-mean2))
```

```
##          [,1]
## [1,] 133.4873
```

```r
a <- p*(n1+n2-2)/(n1+n2-p-1)
(crit.val <- a*qf(.95,p,n1+n2-p-1))
```

```
## [1] 11.53483
```

```r
T2>crit.val
```

```
##      [,1]
## [1,] TRUE
```

```r
# Reject H0

#b
p.vals <- rep(1,p)
t.stat <- (mean1[1]-mean2[1])/sqrt((1/n1+1/n2)*Sg[1,1])
p.vals[1] <- 2*pt(abs(t.stat), n1+n2-2, lower.tail = F)
t.stat <- (mean1[2]-mean2[2])/sqrt((1/n1+1/n2)*Sg[2,2])
p.vals[2] <- 2*pt(abs(t.stat), n1+n2-2, lower.tail = F)
t.stat <- (mean1[3]-mean2[3])/sqrt((1/n1+1/n2)*Sg[3,3])
p.vals[3] <- 2*pt(abs(t.stat), n1+n2-2, lower.tail = F)
t.stat <- (mean1[4]-mean2[4])/sqrt((1/n1+1/n2)*Sg[4,4])
p.vals[4] <- 2*pt(abs(t.stat), n1+n2-2, lower.tail = F)
(p.vals)
```

```
## [1] 4.049179e-04 4.326232e-04 1.645393e-06 1.236427e-05
```

```r
# Reject H0 for all

#c
solve(Sg)%*%(mean1-mean2)
```

```
##          [,1]
## V3  0.3452490
## V4 -0.1303878
## V5 -0.1064338
## V6 -0.1433533
```

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```r
goods <- read.table("T5_8_GOODS.dat")
goods<-goods[,-1]
#a
g1<- subset(goods,V2==1)[,-1]
g2<- subset(goods,V2==2)[,-1]
p <- ncol(g1)
n1 <- nrow(g1)
n2 <- nrow(g2)
mean1 <- colMeans(g1)
mean2 <- colMeans(g2)
S1 <- var(g1)
S2 <- var(g2)
Sg <- ((n1-1)*S1+(n2-1)*S2)/(n1+n2-2)
(T2 <- n1*n2/(n1+n2)*t(mean1-mean2)%*%solve(Sg)%*%(mean1-mean2))
```

```
##          [,1]
## [1,] 18.46248
```

```r
a <- p*(n1+n2-2)/(n1+n2-p-1)
(crit.val <- a*qf(.95,p,n1+n2-p-1))
```

```
## [1] 15.11664
```

```r
T2>crit.val
```

```
##      [,1]
## [1,] TRUE
```

```r
# Reject H0
#b
solve(Sg)%*%(mean1-mean2)
```

```
##            [,1]
## V3 -0.056896013
## V4 -0.009709542
## V5 -0.242134127
## V6 -0.071282739
```

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```r
essay <- read.table("T5_9_ESSAY.dat")
essay <- essay[,-1]
#a
dword<-as.matrix(essay[,1]-essay[,3])
dverb<-as.matrix(essay[,2]-essay[,4])
diff <-cbind(dword,dverb)
p<-ncol(diff)
n<-nrow(diff)
meandiff <- colMeans(diff)
varmat <- var(diff)
(T2 <- n*t(meandiff)%*%solve(varmat)%*%meandiff)
```

```
##          [,1]
```

```
## [1,] 15.19123
```

```
(critval <- p*(n-1)/(n-p)*qf(.95,p,n-p))
```

```
## [1] 8.196602
```

```
T2>critval
```

```
##      [,1]
## [1,] TRUE
```

```
#reject H0

#b
solve(varmat)%*%meandiff
```

```
##             [,1]
## [1,] -0.03601558
## [2,]  0.04770629
```

```
#c
t.test(dword)
```

```
##
##  One Sample t-test
##
## data:  dword
## t = -3.8371, df = 14, p-value = 0.001813
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -51.13367 -14.46633
## sample estimates:
## mean of x
##     -32.8
```

```
# Reject H0
t.test(dverb)
```

```
##
##  One Sample t-test
##
## data:  dverb
## t = -2.4362, df = 14, p-value = 0.0288
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -6.644008 -0.422659
## sample estimates:
## mean of x
## -3.533333
```

```
# Reject H0
```