101B - HW3

##(4.13)

```
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 4.1.2
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
#dat = data.frame(rca = factor(rep(c(1:4),each=12)),
#tp = factor(rep(c(1,1,2,2,3,3,4,4,5,5,6,6),4)),
#y = c(4.93,(0.05), 4.86,(0.04), 4.75,(0.05), 4.95,(0.06), 4.79,(0.03), 4.88,(0.05),
#      4.85,(0.04), 4.91,(0.02), 4.79,(0.03), 4.85,(0.05), 4.75,(0.03), 4.85,(0.02),
#     4.83,(0.09), 4.88,(0.13), 4.90,(0.11), 4.75,(0.15), 4.82,(0.08), 4.90,(0.12),
#      4.89,(0.03), 4.77,(0.04), 4.94,(0.05), 4.86,(0.05), 4.79,(0.03), 4.76,(0.02)))

data <- c(rep("1", 6), rep("2", 6), rep("3", 6), rep("4", 6))
tp <- rep(rep(c(1,2,3,4,5,6),4))

avg <- c(4.93, 4.86, 4.75, 4.95, 4.79, 4.88, 4.85, 4.91, 4.79, 4.85, 4.75, 4.85,
                4.83, 4.88, 4.90, 4.75, 4.82, 4.90, 4.89, 4.77, 4.94, 4.86, 4.79, 4.76)

sd <- c(0.05, 0.04, 0.05, 0.06, 0.03, 0.05, 0.04, 0.02, 0.03, 0.05, 0.03, 0.02,
                0.09, 0.13, 0.11, 0.15, 0.08, 0.12, 0.03, 0.04, 0.05, 0.05, 0.03, 0.02)

d1 <- data.frame(data, tp, avg)
d2 <- data.frame(data, tp, sd)
d3 <- data.frame(d1,d2)

mavg <- aov(avg ~ data + tp, data = d1)
summary(mavg)
```

```
##             Df  Sum Sq  Mean Sq F value Pr(>F)
## data         3 0.00275 0.000915   0.209  0.889
## tp           1 0.00632 0.006318   1.441  0.245
## Residuals   19 0.08330 0.004384
```

```r
#log transformation
msd <- aov(log(sd) ~ data + tp, data = d2)
summary(msd)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## data         3  6.166  2.0554  21.918 2.18e-06 ***
## tp           1  0.090  0.0899   0.959     0.34
## Residuals   19  1.782  0.0938
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

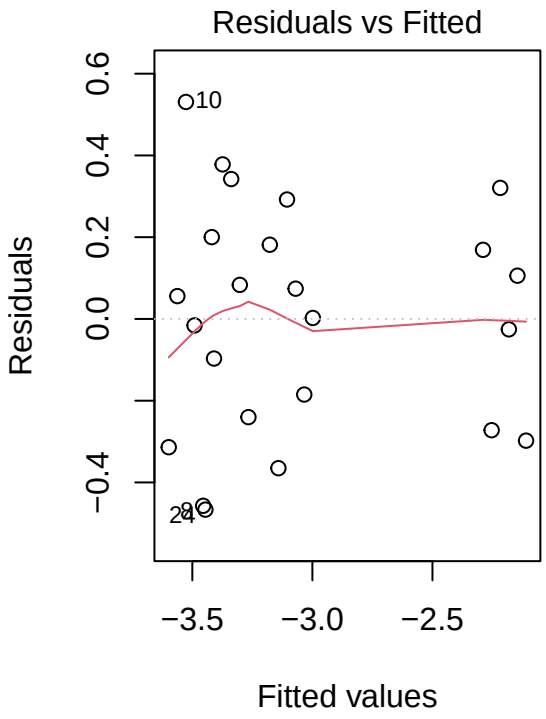
```r
TukeyHSD(msd)
```

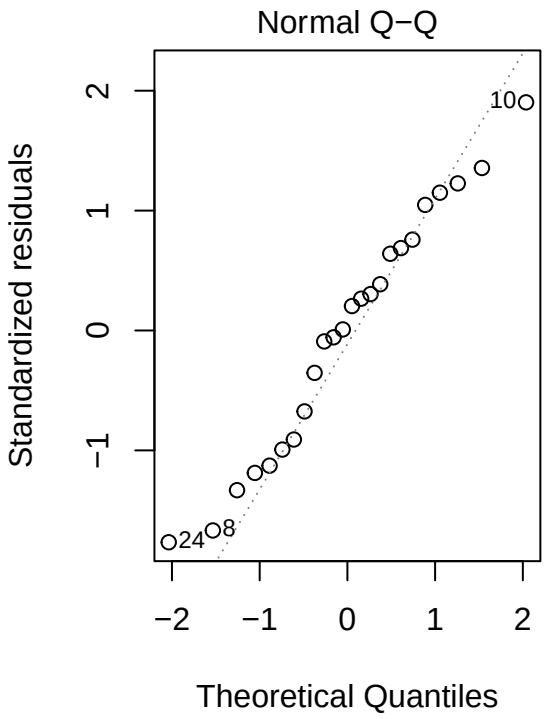
```
## Warning in replications(paste("~", xx), data = mf): non-factors ignored: tp
```

```
## Warning in TukeyHSD.aov(msd): 'which' specified some non-factors which will be
## dropped
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = log(sd) ~ data + tp, data = d2)
##
## $data
##           diff        lwr         upr     p adj
## 2-1 -0.4209548 -0.9180903  0.07618074 0.1150260
## 3-1  0.8879146  0.3907791  1.38505013 0.0004054
## 4-1 -0.2682397 -0.7653752  0.22889586 0.4472614
## 3-2  1.3088694  0.8117339  1.80600491 0.0000029
## 4-2  0.1527151 -0.3444204  0.64985063 0.8232133
## 4-3 -1.1561543 -1.6532898 -0.65901877 0.0000161
```

```r
par(mfrow=c(1,2))
plot(msd,1:2)
```






```
#We would chose algorithm 2, since it minimizes pot noise, but the ratio control algorithm has little e
```

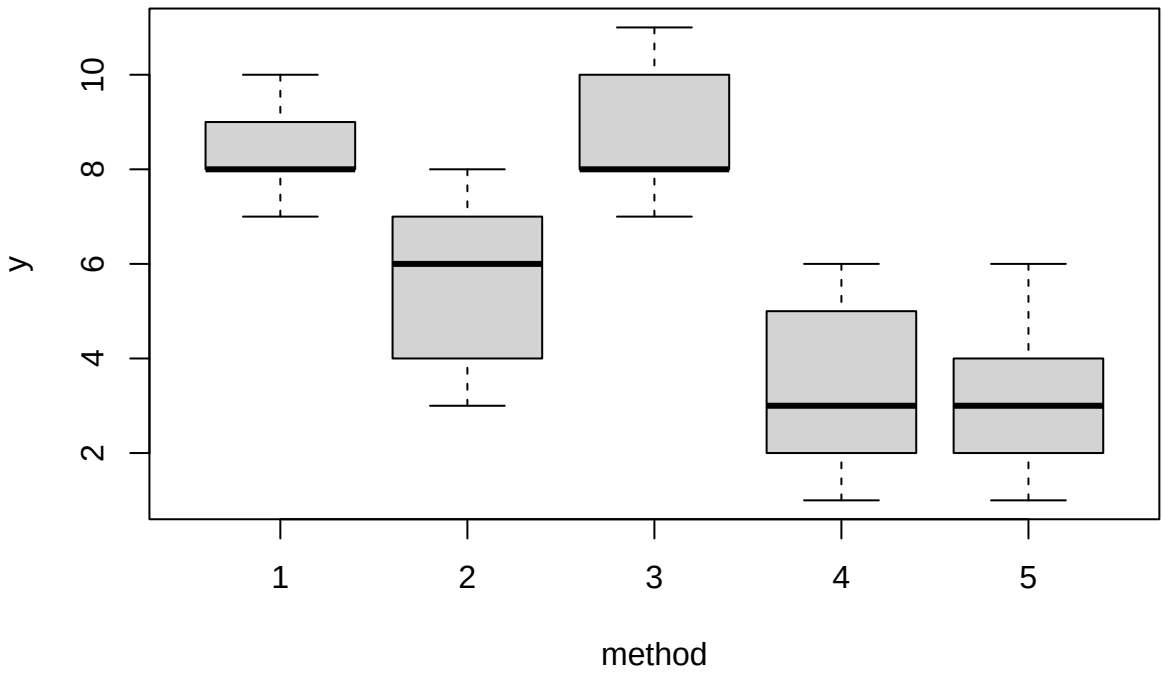
##(4.3)

```
latin <- function (n){
  x <- matrix(LETTERS[1:n], n, n)
  x <- t(x)
  for (i in 2:n) x[i, ] <- x[i, c(i:n, 1:(i - 1))]
  x <- x[sample(n), ]
  x <- x[, sample(n)]
return(x)
}

latin(4)
```

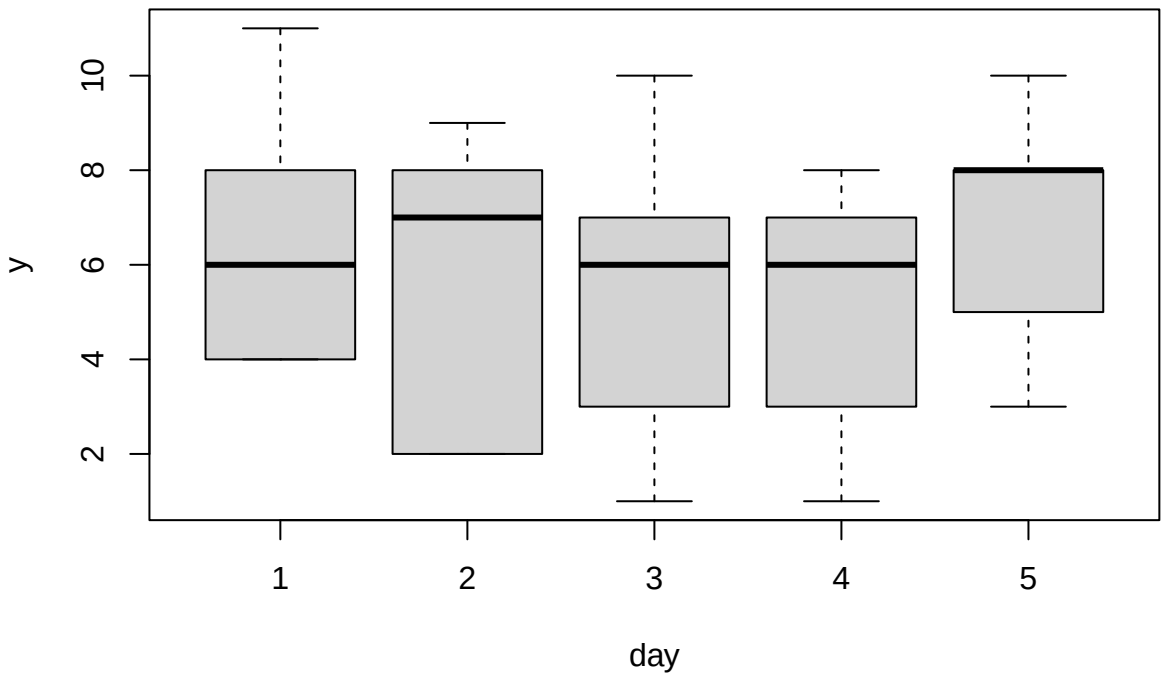
```
##      [,1] [,2] [,3] [,4]
## [1,] "C"  "A"  "D"  "B"
## [2,] "D"  "B"  "A"  "C"
## [3,] "A"  "C"  "B"  "D"
## [4,] "B"  "D"  "C"  "A"
```

##(4.22)

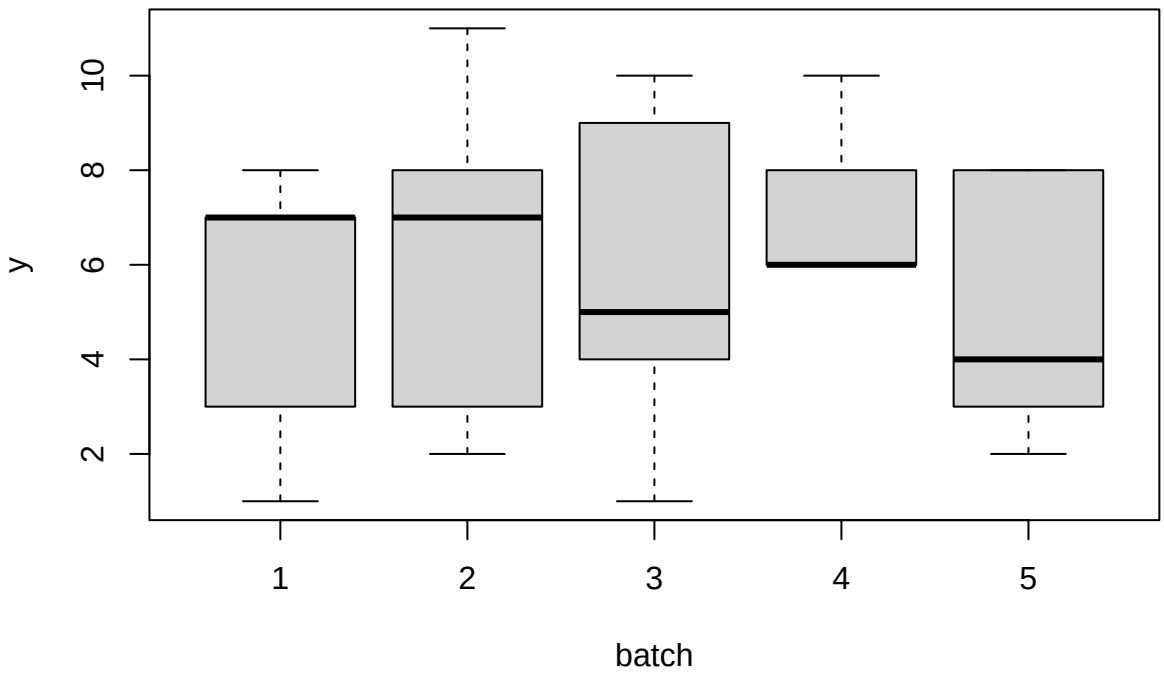
```r
dat = data.frame(day=factor(rep(1:5,5)),
bat = factor(rep(1:5,each = 5)),
method = factor(c(1,2,4,3,5,
                  3,5,1,4,2,
                  2,1,3,5,4,
                  4,3,5,2,1,
                  5,4,2,1,3)),

          y = c(8,7,1,7,3,
                11,2,7,3,8,
                4,9,10,1,5,
                6,8,6,6,10,
                4,2,3,8,8))

boxplot(y~method,data=dat, xlab = 'method')
```




```r
boxplot(y~day,data=dat, xlab = 'day')
```




```
boxplot(y~bat,data=dat, xlab = 'batch')
```




```
res.aov = aov(y~day+bat+method,data=dat)
summary(res.aov)
```

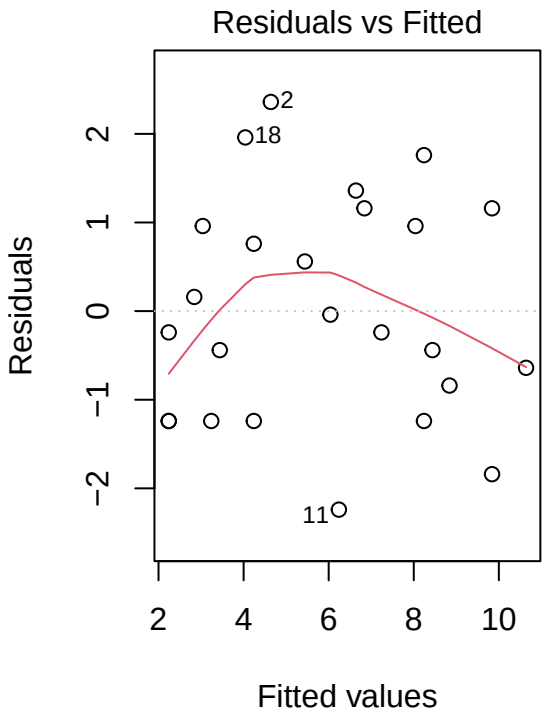
```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## day          4  12.24    3.06   0.979 0.455014
## bat          4  15.44    3.86   1.235 0.347618
## method       4 141.44   35.36  11.309 0.000488 ***
## Residuals   12  37.52    3.13
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

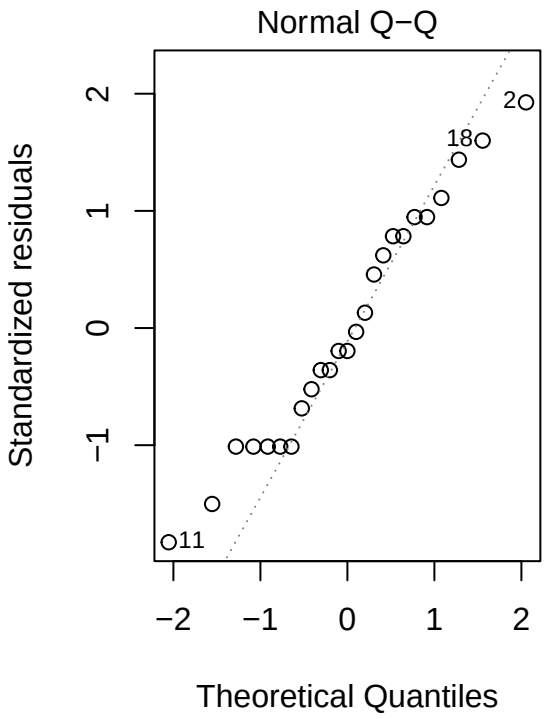
```
TukeyHSD(res.aov)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = y ~ day + bat + method, data = dat)
##
## $day
##     diff       lwr      upr     p adj
## 2-1 -1.0 -4.564608 2.564608 0.8936609
## 3-1 -1.2 -4.764608 2.364608 0.8166339
## 4-1 -1.6 -5.164608 1.964608 0.6212723
## 5-1  0.2 -3.364608 3.764608 0.9997349
```

```
## 3-2 -0.2 -3.764608 3.364608 0.9997349
## 4-2 -0.6 -4.164608 2.964608 0.9816047
## 5-2  1.2 -2.364608 4.764608 0.8166339
## 4-3 -0.4 -3.964608 3.164608 0.9960012
## 5-3  1.4 -2.164608 4.964608 0.7232162
## 5-4  1.8 -1.764608 5.364608 0.5188508
##
## $bat
##     diff       lwr      upr     p adj
## 2-1  1.0 -2.564608 4.564608 0.8936609
## 3-1  0.6 -2.964608 4.164608 0.9816047
## 4-1  2.0 -1.564608 5.564608 0.4225127
## 5-1 -0.2 -3.764608 3.364608 0.9997349
## 3-2 -0.4 -3.964608 3.164608 0.9960012
## 4-2  1.0 -2.564608 4.564608 0.8936609
## 5-2 -1.2 -4.764608 2.364608 0.8166339
## 4-3  1.4 -2.164608 4.964608 0.7232162
## 5-3 -0.8 -4.364608 2.764608 0.9489243
## 5-4 -2.2 -5.764608 1.364608 0.3365811
##
## $method
##     diff        lwr        upr     p adj
## 2-1 -2.8 -6.3646078  0.7646078 0.1539433
## 3-1  0.4 -3.1646078  3.9646078 0.9960012
## 4-1 -5.0 -8.5646078 -1.4353922 0.0055862
## 5-1 -5.2 -8.7646078 -1.6353922 0.0041431
## 3-2  3.2 -0.3646078  6.7646078 0.0864353
## 4-2 -2.2 -5.7646078  1.3646078 0.3365811
## 5-2 -2.4 -5.9646078  1.1646078 0.2631551
## 4-3 -5.4 -8.9646078 -1.8353922 0.0030822
## 5-3 -5.6 -9.1646078 -2.0353922 0.0023007
## 5-4 -0.2 -3.7646078  3.3646078 0.9997349
```

```
par(mfrow=c(1,2))
plot(res.aov,1:2)
```






```
#with the p-value greater than 0.05, we can conclude that the chemicals used have a do not have a signi
```