CA6

2025-03-27

```r
# Question 1

# Loading libraries
library(readr)
library(car)
```

```
## Loading required package: carData
```

```r
library(biotools)
```

```
## Loading required package: MASS
```

```
## ---
## biotools version 4.2
```

```r
library(MASS)

# Loading data
CA1 <- read.csv("~/Downloads/CA1.csv")

CA1$Period <- as.factor(CA1$TimePeriod)


# Extracting numeric variables only
numeric_data <- CA1[, !(names(CA1) %in% c("TimePeriod", "Period"))]


# 1a. Box's M-test

boxM_result <- boxM(numeric_data, CA1$Period)
print(boxM_result)
```

```
##
##  Box's M-test for Homogeneity of Covariance Matrices
##
## data:  numeric_data
## Chi-Sq (approx.) = 45.667, df = 40, p-value = 0.2483
```

```r
# 1b. One-Way MANOVA

manova_model <- manova(as.matrix(numeric_data) ~ Period, data = CA1)

# Multivariate test (Wilks' Lambda)
summary(manova_model, test = "Wilks")
```

```
##            Df   Wilks approx F num Df den Df   Pr(>F)
## Period      4 0.66359   3.9009     16 434.45 7.01e-07 ***
## Residuals 145
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```
```r
# Following up ANOVAs for individual variables
summary.aov(manova_model)
```
```
##  Response MaxBreadth :
##               Df  Sum Sq Mean Sq F value    Pr(>F)
## Period         4  502.83 125.707  5.9546 0.0001826 ***
## Residuals    145 3061.07  21.111
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response BasHeight :
##               Df Sum Sq Mean Sq F value  Pr(>F)
## Period         4  229.9  57.477  2.4474 0.04897 *
## Residuals    145 3405.3  23.485
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response BasLength :
##               Df Sum Sq Mean Sq F value    Pr(>F)
## Period         4  803.3 200.823  8.3057 4.636e-06 ***
## Residuals    145 3506.0  24.179
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response NasHeight :
##               Df Sum Sq Mean Sq F value Pr(>F)
## Period         4   61.2  15.300   1.507 0.2032
## Residuals    145 1472.1  10.153
```
```r
# Question 2

# Loading libraries
library(readr)
library(dplyr)
```
```
##
## Attaching package: 'dplyr'
```
```
## The following object is masked from 'package:MASS':
##
##     select
```
```
## The following object is masked from 'package:car':
##
##     recode
```
```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```
```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
library(car)


fabric_data <- read.table("~/Downloads/CA6.txt", header = TRUE)

# Converting variables to factors
fabric_data$Proportion <- as.factor(fabric_data$Proportion)
fabric_data$Filler <- as.factor(fabric_data$Filler)


# 2a: MANOVA

# Multivariate model
manova_model2 <- manova(cbind(y1, y2, y3) ~ Proportion * Filler, data = fabric_data)
summary(manova_model2, test = "Wilks")
```

```
##                  Df   Wilks approx F num Df den Df     Pr(>F)
## Proportion        2 0.11541    2.591      6      8     0.1066
## Filler            1 0.00552  240.216      3      4 5.703e-05 ***
## Proportion:Filler 2 0.11256    2.641      6      8     0.1023
## Residuals         6
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# Individual ANOVAs

summary(aov(y1 ~ Proportion * Filler, data = fabric_data))
```

```
##                   Df Sum Sq Mean Sq F value Pr(>F)
## Proportion         2   3936  1968.2   6.507 0.0314 *
## Filler             1    192   192.0   0.635 0.4560
## Proportion:Filler  2   1020   510.2   1.687 0.2623
## Residuals          6   1815   302.5
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
summary(aov(y2 ~ Proportion * Filler, data = fabric_data))
```

```
##                   Df Sum Sq Mean Sq F value   Pr(>F)
## Proportion         2   3418    1709   13.23  0.00631 **
## Filler             1  33496   33496  259.33 3.64e-06 ***
## Proportion:Filler  2   2754    1377   10.66  0.01059 *
## Residuals          6    775     129
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
summary(aov(y3 ~ Proportion * Filler, data = fabric_data))
```

```
##                   Df Sum Sq Mean Sq F value   Pr(>F)
## Proportion         2   1251     625   2.245    0.187
## Filler             1  24031   24031  86.261 8.81e-05 ***
## Proportion:Filler  2   1064     532   1.910    0.228
## Residuals          6   1671     279
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# 2c: Minimize wear in final 1000 revs (y3)

boxplot(y3 ~ interaction(Proportion, Filler), data = fabric_data,
        main = "Fabric wear in final 1000 Revolutions (y3)",
        xlab = "Proportion x Filler", ylab = "Wear")
```

Fabric wear in final 1000 Revolutions (y3)
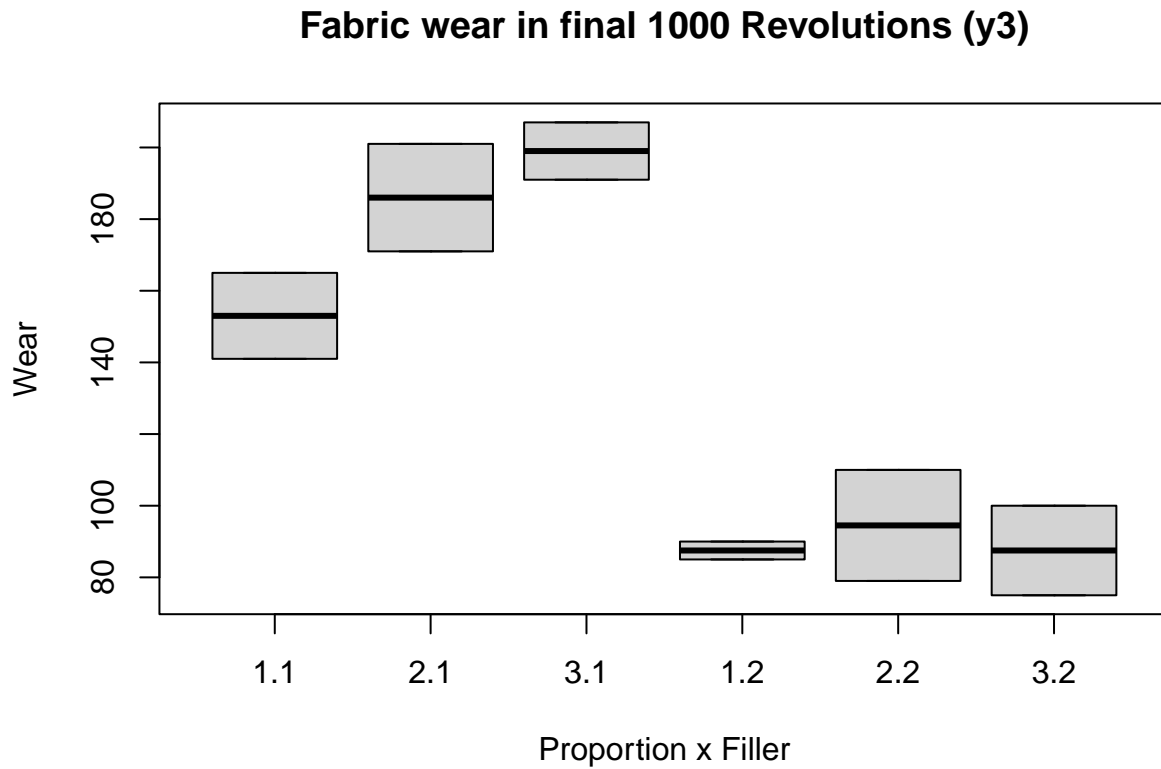

```
# Enhancing visualisation

interaction.plot(fabric_data$Proportion, fabric_data$Filler, fabric_data$y3,
                 main = "Interaction plot for y3",
                 xlab = "Proportion", ylab = "Wear (y3)", col = 1:2, lty = 1:2)
```

Interaction plot for y3