MAS programmes - Statistical Analysis (Autumn Term)

Exercises 9 - SOLUTIONS

1.

(a) Blocks form a *'restriction on the randomization'*: thus we need to apply each dye to a particular brand of denim in random order; however, the order in which each brand of denim is considered can be taken arbitrarily.

(b)
```
> strength <- c(60, 55, 61, 58, 54, 60, 54, 62, 59, 57, 62, 55, 65, 60, 55,
    60, 58, 62, 62, 56)
> d <- rep(1:4, rep(5, 4))
> b <- rep(c("A", "B", "C", "D", "E"), 4)
> dye <- factor(d)
> brand <- factor(b)
> denim <- data.frame(strength, dye, brand)
> denim.aov <- aov(strength ~ dye + brand, data = denim)
> summary(denim.aov)
            Df Sum Sq Mean Sq F value   Pr(>F)
dye          3  12.95    4.32   2.376    0.121
brand        4 157.00   39.25  21.606 2.06e-05 ***
Residuals   12  21.80    1.82
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
```

The relevant F-statistic of 2.376 is not very significant on the $F_{3,12}$ distribution: indeed the p-value is 0.121. Conclusion: no evidence that a difference exists in the effects of the 4 dyes.

2.

(a) The use of 4 different cows in the experiment may contribute in some way to the overall variability in the infectivity readings. We can take this into account by taking the cows as blocks.

(b)
```
> infect <- c(20, 29, 25, 46, 23, 31, 24, 51, 12, 11, 8, 29)
> t <- rep(c("T1", "T2", "T3"), rep(4, 3))
> c <- rep(1:4, 3)
> test <- factor(t)
> cow <- factor(c)
> bse <- data.frame(infect, test, cow)
> bse.aov <- aov(infect ~ test + cow, data = bse)
> summary(bse.aov)
            Df Sum Sq Mean Sq F value   Pr(>F)
test         2  703.5   351.7   40.72 0.000323 ***
cow          3 1106.9   369.0   42.71 0.000192 ***
Residuals    6   51.8     8.6
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
```

The relevant F-statistic is 40.72, which is significant on the $F_{2,6}$ distribution, as evidenced by the p-value of 0.000323. Thus, there are differences in the amounts of infectivity that the 3 tests can detect, i.e. they are **not** equally effective.