

6.5.2: Using R

R Fully Nested Random Effects Model

- Load the data.
- Obtain the ANOVA for the fully nested random effects.

1. Load the data by using the following commands:

```
setwd("~/path-to-folder/")
fullnest_data <- read.table("fullnest_data.txt", header=T)
attach(fullnest_data)
```

2. Obtain the ANOVA for the fully nested random effects by using the following commands:

```
library(lmerTest)
library(lme4)
random_fullnest<-lmer(Temp ~ (1 | Plant) + (1 | Plant:Operator) +
(1 | Plant:(Operator:Shift)) ,fullnest_data)
summary(random_fullnest)
Linear mixed model fit by REML. t-tests use Satterthwaites method ['lmerModLmerTest']
Formula: Temp ~ (1 | Plant) + (1 | Plant:Operator) + (1 | Plant:(Operator:Shift))
Data: fullnest_data
REML criterion at convergence: 1097.2

#Scaled residuals:
#      Min       1Q   Median       3Q      Max
#-2.78620 -0.61163  0.00414  0.56721  1.99397

#Random effects:
# Groups              Name                Variance Std.Dev.
# Plant:(Operator:Shift) (Intercept)    6.5237   2.5542
# Plant:Operator        (Intercept)    0.8061   0.8979
# Plant                 (Intercept)    4.2123   2.0524
# Residual                                12.4063   3.5223
# Number of obs: 192, groups: Plant:(Operator:Shift), 64; Plant:Operator, 16; Plant,

#Fixed effects:
#              Estimate Std. Error      df t value Pr(>|t|)
#(Intercept)  474.880      1.127    3.000   421.4 2.95e-08 ***
#---
#Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

confint(random_fullnest)

#              2.5 %      97.5 %
#.sig01        1.7251242  3.487550
#.sig02         0.0000000  2.475048
#.sig03         0.1192372  4.695585
```

```
#.sigma      3.1311707    4.002066
#(Intercept) 472.4015615 477.358858
```

Note that the command `lmer()` gives the ANOVA table only for the fixed effects. Therefore, in this example, since there are no fixed effects, we won't get the ANOVA table. In the "Random effects" section of the output, under the column variance, we get the estimates for σ_γ^2 , σ_β^2 , σ_α^2 , and σ^2 which are equal to 6.5237, 0.8061, 4.2123, and 12.4063 respectively. In the "Fixed effects" section under the column estimate, we get the estimate of μ for the overall mean, which is equal to 474.880.

With the command `confint()` we will get confidence intervals for the standard deviations and the overall mean. If you take the square of the lower and upper bounds, you will get a confidence interval for the model variances.

Alternatively, we can use the command `aov()` which gives a partial ANOVA table.

```
random_fullnest1<-aov(Temp ~ Error(factor(Plant) + factor(Plant)/factor(Operator) + f
summary(random_fullnest1)

#Error: factor(Plant)
#           Df Sum Sq Mean Sq F value Pr(>F)
#Residuals  3   731.5    243.8

#Error: factor(Plant):factor(Operator)
#           Df Sum Sq Mean Sq F value Pr(>F)
#Residuals 12   499.8    41.65

#Error: factor(Plant):factor(Operator):factor(Shift)
#           Df Sum Sq Mean Sq F value Pr(>F)
#Residuals 48   1535    31.98

#Error: Within
#           Df Sum Sq Mean Sq F value Pr(>F)
#Residuals 128   1588    12.41
detach(fullnest_data)
```

Note that both commands in R don't give the F -values and the p -values for the tests. Therefore, these must be done manually.

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