

RBD lm vs Mixed Model

```
#rm(list = ls()) # Clean the workspace
#install.packages("lme4") # If necessary install the library
library(lme4) # Call the library to the workspace
library(car) # Call the library to the workspace
library(lsmmeans) # Call the library to the workspace
library(multcomp) # Call the library to the workspace

# Read the data
rbd<-read.table(file="C:/Users/toledo/Dropbox/UNIPD/Biostatistics Course R Spring 2018/corso STAT PhD 2018 Mix
stringsAsFactors = TRUE,header = TRUE,sep = "\t")

rbd$block<-as.factor(rbd$block) # Set block as factor
rbd$fertilizer<-as.factor(rbd$fertilizer) # Set fertilizer as factor
contrasts(rbd$block)<-contr.SAS # Change the reference grid to SAS
contrasts(rbd$fertilizer)<-contr.SAS # Change the reference grid to SAS

# Fit the linear model
model.1<-lm(yield ~ fertilizer + block, data=rbd) # Fit the model
summary(model.1) # See the results

##
## Call:
## lm(formula = yield ~ fertilizer + block, data = rbd)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.00000 -0.29167  0.08333  0.33333  0.83333
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.317e+01  4.389e-01  30.002 3.96e-11 ***
## fertilizer1 -2.833e+00  3.801e-01  -7.455 2.17e-05 ***
## fertilizer2 -1.667e+00  3.801e-01  -4.385 0.001366 **
## block1      -2.333e+00  5.375e-01  -4.341 0.001464 **
## block2       1.333e+00  5.375e-01   2.481 0.032504 *
## block3       1.480e-16  5.375e-01   0.000 1.000000
## block4      -2.667e+00  5.375e-01  -4.961 0.000569 ***
## block5      -1.333e+00  5.375e-01  -2.481 0.032504 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.6583 on 10 degrees of freedom
## Multiple R-squared:  0.9328, Adjusted R-squared:  0.8858
## F-statistic: 19.84 on 7 and 10 DF,  p-value: 4.171e-05

Anova(model.1, type=3,test.statistic = "F") # ANOVA table SS type III

## Anova Table (Type III tests)
##
## Response: yield
##              Sum Sq Df F value    Pr(>F)
## (Intercept) 390.06  1 900.144 3.959e-11 ***
## fertilizer  24.33  2  28.077 7.893e-05 ***
## block       35.83  5  16.538 0.0001489 ***
## Residuals    4.33 10
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```

lsmeans(model.1,"fertilizer")           # LSM for factor

## fertilizer    lsmean      SE df  lower.CL upper.CL
## 1             9.50000 0.2687419 10  8.901206 10.09879
## 2            10.66667 0.2687419 10 10.067872 11.26546
## 3            12.33333 0.2687419 10 11.734539 12.93213
##
## Results are averaged over the levels of: block
## Confidence level used: 0.95

print("#####")

## [1] "#####"

# Fit the mixed model
model.2<-lmer(yield ~ fertilizer + (1 | block) ,data = rbd, REML = TRUE)
summary(model.2)           # Results of the mixed model

## Linear mixed model fit by REML ['lmerMod']
## Formula: yield ~ fertilizer + (1 | block)
## Data: rbd
##
## REML criterion at convergence: 49.4
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -1.65689 -0.39715  0.01943  0.61353  1.12814
##
## Random effects:
## Groups   Name      Variance Std.Dev.
## block    (Intercept) 2.2444   1.4981
## Residual                0.4333   0.6583
## Number of obs: 18, groups: block, 6
##
## Fixed effects:
##              Estimate Std. Error t value
## (Intercept)  12.3333    0.6681  18.462
## fertilizer1  -2.8333    0.3801  -7.455
## fertilizer2  -1.6667    0.3801  -4.385
##
## Correlation of Fixed Effects:
##              (Intr) frtlz1
## fertilizer1 -0.284
## fertilizer2 -0.284  0.500

AIC(model.2)           # Akaike's Information Criterion (small is better)

## [1] 59.42816

BIC(model.2)           # Bayesian Information Criterion (small is better)

## [1] 63.88002

Anova(model.2, type=3,test.statistic = "F") # ANOVA table SS type III

## Analysis of Deviance Table (Type III Wald F tests with Kenward-Roger df)
##
## Response: yield
##              F Df  Df.res    Pr(>F)
## (Intercept) 340.830  1  6.2368 1.114e-06 ***
## fertilizer  28.077  2 10.0000 7.893e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```
lsmeans(model.2,"fertilizer")      # LSM
```

```
## fertilizer    lsmean      SE    df  lower.CL upper.CL
## 1             9.50000 0.6680541 6.24   7.880260 11.11974
## 2            10.66667 0.6680541 6.24   9.046926 12.28641
## 3            12.33333 0.6680541 6.24  10.713593 13.95307
##
## Degrees-of-freedom method: satterthwaite
## Confidence level used: 0.95
```