Longitudinal

```
rm(list = ls())   # Clean the workspace
library(lsmeans)  # Call the library
# Read Data
mydata<-read.table(file = "C:/Users/toledo/Dropbox/UNIPD/Biostatistics Curse  R Spring 2018/curso STAT PhD 201
                   sep = "\t",header = TRUE,stringsAsFactors = TRUE)
mydata$Treatment<-as.factor(mydata$Treatment)   # Set the variable as factor
mydata$Cow<-as.factor(mydata$Cow)               # Set the variable as factor
mydata$Period<-as.factor(mydata$Period)         # Set the variable as factor
str(mydata)                                     # See the structure of my data
```

```
## 'data.frame':    60 obs. of  4 variables:
##  $ Treatment: Factor w/ 2 levels "1","2": 1 1 1 1 1 1 1 1 1 1 ...
##  $ Cow      : Factor w/ 20 levels "1","2","3","4",..: 1 1 1 2 2 2 3 3 3 4 ...
##  $ Period   : Factor w/ 3 levels "1","2","3": 1 2 3 1 2 3 1 2 3 1 ...
##  $ Y        : int  25 31 29 28 25 27 34 29 25 26 ...
```

```
contrasts(mydata$Treatment)<-contr.SAS          # Set the contrast as SAS
contrasts(mydata$Cow)<-contr.SAS                # Set the contrast as SAS
contrasts(mydata$Period)<-contr.SAS             # Set the contrast as SAS
table(mydata$Treatment,mydata$Cow)              # Frequencies for factors
```

```
##
##     1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
##   1 3 3 3 3 3 3 3 3 3  3  0  0  0  0  0  0  0  0  0  0
##   2 0 0 0 0 0 0 0 0 0  0  3  3  3  3  3  3  3  3  3  3
```

```
table(mydata$Treatment,mydata$Period)           # Frequencies for factors
```

```
##
##      1  2  3
##   1 10 10 10
##   2 10 10 10
```

```
#Fit the model
mymodel<-lm(Y ~ Treatment + Cow%in%Treatment + Period + Treatment:Period, data = mydata )
summary(mymodel)                                # See the results
```

```
##
## Call:
## lm(formula = Y ~ Treatment + Cow %in% Treatment + Period + Treatment:Period,
##     data = mydata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.8667 -1.5417 -0.2333  2.0500  4.8000
##
## Coefficients: (20 not defined because of singularities)
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)          27.9000     2.0155  13.843 5.49e-16 ***
## Treatment1            1.2667     2.8503   0.444   0.6594
## Period1              -0.5000     1.4252  -0.351   0.7278
## Period2              -0.2000     1.4252  -0.140   0.8892
## Treatment1:Cow1      -1.6667     2.6020  -0.641   0.5259
## Treatment2:Cow1          NA         NA      NA       NA
## Treatment1:Cow2      -3.3333     2.6020  -1.281   0.2084
## Treatment2:Cow2          NA         NA      NA       NA
## Treatment1:Cow3      -0.6667     2.6020  -0.256   0.7992
## Treatment2:Cow3          NA         NA      NA       NA
## Treatment1:Cow4      -3.3333     2.6020  -1.281   0.2084
```

```
## Treatment2:Cow4          NA         NA      NA       NA
## Treatment1:Cow5     -0.6667     2.6020  -0.256   0.7992
## Treatment2:Cow5          NA         NA      NA       NA
## Treatment1:Cow6      2.6667     2.6020   1.025   0.3123
## Treatment2:Cow6          NA         NA      NA       NA
## Treatment1:Cow7      0.0000     2.6020   0.000   1.0000
## Treatment2:Cow7          NA         NA      NA       NA
## Treatment1:Cow8      2.0000     2.6020   0.769   0.4471
## Treatment2:Cow8          NA         NA      NA       NA
## Treatment1:Cow9     -1.6667     2.6020  -0.641   0.5259
## Treatment2:Cow9          NA         NA      NA       NA
## Treatment1:Cow10         NA         NA      NA       NA
## Treatment2:Cow10         NA         NA      NA       NA
## Treatment1:Cow11         NA         NA      NA       NA
## Treatment2:Cow11     4.0000     2.6020   1.537   0.1330
## Treatment1:Cow12         NA         NA      NA       NA
## Treatment2:Cow12     2.6667     2.6020   1.025   0.3123
## Treatment1:Cow13         NA         NA      NA       NA
## Treatment2:Cow13     3.0000     2.6020   1.153   0.2565
## Treatment1:Cow14         NA         NA      NA       NA
## Treatment2:Cow14     3.0000     2.6020   1.153   0.2565
## Treatment1:Cow15         NA         NA      NA       NA
## Treatment2:Cow15     3.6667     2.6020   1.409   0.1674
## Treatment1:Cow16         NA         NA      NA       NA
## Treatment2:Cow16     4.6667     2.6020   1.793   0.0813 .
## Treatment1:Cow17         NA         NA      NA       NA
## Treatment2:Cow17     6.3333     2.6020   2.434   0.0200 *
## Treatment1:Cow18         NA         NA      NA       NA
## Treatment2:Cow18     2.3333     2.6020   0.897   0.3758
## Treatment1:Cow19         NA         NA      NA       NA
## Treatment2:Cow19     2.3333     2.6020   0.897   0.3758
## Treatment1:Period1   2.2000     2.0155   1.092   0.2823
## Treatment1:Period2   1.0000     2.0155   0.496   0.6228
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.187 on 36 degrees of freedom
## Multiple R-squared:  0.388,  Adjusted R-squared:  -0.002976
## F-statistic: 0.9924 on 23 and 36 DF,  p-value: 0.4969
```

```
anova(mymodel)                                  # ANOVA table SS type III
```

```
## Analysis of Variance Table
##
## Response: Y
##                  Df Sum Sq Mean Sq F value  Pr(>F)
## Treatment         1  35.27  35.267  3.4726 0.07056 .
## Period            2   3.60   1.800  0.1772 0.83830
## Treatment:Cow    18 180.80  10.044  0.9891 0.49244
## Treatment:Period  2  12.13   6.067  0.5974 0.55562
## Residuals        36 365.60  10.156
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#ref.grid(mymodel)
lsmeans(mymodel,"Treatment")                    # LSM for factor
```

```
##  Treatment   lsmean        SE df lower.CL upper.CL
##  1         29.33333 0.5818234 36 28.15334 30.51333
##  2         30.86667 0.5818234 36 29.68667 32.04666
##
```

```
## Results are averaged over the levels of: Cow, Period
## Confidence level used: 0.95
```

```
lsmeans(mymodel,"Period")                       # LSM for factor
```

```
##  Period lsmean        SE df lower.CL upper.CL
##  1        30.4 0.7125853 36 28.95481 31.84519
##  2        30.1 0.7125853 36 28.65481 31.54519
##  3        29.8 0.7125853 36 28.35481 31.24519
##
## Results are averaged over the levels of: Cow, Treatment
## Confidence level used: 0.95
```

```
lsmeans(mymodel,~Treatment:Period)              # LSM for factor with interaction
```

```
##  Treatment Period lsmean       SE df lower.CL upper.CL
##  1         1        30.2 1.007748 36 28.15619 32.24381
##  2         1        29.3 1.007748 36 27.25619 31.34381
##  1         2        28.5 1.007748 36 26.45619 30.54381
##  2         2        30.6 1.007748 36 28.55619 32.64381
##  1         3        30.9 1.007748 36 28.85619 32.94381
##  2         3        31.1 1.007748 36 29.05619 33.14381
##
## Results are averaged over the levels of: Cow
## Confidence level used: 0.95
```

```
# Set the factor as an error term
mymodel.1<-aov(Y ~ Treatment + Error(Cow) + Period + Treatment:Period, data = mydata)
summary(mymodel.1)                              # See the results
```

```
##
## Error: Cow
##           Df Sum Sq Mean Sq F value Pr(>F)
## Treatment  1  35.27   35.27   3.511 0.0773 .
## Residuals 18 180.80   10.04
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: Within
##                  Df Sum Sq Mean Sq F value Pr(>F)
## Period            2    3.6   1.800   0.177  0.838
## Treatment:Period  2   12.1   6.067   0.597  0.556
## Residuals        36  365.6  10.156
```