

5.2.3: Nested Model in R

- Load the Exercise Hours data.
- Obtain the ANOVA table for the nested treatment design.
- Obtain estimators and CIs for means for each region and city.
- Obtain means plot for region and city within the region.
- Obtain Tukey's multiple comparisons CIs.

1. Load the Exercise Hours data by using the following commands:

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

2. Obtain the ANOVA table for the nested treatment design by using the following commands:

```
nested<-aov(Ex_hours ~ Region+Region/City,data=ex_hours_data)
summary(nested)
# Df Sum Sq Mean Sq F value Pr(>F)
# Region      2  424.7   212.33    65.33 8.46e-05 ***
# Region:City  3  496.8   165.58    50.95 0.000116 ***
# Residuals    6   19.5     3.25
# ---
# Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

3. Obtain estimators and CIs for means for each region and city by using the following commands:

```
library(lsmeans)
lsmeans(nested,"Region")
# Region lsmean SE df lower.CL upper.CL
# MW      15.2 0.901 6    13.04    17.5
# NE      25.8 0.901 6    23.54    28.0
# W       11.8 0.901 6     9.54    14.0
#Results are averaged over the levels of: City
#Confidence level used: 0.95
lsmeans(nested,"City")
#City      Region lsmean SE df lower.CL upper.CL
# Chicago    MW      9.5 1.27 6     6.38    12.62
# Detroit    MW     21.0 1.27 6    17.88    24.12
# NY         NE     32.5 1.27 6    29.38    35.62
# Pittsburgh NE     19.0 1.27 6    15.88    22.12
# LA         W      18.5 1.27 6    15.38    21.62
# Seattle    W       5.0 1.27 6     1.88     8.12
#Confidence level used: 0.95
```

4. Obtain means plot for region and city within region by using the following commands:

```
library(plotrix)
region_means<-as.data.frame(lsmeans(nested,"Region"))
```

```
plotCI(x = region_means$lmean,y = NULL ,li = region_means$lower.CL, ui = region_means$upper.CL,
axis(1, at=1:3, labels=region_means$Region)
```

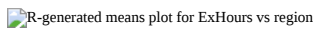


Figure 5.2.3.1: Means plot for ExHours vs region.

```
city_means<-as.data.frame(lsmmeans(nested,"City"))
City_Region<-paste(city_means$City,city_means$Region)
plotCI(x = city_means$lmean,y = NULL ,li = city_means$lower.CL, ui = city_means$upper.CL,
axis(1, at=1:6, labels=City_Region)
```

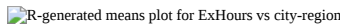


Figure 5.2.3.2: Means plot for ExHours vs City(Region).

5. Obtain Tukey's multiple comparisons CIs by using the following commands:

```
library(multcomp)
library(multcompView)
tukey_multiple_comparisons_region<-TukeyHSD(nested,"Region",conf.level=0.95,ordered=T)
tukey_multiple_comparisons_region
  Tukey multiple comparisons of means
    95% family-wise confidence level
    factor levels have been ordered
Fit: aov(formula = Ex_hours ~ Region + Region/City, data = ex_hours_data)
# $Region
#      diff      lwr      upr      p adj
#MW-W    3.5 -0.4112978  7.411298 0.0747598
#NE-W   14.0 10.0887022 17.911298 0.0000836
plot(tukey_multiple_comparisons_region)
```

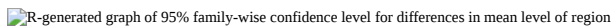


Figure 5.2.3.3: 95% family-wise confidence levels for differences in mean level of region.

```
tukey_multiple_comparisons_city<-TukeyHSD(nested,"Region:City",conf.level=0.95,ordered=T)
cities<-as.data.frame(na.omit(tukey_multiple_comparisons_city$"Region:City"))
cities
```

```
#      diff      lwr      upr      p adj
# MW:Chicago-W:Seattle    4.5 -4.96579743 13.965797 0.5867601138
# W:LA-W:Seattle         13.5  4.03420257 22.965797 0.0087623039
# NE:Pittsburgh-W:Seattle 14.0  4.53420257 23.465797 0.0072411812
# MW:Detroit-W:Seattle   16.0  6.53420257 25.465797 0.0035459602
# NE:NY-W:Seattle        27.5 18.03420257 36.965797 0.0001761692
# W:LA-MW:Chicago         9.0 -0.46579743 18.465797 0.0626471065
# NE:Pittsburgh-MW:Chicago 9.5  0.03420257 18.965797 0.0491884424
# MW:Detroit-MW:Chicago  11.5  2.03420257 20.965797 0.0198221594
# NE:NY-MW:Chicago       23.0 13.53420257 32.465797 0.0004610102
# NE:Pittsburgh-W:LA      0.5 -8.96579743  9.965797 1.0000000000
# MW:Detroit-W:LA         2.5 -6.96579743 11.965797 0.9752059356
# NE:NY-W:LA             14.0  4.53420257 23.465797 0.0072411812
```

```
# MW:Detroit-NE:Pittsburgh  2.0 -7.46579743 11.465797 0.9960158169
# NE:NY-NE:Pittsburgh      13.5  4.03420257 22.965797 0.0087623039
# NE:NY-MW:Detroit        11.5  2.03420257 20.965797 0.0198221594

library(plotrix)
city_diff<-as.character(c("
MW:Chicago-W:Seattle", "W:LA-W:Seattle", "NE:Pittsburgh-W:Seattle", "MW:Detroit-W:Seatt.
par(mar=c(8, 4, 2, 2) + 0.1)
plotCI(x = cities$diff,y = NULL ,li = cities$lwr, ui = cities$upr, xaxt = "
n",ylab="Differences of Means",xlab="")
abline(h=0)
axis(1, at=1:15, labels=city_diff,las = 2, cex.axis = 0.8)
```


 R-generated plot of differences of means by cities

Figure 5.2.3.4: Differences of means by cities plot.

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