

## STAT 512 Section 2 Assignment #8

See Canvas calendar for due date.

**Reading:** Ott & Longnecker sections 14.3 (Factorial Trt Structure)

40 points Total, 2 points per question unless otherwise noted.

A greenhouse study was done to examine the effect of 3 herbicides (A,B, or C) and 2 water regimes (1 = Low or 2 = High) for 2 plant types (Grass or Forb). The response variable is biomass. There are 3 reps per treatment combination for a total of 36 observations. Each observation was a potted plant. The 36 pots were randomly assigned without restriction to locations in the greenhouse. The data is available from Canvas as “Biomass.csv”.

### Important notes:

- Remember to run `str()` and then define things as `factor` where needed.
  - Change contrasts options to get meaningful Type 3 tests (using Anova):  
`options(contrasts=c("contr.sum", "contr.poly"))`
  - Diagnostic plots are considered for several questions. You do NOT need to include these plots in your assignment. But you do need to discuss your findings.
1. Create two-way interaction plots separately for each plant type (Grass/Forb). **(4 pts)** This can be done by first calculating treatment means (using `aggregate` or `dplyr`), then using code something like this:  

```
library(ggplot2)
qplot(x = Herb, y = Biomass, colour = Water, group = Water, data = SumStats) + geom_line() + facet_grid(. ~ Type)
```
  2. Fit the **three-way model with all interactions**. Include the Type 3 ANOVA table in your assignment. You should find evidence of a 3 way interaction.
  3. Consider the diagnostics plots and discuss whether model assumptions are satisfied.
  4. Use `emmeans` to calculate pairwise comparisons of Water (1 vs 2) for each level of Herb and Type. You can use code something like this:  

```
emmeans(Model1, pairwise ~ Water|Herb*Type)
```

**Questions 4 through 9:** Now fit a **two-way model** (including interaction) for **Forb only**.

5. Include the Type 3 ANOVA table in your assignment.
6. Consider the diagnostics plots and discuss whether model assumptions are satisfied.
7. Use `emmeans` to calculate pairwise comparisons of Water (1 vs 2) for each level of Herb.
8. Calculate the LSD value (ME for difference between means) corresponding to the comparisons from the previous question. Show your work for full credit. Hint: See ExpDesign2 slide 81. Recall that you can check your calculation using the SE value given in the output from the previous question.
9. Use `emmeans` to calculate the comparison of Water (1 vs 2) averaging over the levels of Herb.
10. Calculate the LSD value (ME for difference between means) corresponding to the comparisons from the previous question. Show your work for full credit. See hints from #8.
11. Comparing your LSD values from questions #8 (interaction comparison) and #10 (main effect comparison), which comparison has higher power? Briefly discuss.

**Questions 12 through 15:** Now fit a **two-way model** (including interaction) for **Grass only**.

12. Include the Type 3 ANOVA table in your assignment.
13. Consider the diagnostics plots and discuss whether model assumptions are satisfied.
14. Use emmeans to calculate pairwise comparisons of Water (1 vs 2) for each level of Herb.
15. Would it be appropriate to calculate the comparison of Water (1 vs 2) averaging over the levels of Herb? Briefly discuss.

**Questions 16 through 18:** Now we compare the three-way model to the separate two-way models.

16. The comparisons from #7 and #14 were also considered in #4. Considering the corresponding results from the combined analysis (#4) versus the split analysis (#7, #14), briefly discuss what is the same and what is different. Specifically, consider the estimated difference, corresponding SE and df. (4 pts)
17. Give (at least) one reason why we might prefer to split the analysis by Type (running separate 2way ANOVAs for Grass and Forb). Your answer should be based on the output.
18. Give (at least) one weakness of splitting the analysis “by type” as compared to the full 3way ANOVA model.