Interpreting One-Factor ANOVA

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Focus: Interpreting One-Factor Analysis of Variance (ANOVA)

Overview: In this lesson, students will practice interpreting the results of a one-factor analysis of variance (ANOVA). The students work through two examples:

> 1) Comparing mean counts of insects in agricultural plots using the InsectSprays data set in R (?InsectSprays).
>
> 2) Analyzing (made up) data based on the "Radish Problem" experiment, designed to address common misconceptions about "photosynthesis and cellular respiration, particularly their notions that transformation of matter allows for conservation of mass." Data and images adapted from:
> Diane Ebert-May, Janet Batzli, Heejun Lim, Disciplinary Research Strategies for Assessment of Learning, *BioScience*, Volume 53, Issue 12, December 2003, Pages 1221–1228, https://doi.org/10.1641/0006-3568(2003)053[1221:DRSFAO]2.0.CO;2

In working through these examples, students do very basic R coding to interpret the structure of data frames, specify linear models and produce/interpret ANOVA results tables, and do simple calculations to determine effect sizes (pairwise differences between group means). However, much of the code is given to them directly to re-type or modify, but not much prior coding experience is expected. Associated plots (made for them in ggplot) are interpreted (e.g., visually assessing differences between group means, 95% confidence intervals, assessing violations of normality assumption). Results outputs and plots from post-hoc multiple comparison tests are produced for them, and they practice interpreting them. Students can also watch a short video on the Multiple Testing Problem. They also practice identifying the appropriate Null and Alternative hypotheses associated with one-factor ANOVA.

Learning objectives:

By the end of this lesson, students should be able to:

- Identifying the appropriate Null and Alternative hypotheses associated with one-factor ANOVA.
- Assess ANOVA assumptions given some "rules of thumb" appropriate for the data sets being analyzed.
- Interpret the R output (and associated plots) for a one-factor ANOVA and post-hoc multiple comparisons test to determine the statistical significance.

- Calculate effect sizes (pairwise differences between means) from summary statistics.
- Explain issues associated with the “Multiple Testing Problem.”

Pre-lesson activities:

Students will have been presented a general/typical lecture on one-factor ANOVA and associated post-hoc multiple comparison tests, and have done some peer-discussion activities interpreting associated R outputs and plots interspersed throughout the lecture.

Implementation notes:

1) Many plots will be made for them and show up in the RStudio Plots window – make sure to tell them to have the Plots window selected (often the Files window is open by default, and they are confused as to why they are not seeing the plots they are being asked to interpret).

2) The Swirl lesson took most students 25-40 min to work through.

2) I plan to revise this Swirl course extensively and re-post it during Spring Semester 2020. In the next iteration students will have had a little more R coding practice prior to doing this in lab so I plan to have less “hand holding” through the R coding tasks in the new version of the course. In this current version, it was developed for students that will have had some experience running R code given to them and interpreted outputs and plots produced by that code, but very limited experience actually coding. I also plan to break up the larger sections of text with more questions.