EEB1210H Advanced Statistics – Fall 2020
Department of Ecology & Evolutionary Biology

Course Instructor

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Location and Time

Lecture: Tuesdays from 10:00 (sharp) to 11:30 via Zoom link

Course Description

Biologists need to use statistical methods to test their hypotheses. Given the increasing complexity of experiments carried out by biologists, they need however to understand the limitations of these statistics and how to select the appropriate statistics for their needs and how to interpret them properly both statistically and biologically. The goal of this advanced course in statistics is to teach biologists how to choose and use statistics so that they can address relevant biological questions and test them with the appropriate methods. Specifically, an overview of advanced notions about regression analysis and ANOVA will be presented. The course is lecture-based with assignments designed to develop awareness about the misuse of statistics.

Course Objectives

By the end of the course, graduate students should be able to:

- understand the utility and pitfalls of statistics and their appropriate application to biological problems;
- analyse their data with the appropriate statistics and interpret the results adequately;
- read, understand, and critically evaluate paper and their use of statistics.

Topics and Timetable

Date 2019	TOPICS	LAB
Sept 15-Wk1	• Review of the various types of statistical approaches: parametric, non-parametric, Bayesian, randomization tests • Causality 101 • Experimental design, Power analysis, Effect size	Homework DUE at Sept 24: Your questions/objectives and potential data
Sept 22-Wk2	• *Chi*-Square-test, *G*-test • Correlation, partial correlation	Homework DUE
Sept 29-Wk3	• Linear regression and Residual analysis • Multiple regression • Model selection criteria	Lab 1: Regression
Oct 6-Wk4	• Causality 201-Path Analysis • Generalized Linear Models (GLM) • Generalized Linear Mixed Models (GLMM)	Lab 1 DUE
Oct 13-Wk5	• Non-linear regression, Smoothing • Generalized Additive Models (GAM) • Regression Tree Methods; Clustering	Lab 2: Regression tree
Oct 20-Wk6	• ANOVA • Nested ANOVA • Factorial ANOVA/Multiple comparison tests	Lab 3: ANOVA
Oct 27-Wk7	• ANCOVA • Split-plot models • Repeated measures • MANOVA	Lab 3 DUE
Nov 3-Wk8	• Meta-analysis • Survival analysis • Multivariate/Ordination methods	Lab 2 DUE
Nov 17-Wk9	• Student presentations (10 minutes MAX)	Term-paper DUE

Evaluation

1. Lab 1: regression methods (10%)
→ Do not want printout of the figures BUT the statistical and biological interpretations of the results obtained.

2. Lab 2: regression trees (10%)
→ Do not want printout of the figures BUT the statistical and biological interpretations of the results obtained.

3. Lab 3: ANOVA (10%)
→ Do not want printout of the figures BUT the statistical and biological interpretations of the results obtained.

4. Term project = Report (50%): Write the "methods section" of your potential data analysis explaining which statistics you should use to answer your hypotheses/objectives: Compare at least two different statistical methods stressing the assumptions of each selected statistical methods as well as their pros and their cons from a statistical/methodological perspective and from an ecological/evolutionary/biological perspective.

- Maximum 6 pages **single-interlined** (half-page presenting the objectives of the study; half-page presenting the data; 4 pages explaining and comparing the statistical methods; 1 page for the references)

5. Term project = Presentation (20%): Each student will present a 10-minute talk summarizing: The objective(s) of their project; The (potential) data to be analysed; The selected methods that should be used to assess/test your hypotheses.

Useful References

→ **Gotelli NJ, AM Ellison. 2012. *A Primer of Ecological Statistics.* 2nd edition. Sinauer.**
→ Whitlock M, D Schluter. 2015. *Analysis of Biological Data*. 2nd ed. Roberts and Company Publishers.
→ van Emden HF. 2008. *Statistics for Terrified Biologists*. Wiley-Blackwell.

Zuur *et al*. 2009. *Mixed Effects Models and Extensions in Ecology with R*. Springer.
Aho KA. 2016. *Foundational and Applied Statistics for Biologists using R*. Chapman and Hall/CRC.
McDonald JH. 2014. *Handbook of Biological Statistics*. 3rd ed. Baltimore, MD. [pdf free online]

Qian SS. 201x. Environmental and Ecological Statistics with R.
Brimacombe M. 2018. Likelihood Methods in Biology and Ecology: A Modern Approach to Statistics.
Scott Pardo, Michael Pardo. 201x. Statistical Methods for Field and Laboratory Studies in Behavioral Ecology

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