EEB1210H Advanced Statistics – Fall 2022
Department of Ecology & Evolutionary Biology

Course Instructor

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Location and Time

Lecture: Tuesday from 10:00 (sharp) to 12:00
Hybrid: in person RW015A or on zoom: https://utoronto.zoom.us/j/84538785189 Passcode: EEB1210

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 papers and their use of statistics.

Topics and Timetable

2022	Topics	Labs
Sept 13-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 on Sept 20: Your questions/objectives and potential data
Sept 20-Wk2	• *Chi*-Square-test, *G*-test • Correlation, partial correlation	Homework DUE
Sept 27-Wk3	• Linear regression and Residual analysis • Multiple regression • Model selection criteria	Lab 1: Regression
Oct 4-Wk4	• Causality 201-Path Analysis • Generalized Linear Models (GLM) • Generalized Linear Mixed Models (GLMM)	
Oct 11-Wk5	• Non-linear regression, Smoothing • Generalized Additive Models (GAM) • Regression Tree Methods; Clustering	Lab 1 DUE
Oct 18-Wk6	• ANOVA • Nested ANOVA • Factorial ANOVA/Multiple comparison tests	Lab 2: ANOVA
Oct 25-Wk7	• ANCOVA • Split-plot models/Repeated measures • MANOVA	
Nov 1-Wk8	• Meta-analysis/Survival analysis • Multivariate/Ordination methods	Lab 2 DUE
Nov 15-Wk9	• **Student presentations (10 minutes MAX)**	Term-paper DUE

Evaluation

1. Lab 1: Regression methods (15%)
→ Do not want a printout of the figures BUT the statistical and biological interpretations of the results obtained.

2. Lab 2: ANOVA (15%)
→ Do not want a printout of the figures BUT the statistical and biological interpretations of the results obtained.

3. 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)

4. Term project = Presentation (20%): Each student will present a 10-minute talk summarizing: The objective(s) of their project; The (potential) data; 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.
→ Lepš J, P Šmilauer. 2020. *Biostatistics with R. An introduction guide for field biologists*. Cambridge Uni. Press.
→ 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.

•Aho KA. 2016. *Foundational and Applied Statistics for Biologists using R*. Chapman and Hall/CRC Press.
•James G, Witten D, Hastie T, Tibshirani. 2013. *An Introduction to Statistical Learning: with Applications in R*. Springer.
•McDonald JH. 2014. *Handbook of Biological Statistics*. 3rd ed. Baltimore, MD. [pdf free online]
•Qian SS. 2017. *Environmental and Ecological Statistics with R*. 2nd edition. Chapman and Hall/CRC.
•Pardo S, Pardo M. 2018. *Statistical Methods for Field and Laboratory Studies in Behavioral Ecology*. Chapman and Hall/CRC.
•Zuur *et al*. 2009. *Mixed Effects Models and Extensions in Ecology with R*. Springer.

ºEdwards AM, Auger-Méthé M. 2019. Some guidance on using mathematical notation in ecology. *Methods in Ecology and Evolution* 10:92-99.
ºElith J *et al*. 2008. A working guide to boosted regression trees. *Journal of Animal Ecology* 77:802-813.
ºGreen P, MacLeod CJ. 2016. SIMR: an R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution* 7:493-498.
ºGurevitch J *et al*. 2018. Meta-analysis and the science of research synthesis. *Nature* 555(7695):175-182.
ºHarrison XA *et al*. 2018. A brief introduction to mixed effects modelling and multi-model inference in ecology. *PeerJ* 6:e4794.
ºPedersen EJ *et al*. 2019. Hierarchical generalized additive models in ecology: an introduction with mgcv. *PeerJ* 7:e6876.

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