Course Number and Title

ZOO6927-Spring2020: Statistical Ecology

Catalog Description

This is an advanced undergraduate and graduate level course in statistical ecology and evolution methods and concepts. The course focuses on learning the fundamentals of probability distributions as models of animal abundance, models of demographic processes and evolutionary dynamics.

Rationale and placement in the curriculum (from the UCC form, to be deleted in final version)

This course covers methods and topics that are essential for graduate students pursuing research and careers in ecology, evolution, genetics and related fields. The course has a lab component in which students gain experience using the methods and applying them to their own research. This course complements several other courses on statistics for graduate students in the life sciences, including "Data Analysis in the Natural Sciences" and "Introduction to Bayesian Statistics in the Life Sciences". Statistical Ecology differs from the other statistics courses already offered in the life sciences by focusing on the mathematical statistics theory underlying the methods used in ecological and evolutionary analyses, and in having a dedicated lab section that allows extensive hands-on use of methods. Data Analysis in the Natural Sciences, for example, is focused, as its name suggests, on a general overview of how to tackle a first data analysis and visualization without the student having to know the mathematics of why and how the statistical analyses are done, while "Introduction to Bayesian Statistics" focuses on Bayesian methods for which it is required that students be familiar with "likelihood functions" as sampling models in ecology and evolution. Other courses focus on multivariate statistics methods. This course prepares graduate students in the natural sciences to take more advanced computer intensive courses in statistics and take courses that dwell in depth into multivariate statistics, time series analyses and sampling methods. The course is also unique in its focus on exploring the biologically relevant relationships between most known probability distributions as stochastic models of ecological, genetic and evolutionary processes. It covers topics that are not taught in a typical math/stats two semester course, as well as topics in ecology, genetics and evolution that are outside the scope of any other course taught at UF.

Credit Hours

4 credit hours

Pre-requisites and Co-requisites

MAC2312 & STA2023

(Calculus II or its equivalent) & (Intro to statistics I or its equivalent)

STA4321 is highly desirable but NOT required

MAS4105 is highly desirable but NOT required

Course Objectives

- Explain and apply basic and fundamental concepts of probability and statistical inference in Ecology, Evolution and Genetics.

- Use basic probability distributions to model and think about ecological, genetic and evolutionary processes. Thus, I would like the students to restate scientific arguments in these fields of biology using statistical argumentation.
- Employ basic elements of statistical inference in Ecology, Genetics and Evolution by means of mathematical statistics results. Demonstrate correct usage of these results through extensive paper and pencil homework.
- Identify future course work directions in statistics and encourage students to pursue graduate training in statistics.

Instructor Information

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Web site: http://people.biology.ufl.edu/josemi/
Office hours: by appointment, Carr 309 or Friday any time, except from 10:30AM-1:30PM

Course Meeting Time(s)

M,W,F | Period 2 (8:30 AM - 9:20 AM)
Bartram 211

Course Meeting Location(s)

Lectures M,W BAR 211.

Recommended Materials

Textbooks or Other Readings (Not required)

Rice 1995. Mathematical Statistics.

Pielou, E.C. 1969. An introduction to mathematical ecology

Boswell, M.T., Ord, J.K. and G.P. Patil. 1979. Chance mechanisms underlying univariate distributions. In "Statistical Distributions in Ecological Work", pp 3-156. International Cooperative Publishing House.

Ewens, W. 2004. Mathematical Population Genetics 1- Theoretical Introduction. Springer Verlag.

Readings

Required: Additional required readings from the scientific literature will be posted on Canvas.

Course Website

Course materials and related information will be posted on the course E-Learning website at http://lss.at.ufl.edu. You are responsible for all announcements made in class and/or posted on the course website for this course.

Software (Required)

R, freely distributed at http://www.r-project.org

Course Outline (topics covered by week or by class period)

Week	Topic
1	Probability review/ Reading assignment : Essay about statistics in ecology
2	Probability review
3	Discrete probability distributions through practical applications, part I: a Mark-recapture example to introduce Maximum Likelihood (The binomial and hyper-geometric distributions)
4	Discrete probability distributions through practical applications, part II: Animal abundance models and the conditions under which the Poisson distribution arises
5	Continuous distributions through practical examples, part I: The likelihood function for continuous probability models. Waiting times until a demographic event , mutation events, speciation and extinction (births, deaths, density dependence). The Gamma integral in Ecology and Evolution
6	Discrete probability distributions through practical examples, part III: Heterogeneity in Ecology (The Negative Binomial Model). Probability Generating Functions and how to specify your own abundance probability distribution model. Geometric, log-series and compound distributions using randomly stopped sums as population dynamics models.
7	Discrete probability distributions IV: The Multinomial distribution and reduced-parameter multinomial distribution as a general inference tool in ecology and evolution: mark-recapture models, population genetics and Hardy-Weinberg and Phylogenetic inference. Likelihood Ratio Goodness of fit tests
8	Maximum Likelihood inference theory, part I (Fisher's information, Wilks and Wald's theorems)
9	Maximum Likelihood inference part II (Profile Likelihood and Likelihood Ratio Tests) and classical tests as Likelihood Ratio Tests: a review of classic tests like ANOVA with a focus on likelihood ratios
10	Maximum Likelihood inference III and Computer intensive methods (The Delta method and Parametric Bootstrap)
11	Maximum Likelihood inference IV: Population Genetics: the Wright-Fisher model and the coalescent process. Ewens Sampling Formula and Sufficient Statistics.
12	Computer intensive methods: What is MCMC?
13	An introduction to Bayesian Statistics topics.
14	Computer intensive methods: ML inference through Data Cloning
15	Presentation on projects

Attendance Policy

Students are expected to be on time for class. A maximum of 3 absences are allowed. Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx.

Grading

- Bi-weekly Homework and weekly quizzes: 75% of final grade)

- Final Exam (project presentation): 20% of final grade
- Class Participation: 5 % of final grade

Grading Scale

Point Range (%)	Letter Grade	GPA equivalent
≥ 90.00	A	4.0
86.7 – 89.9	A-	3.67
83.3 – 86.6	B+	3.33
80.0 – 83.2	B	3.0
76.7 – 79.9	B-	2.67
73.3 – 76.6	C+	2.33
70.0 – 73.2	C	2.0
66.7 – 69.9	C-	1.67
63.3 – 66.6	D+	1.33
60.0 – 36.2	D	1.0
56.7 – 59.9	D-	0.67
< 56.7	E	0

Note that a "C-" will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html

Grade Curve Policy

No grading curve

Make-up Exam Policy

No make up exam will be given unless the student informs the instructor one week in advance from the scheduled test/quiz. Students with disabilities that need special accommodations for testing are required to inform the instructor about it on the first day of class.

Conduct in Class

Please be courteous. Do not engage in side-conversations during lecture or lab. This can be distracting to other students and your instructor or TA.

Only approved electronic devices may be used in class, and only for the purpose of taking notes or otherwise participating in classroom activities. Approved devices include laptops and tablets. Unapproved electronic devices include phones, video recorders, digital cameras and MP3 players. Students who use unapproved devices in class will be considered disruptive. Multiple disruptions will be considered grounds for the assignment of a failing grade. Please discuss with the instructor in advance if you feel you have a legitimate need for an electronic device other than a laptop or tablet.

Academic Honesty and the Honor Code

Each student is responsible for reviewing and adhering to the UF Student Honor Code: https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/. If you witness any instances of academic dishonesty, please notify your instructor, TA, or the Dean of Students Office (352-392-1261). **I encourage students to work together and to help one another master the material.** You can collect data together, help each other in the field, discuss ideas, practice presentations in front of one another, make up practice exams, critique drafts of each other's reports, etc. Despite this "group learning", the final product that you turn in for grading must reflect your own work. Any contribution from another individual must be credited (e.g., include an acknowledgement section that says "I thank person X and person Y for their helpful comments on a previous draft, and person Z for providing insights about differential equations.").

No discussion is permitted during exams; nor should any student discuss an exam given in class with a student who is taking a makeup (and has not yet taken an exam).

Accommodations for Students with Disabilities

Students who require accommodations for a disability must contact the UF Disability Resource Center (https://www.dso.ufl.edu/drc) to request an Accommodation Letter. No accommodations are available to students until the letter is provided to the instructor. Once your instructor receives your letter, your instructor and TA will be happy to work with you to arrange the necessary accommodations.

UF Counseling, Self-Help, and Career Services

- Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
    - The UF Counseling & Wellness Center (http://www.counseling.ufl.edu/cwc/, 352-392-1575) offers counseling services for depression, anxiety, and other mental health concerns. For Emergency Assistance, please see http://www.counseling.ufl.edu/cwc/Emergency-Services.
    - Many students experience stress and anxiety related to academic performance and college life. In addition to counseling services, the UF Counseling & Wellness Center provides self-help resources that you may find helpful: http://www.counseling.ufl.edu/cwc/SelfHelp-Resources.aspx.
    - The UF Career Resource Center (http://www.crc.ufl.edu/, Reitz Union, 392-1601) offers career and job search services.

Software use

All faculty, staff and student of the University are required and expected to obey laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.

U Matter, We Care

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Course Evaluations:

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/.