

(Updated 1/15/2023) ****Note all contents are subject to change.****

WLE650-0002 Graduate Seminar in Wildlife Science: Multivariate Statistics

Course Information

Description: This course provides students with a conceptual and practical understanding of the application of multivariate statistics in the life sciences. This course consists of a one-hour lecture and a two-hour computer lab (which may occasionally also contain a lecture) where students will code techniques learned in lecture using R, the open source language for statistical computing and graphics.

Credit Hours: 3

Location / Time: Wednesdays 9-10 am and Fridays 9-11 am in Nutting 254.

Prerequisites: BIO509 Experimental Design, BIO593 Biometry, or comparable statistical knowledge and R programming skills with instructor permission. This course will use R, not be teaching how R works. This course is a good option if you know how to use the R editor and console, read and write data in R, wrangle data, and know how to use functions and packages.

General Education requirements satisfied: none

Course Delivery Method

Mode of Instruction

In-person

Time Options

Synchronous

Digital Services, Hardware, Software

Learning Management System: Brightspace (Materials available: Syllabus, Readings aside from Borcard et al. and McGarigal et al., real time gradebook); Piazza;

Web or Video Conferencing Service (Zoom – to be used if Sydne is sick and cannot attend class in-person)

Computational tools: the most recent versions of R, RStudio, GitHub, and GitHub desktop. All lab and project assignments will be available on GitHub.

Faculty Information & Course Communication

Dr. Sydne Record

Associate Professor of Wildlife, Fisheries, and Conservation Biology

Sydne.record@maine.edu (best method of communication)

207-581-2865

Nutting Hall 226

Feel free to stop by and chat during the Computational Learning Center hours, which will take the place of regular office hours. Students will fill out a poll (link is at the Course Resources section of our class Brightspace page) during the first week of classes of their availability to determine the most inclusive meeting times for everyone from week 2 of the semester onward. I am also happy to meet you by appointment. To set up an appointment with me, please send me an email (ideally 24 hours) in advance.

I will do my best to respond promptly to student emails, but I would prefer you to post to Piazza (see below). Generally, I will not regularly be on email evenings (after 5 pm), early mornings (before 9 am), or on the weekends. Thank you in advance for understanding – work-life balance is tricky!

For out of class questions and discussion, we will use Piazza.com. Please, post any questions of general interest to Piazza, rather than asking them via emails to me. This will provide a forum where you will be able to see answers to questions that other students have already asked. In addition, you will be able to answer each other's questions, and I may endorse student answers to make sure everyone stays on track. Active contributions on Piazza via questions, answers, and/or posting links to articles of general interest to the class will count toward your class contribution grade. Piazza is highly catered to getting you help fast and efficiently from classmates and myself. If you have any problems or feedback for the developers, email team@piazza.com.

Find our class Piazza signup link at the Course Resources section of our class Brightspace page.

Instructional Materials and Methods

- Borcard, D., Gillet, F., & Legendre, P. (2011). *Numerical ecology with R*. Springer. The online version of this text is available for free from the UMaine Fogler Library.
- McGarigal, K., Cushman, S., & Stafford, S. (2000). *Multivariate statistics for wildlife and ecology research*. Springer, New York. A physical copy of this book is on reserve in Fogler Library for this course. This book is also available at a reduced price via inclusive access on Brightspace.
- All other readings outlined in the course schedule will be available as pdfs on the course Brightspace page.

I highly encourage you to use the computers in Nutting 254 to ensure that you all have the same versions of [R](#) and [RStudio](#). There will also be the option to use [Git](#) and [GitHub](#) if you want to for version control of your code. All class code will be posted on GitHub at our course [repository](#). However, you may want to also download the most recent versions of these software to your personal computer if you want to work on the assignments outside of the computer lab. If so, you should download these programs in advance of the first day of class. Note that we will be using the RMarkdown functionality

in RStudio, which will require some additional [dependencies](#) for knitting documents. Note that the lab computers have the dependencies needed for knitting word documents from RMarkdown.

Course Goals:

Instructional Objectives:

The overarching objectives of this course are for students to gain proficiency in selecting, implementing, interpreting, and disseminating results from multivariate analyses using R statistical software and RMarkdown. Students will also learn about reproducible computational analyses.

Student Learning Outcomes

Specifically, students will **1)** learn the appropriate application of ordination, clustering, and discrimination techniques for different multivariate data structures and questions, **2)** learn how to manipulate, and analyze multivariate data in R, **3)** learn how to interpret and present results from multivariate analysis through figures and text, and **4)** learn how to use RMarkdown and beginner's Git to promote reproducible computational science.

Grading and Course Expectations

Each instructional lecture session on Wednesday will consist of a data set that the instructor will lead the students through and a set of questions to be answered through the application of the given week's statistical method. Fridays the class will engage a more active learning environment with time allotted to in-class coding. All work is to be submitted to Brightspace except for the final presentations, which will be uploaded to Google Drive.

Course assessment & grading

Activities	Percentage of grade
Course contributions	5%
Labs	55%
Project 1	12.5%
Project 2	12.5%
Final Project	15%

*More detailed descriptions of all assignments can be found on the course Brightspace page.

Course contributions: Contribute actively to class and by posting on Piazza. To do this, readings should be done prior to lectures. For guidelines as to what constitutes a meaningful contribution, please, see the contribution rubric posted to the Course Resources section of our class Brightspace page. Of the 5% contribution grade, 2.5% will be assessed by contributions to Piazza and 2.5% will be assessed by your feedback on student final project presentations.

Lab Assignments: Most weeks (see below schedule) there will be a lab assignment due. Lab assignments are due as RMarkdown Word documents via Brightspace six days after the Friday lab when they are worked on in-class (i.e., Thursdays at 9 pm). Please, show all work, so that you may receive partial credit if necessary. Please, include all R code you use with your assignment.

Projects: Two projects will assess your skills in ordination (project 1) and clustering (project 2) techniques.

Project 1 – Ordination: The objective of this project is to apply Principal Component Analysis (PCA) and Non-metric multidimensional scaling (NMDS) to two data sets in the programming language R. Students will answer a set of questions related to the application and interpretation of these analyses.

Project 2 – Cluster Analyses: The objective of this project is to apply k-means and hierarchical clustering techniques and test the significance of groups/clusters recovered from these cluster analyses using the programming language R. Students will answer a set of questions related to the application and interpretation of these analyses.

Final Project: The objective of the final project is for students to ask a question of their own data, select the appropriate multivariate analysis, conduct the analysis in R, and interpret your results. Students will give a 10-minute presentation on the project in class. In addition to the presentation, students will include annotated code and the data file used in the analysis. You will review another student's final annotated code in RMarkdown format and provide feedback on the reproducibility of their analyses during the final lab section this feedback will be due during finals week (Friday, May 3 at 5 pm).

Grading Scale: A \geq 92%, A- = 90-91.9%, B+ = 87-89.9%, B = 82-86.9%, B- = 80-81.9%; C+ = 77-79.9%, C = 72-76.9%, C- = 70-71.9%; D+ = 67-69.9%, D = 62-66.9%, D- = 60-61.9%, F < 60%

Course Schedule:

Course Schedule is subject to change

*Lecture #	Topic	Readings
Week 1 1/17 – 1/19	Intro to multivariate statistics, RMarkdown, GitHub Lab 1	McGarigal et al., Ch. 1, Cooper et al. 2017
Week 2 1/24 – 1/26	Multivariate Data: screening, transformations, distance measures Lab 2	Borcard et al. , Ch. 2 & 3 (pgs. 31-45)
Week 3 1/31 – 2/1	Ordination 1: Principal Components Analysis (PCA) Lab 3	McGarigal et al., Ch. 2 (pgs.19-55) Peres-Neto et al. 2003
Week 4 2/7-2/9	Ordination 2: Principal Coordinates Analysis (PCoA), Non-Metric Multidimensional Scaling (NMDS) Lab 4	Borcard et al. , Ch. 5 (pgs. 132-145)
Week 5 2/14 – 2/17 <i>Project 1 Due 2/17 at 5 pm</i>	Cluster Analysis 1: Clustering Methods Lab 5	McGarigal et al., Ch. 3 (pgs. 81-104)
Week 6 2/21 – 2/23	Cluster Analysis 2: Choosing Clustering Methods and Visualization Lab 6	Borcard et al. , Ch. 4 (pgs. 53-79)
Week 7 2/28 – 3/1	Testing for groups: perMANOVA, Mantel's test Lab 7	McCune and Grace, Ch.24 & 27
Week 8 3/6 – 3/9 <i>Project 2 Due at 5 pm</i>	Discriminant Analysis/MANOVA Lab 8	McGarigal et al., Ch. 4
Week 9	No Class Spring Break	
Week 10 3/20 – 3/22	Classification and Regression Trees (Cart) Lab 9	De'ath & Fabricius 2000
Week 11 3/27 – 3/29	Constrained Ordination Lab 10	Borcard et al. , Ch. 6
Week 12 4/3 – 4/5	Constrained Ordination continued/Variance partitioning Lab 11	Borcard et al. , Ch. 6 Cushman & McGarigal 2002
Week 13 4/10 – 4/12	Reproducible Analyses No lab meeting – Sydne at NEON headquarters.	Revisit Cooper et al. 2017
Week 14 4/17 – 4/19	Final Project Presentations during lecture and lab time	
Week 15	Comparison of Techniques	McGarigal et al. Ch. 6

4/24 – 4/26	Peer review of code in class during lab.	
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*each lecture has an associated lab. Note that there is no lab on week 13, but we will meet for lab on weeks 14 and 15.

Important Dates:

Friday, 2/17 at 5 pm: Project 1 is due

Friday, 3/9 at 5 pm: Project 2 is due

Tuesday, April 16 at noon: Final Project code and presentation are due.

Friday, May 3 at noon: Peer review of final project code is due.

Last day to hand in work: Noon on Friday, May 3, 2024

Course Policies

Attendance and late policy

You are highly encouraged to attend all classes. Please let me know in an email if there is an issue that will keep you from attending class. You are expected to contribute to class by answering and asking questions and contributing to course discussions.

Late assignments will be marked down 10% for each day that the assignment is late. Any assignment ten days or more late will not receive credit. All labs and projects are required to pass the course. There is no extra credit or make up work options.

Collaboration and online resources

I highly encourage you to talk with one another as you troubleshoot errors in code and grapple with new statistical analyses. Online resources (including AI) may also be extremely helpful when you get stuck. However, all work that you hand in should be your own. *Please acknowledge classmates you worked with on any given assignment and cite any online resources.*

Community guidelines

In the first week of class, we will collectively establish community guidelines in a living document that will provide the principles under which we will hold and create an inclusive learning environment. Throughout the semester, we will revisit that document as needed if anything arises.

Campus Policies

Academic Honesty Statement:

Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, or generated by software or systems without the explicit approval of the instructor, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University.

Please see the University of Maine System's Academic Integrity Policy listed in the Board Policy Manual as Policy 314: <https://www.maine.edu/board-of-trustees/policy-manual/section-314/>

Students Accessibility Services Statement

If you have a disability for which you may be requesting an accommodation, please contact Student Accessibility Services, 121 East Annex, um.sas@maine.edu, 581.2319, as early as possible in the term. Students may begin the accommodation process by submitting an accommodation request form online and uploading documentation at https://umaine-accommodate.symplicity.com/public_accommodation/. Once students meet with SAS and eligibility has been determined, students submit an online request with SAS each semester to activate their approved accommodations. SAS creates an accessibility letter each semester which informs faculty of potential course access and approved reasonable accommodations; the letter is sent directly to the course instructor. Students who have already been approved for accommodations by SAS and have a current accommodation letter should meet with me (Sydney) privately as soon as possible.

Course Schedule Disclaimer (Disruption Clause):

In the event of an extended disruption of normal classroom activities (due to COVID-19 or other long-term disruptions), the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Observance of Religious Holidays/Events:

The University of Maine recognizes that when students are observing significant religious holidays, some may be unable to attend classes or labs, study, take tests, or work on other assignments. If they provide adequate notice (at least one week and longer if possible), these students are allowed to make up course requirements if this effort does not create an unreasonable burden upon the instructor, department, or University. At the discretion of the instructor, such coursework could be due before or after the examination or assignment. No adverse or prejudicial effects shall result to a student's grade for the examination, study, or course requirement on the day of religious observance. The student shall not be marked absent from the class due to observing a significant religious holiday. In the case of an internship or clinical, students should refer to the applicable policy in place by the employer or site.

Sexual Violence Policy

Sexual Discrimination Reporting

The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a faculty or staff member who is deemed a "responsible employee" about sexual discrimination, they are required to report this information to Title IX Student Services or the Office of Equal Opportunity.

Behaviors that can be "sexual discrimination" include sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct, and gender discrimination. Therefore, all these behaviors must be reported.

Why do teachers have to report sexual discrimination?

The University can better support students in trouble if we know about what is happening. Reporting also helps us to identify patterns that might arise – for example, if more than one person reports having been assaulted or harassed by the same individual.

What will happen to a student if a teacher reports?

An employee from Title IX Student Services or the Office of Equal Opportunity will reach out to you and offer support, resources, and information. You will be invited to meet with the employee to discuss the situation and the various options available to you.

If you have requested confidentiality, the University will weigh your request that no action be taken against the institution's obligation to provide a safe, nondiscriminatory

environment for all students. If the University determines that it can maintain confidentiality, you must understand that the institution's ability to meaningfully investigate the incident and pursue disciplinary action, if warranted, may be limited. There are times when the University may not be able to honor a request for confidentiality because doing so would pose a risk to its ability to provide a safe, nondiscriminatory environment for everyone. If the University determines that it cannot maintain confidentiality, the University will advise you, prior to starting an investigation and, to the extent possible, will share information only with those responsible for handling the institution's response

The University is committed to the well-being of all students and will take steps to protect all involved from retaliation or harm.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For confidential resources on campus: **Counseling Center: 207-581-1392 or Cutler Health Center: at 207-581-4000.**

For confidential resources off campus: **Rape Response Services: 1-800-871-7741 or Partners for Peace: 1-800-863-9909.**

Other resources: The resources listed below can offer support but may have to report the incident to others who can help:

For support services on campus: **Title IX Student Services: 207-581-1406, Office of Community Standards: 207-581-1406, University of Maine Police: 207-581-4040 or 911.**

[Visit the Title IX Student Services website at \[umaine.edu/titleix/\]\(http://umaine.edu/titleix/\) for more information.](http://umaine.edu/titleix/)