**ECOL 596W Section 001**
**Practical and Reproducible Data Science for EEB**
Tuesdays and Thursdays 9:30 – 10:45 AM
Koeffler 209
Fall 2025

**Professor:** Dr. Sabrina McNew (she/her/ella)
**Email:** mcnew@arizona.edu
**Office:** BSW 326
**Office Hours:** See calendar

**Course Information and Communication:**

1. The course website is https://github.com/smcnew/ECOL_596W_2024
2. If you have questions or concerns feel free to email the instructor (mcnew@arizona.edu).
3. Tuesdays will be mostly lecture, Thursdays will be mostly in-class practice. Bring a computer with R and R studio to Thursdays, and some Tuesdays TBD.

**Course Description**

Data management and analysis skills are essential for graduate students in the biological sciences. However, these skills can be challenging to learn because they sit at the intersection of three fields: biology, math, and computer science. Here we will pull from each of these disciplines to build your toolkit as a researcher. In this course, we will develop general best analytical practices to ensure that your data are safely stored, that your results are reproducible, and that your research leads to meaningful insights. We will not cover every statistical approach that you may need to complete your graduate degree, and we will not deeply delve into the math behind most analyses. However, by the time you leave the course you should have a foundation that will help you tackle many common types of data analyses, and you should have the confidence to gain new skills to answer your specific research questions.

**General Learning Outcomes:**

By the end of the course you should be able to:

- *Manage your data:* You will learn how to "wrangle" your data into an analysis-ready format. You will learn best practices for storing and archiving your data to ensure reproducibility and easy collaboration with colleagues and future you.
- *Visualize your results:* Plot your data early and often. Visualizing your data is an important first step when organizing your analysis and sharing results with collaborators.

- *Use common statistical approaches:* Know what kind of data you have and what family of statistical approaches to use. You will gain a strong foundation in linear regression and its variations. You will also become acquainted with other techniques including PCA, Bayesian analysis, phylogenetic comparative methods, and more.
- *Learn to google:* Professional scientists face new data challenges with every project. Your goal is not to know every statistical approach but rather how to gain skills to tackle new problems.

**Classroom Philosophy:**
I'm excited you want to learn data science! This class is here to serve you as you work towards your PhD. As a group, our goal is to ensure that everyone feels included and free to engage fully with the content. We welcome:

- *Diverse identities and backgrounds* – all members of this class deserve to be here. We recognize and welcome the fact that our identities and experiences shape our perspectives and what we contribute to the classroom.
- *Respectful interactions* – that show value for others' opinions, identities, and time.
- *Commitment to shared learning* – recognizing that we each have different ways of demonstrating what we learn.

**Prerequisites:**
This course will be taught in R with R Studio. Prior knowledge of R is not a prerequisite; however, there is a learning curve to the language and the more comfortable you are with the code the easier this class will be.

**Course texts/sources:**
Irizarry, Introduction to Data Science: Data Analysis and Prediction Algorithms with R
Whitlock and Schluter, The Analysis of Biological Data
McElreath, Statistical Rethinking

**Prior to the first week of class:**
1. Download R and R Studio. If you need detailed instructions click here.
    *1A. Already downloaded but it's been a while? Time to update R and R studio*
    https://www.r-bloggers.com/2022/01/how-to-install-and-update-r-and-rstudio/
2. If you are totally new to the R language please try one or more of these tutorials to get acquainted with how it works:
    https://swirlstats.com/
    https://stat545.com/r-basics.html
    https://datacarpentry.org/R-ecology-lesson/

| Week/Date | Day | Topic | Class Activities/Problem Sets | Readings |
|---|---|---|---|---|
| **Week 1** | Tuesday | Class overview, philosophies of collaborative and reproducible science | | |
| Aug 28 | Thursday | Intro to R: coding basics, dplyr | Irizzary Ch. 2 | |
| **Week 2** | Tuesday | Principles of data management | | Zuur et al. 2009 |
| Sept 4 | Thursday | Data wrangling, summarizing | Irizzary Ch 4 | |
| **Week 3** | Tuesday | Github 1 | **Before class:** https://happygitwithr.com/ Chapters 4 - 6 | |
| Sept 11 | Thursday | Github 2 | | |
| **Week 4** | Tuesday | Principles of Data Visualization | **Before class:** Send Sabrina an example of a good or a bad figure | Irizarry Ch. 9 |
| Sept 18 | Thursday | Plotting in R | Irizarry Ch. 8 | Irizarry Ch. 9 |
| **Week 5** | Tuesday | Group Project 1 | | |
| Sept 25 | Thursday | Group Project 1 | | |
| **Week 6** | Tuesday | First looks at your data/Review | | |
| Oct 2 | Thursday | **R Language Quiz** | | |
| **Week 7** | Tuesday | Samples and uncertainty | Questions on distributions | |
| Oct 9 | Thursday | t-tests and variance | | |
| **Week 8** | Tuesday | Bit o Bayes 1 | | Ioannidis 2005 |
| Oct 16 | Thursday | Bit o Bayes 2 | | McElreath Statistical Rethinking Ch. 1-2 |
| **Week 9** | Tuesday | Regression/Linear Models | Lms problem set | |

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|---|---|---|---|---|
| Oct 23 | Thursday | lm() | | |
| **Week 10** | Tuesday | Generalized Linear Models | | Buckley 2015<br>Harrison et al. 2018 |
| Oct 30 | Thursday | Mixed Effects Models | GLMs/LMMs problem sets | |
| **Week 11** | Tuesday | Modeling practice | GLMs/LMMs problem sets | |
| Nov 6 | Thursday | Group Project 2 | | |
| **Week 12** | Tuesday | Group Project 2 | | |
| Nov 13 | Thursday | Many Analysts Discussion | | Gould et al. 2023 |
| **Week 13** | Tuesday | Model Selection | | Burnham and Andersen 2014<br>Valpine 2014<br>Murtaugh 2014 |
| Nov 20 | Thursday | Causal Inference | | |
| **Week 14** | Tuesday | Structural Equation Models | | |
| Nov 27 | **Thursday** | **No Class: Thanksgiving** | | |
| **Week 15** | Tuesday | **Present a Package** | | |
| December 4 | Thursday | **Present a Package** | | |
| **Week 16** | Tuesday | Special Topics and/or PCAs/ordination | | |
| **Week/Date** | | **Final exam** | | |

**Assessment Breakdown**

| | Percent of final grade |
|---|---|
| Participation | 20% |
| Group Projects | 40% |
| Present a Package | 20% |
| Quiz | 10% |
| Final | 10% |

## Additional Resources:

Wickham and Grolemund, R for Data Science. Guide focused mostly on coding in R.

Whitlock and Schluter, The Analysis of Biological Data. Good classic biostatistics reference, particularly for learning the math behind basic statistical tests.

McElreath, Statistical Rethinking. Definitive book on Bayesian statistics, great lectures available for free. Advanced.

## General Information:

**Classroom Behavior Policy:** To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

**Additional resources for students:** UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

**Campus Health**
http://www.health.arizona.edu/
Campus Health provides quality medical and mental health care services through virtual and in-person care.
Phone: 520-621-9202

**Counseling and Psych Services (CAPS)**
https://health.arizona.edu/counseling-psych-services
CAPS provides mental health care, including short-term counseling services.

Phone: 520-621-3334

**The Dean of Students Office's Student Assistance Program**
http://deanofstudents.arizona.edu/student-assistance/
Student Assistance helps students manage crises, life traumas, and other barriers that impede success. The staff addresses the needs of students who experience issues related to social adjustment, academic challenges, psychological health, physical health, victimization, and relationship issues, through a variety of interventions, referrals, and follow up services.
Email: DOS-deanofstudents@email.arizona.edu
Phone: 520-621-7057

**Survivor Advocacy Program**
https://survivoradvocacy.arizona.edu/
The Survivor Advocacy Program provides confidential support and advocacy services to student survivors of sexual and gender-based violence. The Program can also advise students about relevant non-UA resources available within the local community for support.
Email: survivoradvocacy@email.arizona.edu
Phone: 520-621-5767

**Confidentiality of Student Records:** Your educational record, including grades and other aspects of classroom performance are considered confidential and yours alone to disclose. More details below:

http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

**University-wide Policies link**

Links to the following UA policies are provided here,
https://academicaffairs.arizona.edu/syllabus-policies

- Absence and Class Participation Policies
- Threatening Behavior Policy
- Accessibility and Accommodations Policy
- Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Subject to Change Statement