ECOL195C: RESEARCH METHODS IN BIOLOGY: HOW TO GET THE MOST OUT OF YOUR RESEARCH EXPERIENCE
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Students are always welcome to ask questions by email (allow for 2 work days response time) or ask for an appointment (also via email, or simply schedule an appointment via https://calendly.com/dornhaus). Currently, all appointments will take place via Zoom (remotely).
In general, most communication will take place on Slack (a text communication platform), and direct messages to me are typically answered the same workday.

Description of the class content

For any STEM major, a university like the UA offers many opportunities to be involved in actual scientific research. But how do you become involved, and how do you make the most of this experience? In this course you will learn about the rules of academia, how to perform rigorous research, how to do statistical analyses in R, and how to graph and present your results to peers and others. You will meet a group of fellow research-active undergraduate students, and we will also discuss possible next steps, such as how to apply for graduate school. This course is intended to be taken alongside your research (we will help you find a research position in the first week if you do not have one yet), so that the data you analyze and present in class will come from your ongoing work.

Learning goals

In all my teaching, I have a single mission: to make the world and our society a better place by helping people differentiate objective information from rumor, speculation, and opinion. This is much harder than it sounds, especially for things we care about.

The superpower of science is that it is able, in principle, to do this: to help us recognize truth even when it is not what we want to believe.

In this course, I will aim for the following overall broad outcomes.
(1) You, the students, will learn to defend the statement above. That is, you will be able to explain how science can produce objective answers to questions about the world, unlike other approaches. You will also be able to apply that same thinking, i.e. a hypothesis-testing framework, to your own research project, and thus learn how to do rigorous science.
(2) You will practice a series of professional skills, in particular, professional communication, how to be part of a research group, and how to analyze data. The practice that you will probably focus on most is to be able to analyze your own data in R, a statistics programming language.

Specific Learning Outcomes

The course has 6 sections. Each section has its own readings, quiz, and channel on Slack.
Each of them contributes to the above outcomes with the following specific learning goals:
#1 Find a lab
- contact faculty with professional emails

- know how to discover options for becoming involved in research from university websites

#2 Define a project
- identify what your own research is about and explain some of its broader context
- identify what makes a promising project, namely impact and feasibility, and what aspects of a project affect them

#3 Generate or understand your experimental design
- explain why having alternative hypotheses is critical to being able to prove yourself wrong
- explain why being able to make predictions is critical to being able to prove yourself wrong
- explain why, if you are not in principle able to prove yourself wrong, you are not gaining objective information
- identify and generate an 'experimental design' for a particular research question, which means, identify the question, alternative hypotheses and critical predictions for the purpose of your project

#4 Methods
- practice communication with your peers, senior lab mates, and research advisor/PI
- identify sources of help for troubleshooting

#5 Data and Analysis
- load your data into R (a statistics package), perform basic statistical analyses, and graph your data in R;
- be able to explain the meaning of your statistical results, and to put it in context of likely uncertainty given the method

#6 Posters and Papers
- professionally (using PowerPoint) present your study question, results, and implications to a peer audience and other audiences

#7 Reflection, Feedback, and Next-Project-Planning
- use reflection as well as peer and expert feedback to learn from your experience and plan your next one

Course format and how to achieve the learning goals above

Learning takes place through (guided) practice with feedback. This class in particular is a learning-by-doing class with no 'lecturing' by the instructor. This is also an online class and you will be able to participate in all activities asynchronously, i.e. on your own time schedule. Your main activities will be to look at your own project in the framework of the 7 aspects above, and to discuss other students' projects through the same lens. This will enable you to see a diversity of approaches, but also, through group discussions (which will largely take place in text form) with both peers and experts, you will get a lot of ideas and feedback and sharpen your own understanding of how to achieve an elegant, rigorous, and impactful research outcome. I highly recommend that you take the time to read this syllabus in its entirety during the first week of class.

Key assessments and requirements

Software and technical tools

You'll need to use three different softwares/tools:
- D2L: The course website on D2L https://d2l.arizona.edu/d2l/le/content/1069053/Home will provide you with reading materials and other resources, your current grade, an approximately weekly graded 'worksheet', and a place to submit written assignments, such as your project outline.

- Slack: We will use this free software as a discussion board. It is similar to Discord for those who know that. It is ideal if you can download the free Slack app (click on the three horizontal lines on the top right of https://slack.com/, then choose 'download'). Alternatively, you can always launch Slack from a browser window (same horizontal lines, click on 'Sign in' or 'Launch Slack'). When signing in, your workspace is 'ecol195cfall21.slack.com'. To join our specific class 'workspace', here is an invitation link: https://join.slack.com/t/ecol195cfall21/shared_invite/zt-ua3xagys-gTi31zhkPu~SxBjcDvmpUQ. This link will remain active for 30 days. If you are joining the class after this date, please contact the instructor.
- RStudio Cloud: Make a free account on the website https://rstudio.cloud/, which you can open from any browser. The code for our joint work and practicing R will be shared on Slack.

What will happen every week

It is critical for online courses that, as much as possible, you set a regular time in your schedule to work on course material. For this course, your activities will be reading (either provided texts/papers, presentations, or other sources of information), planning/designing your own research project, and coding in R. The instructor will be checking new submissions every Tuesday, and generally aim to answer questions on Slack as soon as possible (usually on the same day during working hours).

Specifically, each week, you should take time for the following three activities:

(a) Work on your 'project outline', for which a prepared format is given on D2L. This is where you describe and work on your own research project. You should be adding or revising answers, and submitting your current version to the respective Assignments folder on D2L by Tuesday 9am. The schedule on D2L provides guidance as to which section you should be working on. At minimum, you should re-read your worksheet version from last week to make sure all answers are still accurate and complete, reflecting your current status in the project, and to check whether you've received feedback on your last submission that you need to address.

(b) Fill in a worksheet (provided on D2L). The worksheets are due Mondays at 9am. Worksheets will be closely related to the project outline work for that week, helping you make progress and learn skills you need. Worksheets may alternate with assignments on RStudio Cloud (i.e. programming exercises). Initially you will be solving particular practice problems and working with data provided by R; ultimately you will write your own script for your own data.

(c) Participating in discussions, by both reading contributions by others and posting your own replies, on Slack. The schedule on D2L provides prompts as to what you should do each week; your respective Slack contributions will be due Fridays by 1pm. You are encouraged to make many more than the minimum required contributions, particularly asking questions and commenting on other students' posts.

My suggestion is to dedicate one hour a week to readings on D2L and revising your project outline, one hour to worksheets or R practice, and one hour to engagement with the instructor and peers on Slack. This will add up to the 3 hours / week needed for a 1 credit class at UA.

Written final products

At the end of the semester, you will be submitting finalized versions of three pieces of writing connected to your research project: (1) Project Outline, (2) Your R script, (3) Your slide. However, all of these will go through multiple revisions, and you will be required to repeatedly submit partially completed versions, in addition to submitting completed quizzes on D2L.

(1) The Project Outline

You will receive an (electronic) worksheet for the project outline with different types of questions (in 'Content' on D2L). This will ultimately turn into a summary of your entire research project for this semester, and will be seen & signed off by your project mentor(s). You are free, in fact encouraged, to change your answers on this as the semester progresses, and you will receive written feedback at least twice over the course of the semester. You will submit all the drafts and the final version to the same Assignments folder on D2L.

(2) Your R script

This is a file on your computer written in the 'R' language, i.e. a short program that will be executed on your computer. We will teach how to do this. The end goal will be for your R script to use data you collected in your research project and to generate a p-value from a statistical test as well as a graph illustrating your results (at least one, may be multiple). The 3-4 key steps that your R script should perform are (a) data import (1 pts), (b) data conversion or necessary calculations (if needed, but it is usually needed); (c) plotting your data (3 pts for making a plot that is the equivalent of your sketched graphical predictions in the worksheet); and finally (d) a statistical test (3 pts; it is not relevant whether you have data, just that you have the code that will do the test that will compare the data to your predictions). The final 3 pts are for commenting and clearly explaining throughout the code what each command does.

Note that for the final script, you do not need to have original data, but you do have to have at least a blank data sheet that shows what format your data, when collected, will be in. I do not want you to use 'fake', i.e. made-up, data/numbers, for anything other than testing out your script; for the final figures, please do not submit fake data.

You will ultimately submit your R script in RStudio Cloud, by creating it inside the shared class workspace. As a backup, please submit the R script file (file extension .r) to D2L as well, by downloading it from RStudio and then saving it to D2L. Add your data file or a blank data sheet with the same headers to the shared workspace in RStudio unless you are importing data directly from Google Sheets or the like. The point is that I should be able to run your script to the end (where a graph is produced and a p-value calculated).

(3) Your final presentation slide/poster

By the end of the semester, you will submit an electronic 'slide' (in PowerPoint or other format) that summarizes your project, including question, hypotheses, predictions, results, and implications. This will be similar to a scientific poster but with MUCH less text.

If you have the opportunity to present your research as a poster at a conference, which is highly recommended, you can instead format your slide for printing (larger slide) rather than just for use in the final 'lightning talk'. If you are not presenting at an outside conference and you are just preparing the final slide for this class, please use a standard (screen)-sized slide with a minimum 24 pt font.

Grading for the slide (10 points total) is for: 3 pts – represent specific question, hypotheses, and predictions; 2 pts – graph you made in R that matches predictions in format (does not have to contain data points if you don't have them' axes only, with labels, is fine). Do not use generic labels like 'Measurements'; be as specific while conceptually informative as possible, e.g. 'Aggression [number of attacks per sec]'. Do not graph mock data as results. 1 pt – include title, authors, and acknowledgements. 2s pts – give statistics result derived from your R script, or if you don't have data, state what test you would use. Name test, p-value, and sample size. 2 pts – graphic presentation, readability, images, and context for the study. Submit to the respective Assignments folder on D2L. Acceptable file types for this submission are image files (e.g. .jpg), pdf files (e.g. .pdf), or slides (e.g. .pptx files).

Your lightning talk

At the end of the semester, you will submit a 3-4 minute video in which you show your final presentation slide and explain your research question and the answers gained in your research project. We will talk in more detail about how to make this talk; the simplest version is to generate a PowerPoint slide show (use 'record slide show' in the 'Slide Show' menu, then save as a 'PowerPoint Show', i.e. as .ppsx file not a .pptx file). To do this, i.e. to save your presentation in any format other than .pptx, go to File->Save As->select the format you want from the drop-down menu under the filename (in this case you want .ppsx).

The other option is to do a Zoom meeting with yourself only, in which you share your screen and record the meeting. Either way you will show just that single slide you made for the assignment above. This video file should be submitted to an Assignments folder on D2L as well as posted on the class Slack.

Either way you are generating a video file that plays when opened. Make sure you play the video file on your own computer to check that the sound works.

Grading is based on whether you are explaining how your experimental design answers the question, what the answer is if you have one, and what the relevance of the project is.

Grading
Your final grade will be determined from the weekly contributions, the three written assignments listed above, and your final talk. You can check your current grade status at any time on D2L. If you have questions about your grade, please contact the instructor immediately; I am happy to provide advice on calculating or improving your grade. All of the written assignments can be revised any number of times until the end of the semester or you receive the grade/quality of outcome that you desire; however, you must submit a first version for the given deadline. There are no other exams and no final exam.

Grade calculation	Points
Weekly submission of project outline	8
Weekly engagement on Slack	16
Worksheets (approx. weekly)	20
R practice	6
R script for your project	10
Lightning Talk	10
Poster/Slide	10
Final worksheet	20
Total points	**100**

A: 90-100 %
B: 80-89.9 %
C: 70-79.9 %
D: 60-69.9 %
F (fail): 0-59.9 %

Thus each week you can get 0.5 pt for submitting a revision of the project outline and 1 pt for engaging on Slack. Both of these are just points for doing it, not quality of responses. Most weeks, you can also earn 2 pts from the respective worksheet.

At the end of the semester, the remaining 60% of your grade are evenly spread over having submitted a final correct version of the quizzes/R practices, your research R script, the slide, and lightning talk, as well as the project outline, which is the only item that is more heavily weighted.

Reading
Required readings are posted (and available) on D2L. You do not need a textbook.

Honor's contract
Honors College students can take this course with an additional honors contract. All such contracts will include the following additional requirements: (a) Actually presenting your final

poster at a conference, either a professional meeting or an undergraduate conference at UA (discuss your options with instructor at the beginning of the semester); (b) getting your research mentor to give a short (10 min) recorded presentation on a topic of their choice (either broader research background or career-relevant topic); (c) presenting your talk in a lab meeting after having presented in class (typically this will be in the lab where the research is performed, but if that is not an option we will discuss alternatives).

The student is responsible for discussing their plan for an Honor's contract with the instructor within the first 3 weeks of the semester. Honors contract information is available at http://www.honors.arizona.edu/future-students/honors-credit-across-campus.

General issues
Accommodations for disabilities

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations. You are also welcome to contact the instructor with information on what about the course is less than ideally accessible; I will be happy to work with you to improve accessibility for all materials.

Professional Communication

If you have any questions, feel free to email the instructor at dornhaus@email.arizona.edu. I will attempt to answer as soon as I can, however you should never assume an email will be answered in less than 3 days. It may be more efficient for you, and helpful for everyone else, to post questions on Slack, so that other students can also contribute answers.

If you send any emails to the instructor or TA, make sure to mention the name of the class (ECOL195C) in the subject line. Also, start your email by addressing the recipient, and end it with a greeting. A professional way to address persons with a PhD is, for example, "Dear Dr Dornhaus". In this class, you may address the instructor with their first name, e.g. "Dear Anna". Always end the email with your full or first name (e.g. "Best wishes, Julia Cordero", or "Best wishes, Julia"; however make sure your last name is mentioned in the text of your email). Yes, that's also good form for replies in email chains. Re-read your email to check for spelling and grammar errors. Not adhering to these rules will mean that the addressee will get the impression that you are unused to professional communication, and this will probably result in them focusing on your communication style instead of your actual message; this is very detrimental in emails to future employers or mentors, so you should start practicing good habits now.

Class 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, re-read all your discussion contributions before posting to check that they are kind and productive, i.e. helpful for the task at hand.

This course supports elective gender pronoun use and self-identification; rosters indicating such choices will be updated throughout the semester, upon student request. As the course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect.

Absence Policies

The class is asynchronous so there should generally be enough time for you to complete assignments even if you are sick or have other obligations for a couple of days. If you are ill for longer so that this causes you to miss submission dates, please inform the instructor and discuss any possibilities for make-up activities or generally catching up.

Participating in the course every week is vital to the learning process. If you do not, you will lag behind other students and not be able to productively learn from and contribute to class discussions;

in addition, your learning will be more effective if it includes sufficient time to internalize new information and practice the skills we use in the class.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop.
The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable: http://policy.arizona.edu/human-resources/religious-accommodation-policy.
Absences preapproved by the UA Dean of Students (or dean's designee) will be honored. See http://policy.arizona.edu/employmenthuman-resources/attendance.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

COVID-19.
Visit the UArizona COVID-19 page for regular updates: https://covid19.arizona.edu/. If you or a family member has severe symptoms, as with any other significant illness, please contact the instructor when you are able to discuss any changes in your timetable and dates of assignment submissions.

Life challenges
If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or DOS-deanofstudents@email.arizona.edu.

Physical and mental-health challenges
If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334. CAPS is likely covered by your student health insurance and has been helpful to many of my current and former students.

UA Nondiscrimination and Anti-harassment Policy
The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy
Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Code of Academic Integrity
Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. The use of the internet or published works to help you solve problems in the assignments completed at home is also encouraged.
In particular, research is nowadays typically a very collaborative enterprise: often, several people may be involved both in the design and execution of a project. In practice, what this means for the course, is that the answers on the worksheet should be stated in your own words, but you may show the answers to and discuss the answers with your advisor or other lab members, in particular those concerning the research project. You are also encouraged to discuss them with other students in the class.
However, quizzes on D2L should be answered independently by you.

Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog.
See http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.
The University Libraries have some excellent tips for avoiding plagiarism, available at http://www.library.arizona.edu/help/tutorials/plagiarism/index.html.
Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

Threatening Behavior Policy
The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See
http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Additional Resources for Students
UA Academic policies and procedures are available at http://catalog.arizona.edu/policies.
Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance.

Confidentiality of Student Records
http://www.registrar.arizona.edu/ferpa/default.htm

Subject to change
Please note that the information contained in the course syllabus, other than the grade and absence policies, may be subject to change with advance notice, as deemed appropriate by the instructor. This is particularly true of the details in the course schedule. The most up-to-date version of the class schedule (including assignment due dates) can always be found on D2L.