



“As excellent as our cognitive systems are, in the modern world we must know when to discount them and turn our reasoning over to instruments – the tools of logic, probability, and critical thinking that extend our powers of reason beyond what nature gave us. Because in the twenty-first century, when we think by the seat of our pants, every correction can make things worse, and can send our democracy into a graveyard spiral.” – Steven Pinker

“Politicians use statistics in the same way that a drunk uses lamp posts – for support rather than illumination.” – Andrew Lang

COURSE DESCRIPTION - *Data Analysis and Design for Biologists (4 credits)*

This course is a practical introduction to information literacy, experimental design, and data analysis for biologists. Students will be introduced to coding, data management, and quantitative analysis using the R programming language and the RStudio IDE. However, this is not a traditional statistics course and no math prerequisites are required. Rather this course focuses on practical skills related to effectively asking and answering biological questions with data.

CONTACT AND SCHEDULING INFO

INSTRUCTOR

Dr. Keefe Reuther (he/him/his)

Email address: kdreuther@ucsd.edu (**please put BILD 5 in the subject line**)

LECTURE TIME

MWF 1:00-1:50PM Mandeville Hall Room B-150

FINAL EXAM TIME

Monday, December 5, 2022; 11:30a-2:30p PST

INSTRUCTIONAL ASSISTANTS AND MEETING TIMES

Name	Email Address
Jiawei	jis215@ucsd.edu

SECTION MEETING TIMES

A01	F	8:00 - 8:50 AM	CENTR 218
A02	F	2:00 - 2:50 PM	HSS 2321

REUTHER OFFICE HOURS

TBA

PREREQUISITES

None! And you don't need any experience coding or working in a lab!

TEXTBOOK

Spiegelhalter, D. (2019). The art of statistics: Learning from data. Penguin UK.

TECHNOLOGY REQUIREMENTS

You will need access to a device that can access a web browser (e.g. Chrome, Safari, Firefox). This will be to access Canvas, Zoom, Gradescope, and the UCSD DataHub to run your Jupyter Notebook and RStudio. While any connected device can typically accomplish this (smart phone, tablet, laptop), it is highly recommended that you use a laptop or a desktop computer for connecting to the UCSD DataHub. Trust me, you don't want to write code from your phone! Note that Chromebooks work perfectly well for this course.

You are allowed to bring your technology into lecture - however it is not necessary. **However, since section activities are based around R coding, it is recommended that you bring a laptop to your section if you are able.** If you are unable to bring one, we will be working in small groups during section meetings and so can work with others (however you will ultimately be responsible for turning in your own assignment).

There are resources on campus available if you have tech needs. Please visit: <https://libraries.ucsd.edu/computing-and-technology/computers-and-laptop-stations/index.html>

CONTACT

The best way to contact me is by email: kdreuther@ucsd.edu. On all emails PLEASE put BILD 5 in the subject line to indicate that the email pertains to this course. If you email about anything regarding your status in the course, please include your UCSD username, and PID. If you have questions about course content, it is often faster to email your IA directly.

COURSE LEARNING OUTCOMES

1. *Create* testable hypotheses addressing valid biological questions.
2. *Evaluate* the credibility and value of relevant scientific information.
3. *Design* experiments that effectively test hypotheses.
4. *Construct* figures that effectively communicate data.
5. *Perform* appropriate quantitative and statistical analyses on experimental data.
6. *Interpret* the results of quantitative statistical models and associated analyses.
7. *Utilize* the R programming language for scientific data analysis and graphing.
8. *Combine* the elements of a complete investigative cycle in a student designed project.
9. *Explore* the modern intersection between different subfields of biology, technology, and data science.
10. *Examine* the ethical responsibilities of scientists when creating and communicating scientific evidence.

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LEARNING PHILOSOPHY

This course is designed to be an environment for everyone to learn and construct a shared understanding of the material. **Active participation by engaging with the lecture material, asking and answering questions, and contributing to breakout sessions during discussion time is expected.** Being able to communicate understanding, and confusion, is critical to success in any discipline, and is very useful for learning. To encourage collaboration, section activities will be done in groups, and grades will not be assigned on a curve. You will also be required to provide feedback to your peers on certain assignments. Instead of memorization, we will focus on developing an understanding of fundamental concepts as they apply to different examples. Therefore, assignments and assessments will include questions that are based on solving problems in new contexts.

OVERALL COURSE EXPECTATIONS

What you can do to support your success in the course:	What I will do to support your success in the course:
Read the syllabus and stay current with course information	Be prepared and bring my enthusiasm for teaching to each session. Provide all materials and course information in the time you need it.
Keep up with readings and lab assignments, as each one builds on the previous one.	Respond to emails within one working day, and provide timely feedback on assignments / submissions.
Contribute to the learning environment with fairness , cooperation , and professionalism	Establish a learning environment with fairness, cooperation and professionalism, and will take action if these principles are violated.
Treat your classmates, instructional assistants and myself honestly and ethically	Treat you honestly and ethically, and will address any concerns you might have
Commit to excel with integrity. Have the courage to act in ways that are honest, fair, responsible, respectful & trustworthy. Please read UC San Diego's Policy on Integrity of Scholarship and take the integrity pledge !	Uphold integrity standards and create an atmosphere that fosters active learning, creativity, critical thinking, and honest collaboration.
Manage your time, so you can stay on track with the course and complete tasks on time	Only assign work that is vital to the course, and will work to meet the standard credit hour allotment for the course.
Communicate with me if you determine that a deadline cannot be met due to extenuating circumstances	Consider requests for adjustments and will make reasonable exceptions available to all students when approved

A TYPICAL WEEK IN THIS COURSE

WHAT?	WHERE?
Going to lecture	In-person and synchronous (MWF) The course will be in-person and synchronous. A videocast will be available asynchronously.
Section Meetings/Problem Sets	In-person and synchronous (F) This will NOT be recorded. The problem set may be done on your own time asynchronously. You will benefit greatly from attending (working with others and the IA), but attendance is not mandatory.
Office Hours	Some will be in-person and some will be via Zoom (see Canvas for details)

WEEKLY STUDENT DELIVERABLES

All due times are 11:59pm PST	
Wednesday EVERY WEEK	Discussion Board Prompt post #1
Sunday EVERY WEEK	Discussion Board Prompt post #2, Problem Sets, All other deliverables (SEE BELOW)
Sunday week 1	Pre-Course Survey #1 & #2, Syllabus Quiz
Sunday week 6	Term Project CP 1 - Experimental Design
Sunday week 8	Term Project CP 2 - Analysis Plan
Sunday week 10	Term Project DUE Post-Course Survey #1 & #2 CAPEs
Finals Week	In-person final assessment

COURSE LECTURE SCHEDULE

Week	Day	Date	Lecture Topic
0	F	Sept 23	Why Science?
1	M	Sept 26	Why Statistics?
1	W	Sept 28	Why Programming? - and R and Rstudio intro
1	F	Sept 30	Describing Data: Types of data
2	M	Oct 3	Exploratory Data Analysis: What makes a good figure?
2	W	Oct 5	Exploratory Data Analysis: Different types of figures
2	F	Oct 7	Describing data: Measures of central tendency and the normal distribution
3	M	Oct 10	Describing data: variance and error in normal distribution
3	W	Oct 12	Describing data: Variance and confidence intervals
3	F	Oct 14	Turning questions into biological and statistical hypotheses
4	M	Oct 17	Transformations and other distributions
4	W	Oct 19	Different types of studies - to manipulate or not
4	F	Oct 21	Variables and sampling design/ethical considerations
5	M	Oct 24	Common pitfalls of experimental design
5	W	Oct 26	Calculating a test statistic - the t test
5	F	Oct 28	Power, p values, effect size, and sample size
6	M	Oct 31	P values: the good, the bad, and the ugly
6	W	Nov 2	ANOVA and post-hoc testing
6	F	Nov 4	Choosing and running statistical tests part 1
7	M	Nov 7	Pearson Correlation
7	W	Nov 9	Linear regression & ordinary least squares
7	F	Nov 11	HOLIDAY
8	M	Nov 14	Choosing and running statistical tests part 2
8	W	Nov 16	Logarithmic regression & maximum likelihood
8	F	Nov 18	Multiple regression and the magic of machine learning
9	M	Nov 21	Clustering, PCA - simplifying complex data
9	W	Nov 23	Holiday
9	F	Nov 25	Holiday
10	M	Nov 28	The reproducibility crisis and other issues in science
10	W	Nov 30	The Open Science Framework and other steps forward
10	F	Dec 2	Open

GRADING

Syllabus Quiz	1%
Lecture iClicker participation (4 lowest scores dropped)	9%
Problem Sets (drop lowest score)	30%
Discussion Board Prompts (drop lowest score)	10%
Term Project Checkpoints	10%
Final Term Project	20%
Final Exam	20%
Extra Credit Surveys & CAPEs	up to 1.5%

Grading Scale

Grade cut-offs will never be shifted up, but may be shifted down depending on the final overall grade distribution. There is NO rounding of your course grade.

Name	Range	
A+	100%	to 97%
A	< 97%	to 93%
A-	< 93%	to 90%
B+	< 90%	to 87%
B	< 87%	to 83%
B-	< 83%	to 80%
C+	< 80%	to 77%
C	< 77%	to 73%
C-	< 73%	to 70%
D	< 70%	to 60%
F	< 60%	to 0%

POLICY ON COLLABORATION

Working together is good! Science is a social act and we want this course to mirror the real world of biology. That being said, we also need to adhere to our pledge to act with integrity. Therefore, you may help each other **in general**. This means explaining concepts, definitions, processes, etc. to each other. You may also talk about and share code with each other. Copying and pasting code is an everyday tactic. However, your final answers and responses must be your own and written in your own

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words. There is to be absolutely no sharing of answers. We will frequently ask for you to annotate your code and explain what your code is doing. This, as well as all other written work, must be original. All assignments (including RMarkdown pdfs) will be run through a plagiarism checker. At the end of the day, you are here to learn this material so you can be a better biologist. Focus on learning and grades will come as an indirect, wonderful consequence.

SYLLABUS QUIZ

This short Canvas quiz due at the end of week 1 will cover aspects of the syllabus and the course Canvas site. There will be no time limit and it is open book/open note. You have two attempts to complete the quiz and your average score will be taken.

DISCUSSION BOARD PROMPTS

Each week there will be a discussion prompt placed in the Discussions section of Canvas prior to Monday morning. You must make one substantive response to the prompt before Wednesday @11:59pm. You must respond to another student's reply by Sunday night at 11:59pm. For a response to count for credit, it must be original, substantive, and properly cited (if necessary). Generally, this means a small paragraph. Replies of "I agree" do not count as substantive.

PROBLEM SETS

Every week there will be an activity with a focus on using R and RStudio to conduct the analysis and visualizations we'll learn in lecture. It will be in the form of an RMarkdown document and a .csv data file. After completing the activity, you will upload your response as a PDF RMarkdown file. If you don't know what that means - don't worry, we'll explain! If you have a laptop, please bring it to the section meeting, if possible. If you do not attend your section synchronously, then it is your responsibility to complete the assignment on your own time. Everyone will be required to upload their individual response. This assignment will also include all questions on course material unrelated to programming (e.g. experimental design, ethics, biostatistics, etc.)

FINAL EXAM

You will have 3 hours for the final exam, even though it will not be written to take the entire time. This will be a cumulative exam mirroring the structure of an extended problem set. A study guide with relevant topics will be provided beforehand. You may bring 1 sheet of 8.5"x11" paper with information of your choosing on both sides. You can add anything, but it must be of your own creation - we will collect them at the end. It will be in-person and synchronous. **Alternative times will only be for approved reasons that are outside the control of the student.**

TERM PROJECT

This project will allow you to go through an entire investigative cycle on your own, from the design of your own question through being provided with simulated data to analyze, interpret and report. You will receive instructor feedback after each step. Please take heed of the feedback as grading will get progressively more stringent. See individual rubrics on Canvas for more information. Each step should be adequately researched and cited using core principles of scientific literacy. While the data is fake, your project should be realistic, relevant, and at least moderately original.

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This should be a product that you can put in your portfolio for future interviews. Who knows? Maybe it'll inspire your next research project in graduate school!

EXTRA CREDIT

This can be earned by completing course evaluations and related surveys which aim to improve the course and the educational experiences of your future peers. There are no other opportunities for extra credit beyond what is assigned by the course instructor.

LATE ASSIGNMENTS

It is your responsibility to keep track of due dates and plan accordingly. 0.5% will be deducted for every hour the assignment is late. **However, fill out the Late Assignment Request Form if you need to turn in an assignment late. If the reason for a late submission was outside of your control then you will not be assessed a late penalty.** Once answer keys have been posted, late assignments turned in will receive no higher than a 50% score. Answer keys will be posted after 2 days of the due date - see Canvas for details. If you post when the answer key is available, you still must write everything in your own words. No copying the key! But hey, 50% is more than 30% because we want you to achieve the learning objectives from the assignment.

REGRADES

If a grading error has been made, you should submit a regrade request via email to Dr. Reuther. You will need to explain your regrade and justify your asking for a regrade.

TECHNICAL SUPPORT

First, check the list of video help guides on Canvas to see if your question is addressed. For help with using RStudio or Jupyter Notebooks, please contact your Instructional Assistant.

For help with accounts, network, and technical issues:

<https://acms.ucsd.edu/contact/index.html>

For help connecting to electronic library resources such as eReserves and e-journals:

<https://library.ucsd.edu/computing-and-technology/connect-from-off-campus/>

CAMPUS SAFETY REQUIREMENTS AND EXPECTATIONS

Keeping our campus healthy takes all of us. You are expected to follow the [campus safety requirements](#) and pursue personal protection practices to protect yourself and the others around you. These include:

Participate in the university's daily screening process.

Everyone must complete a [Daily Symptom Survey](#) to access a university-controlled facility.

Participate in the university's testing program.

All students are required to participate in the [COVID-19 Testing program](#) as required by their vaccination status:

- o Unvaccinated students with approved exceptions must complete a COVID-19 test twice a week.
- o Students who are fully vaccinated must complete a COVID-19 test once a week, for the first four weeks of the quarter.
- o

Wear a well-fitted face covering that covers your nose and mouth at all times.

Everyone is required to [wear face coverings indoors](#) regardless of vaccination status. If you see someone not wearing a face covering or wearing it incorrectly, then kindly ask them to mask up.

Monitor the daily potential exposure report.

Every day the university will update the potential exposure report with building and some classroom information and the dates of exposure. Download the [CA COVID Notify app](#) to your phone to receive an alert if you have been potentially exposed to COVID-19.

Assist in the contact tracing process.

If you're contacted by a case investigator, it means you have been identified as [close contact](#), please respond promptly. You must assist with identifying other individuals who might have some degree of risk due to close contact with individuals who have been diagnosed with COVID-19.

Contact the instructional team if you are impacted by COVID-19

Please note that due to the ongoing COVID-19 Pandemic, changes may be made in response to new developments and information.

CAMPUS POLICIES

- [UC San Diego Principles of Community](#)
- [UC San Diego Policy on Integrity of Scholarship](#)
- [Religious Accommodation](#)
- [Nondiscrimination and Harassment](#)
- [UC San Diego Student Conduct Code](#)

Diversity and equity statement

It is important for us to make sure that how we teach this course and how we accommodate different student needs reflects the differences of race, ability, sexual orientation, age, and gender identity that enrich our classroom experience and campus. If you have any concerns related to diversity and equity in the course, please contact the instructor.

If you find yourself in an uncomfortable situation, ask for help. The university is committed to upholding policies regarding nondiscrimination, sexual violence, and sexual harassment.

STUDENT RESOURCES

Learning and Academic Support	
<p><u>Ask a Librarian: Library Support</u> Chat or make an appointment with a librarian to focus on your research needs</p> <p><u>Course Reserves, Connecting from Off-Campus and Research Support</u> Find supplemental course materials</p> <p><u>First Gen Student Success Coaching Program</u> Peer mentor program that provides students with information, resources, and support in meeting their goals</p> <p><u>Office of Academic Support & Instructional Services (OASIS)</u> Intellectual and personal development support</p>	<p><u>Writing Hub Services in the Teaching + Learning Commons</u> One-on-one online writing tutoring and workshops on key writing topics</p> <p><u>Supplemental Instruction</u> Peer-assisted study sessions through the Academic Achievement Hub to improve success in historically challenging courses</p> <p><u>Tutoring – Content</u> Drop-in and online tutoring through the Academic Achievement Hub</p> <p><u>Tutoring – Learning Strategies</u> Address learning challenges with a metacognitive approach</p>
Support for Well-being and Inclusion	
<p><u>Basic Needs at UCSD</u> Any student who has difficulty accessing sufficient food to eat every day, or who lacks a safe and stable place to live is encouraged to contact: foodpantry@ucsd.edu basicneeds@ucsd.edu (858) 246-2632</p> <p><u>Counseling and Psychological Services</u> Confidential counseling and consultations for psychiatric service and mental health programming</p> <p><u>Triton Concern Line</u> Report students of concern: (858) 246-1111</p> <p><u>Office for Students with Disabilities (OSD)</u> Supports students with disabilities and accessibility across campus</p>	<p><u>Community and Resource Centers Office of Equity, Diversity, and Inclusion</u> As part of the <u>Office of Equity, Diversity, and Inclusion</u> the campus community centers provide programs and resources for students and contribute toward the evolution of a socially just campus (858).822-.3542 diversity@ucsd.edu</p> <p><u>Get Involved</u> Student organizations, clubs, service opportunities, and many other ways to connect with others on campus</p> <p><u>Undocumented Student Services</u> Programs and services are designed to help students overcome obstacles that arise from their immigration status and support them through personal and academic excellence</p>

PRIVACY PRACTICES IN THIS COURSE

(From <https://cio.ucop.edu/privacy-tips-for-your-syllabus/>)

This course is a community built on trust; as a learning community, we are collectively responsible for upholding privacy protections. In order to create a community built on trust and the most effective learning experience, our interactions, discussions, and course activities must remain private and free from external intrusion. We have obligations to each other to preserve privacy and cultivate fearless inquiry. We respect the individual dignity of all and will refrain from actions that diminish others' ability to learn.

As your instructor, I am committed to protecting your privacy by only using university-approved course technologies and adhering to the Family Educational Rights and Privacy Act

(FERPA) <https://catalog.ucsd.edu/about/policies/notification-of-rights/index.html> and Campus Privacy Office guidelines. This includes using your educational data only as allowed by FERPA, for example, for legitimate educational purposes such as submitting your final grades to the registrar's office.

Please note the following privacy practices for our course:

Course platform. This course uses Canvas, Datahub, Zoom, and Gradescope, which collects information about your engagement with course materials. I will review this information periodically to ensure students are engaged and look for signs of students falling behind. I will also review this information in case of academic misconduct allegations, if relevant.

Online/video classes. Regarding video-conferencing, while I ask, to the extent you are comfortable and able, that you keep your videos on during lessons to aid in the development of our learning community, I also understand that may not always be possible. Know that you will not be penalized for choosing to disable your video during synchronous course sessions. You are welcome to use an appropriate virtual background if you do not want to have your surroundings visible. Be mindful of others who may not wish to be visible or recorded in the background.

Using learning materials. Course materials (videos, assignments, problem sets, etc.) are for use in this course only. You may not upload them to external sites, share with students outside of this course, or post them for public commentary without my written permission. We will not pin or take screenshots of fellow classmates or record sessions during synchronous online sessions or share discussion thread posts from the learning management system unless granted explicit permission to do so. Unauthorized sharing or uploading to exam questions, test answers, or summaries of exams is prohibited.

Using live class recordings. We are recording class meetings to support remote students and to provide everyone in the class with useful study aids. These recordings will be available for review through our learning management system. Students are prohibited from recording the class themselves unless a student has an approved

academic accommodation for such recording. The university strictly prohibits anyone from duplicating, downloading, or sharing live class recordings with anyone outside of this course, for any reason.

Sharing student information. You may work on group projects with other students or be asked to review or respond to their work. Other materials and activities may provoke debate, argument, or spirited discussion; some of us may volunteer sensitive personal information. Do not share others' personal information, including class dialogue or performance, on sensitive topics outside of our course community. Student work, discussion posts, and all other forms of student information related to this course should be handled with respect and remain within interactions of this course. You may publicly post your own work, provided it does not violate academic dishonesty policies or show responses to assessments; public posting of group work requires consent from all group members. Research conducted as part of a class is subject to UC research policies and may include sensitive information. Students may not share research information without permission from the instructor.

Sharing course information with others. Do not post images or identifiable conversations that occur in class to social media or to those beyond our learning community. Sharing private information about our course community (including discussions, activities, presentations, student work, etc.) with others for the purpose of inviting external attention, intrusion, ridicule, or harassment is an egregious breach of trust.

If you have concerns after reviewing these privacy, I invite you to reach out to the instructor.

LETTERS OF RECOMMENDATION

If you think you may want me to write you a letter of recommendation (or any other instructor), please consider what a good letter would contain and how your actions in the course demonstrate the qualities you will want highlighted in a good letter. When students ask me for a letter of recommendation, I ask them to write to me about how they demonstrated critical thinking, leadership, collaboration, and professionalism. I will be specifically looking for examples of these qualities *that I could have noticed* during class and office hours. Be sure to actively participate in the discussions, talk to me during the lab and my office hours: ask questions, offer your own ideas and interpretations of your results, bring interesting facts/papers that are connected to the material we are studying. If you don't actively show the qualities that are needed to write a good letter, it will be hard for me to write a letter that is meaningful and useful.

SUBJECT TO CHANGE POLICY

Due to unforeseen circumstances, minor aspects of this syllabus may change. This includes changes to scheduling, grading values, and policy. It is the responsibility of the instructor and instructional assistants to announce changes with reasonable

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notice in multiple formats (e.g. lecture and Canvas announcements, email, etc.). It is the responsibility of the student to make note of these changes and communicate with the instructor if you have questions or concerns about the changes.

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