

“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. 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. Liam O’Connor Mueller (he/him/his)

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

LECTURE TIME

MWF 3:00-3:50PM SEQUOYAH HALL Room 147

FINAL EXAM TIME

Wednesday, March 16, 2022; 3-6pm PST (Location TBD)

INSTRUCTIONAL ASSISTANTS AND MEETING TIMES

Name	Email Address
Johnny Rao	jxrao@ucsd.edu

SECTION MEETING TIMES

B01	M	8:00 - 8:50 PM	WLH	2110
-----	---	----------------	-----	------

B02 M 5:00 - 5:50 PM HSS 2152

MUELLER OFFICE HOURS

Monday 6-7pm

Wednesday 11am-2pm

Thursday 11am-1pm (Zoom Only)

Or by appointment! If you need to schedule office hours outside of the times above, email me you schedule for the week and I will do my best to accommodate you.

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. **Section activities are based around R coding, so 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: lomueller@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.

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 run via Zoom synchronously and the recording will be available asynchronously. Attendance is not mandatory but highly recommended!
Section Meetings/Activities	In-person and synchronous This will NOT be recorded. You may Zoom in if you are unable or unwilling to come to campus. Section activity may also be done on your own time asynchronously. You will benefit greatly from attending (working with others and the IA), but it 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 post #1
Sunday EVERY WEEK	Discussion Post #2, Problem Sets, Section Activity, All other deliverables (SEE BELOW)
Sunday week 1	Extra Credit Survey #1, Syllabus Quiz
Sunday week 4	Term Project #1 - Question Due
Sunday week 5	Term Project #1 - Peer Review
Sunday week 6	Term Project #2 - Experimental Design
Sunday week 7	Term Project #2 - Peer Review
Sunday week 8	Term Project #3 - Analysis Plan
Sunday week 9	Term Project #3 - Peer Review
Sunday week 10	Term Project DUE Extra Credit Survey #2
Finals Week	In-person final assessment

COURSE LECTURE SCHEDULE

Week	Day	Date	Lecture Topic
1	M	Jan 3	Why Science?
1	W	Jan 5	Why Statistics?
1	F	Jan 7	Why Programming? - and R and Rstudio intro

2	M	Jan 10	Describing Data: Types of data
2	W	Jan 12	Exploratory Data Analysis: What makes a good figure?
2	F	Jan 14	Exploratory Data Analysis: Different types of figures
3	M	Jan 17	HOLIDAY
3	W	Jan 19	Describing data: Measures of central tendency and the normal distribution
3	F	Jan 21	Describing data: Variance and error in the normal distribution
4	M	Jan 24	Describing Data: Variance and confidence intervals
4	W	Jan 26	Turning questions into biological and statistical hypotheses
4	F	Jan 28	Transformations and other distributions
5	M	Jan 31	Different types of studies - to manipulate or not
5	W	Feb 2	Variables and sampling design/ethical considerations
5	F	Feb 4	Common pitfalls of experimental design
6	M	Feb 7	Calculating a test statistic - the t test
6	W	Feb 9	Power, p values, effect size, and sample size
6	F	Feb 11	P values: the good, the bad, and the ugly

7	M	Feb 14	ANOVA and post-hoc testing
7	W	Feb 16	Choosing and running statistical tests part 1
7	F	Feb 18	Pearson Correlation
8	M	Feb 21	HOLIDAY
8	W	Feb 23	Linear regression & ordinary least squares
8	F	Feb 25	Choosing and running statistical tests part 2
9	M	Feb 28	Its all been linear models so far part 1
9	W	Mar 2	Its all been linear models so far part 2
9	F	Mar 4	Multiple regression
10	M	Mar 7	Clustering, PCA - simplifying complex data
10	W	Mar 9	Machine Learning
10	F	Mar 11	Bayesian analyses and the responsibility of statisticians.

GRADING

Syllabus Quiz	5 points
Problem Sets (10 points each; drop lowest score)	90 points
Discussion Board Prompts (5 points each; drop lowest 2 scores)	40 points
Section Activities (10 points each and drop lowest score)	90 points
Term Project Checkpoints (10 points each)	30 points
Term Project Peer Review (10 points each)	30 points
Final Term Project	30 points
Final Exam	50 points
TOTAL	365 points
Extra Credit Surveys	5 points

Grading Scale

Grade cut-offs will never be shifted up, but may be shifted down depending on the final overall grade distribution.

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 R 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 words. There is to be absolutely no sharing of answers. For coding assignments, we will frequently ask for you to annotate your code and explain what your code is doing. Even if you have copied code from someone else, your explanation of that code must be your own. 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.

PROBLEM SETS

Problem sets will be posted on Gradescope by Sunday afternoon and you must upload your response to Gradescope by Sunday @11:59pm of the following week. The first will be due at the end of week 1 and every week thereafter. All problem sets will be provided to you as Microsoft Word Documents. You must upload your responses to Gradescope via Canvas in **PDF format**. Each problem set will be non-cumulative and focus on topics from the previous week. *If circumstances beyond your control interfere with your ability to participate, please get in touch with me so we can devise a plan for you to succeed in the course.*

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. Your lowest two scores will be dropped.

SECTION ACTIVITIES

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 often an associated .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, even though all work done synchronously will be completed in small groups. Your lowest score will be dropped.

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 and peer 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. 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

The 5 points extra credit 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

Assignments must be submitted on time to be eligible for full credit. 1% will be deducted for every hour the assignment is late. Email Dr. Mueller if you need to turn in an assignment late. 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!

REGRADES

If a grading error has been made, you should submit a regrade request via Gradescope. Students who submit items for regrading understand that we may regrade the entire item and the score may go up or down. You will need to explain your regrade and justify your ask 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:

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

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	

Ask a Librarian: Library Support

Chat or make an appointment with a librarian to focus on your research needs

Course Reserves, Connecting from Off-Campus and Research Support

Find supplemental course materials

First Gen Student Success Coaching Program

Peer mentor program that provides students with information, resources, and support in meeting their goals

Office of Academic Support & Instructional Services (OASIS)

Intellectual and personal development support

Writing Hub Services in the Teaching + Learning Commons

One-on-one online writing tutoring and workshops on key writing topics

Supplemental Instruction

Peer-assisted study sessions through the Academic Achievement Hub to improve success in historically challenging courses

Tutoring – Content

Drop-in and online tutoring through the Academic Achievement Hub

Tutoring – Learning Strategies

Address learning challenges with a metacognitive approach

Support for Well-being and Inclusion

<p>Basic Needs at UCSD</p> <p><i>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</i></p> <p>Counseling and Psychological Services</p> <p><i>Confidential counseling and consultations for psychiatric service and mental health programming</i></p> <p>Triton Concern Line</p> <p><i>Report students of concern: (858) 246-1111</i></p> <p>Office for Students with Disabilities (OSD)</p> <p><i>Supports students with disabilities and accessibility across campus</i></p>	<p>Community and Resource Centers</p> <p>Office of Equity, Diversity, and Inclusion</p> <p><i>As part of the Office of Equity, Diversity, and Inclusion the campus community centers provide programs and resources for students and contribute toward the evolution of a socially just campus</i></p> <p>(858).822-.3542 diversity@ucsd.edu</p> <p>Get Involved</p> <p><i>Student organizations, clubs, service opportunities, and many other ways to connect with others on campus</i></p> <p>Undocumented Student Services</p> <p><i>Programs and services are designed to help students overcome obstacles that arise from their immigration status and support them through personal and academic excellence</i></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 statements, 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 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.

SYLLABUS INDEX

[COURSE DESCRIPTION - *Data Analysis and Design for Biologists \(4 credits\)*](#)

[CONTACT AND SCHEDULING INFO](#)

[COURSE LEARNING OUTCOMES](#)

[OVERALL COURSE EXPECTATIONS](#)

[A TYPICAL WEEK IN THIS COURSE](#)

[WEEKLY STUDENT DELIVERABLES](#)

[COURSE LECTURE SCHEDULE](#)

[GRADING](#)

[TECHNICAL SUPPORT](#)

[CAMPUS SAFETY REQUIREMENTS AND EXPECTATIONS](#)

[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](#)

[STUDENT RESOURCES](#)

[Learning and Academic Support](#)

[Support for Well-being and Inclusion](#)

[Basic Needs at UCSD](#)

[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: \[foodpantry@ucsd.edu\]\(mailto:foodpantry@ucsd.edu\) | \[basicneeds@ucsd.edu\]\(mailto:basicneeds@ucsd.edu\) | \(858\) 246-2632](#)

Triton Concern Line

[Report students of concern: \(858\) 246-1111](#)

[Office for Students with Disabilities \(OSD\)](#)

[Supports students with disabilities and accessibility across campus](#)

[Programs and services are designed to help students overcome obstacles that arise from their immigration status and support them through personal and academic excellence](#)

[PRIVACY PRACTICES IN THIS COURSE](#)

[LETTERS OF RECOMMENDATION](#)

[SUBJECT TO CHANGE POLICY](#)

[SYLLABUS INDEX](#)

-