**Geology 418/518: *Earth and Environmental Data Analysis***

Winter 2019, University of Oregon, 4 credits

**Lecture:** Mon/Wed**,** 8:30-9:50am, Knight Library Reading Room 41

**Lab:** Thu, 10-11:50am, Thu, 2-4:50pm, ***or*** Friday, 8-9:50am, 101 Cascade

**Course Description:**

Screencast lecture, in-class problem solving, and lab-based introduction to earth and environmental science-specific topics. These include: descriptive statistics and data visualization, uncertainty analysis and error propagation, power analysis and hypothesis testing, regression and multiple regression, and directional data. The screen casts, problem sets (both in-class and take-home), and lab exercises emphasize topics that are specific to earth and environmental systems. The framework and much of the material for this course have been adapted from a course developed at UC Berkeley by Jim Kirchner. Prerequisites: MATH 246 or 251.

**Learning Objectives:**

**1.** Students will be able to demonstrate proficiency with the data analytical tools required to quantitatively test hypotheses about basic Earth and environmental processes. See the schedule for the tools to be covered.

**2.** When confronted with example incomplete, inconsistent, and noisy geological data sets, students will be able to develop and test quantitative hypotheses in a systematic way.

**3.** Students will be able to clearly qualify their answers to problems by stating assumptions and caveats**.**

**Instructor:** Dr. Edward Davis

**Office:** 214 Volcanology – but office hours are in the **Price** **Science Commons Earth Sciences Room, B008**

**Email:** edavis@uoregon.edu (please put **Data Analysis** in your email subject to help me find your messages)

**Phone:** 346-3461

**Office Hours:** Earth Sciences Room of Price Science Commons, B008,Wed 10 am - noon or by appt.

**Graduate Teaching Fellows (GTF)**

Dana Reuter, 149 Cascade Annex, dreuter@uoregon.edu, Office Hours: 1-3pm Fridays

David Zakharov, 305A Cascade, [davidz@uoregon.edu](mailto:davidz@uoregon.edu), Office Hours: 10-noon Tuesdays

Matthew Morriss, 124 Cascade, [matthew.c.morriss@gmail.com](mailto:matthew.c.morriss@gmail.com), Office Hours Monday 11-12 pm:

**Required course materials:**

* *Biostatistical Analysis*, Fifth Edition, by Jerrold H. Zar.
* *R*, a language and environment for statistical computing and graphics. [www.r-project.org](http://www.r-project.org). This Free Software solution will be installed on the computers in the lab, but you should download and install it on your personal computer.
* *R Studio*, an open-source user interface for R, will make your scripting and debugging much simpler. We will have this software installed on the computers in your lab, but you can download it from [www.rstudio.com](http://www.rstudio.com) for your personal computer.

**Course website:** *canvas.uoregon.edu*

**Questions?**

If you have questions about **course material,** pleaseuse the **discussion board** on canvas. That way, other students can see your question; if one person has the gumption to ask a question, you can bet that 10 others want to know the answer, too.

If you have questions about **your grade** or need to inform me about something **particular to your experience** of the class, please feel free to **email me** or your GTF and/or **come to office hours**. Please include **Data Analysis** in the subject of your email.

**Lab & computer access**

Computer Cluster (101 Cascade):

* The door code for the lab is **9243261**
* Please bring a **USB drive** to lab to store your files or you can email them to yourself at the conclusion of lab.
* There will be class-specific folders on the machines for students enrolled in the class, but you should save files on your own drive to be sure you’ll have them.

**Assignments:**

Lab assignments

These meetings in *101 Cascade* entail computer-based instruction and independent work facilitated by the GTF. Lab assignments are due to your GTF at the beginning of the following week’s lab period. Lab assignments received within one week of the due date will be docked 50%; after one week past the due date labs are worth **zero points**. Students who cannot attend scheduled lab sessions can arrange to do labs on their own schedule. Students with little experience with computers and math should not “freelance” the lab, because the instructor and GTF will not be present to assist with questions or problems. The cluster will generally be available M-F from 8am-5pm for working outside of laboratory meeting times.

# Problem sets

Weekly problem sets will be **handed out on Mondays** and will be **due the following Monday**. They can be turned in during lecture or **by 5pm to your GTF**. Problem sets received within one week of the due date will be docked 50%; after one week past the due date they are worth **zero points**. Note: my office hours are on Wednesday so that you can ask questions about the week’s problem set after reviewing it on Monday and Tuesday.

In-class problem sets

Most class periods will be “flipped” with a required screen cast for you to watch before class and an in-class group assignment to complete during the class period. These assignments will be geared towards active learning, and consequently will be **due at the end of the class period**. You must watch the screencast to be able to contribute meaningfully to your group’s effort. **Students found not to be contributing to their groups will be asked to leave and will not receive credit for the day.** To accommodate absences, we will **drop your three lowest in-class scores.** You will be able to choose your groups on Mondays, but we will assign groups on Wednesdays.

# Final and midterm projects

These projects will draw upon real-world datasets. In addition to detailed data analyses, students will write a short report describing their results. Note: **Graduate students will be required to construct their own final project**, derived from their thesis or dissertation research projects. They should see me in the first two weeks of class to begin discussing appropriate final projects.

***Note****:* While we encourage group study and collaborative learning, aside from the in-class activities, the work you hand in should be your own. A good rule of thumb is that it is acceptable and actually quite helpful to discuss ideas and concepts with fellow students, but it is inappropriate and counterproductive to copy or view the written reports of other students. Plagiarized or copied assignments will receive **zero points**. Please contact us if you have any questions about what constitutes plagiarism.

***Extra Credit:*** To support **mastery** of the tools in the class, I will allow each student to respond to **up to two** lab or problem set assignments, writing a paragraph explaining any misconceptions that led to missing points on the assignment. If you submit such a response to me **within a week** of the return of your graded paper, and it adequately communicates your misconception and how you have corrected it, I will raise your score on that assignment one letter grate (10%), up to a 100% score. There will be a similar credit opportunity for the midterm project.

**Grading:**

Lab assignments 20%

Problem sets 20%

In-class problem sets 10%

Midterm project 30%

Final project 20%

**Graduate Student Grading:** In this course, the assigned GEs have roles in evaluating graduate students, which could lead to a perceived conflict of interest (COI). If you feel that there is a COI, privacy concern, or other unfairness in your grading by the assigned GEs, you should contact Dr. Davis, the instructor of record. If you request, you can have the instructor of record grade your assignments.

**Class Schedule:** *Geology 418/518*, Winter 2011, University of Oregon

*This schedule is tentative and subject to change*.

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| --- | --- | --- | --- | --- |
| Date | **Lecture topic** | **Problem Set Assigned** | **Lab Topic** | **Reading** |
| Jan. 7 | Introduction and overview of statistical tools |  | 0. Intro to R |  |
| Jan. 9 | Visualizing spatial and temporal data |  |  | Zar 1-20 |
| Jan. 14 | Descriptive statistics of field, lab, and numerical datasets | 1. Descriptive Stats, Lie Factor | 1. Distributions | Zar 21-48 |
| Jan. 16 | Normal distribution, standard error, central limit theorem | 2. Confidence Intervals |  | Zar 66-74 |
| Jan. 21 | **MLK Day – No class**  *Watch:* Uncertainty and confidence intervals |  |  |  |
| Jan. 23 | Simple error propagation rules |  | 2. Central Limit Theorem |  |
| Jan. 28 | Gaussian error propagation, method of moments **(Midterm Project assigned)** | 3. Error Propagation | 3. Uncertainty |  |
| Jan. 30 | One sample hypothesis testing (t-test) |  |  | Zar 74-85, 91-115 |
| Feb. 4 | Significance and power for testing hypotheses | **NONE** | 4. Correlated Uncertainty | Zar 115-120 |
| Feb. 6 | Two-sample hypothesis testing (t-test) |  |  | Zar 130-157, 162-176 |
| Feb. 11 | ANOVA: experiment-wise error and Tukey tests | 4. One sample t-test | 5. Hypothesis Testing | Zar. 189-214, 226-232 |
| Feb. 13 | Linear regression: mechanics **(Midterm Project DUE)** |  |  | Zar 328-342 |
| Feb. 18 | Linear regression: uncertainty in parameters | 5. ANOVA | 6. Regression | Zar 342-372 |
| Feb. 20 | Pitfalls in regression: artifactual correlation and serial correlation |  |  | Zar 379-393 |
| Feb. 25 | Multiple regression: confounding variables | 6. Simple Linear Reg. | 7. Serial Correlation | Zar 419-433 |
| Feb. 27 | Multiple regression: significance and diagnostics |  |  | Zar 433-449 |
| Mar. 4 | Multiple regression: multicollinearity, **(Final Project Assigned)** | 7. Non-param. Reg. | 8. Model Fitting **(essential for final)** |  |
| Mar. 6 | Directional data tools |  |  | Zar 605-619, 624-628, 632-636 |
| Mar. 11 | Nonlinear averaging | **NONE** | **WORK ON FINAL** |  |
| Mar. 13 | Discriminant function analysis |  |  |  |
|  |  |  |  |  |
| Mar. 21 (Thur) | **FINAL PROJECT DUE** (5pm)  Your final exam is **due at the end of the day** of the assigned final period. |  |  |  |

**Additional books of interest:**

Ramsey and Schafer, *The Statistical Sleuth: a course in methods of data analysis*, 2nd ed., Duxbury/Thomson, 2002.

Carr, J.R., *Data Visualization in the Geosciences,* Prentice Hall, 2002.

Huff, D., *How to Lie with Statistics,* Norton, 1954.

Helsel, D. R. and R. M. Hirsch, *Statistical Methods in Water Resources*, 1992, available as PDF online:

*http://water.usgs.gov/pubs/twri/twri4a3/*

Middleton, G., *Data Analysis in the Earth Sciences using Matlab,* Prentice Hall, 1999.

Norman, G.R. and D.L. Streiner, *PDQ Statistics*, 3rd ed., B.C. Decker, 2003.

Taylor, J. R., *An Introduction to Error Analysis*, University Science Books, 1982.

Tufte, E. R., *The Visual Display of Quantitative Information*, Graphics Press, 1983.

**Campus resources to support your learning**

*Tutoring and Learning Center (TLC)* Drop-in math and writing support in addition to tutoring, study skills support, and Class Encore. Located in the 4th Floor Knight Library (541) 346-3226, tlc@uoregon.edu

*Counseling Center*Call anytime to speak with a therapist who can provide support and connect you with resources. Located on the 2nd Floor of the Health Center(541)346-3227

*Accessible Education Center* The University of Oregon is working to create inclusive learning environments. The instructor believes strongly in creating inclusive learning environments. If there are aspects of the instruction or design of this course that result in barriers to your participation, please notify us as soon as possible. You are also encouraged to contact the Accessible Education Center. If you are not a student with a documented disability, but you would like for us to know about class issues that will impact your ability to learn, we encourage you to come visit during office hours so that we can strategize how you can get the most out of this course. Located on the 1st Floor of Oregon Hall (541) 346-1155, uoaec@uoregon.edu

*Center for Multicultural Academic Excellence (CMAE)*mission is to promote student retention and persistence for historically underrepresented and underserved populations. We develop and implement programs and services that support retention, academic excellence, and success at the UO and beyond. We reaffirm our commitment to all students, including undocumented and tuition equity students. Located on the 1st Floor of Oregon Hall (541) 346-3479, cmae@uoregon.edu

The *UO Access Shuttle* is an on-campus ride service provided at no cost to students with conditions that limit mobility. More information and a sign-up form can be found on the parking & transportation department website: <https://parking.uoregon.edu/content/access-shuttle>.

**Class Courtesy**

Please arrive in class on time. Late arrivals distract the instructor and the other students. Please turn off cell phones during the class meeting times. Use your laptop only for class activities. Do not leave class early unless you have cleared it with the instructor in advance. Ask questions if you did not hear or understand something.

Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the quarter (or before) so that I may address you properly.

Open inquiry, freedom of expression, and respect for difference are fundamental to a comprehensive and dynamic education. We are committed to upholding these ideals by encouraging the exploration, engagement, and expression of divergent perspectives and diverse identities. Classroom courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Our classroom is a learning environment, and as such should be a safe, inclusive and respectful place. Being respectful also includes using preferred pronouns for your classmates. Disrespecting fellow students as well as combative approaches, tones and/or actions are not acceptable. Please make me aware if there are classroom dynamics that impede your (or someone else’s) full engagement.

**Academic integrity**

All students will be expected to adhere to the University’s guidelines on academic integrity as outlined in the Student Conduct Code: <https://policies.uoregon.edu/vol-3-administration-student-affairs/ch-1-conduct/student-conduct-code>. As detailed in the policy, academic misconduct means the violation of university policy involving academic integrity. This includes cheating (“any act of deception by which a student misrepresents or misleadingly demonstrates that the student has mastered information on an academic exercise that the student has not mastered”), and plagiarism (“using the ideas or writings of another as one’s own.”) The instructor has a zero tolerance policy for academic dishonesty. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures.

**Discrimination and Harassment**

*Prohibited Discrimination and Harassment*

Any student who has experienced sexual assault, relationship violence, sex or gender-based bullying, stalking, and/or sexual harassment may seek resources and help at [safe.uoregon.edu](http://safe.uoregon.edu/). To get help by phone, a student can also call either the UO’s 24-hour hotline at 541-346-7244 [SAFE], or the non-confidential Title IX Coordinator at 541-346-8136. From the SAFE website, students may also connect to Callisto, a confidential, third-party reporting site that is not a part of the university.

Students experiencing any other form of prohibited discrimination or harassment can find information at [respect.uoregon.edu](https://titleix.uoregon.edu/respect.uoregon.edu) or [aaeo.uoregon.edu](https://aaeo.uoregon.edu/) or contact the non-confidential AAEO office at 541-346-3123 or the Dean of Students Office at 541-346-3216 for help. As UO policy has different reporting requirements based on the nature of the reported harassment or discrimination, additional information about reporting requirements for discrimination or harassment unrelated to sexual assault, relationship violence, sex or gender based bullying, stalking, and/or sexual harassment is available at [Discrimination & Harassment](http://aaeo.uoregon.edu/content/discrimination-harassment).

*Reporting*

The instructor of this class is a Student-Directed Employee. As such, **if you disclose to me, I will respond to you with respect and kindness. I will listen to you, and will be sensitive to your needs and desires. I will not judge you. I will support you.** As part of that support, I will direct students who disclose sexual harassment or sexual violence to resources that can help. **I will only report the information shared to the university administration when you as the student requests that the information be reported** (unless someone is in imminent risk of serious harm or is a minor). Please note the difference between ‘privacy’ and ‘confidentiality.’ As a Student-Directed Employee I can offer privacy because I am not required to report certain information to the university. However, I cannot be bound by confidentiality in the same way that a counselor or attorney is. Confidential resources such as these means that information shared is protected by federal and state laws. Any information that I as a student-directed employee receive may still be accessed by university or court proceedings. This means, for example, that I could still be called as a witness or required to turn over any related documents or notes that I keep.

Please note also that I am required to report all other forms of prohibited discrimination or harassment to the university administration. Specific details about confidentiality of information and reporting obligations of employees can be found at [titleix.uoregon.edu](https://titleix.uoregon.edu/).

*Mandatory Reporting of Child Abuse*

UO employees, including faculty, staff, and GEs, are mandatory reporters of child abuse. Child abuse pertains to individuals who are under the age of 18. This statement is to advise you that your disclosure of information about child abuse to the instructor may trigger my duty to report that information to the designated authorities. Please refer to the following links for detailed information about mandatory reporting: [Mandatory Reporting of Child Abuse and Neglect](https://hr.uoregon.edu/policies-leaves/general-information/mandatory-reporting-child-abuse-and-neglect).

**Safe Ride**

**541-346-7433 ext 2**

**[pages.uoregon.edu/saferide](http://pages.uoregon.edu/saferide)**

Safe Ride is an **assault prevention shuttle** that works to provide free, inclusive, and accessible alternatives to traveling alone at night for **UO students, faculty, and staff**.

We are a schedule-ahead service and riders can (1) call once we open to schedule a ride with a dispatcher or (2) leave a voicemail on the day of their ride request. We do not call riders ahead of time to confirm due to capacity constraints, but riders are always welcome to call us to double-check that their ride was scheduled. We are a feminist, ‘for-the-students/by-the-students’ organization and operate out of the Women’s Center in EMU 12F.

Operating hours:

**Spring term** Sunday - Thursday | 7p - midnight

Friday + Saturday | 7p - 2a

**Summer term** Sunday - Thursday | 9p - midnight

Friday + Saturday | 9p - 2a

**Fall/Winter term** Sunday - Thursday | 6p - midnight

Friday + Saturday | 6p - 2a

Policy and rules:

1. We are a **schedule-ahead service**, we **do not call ahead**, and we can only wait for riders for 5 minutes at their pick-up time and location.

2. We only give rides to groups of **3 or fewer** to prioritize groups that are at higher risk.

3. We are a **free service** and do not accept tips.