GEOG 463/563. Analytical Workflows for Earth Systems Science

Lecture STAG 313, MW 4:00–5:20 PM | Lab STAG 363, R 10:00–11:50 AM
Spring 2025 | 4 credits

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Course Description
Explores data science methods used to gather, validate, organize, analyze, and summarize large amounts of environmental and ecological information. Focuses on developing analytical workflows that are efficient, reproducible, and modular using tools such as the R coding language, RStudio, GitHub, and JupyterLab. Examines case studies including climate change, biodiversity assessments, epidemic modeling, marine spatial planning, and natural resource management.

463 prerequisites: ST 314 with C- or better or ST 351 with C- or better or ST 351H with C- or better
563 recommendations: 9 credits of graduate coursework

Learning Outcomes
Upon completion of this course, all students will be able to:

1) Design and conduct a research project involving the analysis of big environmental data
2) Apply best practices in data collection, cleaning, wrangling, analysis, and visualization
3) Read and write R code using several packages
4) Implement best practices in scientific programming to promote reproducible research
5) Manage complex research projects using a version control system

In addition to the above, graduate students will be able to:

6) Locate and cite relevant primary literature
7) Synthesize their findings within the broader environmental or scientific context

Research Project
The objective of the collaborative, term-long research project is to engage students in a detailed exploration of environmental data, emphasizing data acquisition, analysis, and the formulation of actionable recommendations for stakeholders. Groups of two to three students will identify publicly available datasets related to chosen environmental topics, conduct mathematical and statistical analyses, and present their findings in an oral presentation and white paper. Group members will collaborate to write a white paper as a persuasive, authoritative, in-depth report that presents a problem and provides a solution. Students will also write peer reviews and revise their work based on reviews.

Graduate-level Expectations
One of the core skills that graduate students should develop is finding, reading, and citing literature. As part of their lab summary assignments, students registered in GEOG 563 must write additional Discussion and References sections in their R Notebooks. The Discussion should place their findings or datasets in a broader environmental or scientific context, be between 500–750 words (not including citations), and reference at least 8 primary or secondary research articles. In addition, students enrolled in GEOG 563 are expected to present work that is significantly more rigorous in both depth of study and methodology than students enrolled in GEOG 463.

Course Schedule

Module 1: Running quantitative and collaborative projects in the earth sciences

Week 1				
Lecture	Mon, March 31	Course overview & motivation	Wed, April 2	Reading, writing, & the literature
Lab	Thu, April 3	Identify topics & groups for research project		
Week 2				
Lecture	Mon, April 7	From idea to proposal	Wed, April 9	Thinking algorithmically
Lab	Thu, April 10	Working with RStudio & GitHub, **README due 4/16**		

Module 2: Working with big environmental data

Week 3				
Lecture	Mon, April 14	Data sourcing	Wed, April 16	Data validation
Lab	Thu, April 17	Cleaning messy data, **R notebook due 4/23**		
Week 4				
Lecture	Mon, April 21	Data formatting	Wed, April 23	Coding best practices
Lab	Thu, April 24	Analyzing marine heatwaves, **R notebook due 4/30**		
Week 5				
Lecture	Mon, April 28	Check-in meetings & group work	Wed, April 30	Check-in meetings & group work
Lab	Thu, May 1	**Proposal presentations**		

Module 3: Analyzing, visualizing, and modeling environmental data

Week 6				
Lecture	Mon, May 5	Descriptive & confirmatory statistics	Wed, May 7	Figure & table design
Lab	Thu, May 8	Assessing biodiversity, **R notebook due 5/14**		
Week 7				
Lecture	Mon, May 12	Time series data	Wed, May 14	Spatial data & remote sensing
Lab	Thu, May 15	Creating time series & spatial plots, **R notebook due 5/21**		
Week 8				
Lecture	Mon, May 19	Machine learning for earth science	Wed, May 21	Types of models
Lab	Thu, May 22	Environmental modeling, **R notebook due 5/28**		

Module 4: Completing and evaluating projects

Week 9				
Lecture	Mon, May 26	MEMORIAL DAY HOLIDAY	Wed, May 28	Check-in meetings & group work
Lab	Thu, May 29	Check-in meetings & group work		
Week 10				
Lecture	Mon, June 2	**Peer review**	Wed, June 4	**Peer review**
Lab	Thu, June 5	**Final presentations**		

Evaluation of Student Performance

Assessment	Due Date	Number	Ind. Weight	Total Weight	Learning Outcomes
Lab summaries	Weds. after lab	5	10%	50%	2, 3, 4, 5, 6, 7
GitHub README	April 14	1	5%	5%	1, 4, 5
Proposal presentation	May 1	1	5%	5%	1, 2
Peer reviews	June 2-4	2	5%	10%	2, 3, 4, 5
Final presentation	June 5	1	5%	5%	1, 2, 7
GitHub repository	June 10	1	15%	15%	1, 2, 3, 4, 5
Project white paper	June 10	1	10%	10%	1, 2, 6, 7

Grading Scale

100—93 = A
92—90 = A-
89—87 = B+
86—83 = B
82—80 = B-
79—77 = C+
76—73 = C
72—70 = C-
69—67 = D+
66—63 = D
62—60 = D-
0—59 = F

Weekly Participation

Students are expected to participate in all graded and non-graded assignments. Lab assignments are due on Wednesdays at 11:59 PM the week following lab.

Learning Resources

All learning materials will be posted in Canvas and GitHub. There is no textbook required for this course.

Academic Calendar

All students are subject to the registration and refund deadlines as stated in the Academic Calendar: https://registrar.oregonstate.edu/osu-academic-calendar

Statement Regarding Students with Disabilities

Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval please contact DAS immediately at 541-737-4098 or at http://ds.oregonstate.edu. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

Student Conduct Expectations: https://beav.es/codeofconduct

Reach Out for Success

University students encounter setbacks from time to time. If you encounter difficulties and need assistance, it's important to reach out. Consider discussing the situation with an instructor or academic advisor. Learn about resources that assist with wellness and academic success at oregonstate.edu/ReachOut. If you are in immediate crisis, please contact the Crisis Text Line by texting OREGON to 741-741 or call the National Suicide Prevention Lifeline at 1-800-273-TALK (8255)

Student Bill of Rights
OSU has twelve established student rights. They include due process in all university disciplinary processes, an equal opportunity to learn, and grading in accordance with the course syllabus: https://asosu.oregonstate.edu/advocacy/rights

Student Learning Experience Survey
During Fall, Winter, and Spring term the online Student Learning Experience surveys open to students the Wednesday of week 9 and close the Sunday before Finals Week. Students will receive notification, instructions, and the link through their ONID email. They may also log into the survey via MyOregonState or directly at https://beav.es/Student-Learning-Survey. Survey results are extremely important and are used to help improve courses and the learning experience of future students. Responses are anonymous (unless a student chooses to "sign" their comments, agreeing to relinquish anonymity of written comments) and are not available to instructors until after grades have been posted. The results of scaled questions and signed comments go to both the instructor and their unit head/supervisor. Anonymous (unsigned) comments go to the instructor only.