Course Syllabus-F&W ECOL 458, Spring 2025

General Course Information

Course Number and Title
F&W ECOL 458: Environmental Data Science

Number of Credits
3

Course Designations and Attributes
LAS – Intermediate, 50% Graduate Coursework

Course Description
Introduces fundamental machine learning techniques for numerical modeling and data analysis and modern computer programming tools used to analyze, prepare, and visualize data from common formats of datasets in the field of Earth and environmental sciences. Emphasizes opportunities to consider real-world applications for concepts in environmental data science.

Requisites
STAT 240, 301,324, 371 or Graduate/Professional Standing

Meeting Time and Location
TTh 2:30-3:45 pm @ 243 Russell Labs

Instructional Modality
In-person

How Credit Hours Are Met by the Course
This class meets for two, 75-minute class periods each week over the spring semester (3 hours per week, 42 hours in total). The students are expected to work on course learning, reading course materials, completing homework tasks, and practicing activities for about 6-7 hours outside the classroom every week, 93 hours in total.

Regular and Substantive Student-Instructor Interaction

A qualified instructor will interact regularly and substantively with students through direct instruction during face-to-face class meetings twice a week and through personalized feedback

on the weekly homework assignments. Students can ask questions anytime during class and after class by appointment.

Other Course Information

Instructor and Teaching Assistants

Instructor: Min Chen, Assistant Professor
Instructor Availability: by appointment
Instructor Email: min.chen@wisc.edu
Teaching Assistant: N/A

Course Learning Outcomes

1. Demonstrate introductory skills in using collaboration technology (e.g. Jupyter Notebooks) to write, edit, and run programs in a scientific programming language (e.g. Python);
2. Recognize, read, write, and use common environmental dataset formats;
3. Use a scientific programming language (e.g. Python) to read and process environmental data;
4. Produce visualizations of environmental data, including basic scientific charts, statistics, and maps;
5. Understand fundamentals of modern machine learning algorithms and gain experience with practical use of them;
6. Solve real-world data science problems individually and in teams;
7. Identify the frontiers in real-world environmental science challenges and how data science can help;
8. Identify a problem in environmental science that may be solved or better understood through data science, and provide a basic visualization or analysis of a data set associated with that problem; (Undergraduate-only)
9. Develop in-depth spatial and temporal analyses using advanced data science tools such as machine learning, visualize datasets related to your research or anticipated area of research that meets the standards of scientific journals, critically evaluate your findings, and situate them within the larger context of current research literature; (Graduate-only)

Grading

- Homework: 60%
- Final project: 40%
- Grade cutoffs may be adjusted downward based on the performance of the entire

class; they will not be adjusted upward:

- A: 90-100%
- AB: 85-89%
- B: 80-84%
- BC: 75-79%
- C: 70-74%
- D: 60-69%
- F: 0-59%

Course Website

N/A

Discussion Sessions

None

Laboratory Sessions

None

Class Schedule

Meeting Dates	Topic
Jan 21, 23	Course overview; Introduction to the programming environment; git/GitHub
Jan 28, Jan 30	Fundamentals of Python
Feb 4, 6	Fundamentals of Python, cont.
Feb 11, 13	Python Scientific packages; Introduction to optimization
Feb 18, 20	Data visualization
Feb 25, 27	Analyzing spatial data
Mar 4, 6	Analyzing time series data
Mar 11, 13	Fundamentals of Machine learning; Linear regression and logistic regression
Mar 18, 20	Supporting Vector Machine; Naive Bayes Classification
Mar 25, 27	Spring recess, No class

Apr 1, 3	**KNN; K-Means**
Apr 8, 10	**Decision trees and random forests;**
Apr 15, 17	**Artificial Neural Networks and Deep Learning**
Apr 22, 24	**Other things you need to know; Guest lecture**
Apr 29, May 1	**AI tools; Questions and Answer session; Final project presentations**
May 6, 8	**Final project presentations; Final project paper due**

Required Textbook, Software & Other Course Materials

The students will need to bring their laptops to the classes.
No Textbook is required and the course materials will be published on the course website before the classes. The instructor will provide the data to be used as examples in the classes.

Readings

Burkov, A. (2019). The Hundred-page Machine Learning Book.

Python Data Science Handbook by Jake VanderPlas, available at https://jakevdp.github.io/PythonDataScienceHandbook/

Homework & Other Assignments

Students must do weekly coding-based homework. There will be no homework assignments due during the first or last couple of weeks of the semester or the guest lecture week for a total of 11 homework assignments. Homework writings that demonstrate the results should be uploaded through a personal private Github repository shared with the instructor and the associate codes should be updated on their Github workspace. Homework is due before the class after the week of the assignment release.

Late homework will not be accepted unless it is discussed with the instructor beforehand and permission.

Exams, Quizzes, Papers & Other Major Graded Work

No exam.

Quizzes:

There will be two scheduled quizzes around the end of the fifth week and the tenth week with questions regarding programming and machine learning algorithms, respectively.

Final Project:

Each of the students will work on a self-identified research project. The research project will involve selecting an environmental science challenge that can be addressed or understood through data science. Students are encouraged to discuss the project topic and identified data set (s) with the instructor at least 4 weeks before the last class day. Students will be expected to apply the skills they have learned throughout the course to provide a visualization or analysis of a data set associated with the identified environmental science challenge. A final technical project paper will be required with Jupyter Notebook in the format of a peer-reviewed article covering the introduction, methods, results, discussion, and references.
Graduate students will be expected to apply their knowledge to their area of research or anticipated area of research. Their final project must provide a greater synthesis of their findings with primary literature, use advanced data science tools such as spatial and temporal analysis algorithms and/or machine learning models, and include a more in-depth analysis of results. The final project paper should meet the standard of a scientific journal in the student's field of research. The introduction section must include a thorough discussion of previous research on their topic that situates their findings within the context of current and previous research. The discussion must include the following: 1) a critical evaluation of the models and methods used to generate the data visualization or analysis. 2) a proposal for further research using data science tools.

Privacy of Student Records & the Use of Audio Recorded Lectures Statement

Lecture materials and recordings for this course are protected intellectual property at UW-Madison. Students in this course may use the materials and recordings for their personal use related to participation in this class. Students may also take notes solely for their personal use. If a lecture is not already recorded, you are not authorized to record my lectures without my permission unless you are considered by the university to be a qualified student with a disability requiring accommodation. [Regent Policy Document 4-1] Students may not copy or have lecture materials and recordings outside of class, including posting on internet sites or selling to commercial entities. Students are also prohibited from providing or selling their personal notes to anyone else or being paid for taking notes by any person or commercial firm

without the instructor's express written permission. Unauthorized use of these copyrighted lecture materials and recordings constitutes copyright infringement and may be addressed under the university's policies, UWS Chapters 14 and 17, governing student academic and non-academic misconduct.

Course Evaluations

Students will be provided with an opportunity to evaluate this course and your learning experience. Student participation is an integral component of this course, and your confidential feedback is important to me. I strongly encourage you to participate in the course evaluation.

Digital Course Evaluation (AEFIS)

UW-Madison uses a digital course evaluation survey tool called AEFIS. For this course, you will receive an official email two weeks prior to the end of the semester, notifying you that your course evaluation is available. In the email you will receive a link to log into the course evaluation with your NetID. Evaluations are anonymous. Your participation is an integral component of this course, and your feedback is important to me. I strongly encourage you to participate in the course evaluation.

Diversity & Inclusion Statement

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.

Academic Integrity Statement

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct that may result in disciplinary action. Examples of disciplinary action include, but is not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

Accommodations for Students with Disabilities Statement

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. (See: McBurney Disability Resource Center)