Spring 2-1-2022

GEO 391.01: Computational Methods in the Earth and Environmental Sciences

William Payton Gardner
University of Montana, Missoula

GEO391-ST: Computational Methods in the Earth and Environmental Sciences

Spring 2021
University of Montana
Instructor: Dr. Payton Gardner

Email: payton.gardner@umontana.edu
Office: CHCB 353
Phone: 406-243-2458
Class meetings: Tuesday-Thursday 2:00pm-3:20pm
Dr. Gardner Office hours: T 11-12.

TA: Supanut (Boon) Suntikoon (PhD Student)
Email: supanut.suntikoon@umontana.edu
Office Hourse: M-F: 11:00am-1pm
Zoom link: On Moodle

Note: This Course has a Moodle Site. Additional reading material, problems sets and other information will be posted there with frequent updates, so check the site often.

Description: This course is designed to familiarize students with computers and the use of computers as tools in the Earth and Environmental Sciences. Students will gain a broad overview and practical experience in the fundamentals of writing computer programs and common techniques in the management, exploration and analysis environmental data. Emphasis will be on learning the fundamentals of mid-level languages for data analysis and modeling. The course de-emphasizes the mathematical complexities of the methodologies in favor of generating an intuitive understanding, but we will introduce some linear algebra and statistical concepts.

Learning outcomes: In this course, students will:

- Know the fundamental components of a computer.
- Be able to use essential components of computer coding including: data structures, array manipulation, loops, functions, and libraries.
- Be able to use computer scripts to manipulate, analyze and visualize a variety of data types.
- Understand geospatial data types and be able to plot geospatial vector and raster data.
- Be introduced to panoramic and practical understanding of computational methods commonly used in the fields of Earth and Environmental Sciences.
- Be able use the Python programming language to apply these methods for environmental data analysis, statistical inference, hypotheses testing, and physically modeling Environmental Systems.

Prerequisites: High school physics and algebra. Interest in spending time programming computers

Grades: 60% class activities; 40% midterm and final

Text books:
We will use two text books that are made available online by their authors at no cost. The books will be available on Moodle at the beginning of the semester. Additional reference material will be uploaded to Moodle as necessary.

- Python primer:
  - Severance, C. Python for Everybody - Exploring Data using Python 3. https://www.py4e.com/book.php

- Basic statistics:
  - Diez, D.; Cetinkaya-Rundel, M., Barr, C. OpenIntro Statistics. 4th edition. 2019. https://www.openintro.org/book/os/

Tentative list of topics:

Date	Topic
01/18/22	What is a computer?
01/20/22	Interacting with computers
01/25/22	Interacting with Python
01/27/22	Debugging
02/01/22	Condiitionals/Loops/Interation
02/03/22	Functions
02/08/22	Data structures
02/10/22	Numpy/Library/Array/Array Function
02/15/22	Data Import/Pandas
02/17/22	Plotting/Matplotlib
02/22/22	Plotting Geospatial/Geopandas
02/24/22	Downscaling/Upscaling
03/01/22	Random Variables, CDF and PDF
03/03/22	Normal Distribution/Sampling/Modeling
03/08/22	Recurrence Intervals
03/10/22	Standard Error/Confidence intervals
03/15/22	Hypothesis Testing
03/17/22	MID TERM
03/22/22	SPRING BREAK
03/24/22	SPRING BREAK
03/29/22	Linear systems introduction
03/31/22	Solution of linear systems
04/05/22	Least Sqares/Regression
04/07/22	Propagation of uncertainty in linear systems
04/12/22	
01/14/22	Simulation of physical systems
04/19/22	differential equation solutions
04/21/22	Uncertainty/Paramterization/Monte Carlo
04/26/22	Incorroporating Data - optimization
04/29/22	
05/03/22	Non-linear uncertainty (MCMC)
05/05/22	
05/11/22	Final Exam - 3:20-5:20

POLICIES

Emailing We may occasionally conduct email correspondence with class members and we will use official UM email addresses. All email sent to us must originate from your official UM email address (email originating from non-UM addresses will not be read or responded to). Sorry, but this is the law we are required to follow.

Attendance No formal attendance will be taken. However, the format of this course requires class attendance for success. Substantial course content (i.e., graded in-class exercises and discussions) and information transfer will only occur in class.

Due dates All assignments are due at the start of class on designated due date.

Disabilities The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

Conduct Code All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University. All students need to be familiar with the Student Conduct Code. The Code is available for review online at: http://www.umt.edu/vpsa/policies/student_conduct.php