Open-source hydrologic data analytics

ERT 474/574 **LLB** Department of Earth Sciences, University at Buffalo   **3-credit**
Lecture: MW 1 – 1:50 PM, Lab: W 4-6 PM (Hoch 430)

Details are subject to change; please see the instructor with any questions.

General information

Instructor and Contact Information
    Dr. Yifan Cheng
    ycheng46@buffalo.edu
    Office: Cooke 429
    Office hours: 2-2:30 PM on Mondays and Wednesdays
Catalog & Course Description
    A hands-on introduction to basics of the modern data science stack used across research and industry for hydrology and climate research. We will take a project-based approach, learning software packages and best practices while building our own analysis of a real-world problem. Major topics covered will include Python for scientific computing, GitHub workflows and collaborative open-source development, major data repositories and how to interact with them, introduction to hydrologic modeling, and the basics of visualization. No prior coding experience is required.

Software

This course will be taught using Python coding language, and all software and packages used are open-source and not behind paywall. All coding practices will be conducted in a cloud computing platform, Hydroshare (https://www.hydroshare.org/), and JupyterHub, sponsored by CUAHSI. Therefore, you can use your own laptop or any computers that can access the internet and can open a webpage. In addition, we will use GitHub (https://github.com/) to conduct version control and collaborative coding practices.

Learning Objectives, Outcomes and Assessment

Course Objectives

You will use open-source software and learn the basics of how to:
1. Access existing data repositories and computational systems already developed for water and climate-related sciences
2. Handle a variety of common data types
3. Work with and access real-world data

4. Leverage existing datasets to configure and set up a hydrologic model for real-world applications

Expected Learning Outcomes and the method of assessment

Students will be able to:	Method of Assessment - what the committee expects to see here is all or a combination of the grading requirements, such as:
Interact with code from GitHub repositories and build their own repositories	Class participation, assignments, final project
Write python scripts to download, visualize, and analyze common data types such as point observations and gridded datasets	Assignments, class participation, midterm, final project
Leverage existing datasets to configure and set up a hydrologic model for real-world applications	Assignments, class participation, final project
Write scripts that others can interpret and run without their direct assistance	Assignments, midterm, final project
Identify best coding practices for Finable Accessible Interpretable Reproducible (FAIR) in peer reviews	Class participation, final project

Assessment

- **Class participation (15%):** Active participation in class is expected and is critical to your success in this course. For full credit you should be on time, actively participate in discussions and come prepared to share your work. Excused absences will not affect your participation grade as long as they are (1) excused in advance if possible and (2) you complete whatever makeup requirements are agreed upon between you and the instructor.
- **Assignments (35%):** Timely submission of all assignments are expected. Policies concerning late assignment can be referred to the "Late Work & Attendance" section.
- **Midterm (10%):** Format of midterm is TBD.
- **Final project (40%):** The final project will require you to perform a hydrologic modeling study for a river basin at your selection. Your project will be evaluated through model preparation and data pre-processing (40% of project grade), an oral presentation (20% of project grade), a written report (40% of project grade).
  - **For undergraduate students:** Undergraduate students are only expected to run a pre-configured hydrologic model out of several samples provided by the instructors. The length of the report by undergraduate students is 10-page.
  - **For graduate students:** Graduate students are expected to configure a hydrologic model for a river basin outside of the samples provided in class. The length of the report by undergraduate students is 15-page.

Grading Scale

A	A-	B+	B	B-	C+	C	C-	D+	D	F
≥93%	≥90%	≥87%	≥83%	≥80%	≥77%	≥73%	≥70%	≥67%	≥60%	<60%

Course Schedule, Format, and Policy

A rough schedule for the course is provided below. The schedule is subject to change and will be updated throughout the course. Please refer to UBLearns and our course GitHub page for the most up-to-date course schedule information.

Section	Date	Content
1. Setup and get started	Week 1	An overview of the modern data science landscape, getting started with python and bash script
	Week 2	Cloud computing platforms - moving beyond your laptop
2. Python for data analysis	Week 3	Types, functions, documentation, and introduction to numpy & matplotlib
	Week 4	Python package for access hydrologic datasets, and introduction to Pandas
	Week 5	Python package ecosystem, statistics review for hydrologic studies
	Week 6	Time series data analysis
	Week 7	Rasters and multi-dimensional gridded data - xarray, rasters
3. Hydrologic modeling	Week 8	Recap of surface hydrology & final project establishment
	Week 9	Introduction to hydrologic modeling & run a hydrologic model
	Week 10	Introduction to Git and version controls, and advanced visualization tools
	Week 11	Respository for climate & meteorological datasets - model input
	Week 12	Set up hydrologic models for final projects
	Week 13	Widely used observational datasets - model validation
4. Beyond modeling	Week 14	Data management principal (FAIR)

Week 15	Data management principal (CARE) & final project presentation
Week 16	Course wrap up & finalize final project reports

Course Format

This course will be taught in three formats including lectures, *hands-on workshops*, and **interactive discussions**.

- In lectures, you can expect traditional lectures with instructors presenting course materials.
- In *hands-on workshops*, you will perform coding exercises on your laptops or university-owned computers under instructions.
- In **interactive discussions**, you are expected to actively participate in the discussion fostered by the instructor.

Course Policies

Instructor communication

- I am available to meet with you via "unscheduled" office hours or during class time. If you have a question or a concern that is not addressed in the syllabus or on UBLearns, please email me. However, please note that *lengthy, substantive and/or technical questions are best saved for class or office hours and will not receive a response.* All correspondence will be via UBLearns or via UB e-mail. Students are responsible for checking UBLearns and their UB e-mail. The professor will not reply to emails after 6pm or on weekends. Normally, an email would be replied within 24 hours, but do not leave questions to the last minute! Emails sent over weekend may not be replied until next workday.

Late Work & Attendance

- Students may be justifiably absent from classes due to military obligations, religious observances, illness documented by a physician or other appropriate health care professional, conflicts with university-sanctioned activities documented by an appropriate university administrator, public emergencies, and documented personal or family emergencies. The student is responsible for notifying the instructor in writing with as much advance notice as possible. Instructors may determine a reasonable amount of coursework that should be completed to make up the student's absence. Students are responsible for the prompt completion of any alternative assignments. If the students could not provide timely justification for late or missing homework or failing to attend discussions, following rules will be applied.
  - For assignments that will be discussed on the due date in the **Interactive discussion** (see course schedule), no late assignments will be accepted and will receive a zero.

- For all other assignments, the score for the late assignment will be deductions of 1% per hour the assignment is late. <u>Less than one hour will be rounded up to one hour.</u> These assignments will no longer be accepted once the maximum score is 0, or 4 days and 4 hours after the deadline (for example: a project that would earn 100 % but is submitted 2 days or 48 hours after the deadline, it would earn 52 %).
- In-person attendance in all formats of lectures are highly encouraged. If you have an emergency where you have to skip classes, you need to inform the instructor <u>before</u> your absence.

Policy on Teamwork and Collaboration

- All of the assignments in this course will be submitted and graded individually. It is expected that you will write all of your own scripts. However, teamwork is still highly encouraged. You are welcome to share your work with others, consult classmates for help debugging and follow their examples for how to approach a problem. You will only be penalized if it is clear that you are copying others work without also doing your own.

Academic integrity

Academic integrity is a fundamental UB value. Through the honest completion of academic work, students sustain the integrity of the university and learn knowledge and culture, which is the whole point of being here at UB. Please review the academic integrity policy: academicintegrity.buffalo.edu.

You must perform and present your own work. Studying with others is encouraged, but copying solutions or submitting writeups that are identical, in full or in part, is unacceptable. Academic dishonesty will not be tolerated. A non-exhaustive list of cases considered to be academic dishonesty by UB follows: plagiarism, cheating, falsification of academic materials, misrepresentation of documents, selling or purchasing academic assignments.

All materials prepared and/or assigned by me for this course are for the students' educational benefit. Other than for permitted collaborative work, students may not photograph, record, reproduce, transmit, distribute, upload, sell or exchange course materials, without my prior written permission. "Course materials" include, but are not limited to, all instructor-prepared and assigned materials, such as lectures; lecture notes; discussion prompts; study aids; tests and assignments; and presentation materials such as PowerPoint slides, Prezi slides, or transparencies; and course packets or handouts. Public distribution of such materials may also constitute copyright infringement in violation of federal or state law. Violation of this policy may additionally subject a student to a finding of "academic dishonesty" under the Academic Integrity Policy and/or disciplinary charges under the Student Code of Conduct.

Guidance for Artificial Intelligence

This course allows use of generative AI tools (e.g., ChatGPT) on certain assignments within given guidelines. You are allowed to use AI tools to help you on coding exercises. However, use this as a tool and with caution: you still need to understand how the code works and how to test it. You could be asked any point to explain lines of codes and what they do. Do not treat AI as a black box. Failure to follow these guidelines may be considered a violation of UB's academic integrity policy. If you are unsure of how and when generative AI can be used, be sure to ask.

Etiquette

In my classroom and online (when applicable) I support and want to foster an inclusive, equal, respectful, and open-minded climate so that all of us can live and learn in a welcoming environment free of harassment, bias-motivated behaviors, unfair treatment, and fear. By committing to working with our better selves, we can work, in all our communities, towards greater mutual understanding of the questions that guide our inquiries. The university expects all members of our community to refrain from actions or behaviors that intimidate, humiliate, or demean persons or groups or that undermine their security or self-esteem based on traits related to race, ethnicity, country of origin, religion, gender identity/expression, sexual orientation, age, or physical or mental ability, including learning and/or developmental disabilities and past/present history of mental disorder or other category protected by state or federal law.

Special expectations related to COVID-19

UB has outlined a useful set of Public Health Behavior Expectations, which you can find online at
https://www.buffalo.edu/coronavirus/health-and-safety/health-safety-guidelines.complete-guidelines.html
Please review these expectations and do your part as a campus citizen. Note that Class absences due to COVID-19 isolation or quarantine are considered excusable per the university's Class attendance policies. UB maintains up-to-date safety guidelines at www.buffalo.edu/coronavirus/health-and-safety/health-safety- guidelines. Other good resources are the Centers for Disease Control and Prevention Coronavirus (COVID-19) website, www.cdc.gov/coronavirus/2019-ncov, and the New York State Department of Health Novel Coronavirus website, https://coronavirus.health.ny.gov.

Campus resources to help you succeed

Accessibility Resources

If you have any disability that requires accommodations to enable you to participate in this course, contact the Office of Accessibility Resources and notify me during the first week of

class. The office will provide you with information and review appropriate arrangements for reasonable accommodations.
www.buffalo.edu/studentlife/who-we-are/departments/accessibility.html

Sexual Violence

UB is committed to providing a safe learning environment free of all forms of discrimination and sexual harassment, including sexual assault, domestic and dating violence, and stalking. If you have experienced gender-based violence, including but not limited to intimate partner violence, attempted or completed sexual assault, harassment, coercion, or stalking, UB has resources to help. These include academic accommodations, health and counseling services, housing accommodations, helping with legal protective orders, and assistance with reporting the incident, if you so choose.

- UB's Title IX Coordinator 716-645-2266
- Crisis Services Campus Advocate 716-796-4399 (Confidential service)

Student Wellness

Students experience a range of issues that can cause barriers to learning or reduce ability to participate in daily activities. These include strained relationships, anxiety, high levels of stress, alcohol or drug problems, feeling down, health concerns, or unwanted sexual experiences. Counseling, Health Services, and Health Promotion are here to help with these or other issues you may experience. If you are struggling with student responsibilities this semester, please contact me so I can do my best to help you achieve. UB also has support services that I encourage you to use. Please see:

- https://www.buffalo.edu/academicaffairs/academic-resources.html
- https://www.buffalo.edu/grad/succeed/current-students.html

Take Care of yourself

- Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.
- All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.
- If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

Counseling Services

- www.buffalo.edu/studentlife/who-we-are/departments/counseling.html
- 120 Richmond Quad (North Campus), 716-645-2720
- 202 Michael Hall (South Campus), 716-829-5800

Health Services

- www.buffalo.edu/studentlife/who-we-are/departments/health.html
- Michael Hall (South Campus), 716-829-3316
- 114 Student Union (North Campus), 716-645-2837