Aquatic Algorithms: Exploring hydrology through data science

Schedule:

- August 13th-15th (TU/W/TR) from 1-5:00PM
- August 20th-22th (TU/W/TR) from 1-5:00PM

Location:

TBD

Course Overview

TODO

Goals:

- Learn about the complexity of climate, hydrology, and their interactions with the human environment.
- Learn about the role of water resource engineers, data science, and environmental modeling in the environmental management.
- Become comfortable with basic coding practices and concepts; be able to interpret, run, and write beginner-level Python code.
- Gain familiarity with probability and statistics concepts, how they can be used in environmental studies, and how to use code to measure them.
- Complete a case study for a student-chosen location of interest, focused on the unique interactions between the hydrology and the human system.

Learning outcomes

1. Gain an appreciation and better understanding of watershed and hydrologic processes, and how they impact our lives.
2. Recognize different ways that the human and hydrologic systems are dependent. E.g., climate change and land development impacts on water supply, and how drought impacts society.
3. Recognize that environmental challenges and stress are often distributed inequitably across different countries, economic regions and social groups.
4. Develop a basic understanding of water resource planning and management practices.
5. Understand the role of data, statistics, data visualization, and modeling in environmental management.
6. Use begin-level code (Python) to generate a map of a watershed of interest, view historic streamflow data, and make nice visualization of the data

Internship Materials

Presentations

Students will receive introductory presentations to various topics discussed during the internship. At the longest, these presentations should be 1-hour long, preferably shorter, and will be supplemented by coding and other activities.

All of the presentations are available in the `AquaticAlgorithms/Presentations` folder of this repo, and include the following content (in order):

- `P1_Welcome.ppt`
- `P2_CaseStudy_Overview.ppt`
- `P3_Intro_to_WaterResources.ppt`
- `P4_Probability_and_Statistics.ppt`
- `P5_Modelling.ppt`
- `P6_AI_MachineLearning_and_Water.ppt`

Coding Activities

Throughout the internship you will gain experience with core concepts of programming, and learn some basic coding skills by completing some Python coding exercises.

The code language we will be using in this internship is called Python. Python is one of the most popular coding languages in the world because it is free, relatively easy to read and write, and has a big community of people working together to make it better.

The four coding activities are available in the Aquatic Algorithms repository and are called:

- `P0_Python_Introduction.ipynb`
- `P1_streamflow_analysis.ipynb`
- `P2_intro_to_environmental_statistics.ipynb`
- `P3_mapping_watershed.ipynb`

Code activities will be completed using Google Colab which let's us run code online without requiring complicated installation and set-up.

> ***Note:*** Google Colab greatly benefits from the student having access to their own, or perhaps a parents, Google account so that progress can be saved on Google Drive. It is possible to navigate this course without Google Drive access, but it be more challenging to keep track of progress.

The instructor for this course is glad to make any tech-accommodations that may be needed for a student to participate in this course. Please contact the instructor with any concerns you might have.

Reading

This folder will contain PDF versions of different papers that will be brought up during the presentations, and are available for students to read as desired.

There will ***not*** be any sort of quiz or homework for this internship; the reading is offered as extra material incase the students are interested in learning more.

Case Study Overview

Each student will choose a different Case Study location (Day 2) that interests them using the USGS National Water Information System.

Think of the ***Case Study*** as an opportunity to learn about the unique hydrology and challenges of a specific location.

The Coding Activities are designed to set students up with basic information the case study location (streamflow history, statistics, extreme events, nice plots, etc.) but the student should seek to contribute some unique perspective (or else all the posters will look the same).

Students should focus their Case Study project on identifying a *narrative* for the location of interest. I understand this is a bit vague, but **each Case Study location is going to be different, so it is up to you (the student) to identify what makes the location unique and tell that story.**

Some example questions that might help you put together your case study are...

- What types of water-related challenges has the region faced in the past?
- What types of infrastructure in the region can be impacted by extreme streamflow events (floods or droughts)? Have these happened in the past?
- How might climate change or other *anthropogenic* changes influence the water resources in this region?
- Are people in the region working on changing anything about how they manage water (e.g., changing state/federal policy, asking people to conserve water, building new desalination plants)

Objectives

1. Gain familiar with both the human and natural context for the case study of interest.
    1. Identify the critical water resource infrastructure in the region

2. Identify the primary water resource challenges and objectives
3. Access hydrologic data, study the natural hydrology, and identify drought and floods during the historic record (done through coding activities).

2. Prepare a poster-presentation that helps to summarize the water resource planning challenges for the case study location.
    1. Design data visualizations that help to describe the hydrologic characteristics of the region (done through coding activities)
    2. Draw connections between natural hydrologic processes and urban challenges in the past for this location.
    3. Design a poster which emphasizes a unique narrative for the case study location (e.g., how a historic drought impacted the residents, how the populations are growing and stressing water supplies, how new infrastructure options may be needed in the future)

End-of-Summer Presentation

Students will prepare a poster-presentation highlighting their case study at the end of the internship period. Currently, the STEP-UP program expects to host a **Symposium on August 16th, where students will share their results.** However this date is not finalized.

Daily Schedule

Daily Schedule 2024

- **Day 1: Introduction to the human-natural water cycle**
    - Overview of the internship program, schedule, and case study expectations.
    - Introductory discussion-lecture on the water cycle, human influence, and challenges in environmental engineering.
    - Setting up Google Collab
    - Students select case study locations and begin context study (history, environmental and social challenges, existing infrastructure system, etc.)
- **Day 2: Statistics for hydrology**
    - Lecture on basic environmental probability and statistics.
    - Access the US Geologic Survey Water Information System website and explore data sources.
    - Coding exercise where students get historic streamflow data for their case study location, make nice plots of the data.
- **Day 3: Measuring droughts and floods**
    - Sierpinski triangle group code activity and/or play *The Intelligent Piece of Paper*
    - Students will complete another coding exercise focused on measuring extreme-flow (drought/flood) events at the study location. Students should identify streamflow or other environmental variables relating to location-specific challenges.
- **Day 6: Case study wrap-up and guest presentations**
    - Mini-presentations (2 x 10 minute) from different graduate students in the CEE department about their unique research topics.
    - Time for students and mentor to discuss their case study progress and work on posters prior to the STEP-UP symposium.
    - Any remaining time will be used for case study work.