# Tools for Data Handling and Analysis in Water, Weather, & Climate
# HWRS 401/501 (3 credits)

## 1. General Information

Course Meeting Times

MWF 10:00-10:50 Harshbarger 110

**Office Hours:**

Andrew's office hours:

- Wednesdays 1-2pm
- Harshbarger 322b or via zoom: https://arizona.zoom.us/j/4783089856

Jordann's office hours:

- Mondays 11-12pm
- Harshbarger 322d

Course Prerequisites or Co-requisites

None

Instructor and Contact Information

Instructor: Dr. Andrew Bennett - andrbenn@arizona.edu
TA: Jordann Brendecke - jbrendecke@arizona.edu

Catalog & Course Description

A hands-on introduction to major software tools and methods used across research and industry for hydrology and atmospheric science. We will take a project-based approach, learning software packages and best practices while building our own analysis for a real world problem. Major topics covered will include: Python for scientific computing, GitHub workflows and collaborative open source development, the basics of parallel and cloud computing, major data repositories and how to interact with them, and the basics of visualization. No prior coding experience is required.

Required Texts or Readings

There is no required textbook for this course. How-to guides and resources for all of the material covered will be shared through our GitHub site.

## 2. Learning Objectives, Outcomes and Assessment

Course Objectives

Students will use open source software and learn the basics of how to…

1. access existing data repositories and computational systems already developed for water, weather, and climate-related sciences.
2. handle a variety of common data types.
3. work with and access real-world data.
4. be able to use computational tools/methods to analyze and process large datasets

Expected Learning Outcomes

Students will be able to….

1. interact with code from GitHub repositories and build their own repositories.

2. write python scripts to download, visualize and analyze common data types in the sciences such as point observations and gridded datasets.
3. identify best coding practices for Findable Accessible Interoperable Reproducible (FAIR) in peer reviews.
4. write scripts that others can interpret and run without their direct assistance.

Assignments:

- **Class Participation (20%):** Active participation in class is expected and is critical to the success of the 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.
- **Coding assignments (50%, ~8 submissions):** The main goal of this course is to build literacy and competency in using Python as a data analysis tool for research. During this process you will learn about major packages that are commonly used for this purpose. As a part of your learning you will be asked to run through coding exercises which will reinforce key concepts and build familiarity with these packages.
- **Verde river forecasts (15%, 2 submissions):** Twice during the semester you will develop code to make a forecast of streamflow on the Verde river in northern Arizona. This consists of three parts (1) your forecast values, (2) the script you used to generate your forecasts and short written report explaining your approach and what you forecasted. Details on the requirements for each of these are provided on GitHub. You will not be graded for the accuracy of your forecast but for completion. For full credit you must submit all three parts on time according to the assignment instructions for that week. No credit will be given for late assignments.
- **Mini projects ( 15%, 2 submissions):** Building effective research code is not just about solving small coding problems, but using these fundamentals to build up larger analyses. Twice throughout the semester you will have a chance to develop a larger set of code to demonstrate your understanding of the larger picture. The first project will reinforce skills of data analysis and core competency, while the second will focus on communication and visualization.

Grading Scale and Policies:

This course will be graded using the regular university grading system (http://catalog.arizona.edu/policy/grades-and-grading-system) with the A-E scale.

Grades will be assigned as follows:

A >= 90%

B >= 80%

C >= 70%

D >= 60%

E < 60%

This weighting for the course assignments is provided above. The grade weighting for 400 & 500 level students is the same but the 500 level students will be required to complete two additional code reviews of the mini projects. Your lowest scoring assignment will be dropped from the final grade calculation.

Final Exam:

This course will not include a final exam and will be completed on the last day of regular classes. For reference though to the final exam schedule for other courses, however, click here: https://registrar.arizona.edu/finals?audience=students&cat1=10&cat2=31

Incomplete or Withdrawal:

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Late work policy:

Late assignments will not be accepted and receive a zero, unless prior arrangement has been made with the instructor. The lowest scoring assignment will be dropped from the overall grade though, which can be used in case of missing an assignment.

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 and will come up with your own forecasts. 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.

## 3. Scheduled Topics and Activities

A rough schedule for the course is provided below. This schedule is subject to change and will be updated throughout the course. Please refer to D2L and our course GitHub for the most up to date course schedule information.

Section 1: Foundations of scientific computing with python

- Week 1: An overview of the modern data science landscape, getting started with python and git
- Week 2: Building proficiency with python and git
- Week 3: Numpy and matplotlib 1
- Week 4: Numpy and matplotlib 2

Section 3: Modern geoscience python data stack

- Week 5: Tabular data and timeseries analysis
- Week 6: Exploratory data analysis and API access
- Week 7: Geospatial analysis 1: Vector data
- Week 8: Geospatial analysis 2: Raster data and xarray

Section 4: Workflows, data access, visualization

- Week 9: Data Visualization
- Week 10: Tooling and workflow management
- Week 11: An atlas of Earth systems data

Section 5: From computation to effective communication and collaboration

- Week 12: Code and environment management
- Week 13: Automation and web hosting on GitHub
- Week 14: Work on mini-project 2 (Thanksgiving break)
- Week 15: Generative AI tools & FAIR practices
- Week 16: Course reflection and discussion

## 4. Class format, communication and policies

Course Format

This course will consist of a mixture of lectures, discussion and interactive coding activities. Every week, I

will present new material, students will present their work and we will have group discussions and code walkthroughs. This is a very interactive course and students are expected to participate in discussions and come prepared to share their work and help others.

Course Communication

- Course communications will take place using your official UA email address.
- I will attempt to reply to all email inquiries in a timely manner but please be advised that if your question will take more than 5 minutes to reply to, I will request that you come to office hours or schedule an appointment. For coding questions related to homework or projects, I prefer that you come to office hours or make an appointment as debugging can be difficult over email.
- Emails will generally be handed in normal business hours so do not expect to get a response if you send your question out late the night before an assignment is due.
- Course grades and announcements will be posted through D2L
- All other course materials will be shared through GitHub

Class recordings

For any lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies are subject to suspension or civil action.

Equipment and Software Requirements

All of the work for this class will be done on personal computers using free software packages. You will need daily access to a laptop or other web-enabled device with a webcam and microphone, regular access to reliable internet signal; ability to download and free software including python. Mac or PC computers are both fine for this course.

Makeup Policy for Students Who Register Late

Students may register late with the instructor's permission but will be expected to make up all assignments that they missed within one week of their registration.

**Classroom Behavior Policy**

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable and we can challenge ourselves and each other to succeed. To that end, I would like us all to commit to doing our best, focus on the tasks at hand, practice kindness and patience with one another, and be respectful at all times. Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

**Accessibility and Accommodations:**

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.
Our goal in this classroom is for learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, please plan to meet with me by appointment or during my drop in help to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

## 5. University Resources and Policies

University-wide Policies links

Links to the following policies are provided here, https://academicaffairs.arizona.edu/syllabus-policies:

- Absence and Class Participation Policies
- Threatening Behavior Policy
- Accessibility and Accommodations Policy
- Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Subject to Change Statement

COVID

As we enter the Fall semester, the health and wellbeing of everyone in this class is the highest priority. Accordingly, we are all required to follow the university guidelines on COVID-19 mitigation. Please visit www.covid19.arizona.edu for the latest guidance.

Academic advising

If you have questions about your academic progress this semester, or your chosen degree program, please note that advisors at the Advising Resource Center can guide you toward university resources to help you succeed.

Life Challenges

If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or DOS-deanofstudents@email.arizona.edu

Physical and Mental Health Challenges

If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student assistance/students/student-assistance

Confidentiality of Student Records

http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

*Syllabus Subject to Change Clause: Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor