

ENVR 890-010: Python for Environmental Research (1 credit)

Department of Environmental Sciences & Engineering

Gillings School of Global Public Health

University of North Carolina at Chapel Hill

Fall 2021 Information

Instructors: Andrew Hamilton (andrew.hamilton@unc.edu), Rosa Cuppari (rcuppari@live.unc.edu), Dr. Greg Characklis (charack@email.unc.edu)

Class Room: McGavran-Greenberg 2304

Class Time: Fridays, 10:10-11:25 AM, Eastern time

Office Hours: TBD

Prerequisites: None (although ENVR 755 is a suggested co-requisite, see “Course Objectives”)

Zoom link for in-class exercises: [here](#), passcode 799344

Text: None. We will draw from a variety of free, online resources.

Software and Hardware: All software used for this course is freely available (e.g., Python, Jupyter Notebooks). We will walk through the installations in the first week of class. Due to the nature of this course, all students should have access to a computer on which they can install and run software. *However, if you do not have access to a computer, or if you are unsure whether your device can be used for programming (e.g., a tablet), please email us so we can work to find a solution.*

Syllabus Changes: This syllabus (especially the schedule) is subject to change. Students should refer to the version on Sakai, which will be kept up to date.

Course Motivation

Computer programming is an increasingly important tool for researchers interested in environmental science, engineering, and public health. Recent examples from UNC include [modeling the effect of drought on electricity production](#), [studying the factors associated with extreme hurricane storm surge](#), [estimating air quality co-benefits of climate change mitigation](#), [mapping the global extent of rivers using satellite imagery](#), [estimating the premature mortality associated with traffic-related air pollution](#), and analyzing data to look for relationships between [race and community water/sewer service](#) or between [fecal indicator bacteria and illness in swimmers](#). The ability to formulate research questions, build models, analyze data, and visualize results using computer programming is a valuable toolkit for researchers in academia, government, NGOs, and industry.

Course Objectives

This course will serve as an introduction to computer programming in Python. Students will develop a working knowledge of the Python programming language and learn how to formulate research questions as computer code. They will learn about a variety of Python-based packages and techniques that can be used to build models, analyze data, and create visualizations for research in environmental sciences and engineering.

ENVR 890-010 is a companion course to ENVR 755 (Analysis of Water Resource Systems), and some lectures will place an emphasis on applications related to water resources engineering, economics, and management. Students are encouraged to co-enroll in ENVR 755 for context on these applications. However, all are welcome, and many of the tools and techniques learned in this class will be applicable to a variety of research areas beyond water resources management.

Expectations & Approach

This class is intended for students with little or no experience with programming, so we will start at the beginning. However, there will be a fairly steep learning curve, and students will be expected to spend time outside of class practicing and developing programming scripts to complete assignments. Learning a programming language is much like learning any other language - practice and repetition are key.

There will be short homework assignments approximately every other week, meant to gauge understanding and reinforce techniques learned in class. In-class time will be split between lectures, individual exercises, and group work. Students are encouraged to actively participate in class discussions and exercises, and ask questions. Computer programming concepts can take a while to sink in, and if you are confused, chances are high that others are too!

Grading will be based on quality of assigned work (50%) and in-class participation (50%).

Honor Policy

Students are encouraged to communicate and help one another with the assignments. However, each student is responsible for completing their own work, and plagiarism will not be tolerated. Students are also encouraged to consult online resources (Google, Stack Exchange/Overflow, programming blogs, etc.) - learning to ask the right questions and find answers on the internet is a key skill for computer programmers. However, if you copy any code directly from the internet, please cite your source.

For more details, see the [UNC Honor System](#), the [UNC Libraries' plagiarism tutorial](#), or just ask us directly about expectations for the class.

Diversity, Equity, and Inclusion

Diversity of backgrounds and perspectives is vital as we strive for equitable institutions (race, ethnicity, gender identity, sexuality, age, ability, socioeconomic status, etc.). The diversity of researchers in academia, government, NGOs, and industry affects the voices we consider, the questions we ask, and the answers we find. [Environmental science](#), [computer science](#), and STEM more broadly, have a long way to go on this front. However, changes in recruiting, pedagogy, and work environment can help to encourage students of diverse backgrounds to pursue fields such as [environmental science](#) and [computer science](#). It is our intention to create a classroom in which all students feel respected, valued, and encouraged to apply the material to their own interests. Please let us know of any ways to make the course more welcoming and effective for you personally or for other students or student groups.

Community Standards in Our Course and Mask Use.

This semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to

protect our educational community — your classmates and me — as we learn together. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the [Office of Student Conduct](#). At that point you will be disenrolled from this course for the protection of our educational community. An exemption to the mask wearing community standard will not typically be considered a reasonable accommodation. Individuals with a disability or health condition that prevents them from safely wearing a face mask may seek alternative accommodations through [Accessibility Resources and Service](#). For additional information, see [Carolina Together](#).

Schedule (subject to change)

Date	Lecture	Lecture Topic	Homework Assigned	Due
Aug. 20	1	Intro to Jupyter Notebooks & Python	(1) Hello world	—
Aug. 27	2	Variable types & basic data structures	(2) Basic structures	1
Sep. 3	3	Conditions, loops, & functions	(3) Conditions, loops, & functions	2
Sep. 10	3 + 4	Functions cont. + Logical indexing and NumPy	—	—
Sep. 17	4	Logical indexing and NumPy cont.	—	3
Sep. 24	5	Solving systems of equations & Optimization	(4) Solving & Optimization	—
Oct. 1	6	Pandas	(5) Advanced data structures	4
Oct. 8	7	Environmental data + Visualization	—	—
Oct. 15	8	Regression	(6) Visualization & regression	5
Oct. 22	—	<i>Fall break (no class)</i>	—	—
Oct. 29	9	Time series analysis	(7) Time series analysis	6
Nov. 5	10	Spyder and Applications	—	—
Nov. 12	11	GitHub & Intro to GIS	—	7
Nov. 19	12	Intro to GIS Part II	(8) Final assignment	—
Nov. 26	—	<i>Thanksgiving break (no class)</i>	—	—
Dec. 9	—	<i>Final exam period (no class)</i>	—	8