# Introduction to Scientific Programming with Python

Master in Environmental Sciences, FGSE, University of Lausanne

Syllabus (for Fall 2022, last updated on August 28, 2022)

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## 1 Summary

In this four-week, hands-on course, we will combine tutorials and guided exercises to introduce basic programming skills in Python to help you kickstart your own research projects. By the end of this course, you will know:

1. Which Python libraries are most suitable for your application of interest and how to quickly look up documentation,
2. How to handle data in multiple formats (from text files to gridded spatial data via time series), manipulate them mathematically/statistically, and visualize them efficiently for scientific analysis and communication.

## 2 Logistics

During the course, we will solve programming tasks on real environmental datasets. The two-hour class sessions will be organized as follows: (Min 0-15) We will **answer any question** you may have about the course and tutorials; (Min 15-30) First **tutorial**; (Min 30-45) **Quiz**; (Min 45-60) First **coding session**; (Min 60-75) Break; (Min 75-90) Second **tutorial** and quiz review; (Min 90-120) Second **coding session**. There will be **no final examination** as the course combines:

- **Tutorials** (≈2hr/week, 50% of grade): The first 15-min tutorial covers the basic concepts and Python commands, while the second addresses questions related to the coding exercise so that you don't get stuck. 50% of the grade will be awarded based on the in-class quizzes: Simply taking the quiz will give you 30% of the grade, while the remaining 20% will be awarded based on the quality of your answers. During the second tutorial, we will review the quiz for clarification.
- **Coding Sessions** (≈3hr/week, 50% of grade): You will gain hands-on experience by completing coding exercises in Colab notebooks. The TAs and lecturer will provide assistance during the coding sessions. To get full credits (50%), simply push the completed notebooks to your fork of the course's GitHub repo no more than 24 hours before the following lecture.

## 3 Tentative Schedule

For the most up-to-date information on dates, times, and location, consider adding the course's Google Calendar to your own calendar: Google Cal Link. We highly encourage you to complete the assigned notebooks and push them to your GitHub account no more than 1 week after the assignment date so that you get the full 50% of the "Coding" grade.

**Week 1: Basics of Python and Best Programming Practices**
**Session 1:** File I/O, Retrieving and Storing Data, If/for/while loops, Version control with GitHub
**Session 2:** Functions, Classes/Objects, Dictionaries

**Week 2: Basics of Scientific Computing and Visualization**
**Session 1:** Basics of Scientific Computing with Numpy (Array creation, indexing, broadcasting, etc.) & Interpolation
**Session 2:** Basics of Visualization with Matplotlib (line/contour plots) and Cartopy (drawing a map, changing projection)
**Bonus:** Handling multidimensional gridded data with Xarray (creating data structures, assigning coordinates, indexing, etc.)

**Week 3: Tabular and Geospatial Data Analysis**
**Session 1:** Analyzing tabular data with Pandas (reading/writing data, elementary statistical analysis and visualization, etc.)
**Session 2:** Analyzing geospatial data with Geopandas (reading/writing geodata attributes/methods, perform spatial operations)

**Week 4: Introduction to Statistical Methods**
**Session 1:** Basics of Regression, Classification, and Clustering with Scikit-learn (Linear/logistic regression, k-means, PCA)
**Session 2:** Stastical Graphics with Seaborn (Visualizing statistical relationships, data distributions, plot aesthetics)

# 4 Resources and Ethics

## 4.1 UNIL/FGSE Resources for Students

- Disability resources. If you need academic support, please email me (preferentially before the class starts) so that I can request/provide the appropriate services.
- English resources: Many of us are not native English speakers, and UNIL provides a wealth of resources to practice English, including free consultations/workshops for essay/paper writing, which may come in handy when writing up your final project.
- Financial support resources.
- Confidential and free mental health resources provided by the university's hospital.

## 4.2 Diversity and Inclusion in the Classroom

The University of Lausanne is committed to equal opportunity and stands firm against all forms of discrimination, including discrimination based on based on race, gender, religion, country of origin, ethnicity, socioeconomic status, sexual orientation, and disability. There are confidential resources if you feel harassed, and advice/mediation resources.

In the context of our classroom, this means:

- Choosing how you would like to be addressed by indicating your preferred name and pronouns in the initial course survey,
- Openly discussing and asking about concepts we struggle with to normalize difficulties in learning and applying course materials,
- Being kind and understanding towards each other: Especially in an interdisciplinary and international environment, concepts that seem obvious to you may be unknown to others or have different names depending on your sub-field,
- Emailing me or the equal opportunity office if you feel that students are not treated evenhandedly, or if the context/structure of the course is negatively impacting your learning experience and performance,
- All recognizing and working on our implicit biases by actively listening to each other.

## 4.3 Late Work Policy

Late work is eligible for partial credit of 50% until the official end of the semester (June 3rd, 2021).

## 4.4 Academic Integrity

At UNIL, we all share strict rules on academic integrity, which can be found at this link (in French). In the context of this course, the following behavior can lead to an automatic failure of the class (grade of 0%):

1. Plagiarism. To avoid plagiarism, always cite your sources: at the bottom of your slides during the final presentation, including for photos/schematics, and using bibtex when writing your final report using Overleaf. Please do not take credit for someone else's work and do not have someone write in your name (this also applies to guiding questions during readings).
2. Unauthorized collaboration. Even if you collaborate with some of your peers on the final project, you must answer distinct questions and write separate reports. Please transparently acknowledge any help you received from your peers (coding, research ideas, writing, proofreading, data, citations, etc.) in the acknowledgments section of your final report. During graded quizzes in class, please do not copy your peers' responses. Even if collaboration is highly encouraged, do not copy your peers' code during computer labs. Between classes, do not copy your peers' answers to the readings' guiding questions.
3. Data fabrication or falsification. Please do not fabricate the data reported in the analyses, figures, and tables of your final report. Being transparent about the shortcomings of a method or a dataset is always helpful to the community.