MAE 1117— Introduction to Engineering Computations

Spring 2019

Instructor: Prof. Lorena A. Barba, Mechanical and Aerospace Engineering

http://lorenabarba.com | @LorenaABarba on Twitter | Lab location: SEH 2100

Office hours: To be announced.

Bulletin Description

MAE 1117. Engineering Computations I. 3 credits.
—Foundations of computational thinking focusing on data practices and computational problem-solving. Handling data programmatically, variables and their type, logical operations. Reading data from files; cleaning and organizing text data. Handling multi-dimensional arrays. Basic plotting. Linear regression. Exploratory data analysis, handling labeled data, and data visualization.

Syllabus

Course schedule

Class meets every **Tuesday & Thursday 9:35 AM–10:50 PM**

Location : **SEH Teaching labs 1300/1400/1450** .

Learning objectives

At the end of this course, students will be able to...

1. manipulate a data series programmatically to organize and explore it, and apply descriptive statistics to it;
2. create data visualizations using best practices for communicating with data;
3. compute linear regression from data and explain trends and model accuracy;
4. explore and visualize both quantitative and categorical data;
5. apply full workflows for data analysis, using real data;
6. organize computational work, document it, and present it effectively.

Hours per week

— 2.5 hours of in-class guided interaction (in a computer lab); 5–7.5 hours of individual work

Required textbook and other materials

No required textbook. Required materials written by the instructor will be provided (free and openly licensed).

Weekly schedule

Week:

1. Simple computations in interactive mode; variables and their type; logical operations; manipulating string variables with indexing and slicing.
2. Manipulating, cleaning and organizing text data; string methods.
3. Creating lists of data; manipulating, slicing and organizing lists.
4. Iterations with `for`-statements; conditionals with `if`-statements. Opening a text file and saving its contents into a string or list variable. Application to a full workflow with text data using strings and lists.
5. Creating and manipulating multi-dimensional arrays of data. Array operations, indexing and slicing arrays. Basic plotting.
6. Least-squares linear regression with real data of earth temperature over time, including plotting of the data and regression line.
7. Deep dive into functions and their scope. Exploration of program state.
8. Reading labeled data from a file. Exploring the data, finding missing values in a data series. Descriptive statistics: maximum and minimum values, mean value, variance and standard deviation. Frequency distribution plots (histograms).
9. Quantitative versus categorical data. Visualizing and exploring quantitative data: median value and box plots.
10. Visualizing categorical data with bar plots. Visualizing multiple data with scatter plots and bubble charts.
11. Application to a full workflow analyzing data, e.g., of contaminant exposure from everyday products.
12. Visualizing and analyzing data to learn about the world we live in: life expectancy and wealth around the world. Grouping data for analysis.
13. Getting insights from data: using widgets and interactive visualizations.
14. Classification of data: nearest-neighbor method, training and testing.

Description of course assignments and other assessments

Approximately one homework per week. Two in-class examinations. No final exam.
Grading: homework 60%, in-class examinations 40%.

Course technology

GW Jupyter Hub — http://go.gwu.edu/jupyter — Python on the cloud, via GW Library services— Create, save, upload and edit Jupyter notebooks on this server, making them available to you from any computer or internet-enabled device, via browser. Use your GW credentials to log in.

In class, we will deploy SEAS-owned laptops to each student, running Windows OS. If you wish to use your own laptop computer, you may. But please be advised that we are unable to provide IT support for your personal software installations. (We will try to help, if we can.)

SEAS Open edX — https://openedx.seas.gwu.edu/ — A full online-learning platform, where we provide online materials for the course. Your homework is submitted and auto-graded in this platform.

Student work expectations

This is a 3-credit course, and you are expected to work 3 hours outside of class, for every hour we meet in class. That's about 7.5 hours of personal work every week! Be sure to plan this into your weekly schedule.

Attendance policy

> **Attendance to class meetings is required and any absence needs to be excused by the instructor ahead of time.**

GOOHF cards

Each student gets four **"get-out-of-homework-free"** cards, or GOOHF cards. You can use one card (by "claiming" it *before the deadline*) to get a one-day extension on any homework deadline. We reserve the right to limit the number of GOOHF cards allowed for any given homework, to stay on calendar. Extensions after the deadline will not be granted.

Academic honor code & plagiarism

You must, of course, be familiar with GW's code of academic integrity. Find it at: https://studentconduct.gwu.edu/code-academic-integrity

Among the examples of academic misconduct, plagiarism is a particular source of confusion for students. The simple rule is that **you have to write your assignments yourself**. You should *never* copy text verbatim from other sources, unless it is a quote which is properly marked as such and properly attributed. In your work, you must always include references to any sources you used.

Please bear in mind the following extra guidance for your written assignments:

- You can discuss your work with your classmates. This course encourages collaboration. *But your assignments should be your own original code solutions.*
- Google is your friend. And your worst enemy. Never copy from solutions found online without fully understanding what you are doing.

RECAP—You must complete all the coding assignments individually, although collaboration is allowed and encouraged as you progress. Just **don't copy** other people's code.

Code of conduct

This course by design reflects the ethics of open-source software communities. This means that we value everyone's participation, we strive for transparency and inclusion, and we promote collaboration. We want every student to have a rewarding, fruitful learning experience. To achieve this, everyone is expected to show courtesy and respect towards each other. The following Code of Conduct (CoC)[1] is agreed upon by those taking this course:

- All communication should be appropriate for a professional audience including people of many different backgrounds.
- We will not tolerate harassment in the course, in person or online. Harassment refers to offensive verbal or written comments in reference to gender, sexual orientation, disability, physical appearance, body size, race, or religion; sexual images in public spaces; deliberate intimidation, stalking, following, harassing photography or recording, sustained disruption of class meetings, inappropriate physical contact, and unwelcome sexual attention.
- Be kind to others. Do not insult or put down other participants.
- Behave professionally. Avoid jokes that could be interpreted as sexist, racist, or exclusionary. Remember that humor is a social act

Research Study

At times throughout the semester we will be conducting a research study in this class. You will be asked to voluntarily complete surveys, and a GW researcher may reach out to you to collect individual data. These interviews or focus groups typically involve a limited amount of time, on a one-time basis, and can run for a few sessions. An announcement will be made to the class offering this opportunity to take part in this study. Your participation in such activities is completely voluntary, and you can choose to opt-out at any time.

If you have any questions about the research you can reach out to Prof. Ryan Watkins at rwatkins@gwu.edu.

[1] Adapted from the Software Carpentry CoC, itself evolved from those of PyCon and the Ada Initiative.