Syllabus for CE-ENGIN 597J Computational Methods in Environmental Engineering

Spring 2023

Course details

The class meets on Tuesday and Thursday each week, 10:00-11:15 at Marston Hall, Room 23.

- Instructor: <PROF_FIRST_NAME> <PROF_LAST_NAME>
- Office: 18C Marston Hall
- Phone: <PHONE>
- Office Hours: Thursdays 11:30am-1:30pm, or by arrangement
- Credit Hours: 3

Course description

This course provides an introduction to computational techniques that are applicable (but not exclusive) to environmental problems. The students are expected to attain hands-on experience with numerical and statistical programming tools and learn how to perform a series of analysis and visualization tasks. Moreover, cloud-based and massively parallel technologies will be introduced as well as fundamental computational concepts and abstractions.

Prerequisites

CE-ENGIN 244 (Programming for Civil Engineers), although familiarity with some basic programming concepts should suffice.

Course objectives

This course will introduce students to scientific programming with open source tools, focusing primarily on data analysis, visualization, and modeling. By the end of the course, the students will have learned and developed software code to ingest, process and analyze datasets (both temporal and spatial) with applications relevant to environmental engineering.

Course outcomes

- Understand basic programming abstractions and data structures.
- Implement algorithms in Python.
- Load, parse, process, and store various scientific datasets.
- Produce publication-quality plots and visualizations.
- Perform time series and spatial analyses.
- Implement statistical and machine learning algorithms for engineering problems.
- Understand basic parallelization techniques.
- Deploy algorithms on cloud architectures (AWS, Google).
- Learn good software engineering practices.

Homework and exams

Homework problems will be assigned each week, and will be collected electronically on Gradescope (use **<CODE>** as the entry code to enroll). In addition, a class project will be assigned to each student[1] and a final report will be due at the end of the semester in lieu of a final exam. On the day of the scheduled final exam, each student will be expected to give a brief presentation (5-10 minutes) on their project.

Grading schedule

- Homework assignments (40%)
- Class project (60%)

Grades will be assigned according to the following scale: A (93-100%), A- (90-92%), B+ (87-89%), B (83-86%), B- (80-82%), C+ (77-79%), C (73-76%), C- (70-72%), D+ (65-69%), D (60-64%), F (<60%).

Graduate students cannot earn grades of C-, D or D+, therefore scores lower than 73% are failing grades for graduate students.

Class attendance

Although class attendance is not mandatory, it is strongly recommended to attend every class (either in-person or remotely).

[1] Ideally, the topic will be relevant to the student's research.

Academic honesty policy statement

Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent (http://www.umass.edu/dean_students/codeofconduct/acadhonesty/).

Accomodation statement

The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological, or learning disability on file with Disability Services (DS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements. For further information, please visit Disability Services (https://www.umass.edu/disability/).

Inclusivity

Everyone should feel that they are an integral part of the community and that all individuals and their perspectives are respected. A diversity of perspective and experience provides a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued or respected for any reason, please speak with me privately. If you wish to communicate with someone else in the College or University, there are several ways to do so anonymously or to provide contact information if you so choose:

Notify the University Diversity, Equity, and Inclusion Office through the "Report a Climate Incident" form: https://www.umass.edu/diversity/incident-report-form. Note that this form requires sharing name and contact information. Speak with Assistant Dean Dr. <NAME> (<EMAIL>). Report an incident anonymously to the College of Engineering Diversity, Equity, and Inclusion Office Climate Concerns and Suggestions - https://tinyurl.com/UMassEngineerClimate Classroom Experience - https://tinyurl.com/UMassEngineerClassroom Reach out to the departmental DEI Committee: Anonymous CEE feedback form: https://cee.umass.edu/cee-diversity-equity-inclusion/feedback

We are all members of an academic community with a shared responsibility to cultivate a climate where all individuals are valued and where both they and their ideas are treated with respect.

Everyone has the right to be addressed by the name and pronouns that they use for themselves. Students can indicate their preferred/chosen first name and pronouns on SPIRE, which appear on class rosters. Please let me know what name and pronouns I should use for you if they are not on the roster. A student's chosen name and pronouns are to be respected at all times in the classroom. To learn more, please see this resource: https://www.umass.edu/stonewall/sites/default/files/pronouns_intro.pdf

Class schedule

Below you will find the days of class and the topics that will be covered on those days (subject to change depending on whether we will need to spend more time on topics that might prove more difficult than expected).

- *<2023-02-07 Tue>* Class overview
- *<2023-02-09 Thu>* Setting up your development environment. Introduction to Python.
- *<2023-02-14 Tue>* Data structures, functions and files.
- *<2023-02-16 Thu>* Coding practices.
- *<2023-02-21 Tue>* Version control.
- *<2023-02-23 Thu>* Numerical programming.
- *<2023-02-28 Tue>* Arrays and vectorization.
- *<2023-03-02 Thu>* Plotting basics.
- *<2023-03-07 Tue>* Data analysis.
- *<2023-03-09 Thu>* Data parsing and cleaning.
- *<2023-03-14 Tue>* Spring recess.
- *<2023-03-16 Thu>* Spring recess.
- *<2023-03-21 Tue>* Merging and grouping datasets.
- *<2023-03-23 Thu>* Time series.
- *<2023-03-28 Tue>* More plotting.
- *<2023-03-30 Thu>* Interactive plotting.
- *<2023-04-04 Tue>* Statistical modeling.
- *<2023-04-06 Thu>* Machine learning.
- *<2023-04-11 Tue>* Discussion on algorithmic bias.
- *<2023-04-13 Thu>* N-dimensional analysis.

- *<2023-04-18 Tue>* No class.
- *<2023-04-20 Thu>* Multi-dimensional datasets.
- *<2023-04-25 Tue>* Map visualizations.
- *<2023-04-27 Thu>* Spatial analysis.
- *<2023-05-02 Tue>* Multi-threading.
- *<2023-05-04 Thu>* Parallel computing.
- *<2023-05-09 Tue>* More on parallel computing.
- *<2023-05-11 Thu>* Cloud computing.
- *<2023-05-16 Tue>* QA.