ATMOSPHERIC SCIENCES 5340

Environmental Programming and Statistics (3 credits)

Fall 2020

TH 2:00-3:20 PM (MLIB 1745)

Instructors: Dr. Derek Mallia (derek.mallia@utah.edu), WBB 713.
Professor John Horel (john.horel@utah.edu) INSCC 483. Cell (801) 870-9450.
Office hours: By appointment

Emails sent to us to arrange for an appointment or to discuss a class-related topic should include ATMOS 5340 in the subject line. We will encourage the use of Teams/zoom as a means to ask questions about the class or for communicating directly with us.

Prerequisite: MATH 1210

Online resources: Can be accessed through your courses in the Canvas CIS system. The course notes on statistical and data science methods are an integral part of the course and include 'Check Your Understanding' assignments that will be completed in Canvas.

Text Books: Required. Python Programming and Visualization for Scientists by Alex deCaria: https://sundogpublishingstore.myshopify.com/products/python-programming-and-visualization-for-scientists-alex-j-decaria

Online Resources: This course will rely extensively on the Documentation available from the Center for High Performance Computing (CHPC): https://www.chpc.utah.edu/documentation/

CHPC/LINUX: You will need to confirm the email sent to you to access your CHPC account.

PYTHON: You may want to install the open-source/free Anaconda 3.7.X version of Python on your own computer, but you will be able to complete everything in the classroom, or online using Open OnDemand to complete assignments.

Course Description:
Environmental fields are overwhelmed with information, but methods are available to help acquire, analyze, visualize, and interpret the associated time series and multidimensional fields. To accomplish these tasks, applications of computer programming and statistics relevant to environmental fields are introduced. The Python programming language using the Linux programming environment is utilized for this course. Statistical methods include time series analysis, multivariate data analysis of two-dimensional fields, forecast verification, and hypothesis testing.

Learning to program and use statistical methods is similar to learning new languages: (1) it is hard to do, (2) it is easier for some people than others, (3) it is difficult to learn how on your own

by just reading a book, and (4) it requires practice, lots of practice. This course focuses on the fundamentals and selected applications of statistical methods, data science, and scientific computer programming relevant to environmental fields. Environmental scientists need to have the ability to acquire and process environmental data and communicate results in an efficient and timely matter. While self-contained tools such as Excel can be used effectively in some fields, they are often impractical for the environmental scientist as they do not allow the scientist to analyze and process data efficiently.

Develop skills necessary to solve statistically-based problems using computational resources and methods are stressed. This course relies on the linux computing environment introducing the open source Python language. Programming concepts independent of language syntax are also emphasized in this course. Basic statistical concepts are introduced in parallel with analyzing and visualizing environmental data.

At the end of the course, you will be able to:

- Define and apply Linux commands to access and manipulate data files and computer codes, and edit and execute Linux scripts
- Demonstrate understanding of, and ability to apply, Python syntax related to variables, mathematical operations, flow control, file I/O, array handling, and plotting and visualization of one and two-dimensional fields
- Recognize and apply best practices to design, write and debug computer programs
- State and use basic descriptive statistics and concepts to analyze environmental information
- Analyze time series and two-dimensional fields using univariate and multivariate statistical techniques

Specific topics that will be covered:

- Fundamentals of computer operating systems and compiled vs. interpreted programming languages
- Linux command syntax on local and remote (Center for High Performance Computing) computers
- Local and remote application of Linux; file editing
- Using github, Teams, IPython notebooks and other web resources to exchange information
- Python programming syntax and data types
- Mathematical operators and functions
- Flow control
- File I/O
- Array handling
- Plotting and visualization of time series and 2-dimensional fields
- Basic statistical concepts (uncertainty, population vs. sample, reducing dimensionality, descriptive vs. inferential statistics)
- Exploratory univariate data analysis: sorting, histograms, PDFs/CDFs, central value & spread metrics, transforming time series, (i.e., anomalies, standardized anomalies)
- Probability concepts, conditional probabilities, persistence, forecast verification
- Exploratory multivariate data analysis: linear bi- and multivariate regression/correlation, compositing, significance testing using cross validation and bootstrapping

Course Format: Teaching and Learning Methods:

- Programming and statistical assignments will be completed online using university computing resources or on personal computing resources
- This course requires you to begin and complete assignments as they are assigned- you must complete and turn in assignments by the assigned due date. There is no credit for late work without approval in advance to do so.
- Much of the instructional material will be online in Canvas or github: https://github.com/johnhorel/ATMOS_5340_2020 (Links to an external site.)
- Class sessions may be held in the 1745 MLIB computer lab that allows for a mix of instructional styles (e.g., brief lectures, follow along with the instructor, and independent lab work). However, it is expected that most of the work may be provided through online instructional methods. You will need time beyond the scheduled class hours to complete assignments using your personal computer and computing labs that are available on campus (if access to those labs is allowed).

Class Policies and Grading:

Grades will be determined from class attendance whether online or in-person (5%), on-line 'Check Your Understanding' quizzes (40%); assignments (40%); online final (15%). *Plagiarizing, copying, or otherwise misrepresenting ones' work will not be tolerated and will be dealt with as harshly as permitted under University Policy*. Do not break the scientific code of honor. Final grades are based on the following scale:

Grading scale

93-100 = A	90-92 = A-	87-89 = B+	84-86 = B	80-83 = B-	77-79 = C+
74-76 = C	70-73 = C-	67-69 = D+	64-66 = D	60-63 = D-	0-59 = E

Cutoff points for the specific grades are identified to define reasonable distribution of grades.

Course Outline:

Tentative instructor assignments: JH- John Horel; DM- Derek Mallia
Reading Assignments: DC- DeCaria text; SN- Statistics Notes

- **Week 1. Aug 25. (**JH/DM) Course overview. Computer access. **Aug. 27.** (DM) Computer and linux concepts
- **Week 2. Sep 1.** (DM) Applications of linux **Sep 3.** (JH) Basic statistical concepts (SN Chapter 1)
- **Week 3. Sep. 8.** (DM) Introduction to python (DC Chapter 1) **Sep. 10.** (DM) ipython notebooks and jupyter lab
- **Week 4. Sep 15.** (DM) Python syntax (DC Chapter 2) **Sep 17.** (JH) Exploratory univariate analyses**.** (SN Chapter 2a)
- **Week 5. Sep. 22.** (DM) Math Operators (DC Chapter 3) **Sep. 24.** (JH) Exploratory univariate analyses (SN Chapter 2a-2d)
- **Week 6. Sep 29.** (DM) Flow Control (DC Chapter 5) **Oct. 1.** (JH) Exploratory univariate analyses (SN Chapter 2a-2d)
- **Week 7. Oct. 6.** (DM) File I/O (DC Chapter 6) **Oct. 8.** (DM) Pandas

- **Week 8. Oct. 13.** (DM) Numpy (DC Chapter 7) **Oct. 15. (JH)** Exploratory univariate analyses (SN Chapter 2e)
- **Week 9. Oct. 20.** (DM) Plotting (DC Chapters 10-12) **Oct. 22. (JH)** Probability (SN Chapter 3a)
- **Week 10. Oct. 27.** (DM) Geophysical Data I/O (DC Chapter 13; 17) **Oct. 29. (JH)** Probability (SN Chapter 3a)
- **Week 11. Nov. 3.** (DM) Map plotting (DC Chapter 14-15) **Nov. 5.** (JH) Forecast verification (SN Chapter 3a)
- **Week 12. Nov. 10.** (JH) Exploratory Multivariate Data Analysis. (SN Chapter 4) **Nov. 12.** (JH) Exploratory Multivariate Data Analysis. (SN Chapter 4)
- **Week 13. Nov. 17.** (JH) Exploratory Multivariate Data Analysis. (SN Chapter 4) **Nov. 19.** (DM/JH) Integrating What You Have Learned
- **Week 14. Nov. 24.** (DM/JH) Assignment **Nov. 26. Thanksgiving**
- **Week 15. Dec. 1.** Online only. (DM/JH) Assignment **Oct. 8.** Online only. (DM/JH) Assignment
- **Week 16. Dec. 8. Online Exam Due**

Course Policies and Guidelines:

Policy on Masks in Classroom: TBD

Faculty and Student Responsibilities:

The rights and responsibilities of students and faculty are clearly delineated in the *University Regulations* (https://regulations.utah.edu/academics (Links to an external site.)).

Students should be familiar with *Policy 6-400: Code of Student Rights and Responsibilities* (https://regulations.utah.edu/academics/6-400.php (Links to an external site.)), also known as the Student Code.

Students should particularly aware of expectations regarding academic misconduct and academic sanction, as defined in Section 1.B. of the Student Code:

1. "Academic action" means the recording of a final grade (including credit/no credit and pass/fail) in a course, on a comprehensive or qualifying examination, on a culminating project, or on a dissertation or thesis. It also includes a decision by the appropriate department or college committee to place a student on academic probation or to suspend or dismiss a student from an academic program because the student failed to meet the relevant academic standards of the discipline or program. The term "academic action" does not include the decision by a department or program to refuse admission of a student into an academic program. Academic action also does not include academic sanctions imposed for academic misconduct or for professional misconduct.
2. "Academic misconduct" includes, but is not limited to, cheating, misrepresenting one's work, inappropriately collaborating, plagiarism, and fabrication or falsification of information, as defined further below. It also includes facilitating academic misconduct by intentionally helping or attempting to help another to commit an act of academic misconduct.

3. “Cheating” involves the unauthorized possession or use of information, materials, notes, study aids, or other devices in any academic exercise, or unauthorized communication with another person during such an exercise. Common examples of cheating include, but are, not limited to, copying from another student's examination, submitting work for an in-class exam that has been prepared in advance, violating rules governing the administration of exams, having another person take an exam, altering one's work after the work has been returned and before resubmitting it, or violating any rules relating to academic conduct of a course or program.
4. Misrepresenting one's work includes, but is not limited to, representing material prepared by another as one's own work, or submitting the same work in more than one course without prior permission of both faculty members.
5. “Plagiarism” means the intentional unacknowledged use or incorporation of any other person's work in, or as a basis for, one's own work offered for academic consideration or credit or for public presentation. Plagiarism includes, but is not limited to, representing as one's own, without attribution, any other individual's words, phrasing, ideas, the sequence of ideas, information or any other mode or content of expression.
6. “Fabrication” or “falsification” includes reporting experiments or measurements or statistical analyses never performed; manipulating or altering data or other manifestations of research to achieve the desired result; falsifying or misrepresenting background information, credentials or other academically relevant information; or selective reporting, including the deliberate suppression of conflicting or unwanted data. It does not include honest error or honest differences in interpretations or judgments of data and/or results.
7. “Academic sanction” means a sanction imposed on a student for engaging in academic or professional misconduct. It may include, but is not limited to, requiring a student to retake an exam(s) or rewrite a paper(s), a grade reduction, a failing grade, probation, suspension or dismissal from a program or the University, or revocation of a student's degree or certificate. It may also include community service, a written reprimand, and/or a written statement of misconduct that can be put into an appropriate record maintained for purposes of the profession or discipline for which the student is preparing.

The Americans with Disabilities Act

The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.

Sexual Misconduct

Title IX makes it clear that violence and harassment based on sex and gender (which Includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran’s status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801- 581-8365, or the Office of the

Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585- 2677(COPS)

Student Wellness

Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at www.wellness.utah.edu (Links to an external site.)or 801-581-7776.

Diversity and Inclusivity Statement:

All are welcome and treated with respect and professionalism. I view my classes as professional environments and have the expectation that any form of discrimination is not tolerated by myself and students. Diversity of backgrounds, experiences, and perspectives are welcome and a strength to a robust professional environment. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups.

Student Safety:

The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu (Links to an external site.)."

Note: This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.