ASTR 2600: Computational Techniques

Fall 2018

Instructor
> Jeremy Darling
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> Office: Duane D-341
> Office Hours: 2:00-3:00 Monday and Wednesday **in the SBO Library** and by appointment

Class Time: 3:00-4:15 pm Monday and Wednesday

Class Location: Sommers-Bausch Observatory room S125 (the computer lab)

Course Preparation There are no formal prerequisites for this course. However, this course will be easier for you if you have experience with high school algebra, geometry, and physics, and have an understanding of scientific notation. It would be *extremely* helpful if you already have taken or are currently enrolled in calculus.

Why would you take this course?

The techniques you will learn in this course will enable you to do complex scientific calculations with a powerful programming language. This is a basic requirement for astrophysics research, and for general science, engineering, and information technology. You will have to think logically and linearly, and after this class you will be able teach yourself more extensive computer programming in Python and other programming languages. Thus, this course is for students who want to learn a valuable skill and a way of thinking that will prepare them for astrophysics research or other technical fields.

If you *want* to learn scientific programming skills, then this is the course for you. If your focus is to get through the material, to satisfy a requirement, or to get a passing grade, then you might want to look for a different course.

Course Goals:

Students will:

- Learn the principles of (scientific) programming

- Apply the principles using Python

- Create a complex program (N-body simulation)

- Gain confidence to learn further programming techniques in Python and other languages

- Obtain a critical tool for scientific research or other technical work

Course Content

- Basics of the Linux operating system

- Principles and practices of scientific programming

- The Python programming language

- Visualizing data

- Astronomical examples

Course Format Each class will consist of:

- A 45 minute interactive lecture

- A 30 minute tutorial session in which you will exercise code we have written, answer questions about it, and write some code of your own

Required Text
"A Primer on Scientific Programming with Python," 5th ed., by Hans Petter Langtangen, Springer. This is an excellent text: it has all the basics, it is very clear, and you will use it as a reference in the future. If you don't want a paper copy, it is available online for free through the library (http://bit.ly/2wrXtaF). "Introduction to Computation and Programming Using Python," 2nd ed., by John V. Guttag, is also a very good reference.

Desire2Learn
We will use D2L to turn in homework and tutorials, to access grades, and to make announcements. You can log on with your IdentiKey. *It is your responsibility to check D2L frequently for announcements and to keep track of your grades – do not wait to the end of the term to discover that there is something wrong with your scores.*

Software
We will use Python version 3.6 for this class. Everything you need is pre-installed on the computers in the computer lab. If you would like to install Python on your own computer, you are welcome to, although we will not (in general) help you to do this.

Grades
25% - Daily tutorials due at the end of each class. The lowest two of the semester will be dropped.
50% - Weekly homework due *before* the start of class on Wednesdays. *None will be dropped.*
25% - Semester project (an N-body code) due at the start of the last class of the semester.

Attendance and Late Homework
Attendance is mandatory. Late homework or tutorials will not be accepted. In the case of illness, emergency, bona fide campus schedule conflicts such as absence due to sporting or academic events, or observances of religious holidays, please contact the instructor right away — *and before the due date* — to make special arrangements.

Students with Disabilities

If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Injuries guidelines under the Quick Links at the Disability Services website[1] and discuss your needs with your professor.

Observance of Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance.[2] In this class, if you must miss an exam, assignment, lecture, or recitation because of observance of a religious holiday, please notify the professor in writing at least a week prior.

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veterans status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior[3] and the student code.[4]

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the academic integrity policy[5] of the institution. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at honorcode.colorado.edu.

Office of Discrimination and Sexual Harassment

The University of Colorado Boulder (CU Boulder) is committed to maintaining a positive learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, discrimination, harassment or related retaliation against or by any employee or student. CU's Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking or related retaliation. CU Boulder's Discrimination and Harassment Policy prohibits discrimination, harassment or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment or related retaliation can be found at the OIEC website.[6]

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[1] https://www.colorado.edu/disabilityservices/
[2] https://www.colorado.edu/policies/observance-religious-holidays-and-absences-classes-andor-exams
[3] https://www.colorado.edu/policies/student-classroom-and-course-related-behavior
[4] https://www.colorado.edu/osccr/honor-code
[5] https://www.colorado.edu/policies/academic-integrity-policy
[6] https://www.colorado.edu/institutionalequity/

Table 1: *Approximate* Lecture and Reading Schedule

Lecture	Date	Topic	Textbook Reading
0	Aug 27	Introduction	...
1	Aug 29	Linux	...
...	Sep 3	*Labor Day*	...
2	Sep 5	iPython, Data Types, Print	1.1–1.2
3	Sep 10	Formulas & Terminology, Modules	1.3–1.5
4	Sep 12	While Loops, Boolean Expressions	2.1
5	Sep 17	For Loops, Lists	2.2–2.3
6	Sep 19	Nested Lists & Sublists	2.4
7	Sep 24	Tuples & Functions	2.5, 3.1
8	Sep 26	Vectors, numpy	5.1
9	Oct 1	Plotting & Branching	3.2
10	Oct 3	Dictionaries & Strings	6.1 & 6.2
11	Oct 8	Advanced Functions	...
12	Oct 10	Reading Data from & Writing Data to a File	4.5–4.6
13	Oct 15	Arrays & Plotting (Playing with Data)	5.2–5.3
14	Oct 17	Modules & Packages	4.9
15	Oct 22	Numerical Differentiation	Appendix B.2
16	Oct 24	Numerical Integration	Appendix B.3
17	Oct 29	Error Handling	4.7
18	Oct 31	Multidimensional Arrays	5.7
19	Nov 5	More Multidimensional Arrays	...
20	Nov 7	Random Numbers	8.1–8.2
21	Nov 12	Monte Carlo Simulations	8.3
22	Nov 14	Objects and Classes	7.1
...	Nov 19	*Fall Break*	...
...	Nov 21	*Fall Break*	...
23	Nov 26	Object-Oriented Programming	9.1
24	Nov 28	Animation	...
25	Dec 3	Describing Data	...
26	Dec 5	astropy	...
27	Dec 10	Special Topic	...
28	Dec 12	Projects, Wrap Up	...