

# ASTR 2600: Computational Techniques

Fall 2019

## Instructor

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Office: Duane D-341

Office Hours: 2:15-3:00 Monday and Wednesday in **SBO S125** and by appointment

**Class Time:** 1:00-2:15 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
- Data Visualization and Analysis
- 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

## Helpful Texts

- “A Primer on Scientific Programming with Python,” 5<sup>th</sup> ed., by Hans Petter Langtangen. It is available online for free through the library (<http://bit.ly/2wrXtaF>).
- “Introduction to Computation and Programming Using Python,” by John V. Guttag, is also a very good general reference (<http://tinyurl.com/y4qlhzy2>). Also free.
- “Python for Kids: A Playful Introduction to Programming” by Jason R. Briggs. Good for all ages! CU Library: <http://tinyurl.com/y6jocngl>.

## Canvas

We will use Canvas ([canvas.colorado.edu](https://canvas.colorado.edu)) 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 Canvas 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 3.7 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. Remote access and off-hours access to the computer lab will be available.

## Grades

35% - Daily tutorials due at the end of each class. The lowest two of the semester will be dropped.  
40% - 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 your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website<sup>1</sup>. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or injury, see Temporary Medical Conditions<sup>2</sup> under the Students tab on the Disability Services website.

**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 race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. 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<sup>3</sup> and the Student Code of Conduct.<sup>4</sup>

**Honor Code:** All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the Honor Code Office website.<sup>5</sup>

**Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation:** The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct intimate partner abuse (including dating or domestic violence), stalking, protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting,<sup>6</sup> and the campus resources can be found on the OIEC website.<sup>7</sup>

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

**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.<sup>8</sup> 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 to arrange for accommodation.

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<sup>1</sup><http://www.colorado.edu/disabilityservices/students>

<sup>2</sup><http://www.colorado.edu/disabilityservices/students/temporary-medical-conditions>

<sup>3</sup><https://www.colorado.edu/policies/student-classroom-and-course-related-behavior>

<sup>4</sup><http://www.colorado.edu/osccr/>

<sup>5</sup><https://www.colorado.edu/osccr/honor-code>

<sup>6</sup>[https://cuboulder.qualtrics.com/jfe/form/SV\\_0PnqVK4kkIJIzNf](https://cuboulder.qualtrics.com/jfe/form/SV_0PnqVK4kkIJIzNf)

<sup>7</sup><http://www.colorado.edu/institutionalequity/>

<sup>8</sup><https://www.colorado.edu/policies/observance-religious-holidays-and-absences-classes-andor-exams>

Table 1: *Approximate* Lecture and Assignment Schedule

Lecture	Date	Topic	Tutorial	Homework
-1	Aug 26	Introduction	-1	...
00	Aug 28	Linux	00	...
...	Sep 2	<i>Labor Day</i>	...	...
01	Sep 4	Python Basics	01	00
02	Sep 9	Math & Modules	02	...
03	Sep 11	While Loops, Boolean Expressions	03	01
04	Sep 16	For Loops, Lists	04	...
05	Sep 18	Nested Loops & Lists	05	...
06	Sep 23	Tuples & Functions	06	02
07	Sep 25	Vectors, numpy	07	...
08	Sep 30	Plotting & Branching	08	...
09	Oct 2	Dictionaries	09	03
10	Oct 7	Advanced Functions	10	...
11	Oct 9	Reading & Writing Files	11	04
12	Oct 14	Arrays & Plotting (Playing with Data)	12	...
13	Oct 16	Modules & Packages	13	05
14	Oct 21	Numerical Differentiation	14	...
15	Oct 23	Numerical Integration	15	...
16	Oct 28	Error Handling	16	06
17	Oct 30	Multidimensional Arrays	17	...
18	Nov 4	Astronomical Imaging	18	07
19	Nov 6	Random Numbers	19	...
20	Nov 11	Monte Carlo Simulations	20	08
21	Nov 13	Objects and Classes	21	...
22	Nov 18	Object-Oriented Programming	22	09
23	Nov 20	Animation	23	...
...	Nov 25	<i>Fall Break</i>	...	
...	Nov 27	<i>Fall Break</i>	...	
24	Dec 2	Describing Data	24	10
25	Dec 4	astropy	25	11
26	Dec 9	Data Visualization	26*	...
27	Dec 11	Projects, Wrap Up	...	

\*Optional and not for credit.