Computational Astrophysics
01:750:345
Fall 2020

Instructor: Professor Chuck Keeton

Summary: Introduction to computational astrophysics, including key algorithms, their implementation in code, and their application to current research in astrophysics. Extended projects feature analysis of real data and simulations.

Pre-requisites: 01:750:341 and 01:750:342

This course is required for astrophysics majors.

Meeting times: Two 80 minute lectures per week.
Lectures: MTh 2 (10:20 am – 11:40 am)
Recitations: None

Text: **:** None required. For computational methods *Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib* (2nd ed.) by Robert Johansson is recommended. For astrophysics context and applications, research papers and online resources will be provided.

LMS: Canvas

Provisional plans for remote instruction:

- The course will have the same structure regardless of whether the interactions are face-to-face or virtual (e.g., over Zoom).
- For the units on computational methods, the instructor will record mini-lectures for students to watch before class. Then class time can be used for Q&A. With screen sharing, the instructor will be able to show sample code and view students' code in order to give feedback.
- For the two extended projects, students can use tools for online collaboration. Most students are already familiar with Google docs; instruction will be provided in a collaborative version of LaTeX, and in tools for code sharing (such as github). If we are meeting virtually, groups will work in Zoom breakout rooms.
- All of the course work will be submitted and graded electronically, in Canvas. (There are no exams.)
- Office hours will be arranged once the semester begins, attempting to accommodate students' schedules to the extent possible.

Technology requirements: Access to python, especially jupyter notebooks; the Anaconda distribution is recommended and available for free (https://www.anaconda.com/products/individual). Additional, optional tools include GitHub (https://github.com/) and Overleaf (https://www.overleaf.com/).

Grading: The course grade will be based on the following criteria:

- 50% - five weekly coding exercises
- 25% - project #1 (both group and individual components)
- 25% - project #2 (both group and individual components)

Provisional Schedule:

- 9/3-10/1: Computational methods, part 1
    - Topics: handling data - arrays and plotting; solving equations; optimization and model fitting; integration
    - There will be weekly coding exercises to be completed individually (with time available in class).
- 10/5-10/29: Research project #1, Fitting data
    - Work in groups of 3-4 to analyze typical examples of astrophysical data.
    - Each group will write a report written in the style of an astrophysics research paper, and prepare a presentation for the class. There will be a small individual assessment as well.
- 11/2-11/5: Computational methods, part 2
    - Topic: ordinary differential equations
- 11/9-12/10: Research project #2, Gravitational dynamics
    - Again work in groups of 3-4 to analyze how different astrophysical systems evolve under the influence of gravity.
    - Each group will again write a report and prepare a presentation. There will again be a small individual assessment as well.

Academic Integrity:

Students are expected to maintain the highest level of academic integrity. You should be familiar with the university policy on academic integrity: http://academicintegrity.rutgers.edu/academic-integrity-policy/ Violations will be reported and enforced according to this policy.

Use of external sources to obtain solutions to homework assignments or exams is cheating and is a violation of the University Academic Integrity policy. Cheating in the course may result in penalties ranging from a zero on an assignment to an F for the course to expulsion from the University. Posting of homework assignments, exams, recorded lectures, or other lecture materials to external sites without the permission of the instructor is a violation of copyright and constitutes a facilitation of dishonesty, which may result in the same penalties as explicit cheating.

Not only does the use of such sites violate the University's policy on Academic Integrity, using such sites interferes with your achievement of the learning you are paying tuition for. Assignments, quizzes, and exams are given not simply to assign grades, but to promote the active learning that occurs through completing assignments on your own. Getting the right answer is much less important than learning how to get the right answer. This learning is critical to your success in subsequent courses and your careers.

Student wellness Services
Student Counseling, ADAP & Psychiatric Services (CAPS) wellness for non-emergency psychological health issues services (848) 932-7884, 17 Senior Street, New Brunswick, NJ 08901
http://health.rutgers.edu/medical-counseling-services/counseling/

Violence Prevention & Victim Assistance (VPVA), (848) 932-1181, 3 Bartlett Street, New Brunswick, NJ 08901, http://www.vpva.rutgers.edu/

Office of Disability Services (848) 445-6800, Lucy Stone Hall, Suite A145, Livingston, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854, https://ods.rutgers.edu/

Scarlet Listeners for confidential peer counseling and referral hotline, (732) 247-5555, http://www.scarletlisteners.com