

Introduction to Scientific Programming with Python

Course Description: Astro 9: Introduction to Scientific Programming with Python is an introductory course in scientific programming with emphasis on learning the techniques used to model the universe and analyze data. The focus of the course will be less on theoretical/mathematical aspects but instead on the application and implementation of practical computational techniques useful throughout the physical sciences. In particular we will extensively use the python numpy/scipy/matplotlib stack to create programs and apply them to data drawn from a number of real world sources (astronomy, physics, finance, etc.). Topics covered in the course will include numerical integration, sampling (i.e. markov chain monte carlo), optimization, interpolation and extrapolation of data, and inference with machine learning. Students will complete a final project on a topic of their choosing to apply the techniques learned in class. This course is designed to be an excellent introduction for students interested in astrophysics research.

Topics each Week:

- Introduction to Python, Jupyter Notebooks, and Git
- Numerical Integration and Introduction to Sampling
- Likelihood Methods and Optimization
- Simulations and Numerical Differential Equation Solving
- Data Interpolation, Gaussian Processes, and Machine Learning
- Final Projects

Learning goals: The primary goal of the course is to get students familiar with the tools and techniques used by modern physical scientists (as well as industry). By the end of the course, students should be able to implement the techniques on real world problems within the physical sciences, recognizing the limitations and strengths of a given method. Along the way, students will also learn relevant topics within statistics and computer science.

Target audience: This course is most appropriate for students who are undergraduates interested in the physical science departments.

Course Prerequisites: PHY5 or PHY7 series, or equivalent. Some experience programming would be quite helpful; students without experience should contact the instructor!

Homeworks: (40% of final grade) Weekly homework sets will be assigned, and are due the following Friday by 11:59pm. We will be using GitHub classroom to submit homework assignments.

Exam and Final Project: (60% of final grade) Instead of exams, we will work on final projects, which will be an application of the tools and techniques we learned in class to some topic that interests you. It will include a lab-report style write up in a Jupyter notebook.