ASTRON 3705/PHYS 3705

Astronomical Techniques

Course Information

Meeting Time: Monday and Wednesday, 1 PM – 2:15 PM, 210 Thaw Hall
Credits: 3
Prerequisites: None

Instructor Information

Lecturer: Prof. Jeffrey Newman
Office: 310 Allen Hall
Office Hours: TBD
Email: janewman@pitt.edu
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Textbook

*Practical Statistics for Astronomers***,** by Wall & Jenkins, **Second Edition**

Course Description

Modern astronomy relies heavily on advanced techniques for image and spectrum analysis and the ability to deal with large datasets from surveys. The principal aim of the course will be to provide practical experience with working with state-of-the art survey and multiwavelength datasets (e.g. SDSS, HST, and Spitzer data), based on a firm grounding in statistical techniques. It will cover topics such as data analysis techniques, interfacing with survey datasets, basic statistics, and experiment design. Some prior knowledge of astronomy will be helpful but will not be required; however, students should have some prior experience with computer programming (language does not matter). This course is designed to be useful for students with both theoretical and observational interests.

Course Objectives

The principal goal of this course is for students to gain the skills needed to perform research in Astronomy making use of measurements from data (in any fashion). Today, even 'theorists' make frequent use of survey datasets; this course should be helpful for anyone pursuing astronomical research. The emphasis will be on developing practical skills in applied statistics, data processing/interfacing, and programming, primarily through practical experience with all of these.

By the end of this course, you should be able to:

- Apply a variety of statistical tests to measurements, and identify the correct test for the problem being faced
- Use propagation of errors to determine uncertainties in derived quantities
- Apply Monte Carlo and resampling techniques to predict distributions of errors, estimate significances, etc.
- Perform nonlinear curve fitting and apply maximum likelihood techniques for measurements
- Describe the basic functionality of astronomical imaging and spectroscopic instruments
- Perform basic reductions of imaging and/or spectroscopic data from HST, culminating in an object catalog or extracted spectrum
- Identify and mitigate major systematic effects due to instrumentation or the Earth's atmosphere that may affect astronomical datasets
- Read in catalogs from the SDSS and DEEP2 surveys, select objects of interest, identify major systematics that must be accounted for in selecting a sample, and apply those catalogs to investigate properties of some class of objects
- Perform data analysis, I/O, and plotting in the Python programming language

If time allows, we will also cover Fisher matrices and interfacing with CMB datasets (e.g. WMAP).

Grading

I tentatively expect grading to be based on:

30%	Homework
30%	In-class activities
40%	Final project

Homework:
Every week or two there may be 1-2 small homework problems/tasks.

Students are allowed (and encouraged) to collaborate on homework assignments in developing basic algorithms, but must present their own work (programs/plots, results, etc.).

Please provide either code or notes describing how you did a calculation, to help me understand the cause of any errors. I do not expect a detailed writeup of Python-based problems (e.g. it is not necessary to spend time on nicely formatted equations) unless I specify otherwise. If I say I want a plot, I want a plot; if I want a particular number, I care more about the process of getting that number in Python than a detailed derivation of the methods. Source code or notes allows me to assess that process and helps me to provide more useful feedback.

Conceptual problems are a different case, and I do expect you to explain your reasoning there.

I will accept at most 2 late homeworks from any letter-grade-option student, except in extreme (e.g. medical) circumstances or via prior arrangement more than two days before the deadline. The first late homework will have no penalty, the second one will have a grade penalized by 10%. Late HWs must be turned in within 24 hours of the nominal due date unless otherwise arranged in advance.

In-class activities:
The class will be taught in a computer lab; each student will have their own computer to work with. Class time will be a mix of lecturing with activities (e.g. solution of some problem, data reduction) done on these computers. This will often yield some work product which will contribute to your in-class activities grade (as completion/noncompletion, not graded in detail). If you do need more time, submission after class will be acceptable.

Final Project:
The capstone of the course will be an original project – development of a new data reduction algorithm, a new analysis of a survey dataset, etc. One option is to develop an original observing proposal, in the format required for actual submission; such a proposal must be entirely the student's own work. I will provide a list of some project ideas early in the semester, which students may sign up for, or am happy to discuss your own project ideas. Projects should **not** simply consist of a research project you are already doing, however. Many projects may be suitable for working in groups of 2 or 3.

At the end of the semester, students will give a 20-30 minute presentation of their project to the class. They will also provide a brief writeup (ideally 2-3 pages, 5 pages with 12-point or larger font maximum) to allow both oral and writing skills to be evaluated; presentation of results is a key skill for all scientists.

Calendar

This course will not meet on September 10 (I will be at a DESI review) or September 24 (due to Rosh Hashana). These days will be replaced either by one-on-one meetings with me to discuss your chosen project or by Friday classes, if feasible.

Courseweb and Other Resources

The University of Pittsburgh provides a web-based resource called *Courseweb*, which is a portal to web sites for individual courses. A *Courseweb* site for this course has been created and from there you may view announcements, send email to the instructor or the TAs, and download course material such as the syllabus. **Homework assignments will all be announced on Courseweb.** To access *Courseweb* go to http://courseweb.pitt.edu/ .

Use your Pitt email username and password to login to Courseweb. If you have forgotten your username and password or need to set up an account, contact the help desk at 412-624-4357, or 4-HELP. Once you have logged into the system simply click on the link for this course to access the available material.

Academic Integrity

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

Disabilities

If you have a disability that requires special testing accommodations or other classroom modifications, you need to notify both the instructor and the Disability Resources and Services no later than the 2nd week of the term. You may be asked to provide documentation of your disability to determine the appropriateness of accommodations. To notify Disability Resources and Services, call 648-7890 (Voice or TTD) to schedule an appointment. The Office is located in 216 William Pitt Union.