# AS 803 – Astronomical Data Analysis and Numerical Methods

Prof. Dan Clemens – Spring 2015

**Catalog Description**: Introduction for astronomy graduate students to modern approaches to image processing, data analysis, and numerical methods in astrophysics and space physics. Using the standard astronomical high-level programming language Interactive Data Language (IDL), students will learn good practices in image processing, astronomical data manipulation, and simple numerical techniques for data analysis. This course is intended for students with little or no formal computer science training. It is intended to prepare the students for real, focused, and applied problems in astrophysics and space physics. [Students with extensive training in computing and wishing a more advanced course should consider CS/MA 539 or PY 502 as an alternative.]

**Meeting Times**: Lecture: Usually - Fridays 9:00-10:15am in CAS 500; Occasionally - Wednesdays 5:00-6:15pm (2/11, 3/18, 4/15, 4/29)

**Office Hours:** Mondays and Fridays 1-2pm, in room CAS 417, and by appointment (3-6140; *clemens@bu.edu ); can also attend AS441 office hours (Monday & Wednesdays 9-10am), though those students have priority during those time.*

**Synopsis:** The course will try to touch on many topics of current interest in astronomical data analysis and data processing. We will begin with introductory programming, using the IDL language, proceed to more advanced topics in IDL, including some combination of color graphics, widgets/GUIs, object-oriented graphics and vector applications using 1-D, 2-D, and N-D data sets. We will also delve into numerical techniques such as least-square and non-linear fitting, Monte Carlo simulations, maximum entropy, and adaptive approaches. The mid/latter portion of the course will feature an introduction to the Python programming language. As time permits, we will gain exposure to the elements of Bayesian inference with applications in hypothesis testing and parameter estimation.

**Main Texts (All Required, though you might scare up some local copies in the Department):**

1. "An Introduction to Programming with IDL," by Bowman. ISBN 978-0-12-088559-6
2. "Data Reduction and Error Analysis for the Physical Sciences," by Bevington & Robinson (3rd edition) ISBN 0-07-247227-8
3. "Python for Software Design," by Downey. ISBN 978-0-521-72596-5

**Required Bayesian Text:**

1. "Think Bayes," By Downey. ISBN 978-1449370787 -or- you can download it for free from http://www.greenteapress.com/thinkbayes/

**Additional Optional Texts: (in the "AS803 Library" in my office - come borrow them)**

1. “IDL Programming Techniques,” by Fanning (2nd edition) – more detailed, but at a higher level.
2. “Numerical Recipes, the Art of Scientific Computing,” by Press, Flannery, Teukolsky, & Vetterling (several versions, *none* use IDL – best bet is probably the one using FORTRAN).
3. “Programming in Python 3,” by Summerfield. ISBN-13: 978-0-13-712929-4
4. “Objects & Object Graphics” – for IDL v5.0 (1997 ed.)
5. “Building IDL Applications” – for IDL 5.0 (1997 ed.)
6. "Bayesian Logical Data Analysis for the Physical Sciences," by Phil Gregory (Mathematica). ISBN 9780521150125
7. "Statistics, Data Mining, and Machine Learning in Astronomy," by Ivezic, Connolly, VanderPlas, & Gray (Python). ISBN 9780691151687
8. "Practical Statistics for Astronomers," by Wall & Jenkins. ISBN 9780521732499

**Grading:**

| Course Component | Percentage Weight |
|---|---|
| Problem Sets (~ weekly) | 90% |
| Attendance and Participation | 10% |

**Late Policy**: *Failure to turn in an assignment on the designated date, by the designated time, in the designated format will result in a loss of 15% of the total value of the assignment for each calendar day the assignment is late.*

**Conduct Standards & Collaboration**: It is important that students submit for evaluation work that is properly executed and attributed. I encourage you to discuss problems together, but to write up and submit your assignments separately. You may help each other to find how to solve a problem, but you must present your own discussion of the steps needed to achieve the solution. Do not copy from another student or from another student’s work (including students not in this class).

**Computers**: The computers in CAS 606 are used by AS803, AS202, and AS441, and may be used in a more limited fashion by AS102. AS202 has priority use of the computers in the 4:30-8pm time slot. At other times, AS803, AS441, and AS202 students may share use of the computers (though relinquishing use to AS102 lab sections). Use of your own laptop computers is encouraged.

**No Friday Lecture Dates**: 2/27, 3/6, 4/24