AS803 - Research Methods in Astronomical Data Analysis (Section A1)-Spring 2017

Class Hours: Tuesday 12:30 pm – 1:45 pm, Room CAS 500
Class Dates: Tuesday 24 January 2017 – Tuesday 02 April 2017
Final exam: There is no final exam. Nor any midterms.

Your instructor is Professor Paul Withers. I have a mailbox in CAS 506 (CSP office) and CAS 514 (AS office).

Person	Office	Email	Phone	Office Hours
Withers	CAS 604	withers@bu.edu	617 353 1531	By appointment

Course Description
Computer programming skills, elementary image and data processing, visualization techniques for astronomical datasets. Flat fielding, bias removal, sky subtraction, median filtering, CLEAN algorithm, point-source extraction. Fitting functions to data, solving linear and non-linear equations numerically, approximating solutions of differential equations.
        More succinctly - The basic computational tool-kit needed to conduct research productively.

The aim of this course is to develop the technical skills necessary to begin a typical astronomical research project. That means familiarity with a common programming language, data analysis techniques, and numerical methods. The language used in this course will be IDL. Learning these three topics by reading a textbook is near-impossible, hands-on experience is essential. Consequently, this course will focus on getting you writing programs, analyzing data, and tackling numerical problems. That focus on "doing" will prevent us from comprehensively exploring all possible topics of relevance to this class. So some material that might be useful to you in future research projects will be provided by reference to other sources, but not discussed in class.

Resources
(Status as recommended/required will be discussed in first class) An introduction to programming with IDL: Interactive Data Language; Kenneth Bowman; Academic Press, 2005.
ISBN-10: 01208559X
ISBN-13: 978-0120885596

(Excerpts will be provided) Data reduction and error analysis for the physical sciences, 3rd edition; Philip Bevington and D. Keith Robinson; McGraw-Hill, 2002.
ISBN-10: 0072472278
ISBN-13: 978-0072472271

Other resources will be introduced during the class. The Numerical Recipes books, which are freely available online, will be used towards the end of the semester.

This course has a Blackboard site (learn.bu.edu).

Class structure
We will need to use computers in class. If everyone can bring a laptop to CAS 500, great. If not, expect to be in CAS 606 instead

Assignments
The primary factor influencing your final grade will be problem sets (approximately biweekly). You will work through some ungraded introductory exercises together in class, then complete a related assignment in the subsequent days.

These problem sets will contribute 90% of your final grade. Your participation in class activities will contribute the remaining 10%.

Late Policy
15% of the total value of an assignment will be deducted for each partial or whole calendar day by which the assignment is late.

Conduct and Collaboration
One very important programming skill is not re-inventing the wheel. That is, it is often more efficient to adapt your earlier programs for a new purpose or to borrow a colleague's program than to write a new program from scratch. However, that approach is not optimal for beginners learning new skills, as you are in this class. The programs you write for this class should be typed by your own fingers and should not contain sections that are copied from the work of others. In spite of this, collaborative discussions with other students are encouraged. Talking through a problem with others will help you solve it and understand why some approaches work and some do not. After each assignment, I will meet with you individually for a private discussion of your assignment with the objective of understanding the process by which you completed the assignment. I expect that you will be able to explain why you selected a particular technique and what obstacles you overcame during the assignment. Students who give the impression of not having had a single thought at all during their work on this assignment will be in trouble.

You are reminded of the academic conduct code that can be found online at http://www.bu.edu/cas/students/graduate/grs-forms-policies-procedures/academic-discipline-procedures/ (the URL gets longer each time I teach this course). The underlying principles are that "(1) No honest student should be put to a disadvantage because of the dishonesty of another student; (2) Penalties should be commensurate with the misdemeanors."

Computers
Other groups of students may also use the computers in room 606. If we use this room at all, questions of prioritization will be dealt with collegially. Although many (all?) of you have IDL installed on a desktop computer in your office, be aware that programs you develop on one computer might not run in exactly the same way on another computer...

Planned Schedule
This is the plan, but it is subject to change.

Since some of you have significant IDL experience from AS 710 Observational Techniques in the Fall 2015 semester, but some of you do not, we will spend the first couple of weeks moving through introductory topics and finding the appropriate skill level for the class. Weeks 1 and 2 will cover numbers, math, arrays, and plots.

These are Bowman chapters (not bold, not underlined)
These are Bevington chapters (bold, underlined)
NR means Numerical Recipes

Date	Number	Description	Book Chapter
Tuesday 24 January	01	The foundations	1-8, 17-21
Tuesday 31 January	02	The foundations	1-8, 17-21
Tuesday 07 February	03	Complicated plots and input/output	10-11
Tuesday 14 February	04	Control	9, 15-16
Tuesday 21 February		No class, Academic Monday	
Tuesday 28 February	05	Data manipulation	24
Tuesday 07 March		No class, Spring Break	
Tuesday 14 March	06	Real space physics data	12-14
Tuesday 21 March	07	Real astrophysical data	
Tuesday 28 March	08	Filtering data and power spectra	25
Tuesday 04 April	09	Linear equations and introduction to fitting data	**6-7**
Tuesday 11 April	10	More fitting data and related techniques	**11**, 23,25
Tuesday 18 April	11	Solving ordinary diff. equations	NR
Tuesday 25 April	12	Solving a partial differential equation - The diffusion equation	NR
Tuesday 02 May	13	IDL Astronomy Library	

Nominal assignment schedule (may be modified to balance with AS 802 schedule)

Class 03 – 14 February (or 7 February if you want feedback prior to next assignment)
Class 05 – 07 March
Class 06 – 21 March
Class 07 – 28 March
Class 08 – 04 April
Class 11 – 25 April
Class 12 – 02 May