

ASTR 513

Statistical Methods in (Astro)Physics

Spring 2016

Monday - Wednesday 11am

• Course Description

In this course, we will start with a thorough review of the foundations of modern statistical methods (frequentist and Bayesian) that are used in current research problems in (astro)physics, with emphasis on big-data science. In particular, we will review various mathematical aspects of frequentist and Bayesian inference methods, non-linear regressions methods, error estimation, and model selection.

During the course of applying these methods to topics of current interest, we will explore computational techniques for statistical inference such as Markov-Chain Monte Carlo and Nested Sampling methods. Our applications will include (but not be limited to) comparing stochastic (e.g., turbulent hydrodynamic) models to noisy data, time- and frequency-domain analysis (power spectra, wavelets, etc), density estimation (e.g., luminosity and mass functions), and high-dimensional parameter estimation.

Our focus will be on the application of statistical methods, without sacrificing rigor and detail. The goal of this class is for each participating student to achieve a deep understanding of statistical techniques as well as to develop their own numerical statistical tools that they can use in their graduate research.

The only prerequisite for this class is a competent use of a computer language.

• Textbooks

There is no recommended textbook for this class. We will be using different chapters from various books as well as recent articles that will be posted on the class website.

The University of Arizona offers a number of introductory classes in statistics and you're encouraged to visit the websites of these classes and use their resources. In particular, visit the web site for MATH363, Introduction to Statistical Methods

<http://math.arizona.edu/~jwatkins/math363f15.htm>

for slides and audio from the class, as well as a free introductory textbook on statistics.

• Assignments

There will be **two** different types of assignments in this class, each of which will help you improve different types of skills that you will need in your careers.

(i) **Homework:** this will require solving detailed, quantitative problems that will involve analytic calculations, simple numerical calculations, statistical inferences, etc. I will assign 6 sets of homeworks, about once every two weeks. The due dates for the homework will be on Wednesdays, at the beginning of class.

For each student, I will drop the set with the lowest grade, and the 5 best sets will count for 10% of the grade each, for a total of 50%.

(ii) **Project:** Details on the project, which you will work on in groups, will be announced later in the semester. The project will count for a total of 50%.

There will be no midterm exams. There will be no credit for late assignments.

A total score of 90% will guarantee an A, 80% will guarantee a B, and 70% will guarantee a C grade for the class. However, the final distribution of scores will determine the exact grade breakdown.

- **Class web site:**

<http://u.arizona.edu/~dpsaltis/Astr513>

- **Contact**

Dimitrios Psaltis

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Office hours: Wednesday 1-2 pm.

- **Policies**

Class attendance is optional. Please come to class only if you find it useful. However, if you do come to class, please give your full attention and participate in the discussion. Moreover, you are responsible to learn of any announcements I make in class, which may or may not appear on the web page.

All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion,

Absences (or difficulty turning in assignments on time) that are pre-approved by the UA Dean of Students (or Deans designee) will be honored.

There will also be make up assignments only with a well documented, serious, and valid excuse, such as a serious sickness, death in the family, or a university function.

Cheating or any other form of unethical or threatening behavior will not be tolerated. You can find more information on these issues in the following two web sites of the university:

<http://dos.web.arizona.edu/uapolicies>

<http://policy.web.arizona.edu/~policy/threatening.pdf>

Students with disabilities who require reasonable accommodations to fully participate in course activities or meet course requirements are encouraged to register with the Disability Resource Center and contact me to discuss access issues.

Incompletes will only be given if a student has satisfactorily completed the majority of the work in the class and has a valid reason, such as medical, for not completing the remainder of the course. Students must make arrangements with the instructor in order to receive an incomplete.

Other than grade and absence policies, the information contained in this syllabus may be subject to change with reasonable advance notice.