

ASTR513: Statistical Methods in Astrophysics

Spring 2019; 3 credits; <http://u.arizona.edu/~dpsaltis/Astr513>

Tuesday - Thursday 11:00-12:15

Instructor: Dimitrios Psaltis; SO N324, 621-7859

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Course Description.— In this course, we will review 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. Our focus will be on the application of statistical methods, without sacrificing rigor and detail.

Course Objectives— During this course students will implement Bayesian and Frequentist methods and apply them to topics of current interest, as well as explore computational techniques for statistical inference such as Markov-Chain Monte Carlo and Nested Sampling methods. 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.

Learning Outcomes— Upon completing this course, student should be able to 1. Understand the foundations of modern statistical methods (Frequentist and Bayesian); 2. Develop and implement their own statistical tools; 3. Apply statistical methods to a wide variety of projects in their research.

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

Textbooks.— There is no required 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.

If you would like to follow a textbook, I strongly recommend Pattern Recognition and Machine Learning by Bishop.

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>

offered in the Fall of 2015, 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 homework, 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. The final distribution of scores will determine the exact grade breakdown.

- **Policies**

Attendance.— 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.— 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 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.

Academic Integrity.— 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://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity>

<http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>

Accessibility and Accommodations.— At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520) 621-3268 to explore reasonable accommodation. Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Incompletes.— 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.