PTYS 595B - Statistics and Bayesian Data Analysis

This class is scheduled to be taught in the in person modality.

Class Website

d2l.arizona.edu (student login required)

Instructor

Isamu Matsuyama

Office: Kuiper Space Sciences 527A

(520) 621-4002, isamu@arizona.edu

Office hours

Please email me to arrange an in person or a remote meeting time

Class meetings

Wednesdays and Fridays, 11:00 AM - 12:15 PM, Kuiper Space Sciences Building, Room 7

Textbook

Data Analysis: A Bayesian Tutorial by D. S. Sivia (2nd edition). This book is also available through the University of Arizona libraries.

Objectives and expected learning outcomes

Research in planetary science involves the development of models that are capable of explaining existing observations as well as making testable predictions. This requires data analysis: assessing the plausibility of one or more competing models, and estimating the model parameters and their uncertainties. Bayesian data analysis is an approach to statistical data analysis that explicitly uses as much information as possible by using prior probabilities. The students will develop a broad understanding of the Bayesian approach to statistical data analysis. At the end of the course, students will develop a broad and general tool set that can be applied to the student's own research. A basic background in programming in a language such as Python, Mathematica, Matlab, IDL, C/C++, Fortran, etc. is required.

Class format

Class meetings will generally be built around reading assignments. Students are expected to be prepared with the material assigned prior to each class. We will use a combination of traditional lectures, open discussions and student-led presentations, according to topic and material. Although no formal attendance record will be made, class participation will be part of the grade, and homework assignments are likely to make more sense if you've been to class.

Final project

During the final four weeks, students will work on a project based on actual data, either (preferably) from their own research or a data set provided by the professor. Students must send an email describing their chosen project to the professor no later than Monday, March 28. The results of this project will be presented as a conference-style poster including an abstract, a short introduction to the subject, a description of the data and methods used and a brief discussion of the implications of the findings for our understanding of the topic. Each poster will be accompanied by a more in-depth, two page minimum (12 pt font, 1″ margins, not including figures and tables) write-up describing the methods used. Anonymous draft poster pdfs and methods papers will be due on Wednesday, April 20 by 5 pm. The posters will then be compiled into a single file and circulated to the rest of the class. Each student will be responsible for providing detailed comments on two posters to be assigned at random by 5 pm on Wednesday, April 27. These comments will then be returned to the authors of the posters, who must submit final revised versions of the posters and methods papers by Monday Wednesday, May 4.

Final project schedule

Email describing chosen project due Monday, March 28

Draft posters due Wednesday April 20

Comments on posters due Wednesday April 27, and

Final posters due Wednesday, May 4.

Grading

The grades will be on an A (90% and higher), B (80-89%), C (70-79%), D (60-69%), E (59% and lower) scale, and will be based on three components: class participation (20%), randomly collected homework assignments (50%), and final project (30%).

Due dates, late work, absences

Assignments are due in class on the due date. I would rather have late work than no work, although you should expect it to be for reduced credit. If you anticipate an absence on the due date of an assignment, please either turn in your work early or discuss alternative arrangements with me.

Classroom attendance

- If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructor if you will be missing a course meeting or an assignment deadline.
- Non-attendance for any reason does not guarantee an automatic extension of due date or rescheduling of examinations/assessments.
- Please communicate and coordinate any request directly with your instructor.
- If you must miss the equivalent of more than one week of class, you should contact the Dean of Students Office DOS-deanofstudents@email.arizona.edu to share documentation about the challenges you are facing.
- Voluntary, free, and convenient COVID-19 testing is available for students on Main Campus.

- COVID-19 vaccine is available for all students at Campus Health.
- Visit the UArizona COVID-19 page for regular updates.

Academic integrity

You are expected to know and to abide by the <u>University's Academic Integrity policy</u>. Two primary points you need to know are these: (1) When you turn in (or present) work that uses published material (journal articles, web sites, etc.), you are expected to give the appropriate credit and cite the source(s). (2) Collaboration is encouraged on most assignments, as I strongly believe that we learn more by asking questions and explaining our answers to others' satisfaction. However, if you do work with someone, the work you turn in for grading must be written by you *in your own words*; if I get identical answers, I will divide the credit evenly.

Students with Disabilities

If you anticipate barriers related to the format or requirements of this course, please meet with me so that we can discuss ways to ensure your full participation in the course. If you determine that disability-related accommodations are necessary, please register with Disability Resources (621-3268; http://drc.arizona.edu) and notify me of your eligibility for reasonable accommodations. We can then plan how best to coordinate your accommodations.

Other classroom issues

We try to keep the classroom clean, and ask for your help. Please do not bring any food or drink (other than bottled water) into the classroom. If there are problems with a seat or with its writing table, please let me know, so that the problems can be addressed as soon as possible. Also, the common-sense rules of good conduct apply, such as cell phones turned off and no web-surfing or irrelevant extra-curricular activity during class.

Notice

The information contained in this course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.

Topics Covered
- Introduction, Bayes' theorem, marginalization, and Gaussian approximation
- Parameter estimation, best estimates, error-bars and confidence intervals
- Probability density functions and common probability distributions
- Maximum likelihood and least-squares
- Model selection, hypothesis testing
- Nested sampling, Markov Chain Monte Carlo (MCMC) exploration

Nondiscrimination and Anti-harassment Policy

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see: http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

University Policies

All university policies related to a syllabus are available at: https://academicaffairs.arizona.edu/syllabus-policies.

Academic advising

If you have questions about your academic progress this semester, please reach out to your academic advisor (https://advising.arizona.edu/advisors/major). Contact the Advising Resource Center (https://advising.arizona.edu/) for all general advising questions and referral assistance. Call 520-626-8667 or email to advising@.arizona.edu

Life challenges

If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at (520) 621-2057 or DOS-deanofstudents@email.arizona.edu.

Physical and mental-health challenges

If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520) 621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

COVID-19 Mitigation

As we enter the Fall semester, the health and wellbeing of everyone in this class is the highest priority. Accordingly, we are all required to follow the university guidelines on COVID-19 mitigation. Please visit www.covid19.arizona.edu for the latest guidance.