

Math 408 – Mathematical Statistics (4 units)

Instructor: JAY BARTROFF, 406B KAP, phone 740-1044, email bartroff@usc.edu, office hours TBD

Contacting Jay: The best way to contact me is to speak to me just before or after lecture, or in office hours. After that, email is best, but due to the volume of email I get I usually cannot respond within 24 hours, but make every effort to respond within 48 hours. That said, emailing me the night before an assignment is due or before an exam will probably not be effective.

TA: ALEX TARTER, email atarter@usc.edu, office hours TBD

Discussion Sections: T/Th 10-10:50 or 11-11:50, both in GFS 105

The Course: A good definition for the field of statistics is, “*The science of learning from data, and of measuring, controlling, and communicating uncertainty; and it thereby provides the navigation essential for controlling the course of scientific and societal advances*” (Davidian & Louis, *Science*, 2012). This class is an introduction to modern statistical concepts and methods, with the goal of not only understanding how they are used, but also a deeper appreciation of their properties and behavior through understanding their mathematical foundations.

The main topics of the course include sampling distributions arising from the normal distribution, point estimation, hypothesis testing, goodness of fit, confidence intervals, methods of data summarization, two-sample methods and, time permitting, linear regression and the analysis of variance (ANOVA). In terms of the textbook, I plan to cover chapters 6, a tiny part of 7, 8–11, 14, and, time permitting, 12. However, I do not plan to cover everything in every chapter, and I may cover them out of order, as well as some topics not in our book, so attendance in lecture is important.

Course information, assignments, solutions, and grades will be posted on Blackboard.

Week #	Week of	Chapters	Topics
1	23.Aug	6.1-2	Basic R, sampling distributions: χ^2 , Gamma
2	30.Aug	6.2-3	More sampling distributions: t and F ; sample mean & variance
3	6.Sep	6.3, 7.3.3	Applications of sampling dist'ns, confidence intervals (CIs)
4	13.Sep	8.1-3	Intro to point estimation
5	20.Sep	8.4-5	Method of moments, maximum likelihood estimators (MLEs)
6	27.Sep	8.5	Asymptotic dist'n of MLEs, its use in CIs, CIs by pivoting the c.d.f.
7	4.Oct	8.6	Pivoting the c.d.f. CIs, Bayesian statistics
8	11.Oct	8.6-7	Bayesian statistics, efficiency and the Cramer-Rao lower bound
9	18.Oct	8.8, 9.1	Sufficiency, the Rao-Blackwell theorem, intro to hypothesis testing
10	25.Oct	9.2	Neyman Pearson lemma, application to zip code data
11	1.Nov	9.3	Duality between CIs and testing
12	8.Nov	9.4	Generalized likelihood ratio (GLR) tests
13	15.Nov	9.5-7	GLR tests for the multinomial/categorical data goodness of fit tests, Poisson dispersion test, hanging rootograms
14	22.Nov	9.7-10	Delta method and variance-stabilizing transformations, probability plots
15	29.Nov	14.1-2	Linear regression

Textbook: *Mathematical Statistics and Data Analysis* by John Rice, 3rd edition, is required. As mentioned in the course description, I reserve the right to skip around a little bit and cover some topics not in the book, so attendance in lecture is important.

Occasionally students ask me for other textbooks at about the same level as ours for the purpose of working extra problems for practice, before an exam, say. While this is not required, I do think it can be an effective study tool. Two books that fit this bill are

- *Mathematical Statistics with Applications* by Wackerly, Mendenhall, and Scheaffer
- *Foundations and Applications of Statistics* by Pruim

Computing and Software: Another feature of this class is computing and data analysis. We will do some of this in lectures, discussion sections, and problem sets. In lecture, and for some of your exercises, I will ask you to use the software package R, which is free,* open source, and the most widely used statistical software package in the world, so you won't be wasting your time learning a bit of it, and will probably come to like it. *You are not required to already know R in order to take this class.*

Homework: There will be roughly 7 homework assignments. You are encouraged to work together on the assignments but each student must write up the assignment in his/her own words and show all work; see also the section on academic integrity, below. The assignments are to be turned in in discussion section on the date due, in paper form. Assignments turned in any other way won't be accepted, e.g., emailed to Jay or the TA, left under someone's office door, or in the Math office.

Late policy: Homework can be submitted in the next discussion section after the due date for 25% penalty; anything after that won't be accepted.

Exams: There will be two midterm exams, given at the usual lecture time and place, and a final exam, date and time determined by the registrar, also in the usual lecture location. **The following dates are nonnegotiable so do not take this class if you have any conflicts.**

Midterm exam #1: Friday, October 1st

Midterm exam #2: Friday, November 5th

Final exam: Monday, December 13th, 11AM – 1PM

Grades: Your overall weighted average will be computed as follows: 25% problem sets[†], 20% each midterm exam[‡], 30% final exam, and 5% class participation. Thresholds for letter grades will then be determined so that the grade distribution is similar to this and comparable classes in recent years. These thresholds will be no harsher than, and most likely very close to, the canonical scale: $[90\%, 100\%] = A$, $[80\%, 90\%) = B$, $[70\%, 80\%) = C$, $[60\%, 70\%) = D$, $[0\%, 60\%) = F$. It is recommended that you use this scale if you'd like to estimate your standing in the class.

Statement on COVID-19: The current plans and policies for this course may need to be adjusted should the college, university, or county regulations surrounding COVID-19 change. The current plan is to have all lectures, sections, and exams in-person, but some of those may need to be changed to online, so some flexibility may be required of all of us. Students are expected to comply with all aspects of USC's COVID-19 policy. Failure to do so may result in removal from the class and referral to Student Judicial Affairs and Community Standards.

*You can download R from www.r-project.org

[†]each assignment weighted equally, regardless of points used in grading

[‡]both weighted equally, regardless of points used in grading

Students with Disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. **Such a letter should be delivered to me within the first two weeks of the semester.** DSP is located in STU 301 and is open 8:30 a.m. – 5:00 p.m., Monday through Friday. Website for DSP: sait.usc.edu/academicssupport/centerprograms/dsp/home_index.html and contact information: (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX), ability@usc.edu.

Academic Integrity: USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus (scampus.usc.edu), the Student Guidebook, contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Emergency Preparedness/Course Continuity in a Crisis: In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies. See the university's site on Campus Safety and Emergency Preparedness (preparedness.usc.edu).