Syllabus – STOR 654, Statistical Theory I
Fall 2023 (August 21 – December 6)
Section 001, TuTh 2:00 – 3:15PM
Hanes 107
(Updated on 8/18/2023)

Instructor: Jan Hannig   **Phone:** (919) 962-7511

Office: 330 Hanes   **E-mail:** jan.hannig@unc.edu

Instructor's Office Hours: *(on zoom)*
MW 10:30 – 11:30 AM
and by appointment

Course home page on
https://hannig.cloudapps.unc.edu/STOR654
https://uncch.instructure.com/courses/39712

Zoom link for Office hours:
https://unc.zoom.us/j/99627403569?pwd=VWV
HRm9ZaTJOTWRlVnlhb2dnaXMyZz09
Meeting ID: 996 2740 3569
Passcode: Hanes330

Zoom link for lectures (if needed)
https://unc.zoom.us/j/91329408258?pwd=dDlEQVY3
ZmhNMFNlR1JqMWxQTUZwUT09
Meeting ID: 913 2940 8258
Passcode: MathStat

Teaching Assistant: Jiaying Li   **E-mail:** jyingli@live.unc.edu

TA info: B-54 Hanes Hall   **TA's Office Hour:** *(in person)*
M 2:00-3:00PM

Target Audience: First year Ph.D. students in the Department of Statistics and Operations Research. It is assumed that students have taken statistics at an advanced undergraduate level and are familiar with mathematical ideas such as proofs.

Required Text:
- Keener, Robert W. 2010. *Theoretical statistics: topics for a core course*. Springer, ISBN 978-1-4614-2670-7 (Might be available for download through UNC library).

Optional Texts:
- Casella and Berger: *Statistical Inference*, Duxbury 2/e
- Bickel and Doksum, *Mathematical Statistics, Vol 1*, 2/e, Prentice Hall

Course Objective: This is the first course in mathematical statistics. The main objective of the course is to rigorously develop basic statistical ideas such as point estimation, confidence intervals, and hypothesis testing together with appropriate technical tools such as concentration inequalities. This course will be followed by STOR 655, which covers asymptotical (large sample) approaches to mathematical statistics.

Course Format: Traditional in person lecture

Assessment: Your grade will be based on a midterm exam (30% of the grade), a final exam (50% of the grade) and weekly homework sets (20% of the grade).

Important dates:
- Final Exam: December 12, 12noon-3pm
- Midterm exam: Tuesday, October 10
- Homework: Homework sets will be usually assigned on Tuesdays and due in one week on Gradescope. Late/missed homework will receive a grade of zero. Students are encouraged to discuss the homework problems with other members of the class but should prepare their final answers on their own.

Course Outline: We plan to cover the following topics. Notice that the order is different than in the book.

1. Background
    a. Probability spaces, r.v.'s, expectation, variance, covariance.
    b. Transformations, CDF method, Jacobian method
    c. Basic inequalities (Jensen, Holder, Markov, and Chebyshev)
    d. Moment generating function, Chernoff and Hoerfding's inequality.
    e. Statistical model and identifiability
    f. Properties of sample mean and variance
    g. Order statistics
2. Data Reduction
    a. Scale and location families
    b. Exponential families
    c. Sufficiency. Definition and Factorization theorem.
    d. Minimal sufficiency, sufficient condition
    e. Ancillary statistics
3. Point Estimation
    a. Method of Moments
    b. Maximum likelihood
    c. Bayes estimators: prior, posterior, conjugacy
    d. MSE, bias, and bias-variance decomposition
    e. Bayes risk, Bayes rule
    f. Comparing risk functions
4. Hypothesis Testing
    a. Basic Definitions
    b. Likelihood ratio tests
    c. Error probabilities and power function: size and level of test
    d. Neyman-Pearson lemma
    e. p-values
    f. Multiple testing adjustment (Bonferroni, Benjamini-Hochberg)
5. Interval Estimation
    a. Basic Definitions
    b. Derivation: Inverting test statistic, Pivotal quantities, Pivoting the CDF
    c. Credible intervals
    d. Evaluating interval estimators
6. Practical Issues of Bayesian Statistics (time permitting)
    a. Prior selection (conjugate, objective vs subjective, hierarchical models)
    b. Basic Bayes computations (Metropolis Hastings and Gibbs sampler).

Face Masks   Masks are optional in all University buildings. For additional information, see Carolina Together.

Delivery Method   This course is classified as "in person". While I expect you to come in class, I am also planning to accommodate students who are unable to do so by recording and streaming the lectures. The office hours will be held virtually on zoom.

Etiquette for Zoom   These are my five expectations of you on Zoom:
•   Have your camera turned on.
•   Mute your microphone unless answering or asking a question.
•   Communicate by unmuting yourself or using the chat feature.
•   Be mindful of background noise when not muted.
•   Limit your distractions and avoid multi-tasking.

UNC Attendance Policy   No right or privilege exists that permits a student to be absent from any class meetings, even online classes, except for these university approved absences: authorized university activities, and disability/religious observance/pregnancy, as required by law and approved by Accessibility Resources and Service and/or the Equal Opportunity and Compliance Office (EOC). Significant health condition and/or personal/family emergency as approved by the Office of the Dean of Students, Gender Violence Service Coordinators, and/or the Equal Opportunity and Compliance Office (EOC).

Diversity Statement I value the perspectives of individuals from all backgrounds reflecting the diversity of our students. I broadly define diversity to include race, gender identity, national origin, ethnicity, religion, social class, age, sexual orientation, political background, and physical and learning ability. I strive to make this classroom an inclusive space for all students. Please let me know if there is anything I can do to improve, I appreciate suggestions.

Accessibility Resources   UNC-Chapel Hill facilitates the implementation of reasonable accommodations for students with learning disabilities, physical disabilities, mental health struggles, chronic medical conditions, temporary disability, or pregnancy complications, all of which can impair student success. See the ARS website for contact and registration information: https://ars.unc.edu/about-ars/contact-us

Counseling and Psychological Services CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: https://caps.unc.edu/ or visit their facilities on the third floor of the Campus Health Services building for a walk-in evaluation to learn more.

Title IX Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance (Adrienne Allison - Adrienne.allison@unc.edu), Report and Response Coordinators in the Equal Opportunity and Compliance Office (reportandresponse@unc.edu), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (gvsc@unc.edu; confidential) to discuss your specific needs. Additional resources are available at https://safe.unc.edu

Honor Code Statement Students are bound by UNC's honor code (https://studentconduct.unc.edu/information/policies) in taking exams and in written work, and the submission of said work signifies understanding and acceptance of those requirements. Plagiarism will not be tolerated. Please consult with me if you have any questions about the honor code.

Legal The instructor reserves the right to make any changes he considers academically advisable. It is your responsibility to attend classes and keep track of the proceedings.