

STAT 9700: MATHEMATICAL STATISTICS

COURSE INFORMATION AND SYLLABUS

Lectures. Monday and Wednesday, 5:15 PM–6:45 PM, at F38 Jon M. Huntsman Hall.

Instructor. Bhaswar B. Bhattacharya

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Office Hours: Wednesday, 4:00 PM–5:00 PM.

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Course Description and Syllabus. This is a graduate-level course on statistical estimation and large sample theory. The following is a (tentative) list of topics that will be covered in the class:

- *Fundamentals of Point Estimation:* Unbiasedness, sufficiency, Cramer-Rao lower bound, maximum likelihood estimation, estimation in mixture models.
- *Exponential Families:* Basic definitions, estimation, curved exponential families, Generalized Linear Models.
- *Network Analysis:* Exponential random graph models, estimation in inhomogeneous random graph models, graphons, network sampling, inference in graphical models.
- *Bayes Estimation:* Conjugate Priors, exponential family view, linearity of posterior mean, improper priors, hierarchical Bayes.
- *Minimaxity, Admissibility, and Shrinkage:* Least favorable priors, sufficient conditions for minimaxity, linear estimators of a multivariate normal, Blyth's method, Empirical Bayes derivation of James Stein, Stein's unbiased risk estimation (SURE), risk of threshold estimators.
- *Fundamentals of Hypothesis Testing:* NP Lemma, UMP Tests, Monotone Likelihood Ratio, combinatorial testing problems.
- *Nonparametric Inference:* Density estimation, kernel methods, robust methods.

Prerequisites. Graduate probability theory (taken or currently taking STAT 930 at Penn or equivalent), statistical methodology (STAT 431/511 or STAT 520 at Penn), and real analysis (MATH 508 at Penn).

Text. *Theory of Point Estimation*, Erich L. Lehmann and George Casella, 2nd Edition, Springer, 1998.

Additional References.

- *Testing Statistical Hypotheses*, E. L. Lehmann and J. P. Romano, 3rd edition, Springer, 2005.
- *Gaussian estimation: Sequence and wavelet models*, I. M. Johnstone, 2017.
- *Asymptotic Statistics*, A. van der Vaart, Cambridge University Press, 1998.

Homework. There will be three homeworks. Homeworks will be due on Mondays or Wednesdays and must be handed in during class or in BBB's mailbox (located on the 4th floor of the Academic Research Building) by 7:00 PM on the date the assignment is due. *No late homework will be accepted, but the lowest score will be dropped.*

Scribing. In order to gain experience with technical writing, *each student will be required to prepare scribe notes for 1-2 lectures.* After taking careful notes in class, the scribe for a given lecture will have to prepare a LaTeX document (style file and template available on Canvas) written in full prose and understandable to a student who may have missed class. *The LaTeX document, along with any image or auxiliary files, should be submitted to the instructor and the TA within three days (excluding weekends) of the scribed lecture.* After review, the scribe notes will be posted to the course website.

Midterm. There will be two in-class midterms on **February 27, 2023 (Monday)** and **April 12, 2023 (Wednesday)**. The exams will be closed book, but you are allowed to bring your class notes with you. Laptops, computers, phones are not allowed.

Grading. The course grade will be based on the homeworks, the midterms, and a final project.

- Homework: 10%
- Midterm 1: 25%
- Midterm 2: 25%
- Scribing: 5%

- Final Project: 35%

Collaboration policy. Working together on homework is allowed and encouraged. However, students must write up their homework solutions by themselves. Names of collaborating students should be provided on the front page of each homework write-up.