STAT 970: MATHEMATICAL STATISTICS

COURSE INFORMATION AND SYLLABUS

Lectures. Monday and Wednesday, 10:30 AM–12:00 PM, at G90 JMHH (Jon M. Hunstman Hall).

Instructor. Bhaswar B. Bhattacharya

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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, completeness, ancillarity, UMVUE, Cramer-Rao lower bound.
- *Maximum Likelihood Estimation*: Consistency, asymptotic normality, computation.
- *Exponential Families*: Basic definitions, examples, estimation, Generalized Linear Models, discrete exponential families.
- *Bayes Estimation*: Conjugate Priors, exponential family view, linearity of posterior mean, improper priors, hierarchical Bayes, Bayesian linear model.
- *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.

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 five homeworks, assigned approximately biweekly. 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 JMHH) by 5:00 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 an in-class midterm on **October 29, 2018 (Monday)**. *The exam 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 homework, the midterm, and a take-home final and/or project.

- Homework: 30% (lowest score dropped)
- Scribing: 5%
- Midterm: 25%
- Final Exam: 30%
- Project/Presentation: 10%

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.

Statistical computing. Few homework and take-home assignments will involve coding and statistical analysis on datasets provided. It is recommended that students download and use R for this purpose. Other software such as Excel or Matlab may also be used for data analysis on homework sets. However, R will be the language referred to in class, so students who choose to use another statistical computing platform will need to figure out the equivalent commands on their own.