

BIOS 761: Advanced Probability and Statistical Inference II

Spring, 2007

Instructor: Joseph Ibrahim

Teaching Assistant: Xiaoyan (Amy) Shi

Texts :

1. Testing Statistical Hypotheses, by E. L. Lehmann and Joseph P. Romano (3rd edition).
Publisher: Springer-Verlag.
2. Stochastic Processes, by S. M. Ross (2nd Edition). Publisher: Wiley.

Class notes will also be distributed in class. The notes will cover a lot of material not contained in the textbook.

Prerequisite: BIOS 760

Homework : There will be 5 or 6 homework assignments. The problems will come from the book and separate handouts.

Computing : There might be some computing in this course. We will use the software packages WinBUGS, SAS, and R.

Exams : There will be one midterm exam and a comprehensive final exam. Absolutely no makeup exams will be given.

Grading :

Homework	30%
Midterm	35%
Final exam	35%

Other Useful Reference Books

1. An Introduction to the Bootstrap, by Efron and Tibshirani, Publisher: Chapman and Hall.
2. Mathematical Statistics: A Decision Theoretic Approach, by T. S. Ferguson, Publisher: Academic Press.
3. Statistical Decision Theory and Bayesian Analysis, by J. O. Berger, Publisher: Springer-Verlag.
4. Mathematical Statistics, second edition, by J. Shao, Publisher: Springer-Verlag.
5. Theory of Point Estimation, second edition, by Lehmann and Casella, Publisher: Springer-Verlag.

Material to be Covered

1. Bayes Methods and Elementary Decision Theory (3 weeks)

- Elementary decision theory, decision rules
- Utility functions, loss functions, risk, minimax, and admissibility
- Posterior distributions
- Bayesian decision theory
- Finding Bayes rules and Bayes risk
- Finding minimax rules
- Asymptotic theory of Bayes estimators
- Admissibility and inadmissibility

2. Testing (4 weeks)

- Likelihood ratio, Wald, and Score tests: Simple null and composite null hypothesis
- Neyman-Pearson tests
- Unbiased tests, UMP tests, UMPU tests, conditional tests, permutation tests
 - application to 1 parameter and general exponential families
- Bayesian hypothesis testing

- Invariance in Testing; Rank Methods
 - Rank tests
- Local Asymptotic Theory for Testing: Contiguity theory
- Pivotal quantities, confidence sets and their relationship to tests
- Bayesian interval estimation, highest posterior density regions, credible sets

3. Stochastic Processes (4 weeks)

- Poisson processes
- Renewal Theory
- Markov chains in discrete time: general properties
- Special Markov chains in discrete time
 - Gambler’s ruin
 - Random walk
 - Birth and death processes in discrete time
 - branching processes
 - Martingales in discrete time
- Continuous time Markov chains: general properties
- Birth and death processes in continuous time
- Semi-Markov processes
- Continuous-time martingales
- Applications of the above topics to problems in public health
- The Brownian bridge process
- Brownian Motion

4. Resampling Methods (3 weeks)

- Statistical functionals
- Bootstrap methods
 - Efron’s nonparametric bootstrap
 - Parametric bootstrap methods
 - exchangeably weighted bootstraps
 - Asymptotic properties of the nonparametric and parametric bootstrap

- The bootstrap and the delta method
- Bootstrap tests and confidence intervals
- M-estimates and the bootstrap
- The Jackknife
- Cross-validation

5. Robustness (if time permits)

- Sensitivity and breakdown points
- Influence functions
- M-estimators
- Contamination models
- Robust Regression
- L-estimators