

Advanced Probability and Statistical Inference I (BIOS 760)

Fall 2015

- **COURSE DESCRIPTION** (4 credit hours)

The course introduces the fundamental knowledge of probability measure theory. Large sample theories in probability measure space are given, including a variety of convergence results and central limit theorems. The third part of the course focuses on statistical methods for point(parameter) estimation, with particular attention to the maximum likelihood approach.

- **MEETING TIME** 11:15-1:10, Monday and Wednesday @ Room McG2301

- **CLASS WEBSITE** <http://www.bios.unc.edu/~dzeng/Bios760.html>

- **LECTURE NOTES AND TEXTBOOKS**

- Lecture notes (can be downloaded from the class website)
- *Theory of Point Estimation*, Second Edition, Lehmann, E. and Casella, G., 1998
- *A Course in Large Sample Theory*, Ferguson, T. S., 1996, reprinted 2002

- **INSTRUCTOR**

Dr. Donglin Zeng
Office: 3103B McGavran-Greenberg Building
Email: dzeng@email.unc.edu
Phone: (919)966-7273
Office hours: 4-5 Wednesday or by appointments

- **GRADER**

Mr. Alex Wong
Email: alexwky@live.unc.edu

- **GRADING SYSTEM**

Final grades are based on the performance of weekly assignments, two midterm exams and one final exam. The distribution is 40%, 20%, 20% and 20%. The final grades will be transformed into “HPF” scale (H: 85-100; P: 70-84; LP: 60-69; F: 0-59).

- **TOPICS TO BE COVERED**

1. Distribution Theory (expected 1 week)
 - Basic concepts
 - Special distributions
 - Algebra and transformation of random variables
 - Multivariate normal distribution
 - Families of distributions
2. Measure, Integration and Probability (expected 3 weeks)
 - Set theory and topology
 - Measure space
 - Construction of measure space
 - Measurable function and integration
 - Product of measures–Fubini-Tonelli Theorem
 - Derivative of measures–Radon-Nikodym Theorem
 - Probability measure
 - Conditional probability and independence
3. Large Sample Theory of Random Variables (expected 4 weeks)
 - Modes of convergence
 - Convergence in distribution

- Limit theorems for summation of independent random variables
 - Limit theorems for summation of non-independent random variables–U-statistics and Martingale
 - Some notation in asymptotic arguments
4. Point Estimation and Efficiency (expected 3 weeks)
- Methods of point estimation
 - Crámer-Rao bound for parametric models
 - Information bound and efficient influence function
 - Asymptotic efficiency bound: Le Cam’s lemmas
5. Efficient Estimation: Maximum Likelihood Approach (expected 2 weeks)
- Kullback-Leibler information
 - Consistency of maximum likelihood estimators
 - Asymptotic efficiency of maximum likelihood estimators
 - Computation of maximum likelihood estimators: EM algorithm
 - Nonparametric maximum likelihood estimation

• **OTHER INFORMATION**

- A number of problems are given at the end of each chapter of the lecture notes. Homework will be mostly assigned from these problems. You are encouraged to work on the problems not assigned. Working in groups are not discouraged but plagiarism is strictly prohibited.
- Teaching tool will be mainly based on the use of the projector, sometimes with the help of chalkboards or handouts. The slides for teaching can be downloaded from the webpage.
- Both midterm and final exams will be closed-book exams. The midterm exams will be held in regular class slots.
- Please feel free to send me emails or stop by my office hours if you have questions, comments, ideas or suggestions.
- Work hard and never give up!
- Read the Honor Code at “<http://honor.unc.edu/>”.