STAT 7100
Introduction to Advanced Statistical Inference
Spring 2017

Instructor: Chao DU
E-mail: cd2wb@virginia.edu
Phone: 434-924-3014
Office: Halsey 107

Class Schedule: 2:00pm-3:15pm MW
Location: New Cabell Hall 058
Office Hour: TBD
Grader: Qiannan Yin
gy2mn@virginia.edu

Course Description:

This is an introductory course on statistical inference theory, primarily for graduate students who are planing to take advanced courses in statistics. Topics covered in this course include: likelihood, sufficiency, Frequentist and Bayesian inference, elementary decision theory, point estimation, hypothesis testing, interval estimation, large-sample analysis, empirical Bayes approach. More topics may be included if schedule permits.

Course Assessment:

The final numerical grades will be calculated based on the major factors described bellow. The letter grades will be assigned based on the overall distribution of numerical grades. No fixed threshold will be set in advance.

1. Class participation (10%). You are expected to attend all lectures. The lectures materials would be drawn from a large spectral of sources and do not follow the textbook in general. In addition, the in-class discussion will help you to master the tools learnt from this class, as well as obtain an intuitive understanding of the theoretical matter beyond mathematical derivations.

2. Homework (25%). There will be around 8-9 written assignments. Each assignment will be weighted equally towards the final grades. Homework is designed to help you master the theoretical tools and learn to apply such knowledge to the relevant questions outside the focus of this class. The grading will be generous but it is strongly strongly advised that you should independently work on the problems before discussing with fellow students. Solution will be provided after the due date to help you to self-evaluate your understanding.

3. Exams (65%). Both mid-term (25%) and final (40%) exams aim to test your mastery on the knowledge learned from class and your ability of applying such knowledge to solve theoretical questions, as well as to analyze and evaluate empirical problems. While the mid-term exam would focus on the application of a single skill or theorem, the final exam would gauge your ability to integrate different aspects of this class to solve complicated problems.
Textbook:


Useful References:

College level textbooks on statistics theory:


Advanced textbooks on statistics theory:

- Provide great insights into the philosophical ideas, general concepts and the universal themes in statistics

- Provide a thorough and mathematical rigorous treatment of the theory of statistics


Class Policies:

Class Participation
You are expected to attend all lectures and participate actively in class discussion.

Homework
In order to be graded and counted towards the final grade, each assignment must be submitted on time. Extensions on assignment deadline will be granted only in the most exceptional circumstances. Any extension request must be made to the course instructor at least 24 hours before the due date.

Exams
Both mid-term and final exams are closed-booked but you will be allowed to bring in two/three double-sided A4 sheets with written (NO PHOTOCOPY & NO PRINTING) notes. Besides helping you to pass the exam, the process of preparation notes also helps you to organize the knowledge we learn in this class. For this reason, you must prepare your own notes, and
Honor Policy:
As the only true way to acquire knowledge is through your own hard work, it is of the uttermost importance that all the submitted works, such as homework assignments and exam papers, must reflect your independent efforts made during the learning process. Hence, the following honor policy will be enforced throughout the semester. Any breach to the policy will be reported directly to the UVa Honor Committee.

Although students may discuss homework assignments in small groups, each student must finish his or her assignments independently based on his or her own understanding. Copying others’ works will not be tolerated. Students must not consult any external resource other than the allowed sheets of written notes during both mid-term and final-term exam.

Tentative Weekly Schedule

Week 1 (01/15-01/21)

Concepts and theories: What is statistical inference? What is the difference between statistics and probability? Distribution family and parameter space. Frequentist statistics and Bayesian statistic. Decision theory.

Week 2 (01/22-01/28)


Useful Skills: Write down likelihood function. Apply factorization theorem to find sufficient statistics. Check whether a parameter family belongs to the exponential family.

Week 3 (01/29-02/04)


Useful Skills: Verify minimal sufficiency using likelihood ratio. Verify complete sufficiency in natural exponential family. Verify ancillary statistics based on definition and apply Basu’s theorem to prove independence.

Week 4 (02/05-02/11)

Useful Skills: Evaluate an estimator based on mean square error. Apply Rao-Blackwell theory to improve an estimator and establish UMVUE using Lehmann-Scheffé theorem.

Week 5 (02/12-02/18)

Concepts and theories: Score function and Fisher information. Efficiency and Cramér-Rao lower bound. MLE. Invariant property of MLE.

Useful Skills: Calculate score function and Fisher information. Check whether a given estimator is efficient. Calculate MLE for simple problem, and apply the invariant property.

Week 6 (02/19-02/25)

Concepts and theories: Consistency and asymptotic efficiency of estimator. The asymptotic property of MLE.

Useful Skills: Check the consistency and asymptotic efficiency of estimator. Apply the asymptotic principle to estimate variance of estimator.

Week 7 (02/26-03/04)


Useful Skills: Compare two estimators based on their asymptotic relative efficiency.

Mid-term on Mar 1.

Week 8 (03/05-03/11)

Spring Recess, no class.

Week 9 (03/12-03/18)

Useful Skills: Evaluate a hypothesis test based on errors and power function. Construct UMP test using Neyman-Pearson lemma for simple and one-sided test.

Week 10 (03/19–03/25)


Useful Skills: Construct likelihood ratio test for general problem. Apply Wald test, score test and Pearson chi-square test to solve applied problem.

Week 11 (03/26-04/01)

Concepts and theories: Interval estimation. Pivotal quantity. Optimal interval estimator (with optimal length or optimal coverage). Relationship between hypothesis testing and interval estimation.

Useful Skills: Construct interval estimator using pivotal quantity. Construct interval estimator using corresponding hypothesis test. Evaluate and construct interval estimator based on optimal criteria.

Week 12 (04/02-04/08)


Useful Skills: Combine the prior and likelihood. Find conjugate prior for common parametric family. Calculate risk and Bayes risk. Find Bayes estimator. Compare decision rules based on risk functions. Verify whether a given decision rule is admissible.

Week 13 (04/09-04/15)


Useful Skills: Verify whether a given decision rule is minimax. Calculate risk functions for hypothesis test.
Week 14 (04/16-04/22)


Useful Skills: Calculate posterior distribution. Construct simple Bayesian estimator and credible region. Calculate Bayes factor.

Week 15 (04/23-04/29)


Week 16 (04/30-05/06)

Review. No class on May 3.

Week 17 (05/07-05/13)

Final Exam on May 8.