

STA 6448: Advanced Probability and Inference II

Lecture: Tuesday and Thursday 1:20pm - 2:35pm, Statistics 204

Instructor: Yiyuan She, Statistics 209F (yshe@stat.fsu.edu)

Grader: Kaizhou Lei <kl19o@my.fsu.edu> Statistics 342

Office hours: Tuesday 2:35pm – 3:35pm and by appointment.

Grader: Monday, Wednesday 11:00am-noon

Text: None. I will make lecture notes and slides.

Some useful reference books (optional):

1. *High-Dimensional Statistics: A Non-Asymptotic Viewpoint*, Wainwright, 2019
2. *Asymptotic Statistics*, van der Vaart, 1998.
3. *Empirical Processes in M-estimation*, van de Geer, 2000.
4. *Weak Convergence and Empirical Processes with Applications to Statistics*, van der Vaart and Wellner, 1996.
5. *Concentration Inequalities: A Nonasymptotic Theory of Independence*, Boucheron, Lugosi, and Massart, 2013.
6. *Foundations of Machine Learning*, Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, 2012.
7. *Topics in Random Matrix Theory*, Terence Tao, 2012.

Prerequisites: Distribution Theory STA 5326, Statistical Inference STA 5327, STA 6346. **This is a hard course if you don't have a strong background in mathematics.**

Course Description: The course involves some theoretic topics in statistics and machine learning. By the end of this course, students will acquire a basic understanding of some mathematical statistical tools with a focus on finite-sample analysis including concentration inequalities, empirical processes and their applications in statistics.

Some of the topics include:

Chernoff's bounding, subGaussian random variables, Hoeffding's inequality, Bernstein's inequality, subexponential random variables, Bernstein's moment growth condition, Johnson-Lindenstrauss Lemma, McDiarmid's inequality, the martingale method, Gaussian concentration, Talagrand concentration inequality, the entropy method, Herbst's argument, log-Sobolev inequalities

Glivenko-Cantelli theorem, empirical risk minimization, Rademacher complexity and empirical Rademacher complexity, symmetrization, contraction inequalities, Massart's finite-class lemma, growth function, VC dimension, Sauer's lemma, Goldberg-Jerrum theorem, covering, packing, metric entropy, the volume argument, sub-Gaussian processes, Dudley's entropy integral, chaining, Hausler's bound, Sudakov's minoration inequality, Orlicz norms, Hanson-Wright inequality, random entropy condition, entropy with bracketing, uniform entropy, Donsker classes

Regression, L0-constrained regression, sparse regression, nonconvex penalties, oracle inequalities, regularity conditions, nonparametric regression, localization, classification, PAC learning, empirical risk minimization, margin loss, hinge loss, support vector machines, M-estimators, U statistics, and so on.

Homework (50%): There will be regular homework assignments. Each student must hand in a complete set of their own solutions. The homework must be neatly written. Illegible homework will not be evaluated by the course grader. Penalty for late homework: 10% of the maximum score per day. All questions about scores should be directed to the TA via email or in person during the TA's office hours.

Project/Exam (50%): Students must complete course project and report to get a grade for the course. (You may also be given a few days to complete a take-home exam.)

For the project, you can read one theoretical paper carefully and write a report. You need to go beyond the paper in some way, say, giving a new proof of some theorem. It is recommended to stay focused on one or some parts of the paper. You may also choose to do a literature survey on the key theoretical results on a particular topic. You **MUST** submit a one-page proposal by March 29. You are required to turn in a 10-page paper (in LaTeX) by 5pm on April 19.

Course Website: All pertinent information for this class will be posted on the course website at [FSU's Canvas](#).

Grades: Your course grade is based on homework (50%) and project (50%).
90-100 A, 80-89 B, 70-79 C, 60-69 D, Below 60 F

Syllabus Change Policy: Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.

University Attendance Policy:

Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

Academic Honor Policy:

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "... be honest and truthful and ... [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at <http://fda.fsu.edu/Academics/Academic-Honor-Policy>.)

Americans with Disabilities Act:

Students with disabilities needing academic accommodation should: 1. register with and provide documentation to the Student Disability Resource Center; and 2. bring a letter to the instructor indicating the need for accommodation and what type. Please note that instructors are not allowed to provide classroom accommodation to a student until appropriate verification from the Student Disability Resource Center has been provided.

This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact the: Student Disability Resource Center, 874 Traditions Way, 108 Student Services Building, Florida State University, Tallahassee, FL 32306-4167. (850) 644-9566 (voice) (850) 644-8504 (TDD) sdrc@admin.fsu.edu <http://www.disabilitycenter.fsu.edu/>
