SDS 384-11 Syllabus

Theoretical Statistics

Spring 2025

Tu/Th 2-3:30pm

Professor	Purnamrita Sarkar
Class	TTH 2:00 p.m3:30 p.m. JES A307A
Office Hours	TBD via Zoom
Email	purna.sarkar@austin.utexas.edu
Course website	https://psarkar.github.io/sds384.html

Course Description

This course provides an introduction to theoretical frequentist Statistics. The first half of the course covers concentration of measure and U statistics, etc. The second half introduces basics from empirical processes, uniform laws of large numbers, and applications, including high dimensional covariance estimation, sparse estimation, matrix completion, etc.

We will cover

- Consistency of parameter estimates
 - Stochastic Convergence
 - Concentration inequalities
 - * Sub-gaussian, sub-exponential random variables
 - * Martingale methods
 - * Lipschitz continuous functions of standard normal R.V's
 - * Talagrand's inequality
 - Efron-Stein inequalities
- U Statistics and its applications in Statistics and Computer Science
- Uniform law of large numbers
 - VC classes
 - Covering numbers
 - Chaining and Dudley's entropy integral
- Applications¹
 - High dimensional covariance estimation
 - Sparse estimation (sparse PCA, Lasso consistency)
 - Matrix completion

¹Some may be left out based on how much time is left.

Prerequisites Students are expected to have a good familiarity with Calculus and undergraduate probability.

Textbook

This course is designed to be self-contained, and there is no required textbook. Two textbooks that you may find useful is:

- High dimensional Statistics: A Non-Asymptotic viewpoint, Martin Wainwright, Cambridge,
- Asymptotic Statistics, Aad van der Vaart. Cambridge. 1998.
- Convergence of Stochastic Processes, David Pollard. Springer. 1984. Available on-line at http://www.stat.yale.edu/~pollard/1984book/

Evaluation Grading - 5 homeworks (58%), Class participation (2%) Final Project (40%)

Class participation - 2% is for speaking up and asking questions. If you don't do that at all, you will lose this portion.

Course evaluation

Everyone will get 1 point if 80% of the class submits a course evaluation.

Final Project

A project proposal in the Neurips format is due on February 15th. A mid-project check-in is due on March 15th. The final project (8 pages excluding bibliography and appendix) is due on April 28th. The percentage of 40% for the final project grade is to be divided as 10%, 10%, 20% for the three parts. You can pick any paper on theoretical statistics or ML theory and reproduce the key results. You can also do an independent project - the only requirement is that it needs to be centered around a theoretical component. If you copy part of a paper verbatim it will be considered academic dishonesty. Please see the section about scholastic honesty.

Homework will be assigned biweekly and due via canvas. You must submit a PDF and latex version of your homework. Please do **not** include your names on your homework submission. *Please note that everyone has to submit their homework written in their own words.* Nearly identical assignments from two persons will result in a zero grade for that entire HW.

Attendance: The class modality will be in person. Attendance is recommended, but not mandatory. Masks and physical distancing are strongly recommended. If you are unwell, I strongly recommend staying at home. I will make the day's material available.

Requests for Regrade: Clerical requests will be corrected without hassle. Other regrading requests must be submitted in writing within 2 days of the assignment/exam return. Be aware that the entire assignment/exam will be subject to regrading, and grades may go up or down.

Students with Disabilities

Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 512-471-6259, http://www.utexas.edu/diversity/ddce/ssd/.

Religious Holidays

By UT Austin policy, you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, you will be given an opportunity to complete the missed work within a reasonable time after the absence.

Scholastic Honesty

We expect students to behave with integrity. Students found Cheating on exams or homeworks will receive a score of zero for that exam or assignment, and may be subject to **additional disciplinary action**. For more information on the University of Texas scholastic dishonesty policy, see the 2006-2007 General Information Catalog, Appendix C.

Campus Safety

Please note the following recommendations regarding emergency evacuation from the Office of Campus Safety and Security, 512-471-5767, http://www.utexas.edu/safety:

- Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.
- Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- Students requiring assistance in evacuation should inform the instructor in writing during the first week of class.
- In the event of an evacuation, follow the instruction of faculty or class instructors.
- Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- Behavior Concerns Advice Line (BCAL): 512-232-5050
- Further information regarding emergency evacuation routes and emergency procedures can be found at: http://www.utexas.edu/emergency.