Syllabus of STAT260
(Mean Field Asymptotics in Statistical Learning)

Instructor: Song Mei (songmei@berkeley.edu)
Lectures: M/W 10:00 - 11:30 am. Zoom link through bCourse mailing list
Office hours: Tuesday, Friday 4-5 pm. Zoom link through bCourse mailing list
Course website: https://www.stat.berkeley.edu/~songmei/Teaching/STAT260_Spring2021/index.html

Course introduction

This course focuses on the computational and statistical aspects of statistical models in the high dimensional asymptotics (the mean-field asymptotics). We will cover a few useful tools including concentration inequalities, replica methods in statistical physics, Gaussian comparison inequalities, moment methods and Stieltjes transforms for random matrices, and approximate message passing algorithms. A few applications of these methods include the spiked matrix model, the LASSO problem, the double-descent phenomenon, random features models, and the phase retrieval problem.

Prerequisite

Solid background of matrix calculus, probability theory, theoretical statistics, and convex optimization. Some useful prior knowledge includes statistical learning theory.

Homework/Grading

- Class attendance is required. Each enrolled student is expected to scribe the notes for at least one lecture, which is due in one week from the lecture. LaTeX template is available online.
- There will be four problem sets.
- No mid/final exam.
- Course project: literature review or original research.
- For pass/no pass students, project is optional (but encouraged).
- Final score will be max{assignment $\times 50\%$ + course project $\times 50\%$, course project}.

Project logistics

https://www.stat.berkeley.edu/~songmei/Teaching/STAT260_Spring2021/project.pdf

Code of conduct; attribution of work

The high academic standard at the University of California, Berkeley, is reflected in each degree awarded. Every student is expected to maintain this high standard by ensuring that all academic work reflects unique ideas or properly attributes the ideas to the original sources.

These are some basic expectations of students with regards to academic integrity: Any work submitted should be your own individual thoughts, and should not have been submitted for credit in another course unless you have prior written permission to re-use it in this course from this instructor.

All assignments must use "proper attribution," meaning that you have identified the original source and extent or words or ideas that you reproduce or use in your assignment. This includes drafts and homework assignments! If you are unclear about expectations, ask your instructor.

Do not collaborate or work with other students on assignments or projects unless the instructor gives you permission or instruction to do so.

Disability accommodations

If you need an accommodation for a disability, if you have information your wish to share with the instructor about a medical emergency, or if you need special arrangements if the building needs to be evacuated, please inform the instructor as soon as possible.

If you are not currently listed with DSP (the Disabled Students' Program) and believe you might benefit from their support, please apply online at https://dsp.berkeley.edu/.

References

• Andrea Montanari's summer course. https://www.math.ubc.ca/Links/OOPS/index.php
• A quick introduction to concentration inequalities: Chapter 2 of "High-dimensional statistics: A non-asymptotic viewpoint" by Martin Wainwright
• A quick introduction to the replica trick: https://meisong541.github.io/jekyll/update/2019/08/04/Replica_method_1.html
• A quick introduction to convex Gaussian comparison inequality: "Regularized linear regression: A precise analysis of the estimation error" by Christos Thrampoulidis, Samet Oymak, and Babak Hassibi: http://proceedings.mlr.press/v40/Thrampoulidis15.pdf
• A quick introduction to AMP: "Graphical Models Concepts in Compressed Sensing" by Andrea Montanari: https://arxiv.org/abs/1011.4328
• Advanced reading: "Information, Physics, and Computation" by Marc Mézard and Andrea Montanari: https://web.stanford.edu/~montanar/RESEARCH/book.html