STAT 213: Statistical Inference 2

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1 Time, Location and Logistics

Monday-Wedsday, 9:00-10:15. Science Center, 304.
Instructor: Natesh S. Pillai, email: pillai@fas.harvard.edu
I have an open door policy and you can come talk with me anytime.
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Section/Office hours: TBA.

2 Introduction: What the course is about.

This course will cover a broad range of topics in **theoretical** statistics. The only prerequisites are Stat 210, 211 or an equivalent graduate level courses The course is designed to give students a working knowledge of *useful* concepts from probability and statistics which will help them for doing statistical research. There should be some (but minimal and often complementary) overlap with stat 212; these two courses can be taken concurrently.

I (and most others too!) believe that probability and statistics are *different* from measure theory and therefore the primary emphasis will be on developing intuition before doing rigorous calculations. We will then develop tools to "rigorize" the intuition into a water-tight argument. To aid this process, in every topic we will spend ample time on examples in which it is possible to do concrete calculations, or perform simulations.

Students are encouraged to attend lectures, and actively participate in the class. Raising questions/comments is very vital to understanding the material and will be beneficial to the entire class. Also, the *only* way to master this material is by *doing it* and thus the lectures will complimented by a set of carefully chosen problems to work outside the class.

3 Tentative List of Topics

The following is a tentative list of topics we would like to cover.

- **Review of Basics:** Sta 210 review: Different modes of convergence (L_p, almost sure, in probability, weak convergence), Borel Cantelli, Conditional Expectations. Hoeffding, Bernstein, Delta method
- **Consistency of MLE:** Basic properties, Uniform law of large numbers, covering numbers, Glivenko Cantelli , Empirical processes
- **Asymptotic normality:** Basic properties, LAN, basics of minimax theory
- **Markov Chains:** Basics, Stationary distribution, reversibility, convergence, coupling proofs, basics of mixing times, basic MCMC algorithms and discussion around them
- **Bayesian asymptotics:** Posterior convergence rates, machinery behind proving them
- **Random Matrices:** Basics, MP law

4 Grading

Homework assignments are given bi-weekly and the students are required to turn them in, as these contribute towards your final grade. You are allowed (and even encouraged) to discuss the homework problems with your fellow students, but you *must* write up your own solutions. In some case where simulations are needed, you must turn in both the code and the output in any language you prefer (e.g., R/Splus, Matlab, Python). All the submitted homeworks should be final drafts and not first drafts. We also prefer them to be written LaTeX.

There will be an in-class midterm and a final examination. Mid-term will be in-class. Finals will be a two-part exam: we will have a one hour in-class portion and a take home portion. Students will also have to turn in a 5-7 page document about writing up an exposition of a related topic they have learnt from reading a paper. It does not have be a an original work; a nice exposition explaining the idea carefully and in your own words is good. The mid-term is on March 30. The homeworks account for 20%, the mid-term accounts for 20%, the paper accounts for 25%, and the final counts for 30% towards the final grade. Every student taking this class for grade should scribe (and latex!) at least one lecture. This counts for 5% of the grade.

5 Class Logistics/References

No specific text book is required for the class. However the material covered is available in most classic text books and references will be provided. A few books are:

1. Asymptotic Statistics, Van der Vaart. https://www.cambridge.org/core/books/asymptotic-statistics/A3C7DAD3F7E66A1FA60E9C8FE132EE1D

2. Mathematical Foundations of Infinite-Dimensional Statistical Models, https://www.amazon.com/Mathematical-Foundations-Infinite-Dimensional-Statistical-Probabilistic-ebo dp/B018MFKLJE

3. All of Statistics, Larry Wasserman, https://link.springer.com/book/10.1007/978-0-387-21736-9

4. High Dimensional Probability, https://www.math.uci.edu/~rvershyn/papers/HDP-book/HDP-book.pdf

5. Markov Chains, James Norris, http://www.amazon.com/Markov-Cambridge-Statistical-Probabilis dp/0521633966/ref=sr_1_2?s=books&ie=UTF8&qid=1453683503&sr=1-2&keywords=Markov+chains

6. Markov Chains and Mixing Times, by Levin, Peres and Wilmer. Available online: http://pages.uoregon.edu/dlevin/MARKOV/