Stat 668a :
Information and Probability

Instructors: Andrew Barron, Mokshay Madiman. Use `firstname.lastname@yale.edu` to contact either of us.

Class Time: T-Th 10:30-11:45am.

Class Location: Room B5A, 24 Hillhouse Ave.

Grading: One problem will be assigned in each class. All class participants are expected to participate in solving these problems at the beginning of the next class, since the problem will be relevant to the content being covered. [If you are taking the course for credit, you are expected to have thought about the problem beforehand rather than making impromptu attempts on the board.]

You can *optionally* choose to present a review of a paper covering an important development in the field at the end of the semester; the choice of paper needs to be discussed with and approved by the instructors before December 1.

Course Description: Study of several key results in probability using ideas and methods from information theory. Topics include entropy and its relationship to Fisher information, the law of large numbers, central limit theorem (normal approximation), law of small numbers (Poisson approximation), large deviations, martingales, Markov chains, and information projection. The approach we take quantifies the increase in entropy or more generally the drop in information distance from an approximating distribution. Interpretations from statistics, physics, and finance.

Prerequisites: Prior exposure to probability theory is assumed. Measure-theoretic probability will be occasionally useful, but is not essential. You do not need to know any information theory (although prior background will, of course, enrich your learning experience).

Wk #	Dates	Content	Who
1	Sep 1	*Course Introduction*: motivate course; give outline; define information quantities	MM
2	Sep 6	*Properties of Information*: relative entropy as coding cost; as a notion of convergence; as an error exponent in hypothesis testing	MM, AB
3	Sep 13	*Poisson Approximation*: data processing inequality; approximation bounds; generalizations	MM
4,5	Sep 20,27	*Empirical Distributions*: law of large numbers; large deviations; Sanov properties; conditional limit theorem; interpretations	MM, AB
6,7,8	Oct 4,11,18	*Central Limit Theory*: Fisher information; entropy power inequality; de Bruijn's identity; subadditivity; convolution identity and consequences; normal approximation bounds	MM, AB
9,10	Oct 25, Nov 1	*Information Projection*: Chain rule demonstration of projection and Pythagorean-like inequalities; consequences for information limits and martingales	AB, MM
11	Nov 8	*Markov Chains*: convergence to stationarity; applications	MM, AB
12	Nov 15	*Statistical Implications*: Risk characterization for maximum likelihood, Bayes and minimum description length estimators	AB
13	Nov 29	*Additional Topics*	
14	Dec 6	*Optional Student Presentations*	

Table 1: Rough Course Outline (modulo evolution)