Fall 2016

STAT 364/664 - Information Theory

Syllabus

Schedule:	Tue & Thu 11:35-12:50pm, 24 Hillhouse Room 107
First lecture:	Tuesday, Jan 17 2016
Professor:	Yihong Wu yihong.wu@yale.edu, 24 Hillhouse Room 203
Office hours:	Tue 2-4pm, 24 Hillhouse Room 203
Teaching fellow :	Jason Klusowski jason.klusowski@yale.edu
Website:	http://www.stat.yale.edu/~yw562/teaching/364/

1 Content

Welcome to STAT 364/664! This is a graduate-level introduction to the mathematics of Information Theory, with emphasis on the modern aspects of non-asymptotics and information spectrum methods. These methods enable one to consider delay-constraints (finite blocklength) and give a unified treatment of continuous and discrete sources/channels. Those taking IT for the first time would benefit from learning (in parallel) the classical material presented in the textbook by Cover and Thomas. We will also discuss various connections/applications to statistics and computer science.

1. **Information measures**. Entropy, divergence, mutual information. Conditional information measures. Convexity and continuity. Sufficient statistics. Data processing inequalities. Extremization, saddle point, capacity as information radius. Variational characterizations. Fano's inequality.

2. **Lossless data compression**. Variable length and fixed length (almost lossless). Huffman codes. Linear compression. Slepian-Wolf problem. Asymptotic equipartition property.

3. **Binary hypothesis testing**. Finite-sample bounds. Asymptotics: Stein and Chernoff exponents. Large deviations: I-projection, tilting.

4. **Channel coding**. Achievability and converse bounds. Asymptotics: capacity, strong converse, channel dispersion. Linear channel codes. Computational complexity of reliable communication. Coding with feedback: zero and non-zero error capacities, Schalkwijk-Kailath scheme. Joint-source-channel coding.

5. **Lossy data compression**. Quantization. Rate-distortion theorem. Shannon lower bound. Separation principle.

6. **Advanced topics**.[1] Random number generation: Fundamental limits, von Neumann's and Peres' schemes. Entropy and counting. Information-theoretic methods in statistical decision theory: f-divergence, information bounds, Yang-Barron methods.

[1] Subject to time constraints and class interests.

2 Administrivia

1. Course prerequisites: theorem-proof exposition, solid knowledge of probability theory.
2. Problem sets: weekly assignments.
3. Exams: closed book, closed notes.
4. Final grade: 45% homeworks, 20% midterm (in class), 35% final.
5. References: lecture notes (available at http://www.stat.yale.edu/~yw562/teaching/itlectures.pdf) and reading of [1].

References

[1] T. Cover and J. Thomas, *Elements of Information Theory,* Second Edition, Wiley, 2006