



CONCENTRATION INEQUALITIES

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PRE-REQUISITES : A course on either probability, random processes or measure theory. Basic mathematical maturity and working familiarity with probability calculations.

COURSE OUTLINE : It is well-known that functions of large numbers of random quantities tend to behave rather predictably and 'less randomly' than their constituents. For instance, the laws of large numbers tell us that the average of many independent random variables is asymptotically the expected value; higher-order refinements such as the central limit theorem and large deviations techniques uncover the asymptotic rate at which this reduction in randomness takes place. However, if one is interested in sharper estimates, for the probability of deviation from the typical value, for a fixed number of observations, for functions other than the average, or for functions of dependent random variables, one must take recourse to more specific measure concentration bounds. Perhaps the most basic, nontrivial examples in this regard are the Markov and Chebyshev inequalities, which are encountered in a first course on probability.

This graduate-level course on concentration inequalities will cover the basic material on this classic topic as well as introduce several advanced topics and techniques. The utility of the inequalities derived will be illustrated by drawing on applications from electrical engineering, computer science and statistics. A tentative list of topics is given below.

1. Introduction & motivation: Limit results and concentration bounds
2. Chernoff bounds: Hoeffding's inequality, Bennett's inequality, Bernstein's inequality
3. Variance bounds: Efron-Stein inequality, Poincaré inequality
4. The entropy method and log Sobolev inequality
5. The transportation method
6. Isoperimetric inequalities
7. Other special topics

ABOUT INSTRUCTOR :

Prof. Himanshu Tyagi is an Associate Professor Department of Electrical Communication Engineering Participating Faculty Robert Bosch Center for Cyber Physical Systems Member Faculty Analysis and Probability Research Group (APRG)

Prof. Aditya gopalan is working in Department of Electrical Communication Engineering (ECE) IISc Bangalore.

COURSE PLAN :

- Week 1:** Chernoff bounds
- Week 2:** Concentration bounds for sums and other functions of independent random variables
- Week 3:** Variance bounds for functions of independent random variables
- Week 4:** The Entropy method for concentration inequalities
- Week 5:** Entropy method (contd.) and Transportation method
- Week 6:** Transportation method, isoperimetry and concentration
- Week 7:** Log-Sobolev inequalities revisited
- Week 8:** Concentration inequalities for sequential data