Minicourse on Markov chain mixing time

Date: May 19 - 31, 2019

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Objectives: The study of Markov chain mixing time finds many applications ranging from statistical physics, theoretical computer science to Markov chain Monte Carlo (MCMC). In this course, we will first give a review on various classical topics of Markov chains, followed by surveying the latest trend in the literature of Markov chain mixing time.

Tentative topics:

1. **Basic finite Markov chains**: ergodicity, reversibility, hitting time, mixing time, stationary time, eigentime, cover time
2. **Functional analysis and functional inequalities**: spectral expansion, eigenvalues, spectral gap, log-Sobolev constant, relative entropy
3. **Geometric bounds on eigenvalues**: Diaconis-Stroock bounds, Cheeger's inequality, comparison theorems
4. **Cutoff phenomenon**: separation cutoff, L^2-cutoff, total variation cutoff
5. **Applications in statistical physics and MCMC**: Metropolis-Hastings algorithm, simulated annealing, Gibbs sampling, Glauber dynamics, Ising model.

Main References: The following are useful books related to the course:

- David Aldous and Jim Fill. *Reversible Markov Chains and Random Walks on Graphs*. Unpublished. 2014.
- David Levin, Yuval Peres and Elizabeth Wilmer. *Markov Chains and Mixing Times*. 2009.
- Prasad Tetali and Ravi Montenegro. *Mathematical Aspects of Mixing Times in Markov Chains*. 2006.
- Pierre Bremaud. *Markov chains, Gibbs fields, Monte Carlo simulation and Queues*. 1999.
- Laurent Saloff-Coste. *Lectures on finite Markov chains*. 1996.

Prerequisites: An undergraduate level understanding of probability and stochastic processes.