Bayesian Statistical Theory I

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Course description

The course introduces students to foundational, modeling and computational aspects of the Bayesian approach to statistical inference. The presentation moves from the classical Bayes-Lalpace paradigm to the discussion of the case of sequences of exchangeable observations and some noteworthy examples of priors. Some asymptotic issues related to Bayesian procedures will also be addressed. Finally, most popular algorithms for posterior convergence will be introduced and discussed.

Syllabus

1. The Bayes-Laplace paradigm. Statistical model and prior distribution. Hypothetical and predictive inference.
2. Exchangeable sequences of observations and de Finetti's theorem.
3. Natural exponential families and conjugate priors. Predictive and posterior distributions.
4. The Dirichlet process.
5. Frequency properties of Bayesian procedures with increasing information. Doob's theorem and asymptotic normality.
6. Algorithms for posterior computation. Numerical integration, deterministic / variational approximations and Monte Carlo methods. Importance sampling and variance reduction.
7. Markov chain Monte Carlo. Metropolis–Hastings and Gibbs Sampler. Convergence of discrete time Markov chains. Mixing times, spectral theory and asymptotic variances.
8. Gradient–based sampling algorithms: Langevin and Hamiltonian Monte Carlo. Convergence analysis on general state spaces.

Exam: written test.