

40025 - Bayesian Statistical Theory I

PhD in Statistics & Computer Science - Bocconi University

A.Y. 2026-2027

Instructors: Antonio Lijoi & Giacomo Zanella

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-Laplace paradigm to the discussion of the case of sequences of exchangeable observations and some noteworthy examples of priors. Finally, popular algorithms for posterior computation will be introduced and discussed.

Course contents

1. The Bayes-Laplace paradigm. Statistical model and prior distribution. Hypothetical and predictive inference.
2. Natural exponential families and conjugate priors. Predictive and posterior distributions.
3. Exchangeable sequences of observations and de Finetti's theorem.
4. The Dirichlet process.
5. Posterior computation as an integration problem. Numerical integration and Monte Carlo methods. Importance sampling and limitations.
6. Markov chain recap: asymptotic convergence. Spectral theory for finite Markov chains, χ^2 -mixing times and asymptotic variances.
7. Markov chain Monte Carlo methods. Metropolis-Hastings and Gibbs Sampler.
8. Gradient-based sampling algorithms: recap of SDEs and the Langevin diffusion, gradient-based MCMC, Hamiltonian Monte Carlo and related integrators.

Exam: written test.

Reading material: lecture notes will be made available by the instructors on the Blackboard platform.