Contact Information
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Course Description
The course provides an introduction to the Bayesian approach to statistical inference. Unlike
with the classical frequentist approach to statistics, a Bayesian statistical model can incorpor-
ate prior beliefs about the object of inference that are formally combined with the informa-
tion provided by the collected data. These in turn produce an updated, or posterior, model,
which formalises the process of learning from experience in a mathematically coherent way.
The course will start from foundational and methodological aspects of Bayesian statistics
and will move to more sophisticated constructions and related computational considera-
tions in the second part. By the end of the course, students will be able to formulate and
implement the most used Bayesian models and develop their own constructions. Computa-
tions will be carried out by making use of the statistical software $\text{R}$.

Prerequisites
Basic Probability theory: discrete and continuous random variables. Frequentist paramet-
ric Statistics: point estimation, hypothesis testing, interval estimation and linear regression.
Familiarity with the $\text{R}$ software (www.r-project.org) is not required, but some basic program-
ming skills with some programming language can be useful.
Outline of the Course

1. The Bayesian approach to statistics.
   (a) The likelihood principle, the prior and posterior distributions.
   (b) The Bayes Theorem for dominated models.
   (c) Interpretation of the scientific inference via the Bayesian approach.

2. The three fundamental problems of inference.
   (a) Point estimation, hypothesis testing and interval estimation.
   (b) Comparison between the Bayesian and frequentist methods.

3. Prior distributions.
   (a) Noninformative prior distributions. Conjugate and mixture distributions.
   (b) Examples of univariate conjugate models: Bernoulli beta model, Poisson gamma model, normal normal-inverse-gamma model.

4. Computational methods for non-conjugate Bayesian models.
   (a) Importance sampling.
   (b) General outline of Markov chain Monte Carlo methods.
   (c) Gibbs sampling and the Metropolis-Hastings algorithm.
   (d) Checking convergence of a Markov Chain.

5. Introduction to more advanced models.
   (a) Hierarchical models.
   (b) (If time allows) Multivariate linear models and generalized linear models in the Bayesian framework.

Grading
50% assignment + 50% written exam.

Textbooks
Main references: