Course Outline

An Introduction to Bayesian Analysis

February-March 2024

Instructor Information

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Brief Course Outline:

The aim of this course is to provide researchers with an introduction to practical Bayesian methods. Topics will include Bayesian philosophy, simple univariate models, linear and logistic regression, hierarchical models and Bayesian nonparametrics. Numerical techniques including Monte Carlo integration, sampling importance resampling (SIR), the Gibbs sampler and the Metropolis-Hastings alwill be covered, including programming in `R`, `JAGS`, `Nimble`, `RStan` and `INLA`.

Place and Time:

February 6 to March 7, 2023
4h per week, with 2 classes of 2h each.

Prerequisites:

Previous courses in differential and integral calculus, probability theory and inference.

Equipment:

- Access to a computer with `R` software loaded on (freeware) is required.

Reference material:

Course material will be made electronically available, and the following books are used as the main references:

- Bayesian Data Analysis (2013) by Andrew Gelman, John Carlin, Hal Stern, David Dunson, Aki Vehtari, and Donald Rubin. Third Edition. CRC Press, Taylor & Francis Group.
- Bayesian Statistical Methods (2019) by Brian J. Reich and Sujit K. Ghosh. CRC Press, Taylor & Francis Group.
- Statistical Inference: An Integrated Approach, Second Edition 2nd Edition (2014) by Helio S. Migon, Dani Gamerman, Francisco Louzada. Chapman & Hall/CRC Press.
- Statistical Rethinking: a Bayesian course with examples in `R` and `Stan` (2020) by Richard McElreath. Second Edition. Chapman & Hall/CRC Press.
- An Introduction to Bayesian Thinking - A companion to the Statistics with R Course (2021) Merlise Clyde, Mine Cetinkaya-Rundel, Colin Rundel, David Banks, Christine Chai and Lizzy Huang. Electronically available from `https://statswithr.github.io/book/`

Overview of Content:

The course will be divided into five main sections:

1. Basic elements of Bayesian Analysis: Conjugate families; Non-informative priors; Predictive distribution; Bayes estimators;
2. Computational methods: Monte Carlo methods, Importance Sampling, Sampling Importance Resampling (SIR); Markov chain Monte Carlo methods; Gibbs sampling; Metropolis-Hastings; Integrated Nested Laplace Approximations;
3. Generalized linear models under the Bayesian paradigm;
4. Hierarchical models and missing data;
5. Variable selection and model comparison: Bayes factors; Deviance Information Criterion; Watanabe-Akaike Information Criterion;
6. Bayesian nonparametrics.