University of Zurich[UZH]

Master Program in Biostatistics

Module STA421 Foundations of Bayesian Methodology

Syllabus, Spring 2022

1 General information

Lectures: PD Dr. phil. Malgorzata Roos, HRS-F-22.2, malgorzata.roos@uzh.ch
Exercises: Mr. Georgios Kazantzidis, georgios.kazantzidis@uzh.ch
Lectures: Thursdays, 09–11 (7×2h)
Exercises: Thursdays, 11–12 (7×1h)
Practicum: Thursdays, 09–11 (7×2h)
Online: Zoom
Website: 22FS STA421.1 STA 421 Foundations of Bayesian Methodology on OLAT

2 Course description

The well-established Bayesian methodology provides powerful tools for data analysis in many domains of science. The unique ability to incorporate prior knowledge makes Bayesian methods attractive especially for empirical research. This ability is attracting a growing number of practitioners who see the Bayesian paradigm as an intuitive approach to answering relevant research questions. An additional advantage is that Bayesian modeling has become easily accessible in R, which provides interfaces for general-purpose and specialized software systems for Bayesian computation. However, Bayesian methodology is often used without any deeper understanding of its intricacies. This hinders thoughtful and efficient applications of Bayesian methods in practice. This lecture reviews fundamental concepts of Bayesian methodology and provides an accessible introduction to its theoretical concepts and practical tools. Biomedical applications discussed in this lecture and an individual project establish a strong link between Bayesian theory and practice. Successful participants will be able to use the skills acquired and apply Bayesian methods in other areas of research.

3 Prerequisites

- basic probability calculus
- standard probability distributions
- standard statistical methods
- software: R/RStudio
- a successfully completed STA402 “Likelihood Inference” lecture is an advantage

4 Goals

- to understand the foundations of classical and Bayesian statistics
- to understand, apply, and interpret results provided by Bayesian methods
- to understand the principles of MC and MCMC sampling
- to implement Bayesian models in JAGS
- to conduct convergence diagnostics (CODA)
- to compute Bayesian regression models and Bayesian meta-analysis
- to become aware of challenges and intricacies of Bayesian methodology

5 Tentative schedule lectures (L), exercises (E), and practica (P)

Date	Topic
February 24, 2022	L + E: Classical vs Bayes paradigms and conditional probability
March 03, 2022	P: Classical vs Bayes paradigms and conditional probability
March 10, 2022	L + E: Conjugate Bayes, point, and interval estimates
March 17, 2022	P: Conjugate Bayes, point, and interval estimates
March 24, 2022	L + E: Predictive distributions, asymptotics, and Monte Carlo
March 31, 2022	P: Predictive distributions, asymptotics, and Monte Carlo
April 07, 2022	L + E: MCMC sampling in R
April 14, 2022	P: MCMC sampling in R
April 28, 2022	L + E: JAGS and CODA
May 05, 2022	P: JAGS and CODA
May 12, 2022	L + E: Bayesian meta-analysis and empirical Bayes
May 19, 2022	P: Bayesian meta-analysis and empirical Bayes
June 02, 2022	L + E: Priors and Bayesian model selection
June 16, 2022	P: Preparation for the exam

6 Material and reading

- Held, L. and Sabanés Bové, D. (2020) Likelihood and Bayesian Inference: With Applications in Biology and Medicine, Springer.
- Lesaffre, E. and Lawson, A.B. (2012) Bayesian Biostatistics, John Wiley & Sons.
- Lunn, D., Jackson, Ch., Best, N., Thomas, A. and Spiegelhalter, D. (2012) The BUGS Book: A Practical Introduction to Bayesian Analysis, Chapman and Hall/CRC.
- For each session further reading and additional material can be provided in OLAT.
- Software:
– R/RStudio (www.r-project.org/www.rstudio.com)
– JAGS (mcmc-jags.sourceforge.net)
– R-packages: coda, rjags, bayesmeta

7 Exercises and admittance to exam

Evaluation of the course will be based on several components:
- 30% for solving compulsory exercises in groups
- 35% for the individual project
- 35% for the written exam
- 10% bonus for active participation in discussions and presentation of solutions

Compulsory exercises in groups:
Participants will be asked to work in groups. Each group will submit each week solutions to all compulsory exercises and will present one of them. The grade from compulsory exercises solved in groups and handed in by the group will contribute 30% to the final grade.

Individual project:
Every participant will work individually on an applied project that will evolve over the course of the whole semester. Solutions will be handed in directly to the lecturer. These solutions do not have to be completely correct, but the approach taken should be apparent. The grade for the individual project will contribute 35% to the final grade.

Written exam:
To be admitted to the written exam, participants have to submit 100% of the solutions of compulsory problems solved in groups and 75% of the tasks within the individual project. The written exam will contribute 35% to the final grade.

8 Exam

Date: June 23, 2022
Time: 10 – 12 am
Room: Irchel
Mode of examination: theoretical written (120 min)
Written aids: 10 sides on 5 sheets of paper DIN A4 (210 mm x 297 mm) handwritten summary
Exam grading: 1–6, in half grades (30% for solving compulsory exercises in groups, 35% for the individual project, 35% for the written exam)
On July 07, 2022, 14 – 15 pm, HRS-F-22.2 at EBPI, both the grades and the exam can be discussed with the lecturer.