
PROGRAMA DE VERÃO 2024 - 709

ESCOLA DE MATEMÁTICA APLICADA FGV EMAP

DISCIPLINA: Bayesian Modelling with Informative Priors

PROFESSOR: Joseph G. Ibrahim

CARGA HORÁRIA: 08h

PRÉ-REQUISITO:

PERÍODO: 26/01 a 02/02/24 (Sextas-feiras)

HORÁRIO: 14h às 18h

PLANO DE ENSINO

1. Ementa

Abstract: This full-day short course is designed to give biostatisticians and data scientists a comprehensive overview of informative prior elicitation from historical data, expert opinion, and other data sources, such as real-world data, prior predictions, estimates, and summary statistics. We focus both on Bayesian design and analysis and examples will be presented for several types of applications such as clinical trials, observational studies, environmental studies as well as other areas in biomedical research. The methods we present will be demonstrated Stan, SAS, and the newly developed R packages hdbayes and BayesPPD. The first part of the course gives a brief but broad overview of Bayesian inference, examining concepts of Bayesian design and analysis such as i) Bayesian type 1 error and power, ii) calculation of posterior and predictive distributions, iii) MCMC sampling methods, iv) fundamental concepts in informative and non-informative prior elicitation, v) Bayesian point and interval estimation, and vi) Bayesian hypothesis testing. These topics will be presented in a general context as well in several contexts in regression settings including linear and generalized linear models, models for longitudinal data, and survival models. The first part of the course contains two sections. The second part of the course will focus broadly on advanced methods for informative prior elicitation, including i) informative prior elicitation from historical data using the power prior (PP) and its variations including the normalized power prior, the partial borrowing power prior, the asymptotic power prior, and the scale transformed power prior (STRAPP). In addition, ii) the Bayesian hierarchical mode (BHM) commensurate prior, and the robust Meta-analytic Mixture Prior (MAP) will also be examined and properties and performance of the four priors (BHM, PP, commensurate, robust MAP) will be analytically compared and studied via simulations and real data analyses of case studies.

In addition, we will also examine iii) informative prior elicitation from predictions, including the hierarchical prediction prior (HPP), and the Information Matrix (IM) prior. We also examine iv) strategies for informative prior elicitation from expert opinion. Finally, we discuss(v) synthesis of randomized controlled trial and real-world data using Bayesian nonparametric methods. For (i) – (iv), we will present examples both in the context of Bayesian design and analysis and demonstrate the performance of these prior through several simulation studies and case studies involving real data in the context of linear and generalized linear models, longitudinal data, and survival data. We will also demonstrate the implementation of these priors through the hdbayes and BayesPPD R packages, SAS, Nimble, and Stan. The second part of the course consists of two sections.

Section 1: Overview

- a) Non-informative and informative priors
- b) Point, interval estimation, and hypothesis testing
- c) MCMC methods
- d) Nonparametric methods
- e) Demonstrations with hdbayes R package, Nimble, Stan, and SAS

Section 2: Bayesian Design

- a) Basics
- b) Bayesian power and type 1 error
- c) Sample size determination (SSD): sampling and fitting priors
- d) Informative priors Applications and software demonstrations using BayesPPD package

Section 3: Informative prior elicitation from historical data

- a) Power prior (PP)
- b) Scale transformed power prior (STRAPP)
- c) Bayesian hierarchical model (BHM)
- d) Commensurate Prior
- e) Robust MAP
- f) The Latent Exchangeability Prior for external controls
- g) Priors from real-world evidence studies
- h) Software using hdbayes, BayesPPD, and SAS.

Section 4: Informative prior elicitation from predictions, expert opinion and other data sources

- a) Conjugate prior for GLMs
- b) Hierarchical prediction prior
- c) Information matrix prior
- d) Software using hdbayes, BayesPPD, and SAS

Learning Outcomes:

The primary learning objectives for this course are to (1) provide practitioners with a sound understanding of core, cross-cutting concepts for Bayesian informative prior elicitation for Bayesian design and analysis, (2) help practitioners understand the benefits and challenges of applying informative prior in using realistic case studies, and (3) to teach practitioners about software tools developed by the instructors (SAS, hdBayes, BayesPPD, and others) that can be used to implement and evaluate Bayesian methods using informative priors. Moreover, Furthermore, software demonstrations will be presented for several case studies illustrating the above mentioned packages as well as STAN, Nimble, and JAGS, By providing applied practitioners with a sound understanding of core

concepts related to prior elicitation, they will be better equipped to have discussions with internal and external colleagues regarding the appropriate use of these important methods for Bayesian design and analysis.

2. Procedimentos de avaliação

Não será aplicado avaliação durante o curso.

3. Bibliografia Obrigatória

4. Mini Currículo

Dr. Ibrahim's areas of research focus are Bayesian inference, missing data problems, medical imaging analysis and genomics. He received a Doctor of Philosophy degree in statistics from the University of Minnesota in 1988. With more than 30 years of experience working in cancer clinical trials, Ibrahim directs the UNC Center for Innovative Clinical Trials -- one of eight Gillings Innovation Labs funded by a gift to the School from Dr. Dennis and Joan Gillings.

Dr. Ibrahim is also the director of graduate studies in the Department of Biostatistics at the Gillings School, as well as the program director of the cancer genomics training grant in the same department. He has served on several national committees and study sections, including as the section chair of the Section on Bayesian Statistical Science of the American Statistical Association and the Biostatistical Methods and Research Design (BMRD) NIH Study Section. He has also served as the associate editor for several statistical journals, and was the editor of the Journal of the American Statistical Society (JASA) - Application and Case Studies from 2013 to 2015.

Dr. Ibrahim has published more than 360 research papers, mostly in the top statistical journals. He also has published two advanced graduate-level books on Bayesian survival analysis and Monte Carlo methods in Bayesian computation. He has also supervised over 40 doctoral dissertations. He is an elected fellow of the International Society of Bayesian Analysis, American Statistical Association, Institute of Mathematical Statistics, Royal Statistical Society, and an elected member of the International Statistical Institute.