Bayesian data analysis and cognitive modeling

This version: (First official draft)

Course instructors

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Application procedure

Goal and target audience

The seminar aims at all researchers concerned with the analysis of empirical data, in particular data obtained in behavioral experiments.

Application process

Please apply to Prof. Pachur directly via email: pachur@tum.de

Course aims

What this course is

The advantages of a Bayesian approach to data analysis have been known for a long time (e.g., Edwards, Lindman, & Savage, 1963). Recent developments in computer science have made the practical application of these approaches accessible. Bayesian methods avoid many of the problems of frequentist methods—such as not being able to confirm the null hypothesis or that p-values depend on the goals during participant recruitment (e.g., Wagenmakers et al., 2017; Kruschke, 2014). In addition, Bayesian statistics is more intuitive than frequentist statistics, in that it evaluates a hypothesis given the data rather than the other way round. Bayesian approaches are therefore likely to eventually replace frequentist approaches in data analysis. The goal of this course is to introduce students to the logic and practice of Bayesian statistics as well as to provide an introduction to cognitive modeling.

What this course is not

This course does not provide an introduction into frequentist statistics.

Course objectives

Knowledge Objectives

In the course, students will learn to understand the key Bayesian concepts of data analysis, such as the updating of a prior into a posterior distribution of beliefs, Bayes factors, and how Bayesian statistics helps to overcome limitations of the classical frequentists approach to data analysis. The course also provides an introduction into cognitive modeling, including the development and refinement of a model, and how to interpret the results of Bayesian parameter estimation with JAGS.

Skills Objectives
In the course, students will acquire the skill to implement common statistical tests (t-tests, ANOVA, correlation, regression) with the analysis program JASP (that can implement both frequentist and Bayesian implementations of these tests), learn how to interpret the results of Bayesian data analyses, to write code for Bayesian data analysis in JAGS, to implement cognitive models (e.g., memory models, prospect theory) in JAGS, and calling JAGS from R.

Learning Objectives
(see knowledge objectives and skills objectives)

Preliminary schedule

5.-7. September 2023, 9am - 6pm

Core readings

Dienes, Z. (2008). Bayes and the probability of hypotheses. In Dienes, Z., *Understanding psychology as a science: An introduction to scientific and statistical inference* (p. 82-120). Palgrave Macmillan.

Kruschke, J. K. & Liddell, T. M. (2018). Bayesian data analysis for newcomers. *Psychonomic Bulletin & Review*, *25*, 155-177.

Wagenmakers, E.-J. et al. (2018). Bayesian inference for psychology. Part I: Theoretical advantages and practical ramifications. *Psychonomic Bulletin & Review*, *25*, 35-57.

Shiffrin, R. M., Lee, M. D., Wagenmakers, E.-J., & Kim, W. J. (2008). A survey of model evaluation approaches with a focus on hierarchical Bayesian methods. *Cognitive Science*, *32*, 1248-1284.

Course procedures

The course will involve presentations from the instructor as well as many practical elements in which students get hands-on experience with the JASP, JAGS, and R. In addition, there will be group exercises. All students should bring a laptop with preinstalled free software (more information on the software that needs to be installed beforehand will be provided two weeks before the beginning of the course).

Assessment

Performance will be assessed with a quiz at the end of the course as well as a programming homework and a short report.

Credits

4 ECTS