

IOPS Course “Bayesian Item Response Modeling”

Lecturer Jean-Paul Fox

Department of Research Methodology, Measurement and Data Analysis

University Of Twente

8-9 October, 2020.

Location U Park Hotel at the Campus of the University of Twente

This two-day course will give an overview of recent developments in Bayesian (item) response modeling. Bayesian statistical theory has shown to be increasingly important in mainstream data analysis. The Bayesian paradigm makes it possible to include (prior) information in addition to the sample to improve statistical decision making. The combined set of information (prior and data information) can be used to make inferences, and as new information is collected, statements can be updated. An essential element is that probability statements are made about the quantities of interest.

In this course I will introduce the Bayesian methodology for modelling and analyzing (item) response data. The important features of the Bayesian approach will be discussed; (1) the powerful simulation-based methods for estimating models and (2) the possibility of incorporating prior information into the analysis. Data examples will be given of basic and more complex item response theory models. Posterior predictive assessment tools will be discussed for model evaluation and specific implementations will be discussed to evaluate the fit of Bayesian item response (theory) models.

More complex settings will be discussed to address challenges such as complex (multilevel) sampling designs, missingness and nonresponse, and complex response behavior. The multilevel modelling framework as well as the integration into the measurement model will be discussed. It will be shown that the Bayesian response modeling framework can be extended to include response times. I will also pay attention to recently developed joint models for responses and response times, which can deal with varying working-speed behavior. Examples will be given to illustrate the flexibility of the modeling framework, the often complex dependencies between response observations, while taking control of latent scale issues.

The software programs JAGS and R (Rstudio) will be used in the practical sessions. The practical sessions will focus on standard applications but the opportunity will be given to get further acquainted with Bayesian modeling software.

Prior Requirements

To take active part in the practical session, you need to bring your own laptop with JAGS (<http://mcmc-jags.sourceforge.net/>) and R (<http://www.r-project.org/>) installed. Some will prefer to work with RStudio (<https://www.rstudio.com/products/rstudio>). The R-packages LNIRT and GLMMRR can be downloaded from CRAN (<https://cran.r-project.org>).

Background Information (Literature):

- Fox, J.-P. (2010). *Bayesian Item Response Modeling: Theory and Applications*. Springer, New York. (see library UT)
- Albert, J.H. (1992). Bayesian estimation of normal ogive item response curves using Gibbs sampling. *Journal of Educational Statistics*, 17, 251-269.
- Fox, J.-P. and Glas, C.A.W. (2001). Bayesian estimation of a multilevel IRT model using Gibbs sampling. *Psychometrika*, 66, 269-286.
- Patz, R.J. and Junker, B. (1999). A straightforward approach to Markov Chain Monte Carlo methods for item response models. *Journal of Educational and Behavioral Statistics*, 24, 146-178.

Short Resume: Jean-Paul Fox (www.Jean-PaulFox.com)

Jean-Paul Fox works at the department of research methodology, measurement and data analysis, at the University of Twente, the Netherlands. He is a researcher in the area of Bayesian item response modelling and author of the monograph Bayesian Item Response Modeling published in 2010. He is known for his work on multilevel IRT modelling, where a multilevel survey design is integrated in the psychometric model. He received the 2001 Psychometric Association Dissertation award for his work on multilevel IRT modelling. He received two personal grants (veni,vidi) from the Netherlands Organization for Scientific Research to develop psychometric models for large-scale survey research.

Time Schedule:

Morning sessions: 10.00-12.30

Lunch: 12.30-13.30

Afternoon: 13.30:16.00

Hotel accommodation: Participants arrange their own accommodation. The course will be held at Hotel U Park, which is located on the campus.

(Preliminary) Overview

A) Thursday (08-10-2018).

- 1) Lecture.
 - a) Introduction to Bayesian Inference (Bayes is Probability Theory)
 - b) (Generalized) Bayesian Item Response Modeling
- 2) Practical (Exercises).
 - a) Learn Bayesian software (Bayes rule, Bayesian inference).
 - b) Bayesian IRT in JAGS.
 - c) General Bayesian Response Modeling.

B) Friday (09-10-2018).

- 1) Lecture.

Advances in Bayesian Response Modeling (Generalized multilevel IRT, Joint Response Models, Marginal Modeling Approaches)
- 2) Practical. (Exercises).
 - a) Bayesian Model Assessment.
 - b) Joint Modeling of Responses and Response Times (R-Package LNIRT)
 - c) Mixture modeling of Randomized Response Data (R-Package GLMMRR)

Please register as soon as possible (j.p.fox@utwente.nl).

Second-year Research master students (methods and statistics) can pre-enroll, enrollment becomes definitive when places are available since IOPS students have priority. Non-IOPS students can participate in this course but need to pay the course fee (Euro 400 for the two-day course). Furthermore, a bachelor-level understanding is required of statistical data analysis (e.g., generalized linear regression, scale analysis, item response theory, multilevel models). The course will be given in English.