Bayesian Modeling for the Social Sciences II:
Advanced Topics

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<tr>
<th>Date &amp; Time</th>
<th>Office hours</th>
<th>Teaching assistant</th>
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<tr>
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<td>Shuai Jin</td>
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Course Outline:

This course covers the theoretical and applied foundations of Bayesian statistical analysis at a level that goes beyond the introductory course at ICPSR. Therefore knowledge of basic Bayesian statistics (such as that obtained from the Introduction to Applied Bayesian Modeling for the Social Sciences workshop) is assumed. First, we will discuss model checking, model assessment, and model comparison, with an emphasis on computational approaches. Second, the course will cover Bayesian stochastic simulation (Markov chain Monte Carlo) in depth with an orientation towards deriving important properties of the Gibbs sampler and the Metropolis Hastings algorithms. Extensions and hybrids will be discussed. The third and fourth modules will focus on applications of Bayesian statistics in social science data analysis. The topics include Bayesian variants of classical “workhorse” models (Logit, Probit, Poisson) and their extensions, discrete choice models for ordered and unordered outcomes, Hierarchical models for cross-sections and panel data, factor analysis models, and Instrumental Variable Models. Throughout the workshop, estimation with modern programming software (R and JAGS) will be emphasized.

Reading:

Week I (Menninga)

Monday

• No course meeting. Recommended: start tomorrow’s reading.

Tuesday: Quick Review of Bayesian Inference & The Bayesian Prior

• Why Bayes?
• Bayesian Shrinkage
• (Many) Types of Priors
• Essential Reading: Gill (2014) Chapters 1-5

Wednesday: Bayesian Models; Assessing Model Quality

• Global Sensitivity Analysis
• Local Sensitivity Analysis
• Global Robustness
• Local Robustness
• Comparing Data to the Posterior Predictive Distribution
• Essential Reading: Gill (2014) Chapter 6

Thursday: Model Comparison

• Posterior Probability Comparison
• Cross-Validation
• Bayes Factors
• AIC, BIC, DIC
• Software Issues
• Essential Reading: Gill (2014) Chapter 7

Friday: Introduction to Markov Chain Monte Carlo

• What are Markov Chains?
• Some Simple Examples
• Marginal Distributions
• Properties of Markov Chains
• The Ergodic Theorem
• Rejection Sampling
• Classical Numerical Integration
• Importance Sampling
• Mode finding and the EM Algorithm
• Essential Reading: Gill (2014) Chapter 9

Optional additional reading


Week II: Markov Chain Monte Carlo (Menninga)

Monday: Gibbs sampling; Metropolis-Hastings
- The Gibbs Sampler
- The Metropolis-Hastings Algorithm
- The Hit-and-Run Algorithm
- Software Issues
- Essential Reading: Gill (2014) Chapter 10

Tuesday: Convergence Diagnostics
- Trace Plots
- Running mean plots
- Density/HPD plots
- The Geweke Diagnostic
- The Gelman and Rubin Diagnostic
- The Raftery and Lewis Diagnostic
- The Heidelberger and Welch Diagnostic
- Software Issues
- Essential Reading: Gill (2014) Chapter 14

Wednesday: Bayesian Decision Theory
- Essential Reading: Gill (2014) Chapter 8

Thursday: Bayesian Change Point Analysis
- Essential Reading: TBA

Friday: Dynamic Latent State Models
Essential Reading: TBA

Optional additional reading


Week III: (Bakker)

Monday: Review of the Linear Model and Extensions

- Bayesian linear model
- Residual analysis
- Model fit
- Conjugate and nonconjugate priors

Tuesday: Missing Data

- Multiple Imputation
• "Gibbs" imputation

Wednesday: Latent Variable Models I

• Bayesian factor model
• Bayesian IRT
• Identification through priors
• Uncertainty and information

Thursday: Latent Variable Models II

• Dynamic Latent Variables
• Random-walk prior
• Graphical Representation

Friday: Latent Variables III

• Correcting for cross-contextual biases/ Bayesian Aldrich-McKelvey model
• MIMIC models
• Incorporating uncertainty from latent variables in predictive models.

Week IV: Multilevel Models and other ’stuff’ (Bakker)

Monday: Multilevel Models

• Random vs Fixed effects
• The Bayesian Hierarchical Linear Model
• Advantages of Bayesian vs. Frequentist hierarchical models

Tuesday: MLM II

• Non-continuous level I outcome variables

Wednesday: Using informed priors

• Pros/cons of informed priors
• Where do they come from?

Thursday: Bringing it all together

• Demonstration/discussion of all of the above