POLSCI 9596B: Advanced Quantitative Methods

Bayesian Modeling

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- Office: 7210 SSC
- Office Hours: By Appointment

Course Overview

This course provides an applied introduction to Bayesian Modeling. The goal of the course is introduce you to why we might use Bayesian models, how we can evaluate them and how to write about them in practice. There are really three important aspects to this approach:

1. Understanding the theoretical underpinnings of Bayesian analysis (at least at an intuitive level).
2. Being able to estimate flexible Bayesian models in R.
3. Being able to summarise, compare and evaluate the performance of models.

The course does not focus explicitly on a one-to-one translation of Frequentist models in the Bayesian framework (though we will do this to some extent). Rather the course will focus on how to translate your conceptual ideas into empirical Bayesian models.

Computing

The computing landscape here has gotten considerably friendlier over the past decade or so. In the course, all computation will be done through R, though we will also use some boutique Bayesian modeling software, such as JAGS and Stan . JAGS uses code that is not difficult to learn if you're already an R user. Stan's code is a bit more complex, though much of the burden is removed by using the brms package, which we will discuss.

You should have the newest version of R and RStudio (or another IDE if you prefer). You should also install JAGS. We can install Stan through R.

Assignments

All homework assignments will be posted on OWL and you can turn in the assignments on OWL as well. The assignment write-up and code should both be included.

1. Dataset and Codebook - Due 1/23 [10 pts]
2. Means, Variances and Priors - Due 1/30 [10 pts]
3. Hierarchical Means, Variances and Priors - Due 2/6 [10 pts]
4. Simple Hypothesis Testing - Due 2/13 [10 pts]
5. Estimating and Evaluating Models - Due 3/6 [10 pts]
6. Final Paper - Due 4/17 [50 pts]

Outline and Readings

Week 1. Why be Bayesian? (1/9)

- Gill, *The Insignificance of Null Hypothesis Significance Testing*
- Western and Jackman, *Bayesian Inference for Comparative Politics*
- Efron, *Why Isn't Everyone a Bayesian* (OWL)
- Lambert, *A Student's Guide to Bayesian Statistics* , Chapter 2 (OWL)

Week 2. Nuts and Bots of Bayesian Analysis. (1/16)

- Kruschke, *Doing Bayesian Data Analysis* , Chapters 2, 4 and 5 (OWL)

Week 3. Introduction to Markov Chain Monte Carlo (MCMC) Simulation (1/23)

- Kruschke, *Doing Bayesian Data Analysis* , Chapters 6-8 (OWL)

Week 4. Hierarchical Models (1/30)

- Kruschke, *Doing Bayesian Data Analysis* , Chapters 9-10 (OWL)

Week 5. Bayesian Approaches to Hypothesis Testing (2/6)

- Kruschke, *Doing Bayesian Data Analysis* , Chapters 11-13 (OWL)
- Wagenmakers, Lodewyckx, Kuriyal and Grasman, _Bayesian Hypothesis Testing for Psychologists: A Tutorial on the Savage-Dickey Method

Week 6. Stan (2/13)

- Kruschke, *Doing Bayesian Data Analysis* , Chapter 14 (OWL)

- Betancourt, *An Introduction to Stan*
- Jackman, *Estimation and Inference Are Missing Data Problems*

Week 7. Bayesian Analogs to Frequentist Models using brms (2/27)

- Kruschke, *Doing Bayesian Analysis* , Chapter 15 (OWL)

Week 8. Measurement - Cross-Sectional (3/6)

- Congdon, *Applied Bayesian Modeling (2nd, ed.)* , Chapter 9 (OWL)
- Bruekner, *Bayesian Item Response Modeling in R with brms and Stan*

Week 9: Measurement - Time (3/13)

- Armstrong, *Measuring the Democracy-Repression Nexus*
- Armstrong, _Stability and Change in the Freedom House Political Rights and Civil Liberties Measures
- Fariss *Respect for Human Rights has Improved Over Time*

Week 10: GAMs and BAMs (3/20)

- Umlauf, Klein and Zeileis, _BAMLSS: Bayesian Additive Models for Location, Scale and Shape (and Beyond)
- Umlauf, Klein, Simon and Zeileis, _bamlss: A Lego Toolbox for Flexible Bayesian Regression (and Beyond)

Week 11: Multilevel Models (3/27)

- Gelman and Hill, *Data Analysis Using Regression and Multilevel/Hierarchical Models* , Chapters 11-13 (background reading on MLMs, OWL)
- Buerkner, *brms: An R Package for Bayesian Multilevel Models Using Stan*
- Buerkner, *Advanced Bayesian Multilevel Modeling with the R Package brms*

Week 12: Model Comparison and Selection (4/3)

- Lambert, *A Student's Guide to Bayesian Statistics* , Chapter 10 (OWL)
- Yao, Vehtari, Simpson and Gelman, _Using Stacking to Average Bayesian Predictive Distributions (with discussion) [Read main article, particularly the applied parts]
- Betancourt, *Sparsity Blues*