999: Workshop in Bayesian Analysis

Instructor of Record: John Ahlquist

Spring 2015

Course Overview

This is a collaborative independent reading about Bayesian methods in political science. There are no weekly assignments for this independent study. Weekly meetings will be optional except for the final session for project presentation and feedback. Those in attendance at the weekly meeting space will watch video lectures (courtesy of Justin Esarey) as a group, and will discuss the lecture and the readings, time permitting. This syllabus guides the expectations for each student enrolled in the independent study, and borrows heavily from syllabi constructed by Simon Jackman, Justin Esarey, and Patrick Brandt.

Joint session meetings are **Tuesdays 6–8 pm in Ogg**. Contents of the syllabus and time/location of these meetings are subject to change. Course readings will be collected and disseminated through Github. You can access shared materials here: https://github.com/bouchat/BayesWorkshop2015.git. John will also have office hours for this independent study on Tuesdays 1.15–2.15 pm.

Video Lecture Links

Video Lecture 1: Basic Concepts of Bayesian Inference

Video Lecture 2: Simple Bayesian Models

Video Lecture 3: Basic Monte Carlo and Sampling

Video Lecture 4: Metropolis-Hastings, Gibbs Sampler, and MCMC

Video Lecture 5: Practical MCMC

Video Lecture 5.1: JAGS

Video Lecture 6: Bayesian Hierarchical Models & GLMs

Video Lecture 7: Fitting Hierarchical Models with BUGS

Video Lecture 8: Item Response Theory & Scaling Latent Dimensions

Video Lecture 9: Model Checking, Validation, and Comparison

Video Lecture 10: Missing Data Imputation

Video Lecture 11: Multilevel Regression and Poststratification

Video Lecture 12: Bayesian Spatial Autoregression

LEGACY Video Lecture 6: IRT

LEGACY Video Lecture 10: Missing Data and Imputation

EXTRA Ensemble models (Bayesian model averaging et al)

EXTRA Computational Tools

Texts & Software

Jackman, Simon. 2009. Bayesian Analysis for the Social Sciences. Wiley. **(Most closely followed)**

Gelman, Carlin, Stern, and Rubin. Bayesian Data Analysis, Third Edition. Chapman and Hall/CRC. **(Recommended, listed as "BDA3")**

Gelman, Andrew, and Jennifer Hill. 2007. Data Analysis Using Regression and Multilevel/Hierarchical Models. Cambridge. **(Recommended)**

Hoff, Peter D. 2009. A First course in Bayesian Statistical Methods. New York: Springer. **(Recommended)**

This course is structured primarily around the use of R for analysis, although reference will also be made to OpenBugs (formerly WinBugs) and JAGS. If time allows, programming more complex models in Stan will also be addressed.

Assignments & Due Dates

Assignments for this class depend on whether students enroll for the 2 or 3 credit option, but are geared toward being able to understand and practically apply Bayesian methods to a research question. **Final projects are due one week after the last joint meeting session, at 5 pm.**

- Project Abstract: Regardless of credit status, all enrolled students will submit an abstract for their final project on **(Week 7)** of no more than 350 words (2000 characters). Abstracts should describe the research question, data, methods, and expected findings. Abstracts are expected to be of the format accepted for applications to the Political Methodology conference.

- Research Design (2 credit option): The final project for 2 credits is a research design of no more than 10 double-spaced pages. The research design will outline a project using Bayesian methods and discuss tradeoffs of this approach without performing the analysis. The research design could, for example, begin as a critique of an existing project using a frequentist approach and discuss the merits and potential value of pursuing the project in a Bayesian framework.

- Paper or Poster (3 credit option): The final project for 3 credits is either a final paper of no more than 15 double-spaced pages or a poster that could be used for a conference such as Political Methodology. The paper/poster will address a question of social scientific interest and present findings based on analysis using Bayesian methods.

Course Meetings & Readings

Week 1: Background and Theory of Bayesian Inference [No meeting, organizational]

Jackman, Ch. 1–2.

Jackman, Simon. 2004."Bayesian Analysis for Political Research." Annual Review of Political Science 7: 483-505.

Paxton et al. 2001. "Monte Carlo Experiments: Design and Implementation." Structural Equation Modeling 8(2): 287-312. http://www.unc.edu/~curran/pdfs/Paxton,Curran,Bollen, Kirby&Chen(2001).pdf

Week 2: Theory of Bayesian Inference, cont'd. (Single and multi-parameter models, relation to non-Bayesian techniques)

BDA3, Ch. 1–4

Sivia, Devinderjit and John Skilling. 1996. Data Analysis: A Bayesian Tutorial, 2nd Edition. Oxford: Oxford University Press. Ch. 1–2

Weeks 3–6: Posteriors and Sampling from Distributions/MCMC, BUGS, and JAGS (Video Lectures 2–5)

Jackman, Ch. 3–6

BDA3, Ch. 10–12 (skim)

The WinBUGS manual, particularly the Tutorial section. http://cran.r-project.org/web/ packages/R2WinBUGS/vignettes/R2WinBUGS.pdf

Sturtz et al. "R2WinBUGS: A Package for Running WinBUGS from R." http://cran.r-project. org/web/packages/R2WinBUGS/vignettes/R2WinBUGS.pdf

The MCMCpack manual http://mcmcpack.wustl.edu/files/MCMCpack-manual.pdf

Extra: Gill, Jeff. 2004. "Introduction to the Special Issue." Political Analysis 12: 323–337.

Extra: Gill, Jeff. 2008. "Is Partial-Dimension Convergence a Problem for Inferences from MCMC Algorithms?" Political Analysis 16: 153–178.

Extra: Jackman, Simon. 2000. "Estimation and Inference are Missing Data Problems: Unifying Social Science Statistics via Bayesian Simulation." Political Analysis 8(4): 307–332.

Week 7: Workshopping project abstracts [Please circulate abstracts by 12 noon on Monday]

Week 8: Latent Variable Models & Item Response Theory

Jackman, Ch. 9

Ayala, R. J. 2009. The Theory and Practice of Item Response Theory. Guilford. Ch. 1–2, 5

Curtis., S., McKay. 2010. "BUGS Code for Item Response Theory." Journal of Statistical Software 36: Code Snippet 1. www.jstatsoft.org/v36/c01/paper/

Clinton, Joshua, Simon Jackman, and Douglas Rivers. "The Statistical Analysis of Roll Call Data." American Political Science Review 98(2): 355-370.

Week 9: Model Checking

BDA3, Ch. 6–7

Kutner, Nachtsheim, Neter, and Li. Applied Linear Statistical Models, 5th ed. McGraw Hill-Irwin. Ch. 9–10

Jackman, Ch. 8

Week 10: Imputation

Gelman and Hill, Ch. 25

BDA3, Ch. 18

van Buuren and Groothuis-Oudshoorn. 2011. "mice: Multivariate Imputation by Chained Equations in R." Journal of Statistical Software 45(3). http://www.jstatsoft.org/v45/i03/

Week 11: Model Selection & Abstracts

Workshopping project abstracts

Papers featuring: causal identification, model selection, Bayes factors

Week 12: Multilevel & Hierarchical Models (Video Lecture 6)

Gelman and Hill, Ch. 11–13, 16

BDA3, Ch. 15

Jackman, Ch. 7

Park, David, Andrew Gelman, and Joseph Bafumi. 2004. "Bayesian Multilevel Estimation with Poststratification: State-Level Estimates from National Polls." Political Analysis 12(4): 375-385.

Lax, Jeffrey and Justin Phillips. 2009. "How Should We Estimate Public Opinion in the States?" American Journal of Political Science 53(1): 107-121.

Week 13: Discussion of Applications

Lindstadt, Rene, Jonathan B. Slapin, and Ryan J. Vander Wielen. 2011. "Balancing Competing Demands: Position Taking and Election Proximity in the European Parliament." Legislative Studies Quarterly 36: 37-70. http://goo.gl/XQkucs

Brandt, Patrick T. and John R. Freeman. 2009. "Modeling Macro-Political Dynamics." Political Analysis 17: 113-142. http://goo.gl/UQDOSm [optional]

Gill, Jeff and John R. Freeman (forthcoming) "Dynamic Elicited Priors for Updating Covert Networks," Network Science.

Montgomery, Jacob and Brendan Nylan. 2010. "Bayesian Model Averaging: Theoretical Developments and Practical Applications." Political Analysis 18(2): 245-270.

Montgomery, Jacob M., Florian M. Hollenbach, and Michael D. Ward. 2012. "Improving Predictions Using Ensemble Bayesian Model Averaging." Political Analysis 20(3): 271-291.

***More on Bayesian model averaging TBD

Week 14: Bayesian Decision Theory

BDA3, Ch. 9

E. T. Jaynes. Probability Theory: The Logic of Science. Ch. 13–14

Valen Johnson, "Revised standards for statistical evidence." Proceedings of the National Academy of Sciences, forthcoming. http://www.pnas.org/content/early/2013/10/28/1313476110.abstract

Murphy et al. Statistical Power Analysis: A Simple and General Model for Traditional and Modern Hypothesis Tests, Third Edition. Ch. 1–2

Justin Esarey and Nathan Danneman. "A Quantitative Method for Substantive Robustness Assessment." http://jee3.web.rice.edu/riskstats.pdf

Week 11: No meeting, Spring Break

Week 12: Advanced Topics [Optional]

Lee, Duncan. 2013. "CARBayes: An R package for Bayesian Spatial Modeling with Conditional Autoregressive Priors." Journal of Statistical Software 55(13): 1-24. http://www.jstatsoft.org/v55/i13/paper

Beck, Nathaniel, Kristian Skrede Gleditsch, and Kyle Beardsley. 2006. "Space is More than Geography: Using Spatial Econometrics in the Study of Political Economy." International Studies Quarterly 50: 27-44. http://www.nyu.edu/gsas/dept/politics/faculty/beck/isq_reprint.pdf

Besag, York, and Mollie, "Bayesian Image Restoration, with Two Applications in Spatial Statistics." Annals of the Institute of Statistical Mathematics 43(1): 1-59. http://www.ism.ac.jp/editsec/aism/pdf/043_1_0001.pdf

Sequential MCMC and Particle Filters: Lopes, Hedibart and Ruey Tsay. 2010. "Particle Filters and Bayesian Inference in Financial Econometrics." Journal of Forecasting 30: 168–209.

Building a new Bayesian model from scratch: Brandt, Patrick T. and Todd Sandler. 2012. "A Bayesian Poisson Vector Autoregression Model." Political Analysis. 20(3): 292–315.

Weeks 13–15: Workshopping projects/independent work on projects

Each participant will briefly present their progress on their project and receive feedback from other participants