Brown University, Department of Economics, Fall 2016

Syllabus, ECON 2600

Bayesian and Structural Econometrics

Instructor: Andriy Norets, andriy_norets@brown.edu

Lectures: MW, 2:30-3:50am, 45 Prospect St-Corliss Brackett 006B

Office Hours: M, 4:00-5:00pm, 209 Robinson Hall

Course Description: This course will cover a number of topics in Bayesian econometrics and estimation of structural dynamic discrete choice models. The Bayesian econometrics part of the course will start with introductory textbook material (Geweke, 2005, Contemporary Bayesian Econometrics and Statistics, denoted by G). A list of 11 topics with corresponding readings is given below. Topics 1-5 will be covered. A subset of topics 6-11 determined by interests of the course participants will be covered as well. Readings marked with asterisk * are not required.

Grading: The grade for the course will be based on problem sets. The problem sets will include analytical and computer problems. The computer problems will require the use of a programming language, such as Matlab or R. There will be a problem set for each topic we cover, 6-7 problem sets overall. A problem set will be assigned soon after the relevant material is covered in class; students will have 7-10 days to complete it. The problem sets will be equally weighted in determining the final grade, except for two problem sets with computer problems (these two problem sets will have a 3 times higher weight). Late problem sets will not be accepted.

Learning Goals:

- Understand the basics of the Bayesian approach to statistical inference and how it can be used in standard econometric models
- Learn about frequentist asymptotic properties of Bayesian procedures in parametric settings and how they relate to and contrast with the properties of standard frequentist procedures (some basics for nonparametric settings might also be covered in topics 6-11)
- Learn modern Bayesian simulation methods (Markov chain Monte Carlo) and how to implement them.
- Learn standard Bayesian nonparametric methods (Dirichlet processes and mixtures)
- Get close to the research frontier in one or two sub-areas of Bayesian econometrics or/and estimation of structural dynamic discrete choice models (topics 6-11)

Course Activities: Over 13 weeks, students will spend 3 hours per week in class (39 hours total). Reading, studying and completing analytical assignments will take approximately 10 hours per week for a total of 130 hours. Two computer assignments will take approximately 13 hours each for a total of 26 hours. Total number of hours is 195.

Useful books:

- Ferguson (1967) and Berger (1985) are books on statistical decision theory and Bayes.
- Berger and Wolpert (1984) contains good critique of frequentist procedures.
- Lancaster (2004) and Koop (2003) are introductions to Bayesian econometrics.
- Gelman et al. (2003) is a book on Bayesian statistics.
- Ghosh and Ramamoorthi (2003) - frequentist properties of Bayesian nonparametric procedures.

List of topics

1. Course overview and motivation
   - 1.1 Dehejia (2005) - an application of Bayesian decision theory to program evaluation
   - 1.2 Barberis (2000) - taking into account parameter uncertainty in portfolio optimization
   - 1.3 Keane (2010) - structural vs. non-structural econometrics
2. Bayesian approach to inference
   - 2.1 Probability as a degree of belief
   - 2.2 Conditioning
   - 2.3 Bayesian Modelling: ingredients, complete model, estimation, credible sets, model comparison (G Ch 2);
   - 2.4 Prior distributions: conjugate, non-informative, hierarchical (G Ch 3.1, 3.2; Berger (1985)*, Ch 3*; Bernardo (1979)*, Berger et al. (2009)*);
3. Frequentist asymptotic properties of posterior distributions in parametric Bayesian models
   - 3.1 Posterior consistency (G 3.4, Ghosh and Ramamoorthi (2003)*)
   - 3.2 Posterior asymptotic normality / Bernstein-von Mises theorem (G 3.4, Ghosh and Ramamoorthi (2003)*)
   - 3.3 Laplace approximations and BIC (Kass (1993)*), consistency of BIC (Hong and Preston (2012)*)
4. Simulation methods for Bayesian inference
   - 4.1 Basic simulation methods: pseudo random numbers, inverse cdf method, acceptance and importance sampling (G Ch 4);
   - 4.2 Intro to MCMC, Gibbs sampling, Metropolis-Hastings, and Hybrid MCMC algorithms (G Ch 4);

4.3 Econometric models: linear models, models with latent variables, hierarchical models for heterogeneity, time series models, SUR, mixtures of distributions (G Ch 5, 6, 7)

4.4 Practical issues: implementation checks, convergence testing, numerical accuracy, improving mixing, variance reduction, (G Ch 4.4, 4.7, 8.1).

4.5 MCMC for classical inference (Chernozhukov and Hong (2003)).

4.6 Unbiased likelihood simulation and MH (Flury and Shephard (2011))

4.7 Computing marginal likelihood (G Ch 8.2)

5. Bayesian nonparametrics: Dirichlet process priors

   5.1 Introduction (Ghosh and Ramamoorthi (2003), Ch 3; Ferguson (1973), Sethuraman (1994));

   5.2 MCMC for DP mixtures (Escobar and West (1995), Steven N. MacEachern (1998))

   5.3 Applications of DP mixtures in economics (Hirano (2002)*, Conley et al. (2008)*)

6. Bayesian nonparametrics: Gaussian process priors

   (G 5.4.1, Rasmussen and Williams (2006)*)

7. Dynamic discrete choice models, identification and estimation

   7.1 Surveys: Rust (1994); Aguirregabiria and Mira (2010);

   7.2 Hotz and Miller (1993); Bajari et al. (2007)

   7.3 Bayesian inference (Norets (2009), Norets and Tang (2010))

8. Foundations of Bayesian approach to inference

   8.1 Subjective probability and utility (Ferguson (1967))

   8.2 Frequentist decision theory and complete class theorem (Ferguson (1967), Berger (1985)*)

   8.3 Confidence sets and betting (Müller and Norets (2012))

   8.4 Likelihood principle (G Ch 1, 3.5; Berger and Wolpert (1984), Ch 1-3);

   8.5 De Finetti theorem (Heath and Sudderth (1976)*);

9. Bayesian bootstrap

   (Rubin (1981), Lancaster (2003), Poirier (2011), Chamberlain and Imbens (2003))

10. Theory of MCMC

    Tierney (1994), Roberts and Rosenthal (2004)

11. Frequentist asymptotic properties of posterior distributions in nonparametric models

    Ghosh and Ramamoorthi (2003) Ch4

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