ADVANCED ECONOMETRICS: BAYESIAN ECONOMETRICS and MCMC

by

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COURSE OUTLINE

Week I: Bayesian modeling and MCMC

Unit 1 : Bayesian Inference and Monte Carlo methods
Tuesday, February 21th, 9:00-10:30

Unit 2 : Metropolis-Hastings and Gibbs sampler
Wednesday, February 22th, 9:00-10:30

LAB 1 : Bayesian AR(1): Gibbs sampler in R
Wednesday, February 22th, 16:15-17:00

Unit 3 : Model criticism I
Thursday, February 23th, 9:00-10:30

Unit 4 : Model criticism II
Thursday, February 23th, 11:00-12:30

LAB 2 : Bayesian AR(p): model selection in R
Thursday, February 23th, 16:15-17:00

Unit 5 : General linear regression models
Friday, February 24th, 9:00-10:30

Week II: Econometric models

Unit 6 : Hierarchical models
Monday, February 27th, 9:00-10:30

Unit 7 : Limited dependent variable models
Monday, February 27th, 11:00-12:30

Unit 8 : Mixture and regime switching models
Tuesday, February 28th, 9:00-10:30

LAB 3 : Bayesian computation using WinBugs
Tuesday, February 28th, 16:15-17:00

Unit 9: Factor models
Wednesday, March 1st, 9:00-10:30

LAB 4 : Dynamic models
Wednesday, March 1st, 16:15-17:00

Unit 10: Stochastic volatility models
Friday, March 3rd, 9:00-10:30

Unit 1: Overview of Bayesian Inference and MCMC

(a) Bayesian ingredients

- Prior, posterior, and predictive distributions
- Sequential Bayes
- Conjugate analysis: normal model and normal prior
- Example from Box and Tiao (1973)

(b) Bayesian computation via Monte Carlo methods

- Chronological advances
- MCMC: a bit of history
- Simple Monte Carlo integration
- Monte Carlo integration via importance function
- Rejection method
- Sampling importance resampling (SIR)

Unit 2: Metropolis-Hastings and Gibbs sampler

(a) Historical background

(b) Metropolis-Hastings algorithms

- Random walk proposal
- Independence proposal
- Example: mixture of normals

(c) Simulated annealing

- Example: binomial regression

(d) Gibbs sampler

- Example: Poisson with changing point

Unit 3: Model criticism I

(a) Prior and posterior model probabilities

(b) Marginal likelihood and Bayes factors

(c) Computing the normalizing constant $p(y)$

  i. Laplace-Metropolis estimator
  ii. Simple Monte Carlo estimator
  iii. Monte Carlo estimator via importance function
    A. Harmonic mean estimator
    B. Newton and Raftery's estimator
    C. Generalized harmonic mean estimator
  iv. Annealed importance sampling estimator
  v. Brigde sampling estimator
  vi. Path sampling estimator
  vii. Chib's estimator
  viii. Chib and Jeliazkov's estimator

Unit 4: Model criticism II

(a) Savage-Dickey density ratio

(b) Bayesian model averaging (BMA)

  i. AR(p) models

(c) Deviance information criterion (DIC)

(d) Trans-dimensional MCMC algorithms

  i. Green's (1995) RJMCMC
  ii. Carlin and Chib's (1995) pseudo-priors
  iii. Godsill's (2001) composite model

Unit 5: General linear regression models

(a) Linear regression with general covariance matrix

  i. Heteroskedasticity of known form
  ii. Student's t errors
  iii. Autocorrelated errors

(b) Seemingly unrelated regression

Unit 6: Hierarchical models

(a) Hierarchical model/panel data
   i. Pooled model
   ii. Individual effects with (i) non-hierarchical and (ii) hierarchical priors
   iii. Random coefficients model

(b) Example: cost of airline companies

(c) Panel data examples in WinBugs
   - Orange trees, nonlinear growth curve
   - London school system
   - Repeated measures on Poisson counts

(d) Conditionally autoregressive (CAR) models

Unit 7: Limited dependent variable models

(a) General Tobit and linear Tobit models

(b) Probit and ordered probit models

(c) Multinomial probit model

(d) Example: Fair's (1978) extramarital affairs data

Unit 8: Mixture and regime switching models

(a) Mixture of univariate normal distributions
   - Example: velocities of galaxies

(b) Mixture of multivariate normal distributions

(c) Linear regression with mixture of normal errors
   - Example: three-component mixture

(d) AR(1) model with Markov switching regimes
   - Example: two-regime model

Unit 9: Factor models

(a) Classical factor models

(b) Bayesian factor models

Unit 10: Stochastic volatility model

(a) Model and prior

(b) Sampling the log-volatilities (single moves)

(c) Sampling the log-volatilities (block moves)
   - Approximating $\log \chi_1^2$ by a mixture of 7 normal densities

(d) Other stochastic volatility models

(e) Example 1: simulated study

(f) Example 2: Emergent stock markets

LAB1: Bayesian AR(1): Gibbs sampler in R

- Maximum likelihood estimation
- Closed form posterior dentities
- Gibbs sampler
- Forecasting
- Example 1: simulating an AR(1) process
- Example 2: revisiting Nelson and Plosser's (1982) data

LAB2: Bayesian AR(p): model selection in R

- Model structure
- Conditionally conjugate prior distributions
- Full conditional distributions
- Particular case: limited prior information
- Savage-Dickey density ratio
- Bayesian model averaging
- Simulation studies
  - Simulation 1: AR(1),. . .,AR(4), harmonic mean estimator
  - Simulation 2: AR(10), DIC, posterior model probabilities and RJMCMC

LAB3: Bayesian computation using WinBugs

- Graphical model
- From doodles to Bugs code
- From Bugs to R: R2WinBugs
- Examples:
  - Example 1: Hierarchical linear model
  - Example 2: Nonlinear growth model

LAB4: Dynamic models

- General dynamic linear model (DLM)
- First order DLM
- Second order DLM
- Forward distributions
- Smoothed distributions
- Full conditionals
- Generalized DLM

A few references

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