Preliminary Course Outline and Reading List

This outline lays out the topics that we should try to cover in this course. Probably we can't cover them all. Parts of the outline are more detailed, with specific references, because they correspond to material from previous versions of this course. The less detailed parts of the outline will be filled in. If viewed online with Acrobat Reader, there should be clickable links in the text.

Kallenberg (2002) is an advanced, thorough, account of probability and stochastic process theory. It assumes solid grounding in real analysis and measure theory. It is listed here only as a reference, for students whose mathematical background is strong and may want to pursue topics in this course at a more advanced or rigorous level. The Hamilton (1994) book covers many of the models used in time series econometrics and that we will deal with in this class. Hamilton proceeds more slowly through the material than we will in this class and he gives more emphasis to non-Bayesian asymptotic theory of inference than we will (and less to Bayesian inference). The Bauwens, Lubrano, and Richard (1999) book is closer in approach to this course than is Hamilton's but because of its variations in mathematical level and choice of topics only parts of it are assigned reading.

This course will primarily discuss inference from a Bayesian perspective. Since this perspective is sometimes given scant attention in the Princeton first-year econometrics sequence, we will introduce and review Bayesian inference ideas as we encounter them. The 2004 version of ECO517 gave a systematic introduction to Bayesian inference; if you have had little or no previous exposure to those ideas, you might find it useful to look at course materials from that version of the course, which are available online, and/or any of the books Schervish (1995), Robert (1994), Berger (1985), Geweke (2006), Lancaster (2004) and Gelman, Carlin, Stern, and Rubin (1995). They have somewhat different choices of topics and assume varying levels of mathematical background, with Schervish the most demanding and Lancaster or Gelman et al the least, in this respect. Geweke and Lancaster are both oriented toward econometrics, while the others are oriented toward statistics. A reference for Monte Carlo computational methods for sampling from posterior densities is Robert and Casella (2004).

There will be exercises that assume you are able to use a programming language like S, R, Matlab, Scilab, Octave, or possibly Mathematica, to carry out matrix algebra calculations and to run iterative algorithms. R and Octave are free, open-source software. R is almost identical, as a language, to S, but has a limited graphical interface (GUI). (Its ability to produce graphs is not limited. It just has limited ability to produce menus and let you initiate actions with mouse clicks.) Octave is similarly very close as a language to Matlab, while having a more limited GUI. S and Matlab and R are available on the departmental computer cluster and on the university's network servers `hats.princeton.edu` and `arizona.princeton.edu`. If you use, or want to try, R, good references are Venables and Ripley (2001) and Venables and Ripley (2002).

None of the books are required for purchase, but any of those listed that fit your mathematical and statistical background would be good investments, both for this course and later reference.

1. Inference: Bayesian basics
    (a) Decision theory
    (b) Complete class theorems
    (c) Likelihood principle
    (d) Bayesian scientific reporting
2. Stochastic processes
    (a) Probability as $(S, \mathcal{F}, \mu)$ triple.
    (b) Conditional expectation, conditional probability
    (c) Discrete and continuous time processes
    (d) i.i.d discrete time processes
    (e) First finite-parameter family of processes: Discrete time Gaussian MA processes; their likelihood; uniqueness.
3. General Gaussian stationary processes
    (a) Autocovariance function
    (b) Spectral density
    (c) Ergodicity
    (d) Mixing conditions
    (e) One-sided inversion of convolution operators.
    (f) Innovations, fundamental MA representation.
    (g) Linearly deterministic and linearly regular processes, the Wold decomposition
    (h) Seasonality
    (i) Time aggregation
4. The ARMA family of processes
    (a) AR processes
    (b) MA processes
    (c) Density in the Gaussian stationary class
5. Inference for ARMA models: The Kalman filter.
    (a) Priors and posteriors for the standard normal linear model
    (b) The Kalman filter
    (c) Initialization
    (d) AR coefficients as states

(e) Lagged innovations in MA models as states
(f) The Kalman filter as a component of likelihood-based inference
(g) Smoothing vs. filtering

6. Importance Sampling, Metropolis-Hastings MCMC

    (a) Importance sampling and its pitfalls
    (b) Metropolis Markov Chains and their pitfalls
    (c) Metropolis-Hastings
    (d) “Gibbs” Sampling
    (e) Assessing convergence
    (f) Computing marginal data density
    (g) Particle filtering
    (h) Application to ARMA models nonlinear in parameters: Linearized DSGE models.

    (Hamilton, 1994, section 12.3)
    Gelman, Carlin, Stern, and Rubin (1995), Chapter 11
    Notes: “Proof of Fixed Point Property for Metropolis Algorithm"

7. ARMA models nonlinear in parameters: Linearized DSGE models.

    (a) The Smets and Wouters project

    Smets and Wouters (2003)

8. High-order and multivariate AR models

    (a) Review of multivariate linear stochastic difference equations
        i. Roots to qualitatively characterize models
        ii. Impulse response functions
            A. Impulse responses vs. ACF’s as data summaries
    (b) Exogeneity, Granger causality, Wold and Granger causal orderings
    (c) Structural VAR’s and identification
        i. Delay restrictions
        ii. Long run restrictions
        iii. Restrictions on impulse responses
    (d) Stochastic volatility and GARCH
    (e) Factor models

    (Hamilton, 1994, Chapters 10.1-10.3)

9. Hidden Markov chain and non-recurrent break models
   (a) Structural breaks
   (b) Regime shifts
   (c) Approximation to parameter change and stochastic volatility models

   Hamilton (1994), Chapter 22
   Chib (1996)

10. Modeling initial conditions and “trend”
    (a) High-order AR + conditioning on initial conditions + flat prior $\Rightarrow$ belief in likely historical uniqueness of sample start date
    (b) Unit roots
    (c) Cointegration
    (d) Fractional integration
    (e) Realistic modeling of uncertainty about the long run vs. “removing trend”.

    (Sims, 2000)
    (Sims, 1989)
    (Sims, revised 1996)
    (Hamilton, 1994, section 19.1)
    (Sims and Uhlig, 1991)

11. Dummy-observation priors for VAR’s

    (Sims and Zha, 1998)
    Notes: Dummy observation priors

12. Formulating, using, testing restrictions or priors on VAR’s
    (a) Recursiveness restrictions
        i. Exogeneity and likelihood structure
           (Bauwens, Lubrano, and Richard, 1999, sections 2.6, 5.2.1-2)
    (b) Priors and restrictions for structural VAR’s
        i. Litterman/Leeper/Sims/Zha
        ii. Long run restrictions
        iii. Priors on impulse responses
        iv. Reduced form vs. structural parameters as space for prior
        v. Error bands for impulse responses

        (Hamilton, 1994, Chapters 11, and 9, section 12.2)
        Notes: “Granger Causality” (There is some redundancy between these notes and the set below.)

Notes: Likelihood for VAR systems
Blanchard and Quah (1989)
Leeper, Sims, and Zha (1996)
Sims and Zha (1998)
Sims and Zha (1999)
DelNegro, Schorfheide, Smets, and Wouters (2006)

13. More models

    (a) Dynamic factor models
    (b) Stochastic volatility

14. Inference: Asymptotic theory

    (a) Central limit theorems and functional central limit theorems
    (b) Bayesian and sampling theory asymptotics: differences and connections
    (c) Asymptotics do not free us from assumptions
    (d) Asymptotics for nonstationary models

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