PSC 585 Dynamic and Computational Modeling

Spring, 2008
TTh 11:00-12:20pm
Harkness 329

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Dynamic considerations are becoming increasingly important in the study of such political processes as stability of international systems, the conduct of war, legislative policy making, regime change, and the impact of political variables on economic growth and industry dynamics. We provide theoretical and computational tools for the study of such applications. The course covers the basics of dynamic programming and general dynamic games and the main results on Markov chains. The main focus is the study of stochastic games with an emphasis on numerical analysis of models illustrated in a number of applications. The goal of the course is to equip graduate students with analytical and numerical tools that can be used in their future research on applied topics.

Students are expected to have taken the first-year sequence in formal theory, PSC 407 and 408, as well as PSC 584. Some familiarity with a programming language (such as Matlab or R) is a plus, but the dedicated student should be able to acquire basic programming skills needed for the course. Homeworks are a definite possibility.

There are three textbooks for the course, the first two required and the third optional.

- N. Stokey and R. Lucas with E. Prescott (1989) *Recursive Methods in Economic Dynamics,* Cambridge, MA: Harvard University Press.
- M. Miranda and P. Fackler (2002) *Applied Computational Economics and Finance,* Cambridge, MA: MIT Press.
- R. Sundaram (1996) *A First Course in Optimization Theory,* New York, NY: Cambridge University Press.

We break the content of the course into six sections. Note that some of the readings referenced below are mathematically demanding. We will intersperse mathematical background throughout the course and, where appropriate, present simplified versions of the readings. Jean-Jacques Herings will be giving two guest lectures on computational economics during the week of March 17–21.

1. Markov chains

   (a) finite state: Stokey-Lucas-Prescott, Section 11.1

(b) general state: Stokey-Lucas-Prescott, Sections 11.2–11.4

(c) strong law of large numbers: Stokey-Lucas-Prescott, Chapter 14

(d) MCMC & Computation of invariant distributions:

- Grassman, Taksar, Heyman (1985) "Regenerative Analysis and Steady State Distributions for Markov Chains," *Operations Research,* 33(5): 1107–1116.
- Sheskin, T. (1985) "A Markov Chain Partitioning Algorithm For Computing Steady State Probabilities," *Operations Research,* 33(1): 228–235.
- Tierney (1994) "Markov Chains for Exploring Posterior Distributions," *The Annals of Statistics* 22(4): 1701-1762.

2. Dynamic programming

(a) certainty:

- Stokey-Lucas-Prescott, Chapter 4
- Sundaram, Chapter 12
- J. Rust (2006) "Dynamic Programming," working paper.

(b) uncertainty: Stokey-Lucas-Prescott, Chapter 9

3. Computational dynamic programming:

(a) finite state: Miranda-Fackler, Chapter 7

(b) general state:

- Miranda-Fackler, Chapters 8 and 9
- J. Rust (1987) "Optimal Replacement of GMC Bus Engines - An Empirical Model of Harold Zurcher," *Econometrica,* 55: 999-1033.

4. Game theory

(a) static games

- R. McKelvey and T. Palfrey (1995) "Quantal Response Equilibria for Normal Form Games," *Games and Economic Behavior,* 10: 6–38.
- S. Govindan and R. Wilson (2001) "Direct Proofs of Generic Finiteness of Nash Equilibrium Outcomes," *Econometrica,* 69: 765–769.

(b) stochastic games

- E. Maskin and J. Tirole (2001) "Markov Perfect Equilibrium: I. Observable Actions," *Journal of Economic Theory,* 100: 191–219.
- P. Dutta and R. Sundaram (1998) "The Equilibrium Existence Problem in General Markovian Games," in Mukul Majumdar, ed., *Organizations with Incomplete Information: Essays in Economic Analysis, A Tribute to Roy Radner,* Cambridge.
- H. Haller and R. Lagunoff (2000) "Genericity and Markovian Behavior in Stochastic Games," *Econometrica,* 68: 1231–1248.
- S. Chakrabarti (1999) "Markov Equilibria in Discounted Stochastic Games," *Journal of Economic Theory,* 85: 294–327.

5. Computation of equilibrium

   (a) simplicial methods for fixed points

      - R. McKelvey and A. McLennan (1996) "Computation of Equilibria in Finite Games," in, H. Amman, D. Kendrick, and J. Rust, eds, *Handbook of Computational Economics, Vol. 1,* Elsevier: Amsterdam.

   (b) static games

      - J.-J. Herings and R. Peeters (2001) "A Differentiable Homotopy to Compute Nash Equilibria of n-Person Games," *Economic Theory,* 18: 159–185.
      - J.-J. Herings and A van den Elszen (2002) "Computation of the Nash Equilibrium Selected by the Tracing Procedure in n-Person Games," *Games and Economic Behavior,* 38: 89–117.
      - T. Turocy (2005) "A Dynamic Homotopy Interpretation of the Logistic Quantal Response Equilibrium Correspondence," *Games and Economic Behavior,* 2005: 243–263.
      - J.-J. Herings and R. Peeters (2005) "A Globally Convergent Algorithm to Compute All Nash Equilibria for n-Person Games," *Annals of Operations Research,* 137: 349–368.
      - J.-J. Herings and R. Peeters (2006) "Homotopy Methods to Compute Equilibria in Game Theory," working paper.

   (c) stochastic games

      - J.-J. Herings and R. Peeters (2004) "Stationary Equilibria in Stochastic Games: Structure, Selection, and Computation," *Journal of Economic Theory,* 118: 32–60.

6. Applications

   (a) estimation in dynamic models

      - V. J. Hotz and R. Miller (1993) "Conditional Choice Probabilities and the Estimation of Dynamic Models," *Review of Economic Studies* 60: 497–529.
      - R. Ericson and A. Pakes (1995) "Markov-Perfect Industry Dynamics: A Framework for Empirical Work" *Review of Economic Studies* 62: 53–82.
      - V. Aguirregabiria and P. Mira (2002) "Swapping the Nested Fixed Point Algorithm: A Class of Estimators for Discrete Markov Decision Models," *Econometrica* 70: 1519–1543.
      - P. Bajari, C. L. Benkard, and J. Levin (2007) "Estimating Dynamic Models of Imperfect Competition," *Econometrica* 75: 1331–1370.
      - V. Aguirregabiria and P. Mira (2007) "Sequential Estimation of Dynamic Discrete Games," *Econometrica* 75: 1–53.

   (b) computation in dynamic bargaining games: TBA