Syllabus

Applied Computational Economics

Universidad de los Andes
June 23 – July 7, 2009

Purpose and Scope

The course will provide a thorough introduction to the rapidly developing field of computational economics. The course will focus on practical applications of numerical methods to the formulation, solution, and analysis of stochastic dynamic models in economics and finance, with special emphasis on nonlinear dynamic optimization and equilibrium models.

Who Should Take the Course

The course should be of interest to established and emerging economists who wish to learn how to use numerical techniques to solve and analyze economic models that do not possess closed-form algebraic solution or that otherwise cannot be readily solved using conventional mathematical analytic techniques. Potential areas of application include, but are not limited to, agricultural, environmental, development, financial, industrial, and macro- economics.

Course participants should have completed standard undergraduate courses in Calculus, linear algebra, and probability and an advanced mathematically-based course in microeconomics. Familiarity with computers is also expected. Experience with the Matlab or Gauss is highly desirable, but not essential.

Instructor

Mario J. Miranda, Ph.D., Andersons Professor of Finance & Risk Management and Director of Graduate Programs, Department of Agricultural, Environmental, & Development Economics, The Ohio State University, USA; Associate Editor, Journal of Economic Dynamics and Control and Journal of Computational Economics.

Course Structure

Students will be expected to attend ten four-hour lectures and one two-hour final examination. Lectures will take place from 2:00pm-6:00pm on the following dates: Tuesday, June 23 – Friday, June 26, 2009; Tuesday, June 30-Friday, July 3; and Monday, July 6 – Tuesday, July 7. Computationally-intensive homework assignments will be assigned on Friday, June 26 and Friday, July 3. Both assignments will be due the following Monday.

Textbooks

Strongly Recommended: *Applied Computational Economics and Finance*, by Mario J. Miranda and Paul W. Fackler, MIT Press, Cambridge, MA, 2002.

Recommended: *Numerical Methods in Economics*, by Kenneth L. Judd, MIT Press, Cambridge, MA, 1998.

Recommended: *Economía de Recursos Naturales: Aplicaciones de Economía Computacional en la Solución de Problemas Dinámicos*, by Jorge Higinio Maldonado, Monograph, Universidad de los Andes, 2008.

Software

Because the course will involve hands-on applications on a computer, each student will be expected to have access to a personal computer on which MATLAB Release R2007a or higher is installed. In addition, each computer must have installed the CompEcon Toolbox, which may be freely downloaded from the website http://www4.ncsu.edu/~pfackler/compecon/toolbox.html. Participants who have no experience with Matlab will be provided with an elementary self-directed tutorial which should be completed before attending the workshop.

Evaluation

Course grades will be assigned based on the following weights: class participation 10%, problem sets 30%, final examination 60%. The written comprehensive final examination is tentatively scheduled for 10:00am-12:00 noon on Saturday, July 11.

Course Outline

The first half of the course will be devoted to numerical techniques, including linear equation, nonlinear equation, integration, differentiation, and function approximation methods. The second half of the course will be devoted to the application of these methods to the formulation, solution, and analysis of dynamic stochastic economic models, with examples drawn from agricultural, environmental, financial, and macro- economics.

1. **Introduction**
   Some Apparently Simple Questions
   An Alternative Analytic Framework

2. **Linear Equations and Computer Basics**
   L-U Factorization
   Rounding Error and Pivoting
   Ill Conditioning
   Special Linear Equations

3. **Nonlinear Equations and Complementarity Problems**
   Function Iteration
   Newton's Method
   Quasi-Newton Methods
   Problems With Newton Methods
   Choosing a Solution Method
   Complementarity Problems

4. **Finite-Dimensional Optimization**
   Univariate Optimization
   Newton-Raphson Method
   Quasi-Newton Methods

5. **Numerical Integration and Differentiation**
   Newton-Cotes Methods
   Gaussian Quadrature
   Monte Carlo Integration
   Quasi-Monte Carlo Integration
   Numerical Differentiation

6. **Function Approximation**
   Interpolation Principles
   Polynomial Interpolation
   Spline Interpolation
   Multidimensional Interpolation
   Choosing an Approximation Method
   The Collocation Method

7. **Discrete Time Dynamic Models: Theory**
   Continuous Space Dynamic Programming
   Euler Conditions
   Continuous State, Discrete Choice Models
   Continuous State, Continuous Choice Models
   Rational Expectations Models

8. **Discrete Time Dynamic Models: Methods**
   Linear Quadratic Control
   Bellman Equation Collocation Methods
   Implementation of Collocation Methods
   Postoptimality Analysis
   Discrete Choice Examples
   Continuous Choice Examples
   Rational Expectations Examples