Course Objectives: Most of the dynamic economic models used in modern quantitative research in economics do not have analytical (closed-form) solutions. For this reason, the computer has become an indispensable tool for conducting research in dynamic economics. The goal of this two-part course is precisely to teach students computational tools for conducting numerical analysis of dynamic economic models. The focus of the first half of the course, taught by Prof. Tony Smith, is on solving dynamic programming problems and on computing competitive equilibria of dynamic economic models. The first half of the course also provides an introduction to some of the basic tools of numerical analysis, including minimization, root-finding, interpolation, function approximation, and integration. The focus of the second half course, taught by Prof. Michael Keane, is on solving and estimating discrete-choice dynamic programming models of economic behavior. Taken together, the two halves of the course provide students with a thorough introduction to the numerical analysis of dynamic economic models in both microeconomics and macroeconomics.

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Class Meetings: The course meets on Mondays and Wednesdays from 2:30PM to 3:50PM in a room to be determined.
Prerequisites: This course is designed for graduate students in economics who have taken first-year graduate courses in microeconomics, macroeconomics, and econometrics. No prior knowledge of either numerical methods or computer programming is assumed, but some familiarity with a programming language would prove helpful.


Other (optional) books that students might find useful are:


Grading: The course grade will be based on two (equally-weighted) projects, one for the first part of the course and one for the second part of the course. Each project consists of writing a program in Fortran to solve an assigned problem. Students must submit their code as well as a brief (roughly five pages) description of their numerical findings. The first project will involve solving for the competitive equilibrium of a dynamic macroeconomic model; the second project will involve solving and estimating a discrete-choice dynamic programming model. Fortran is the language of choice for most researchers in computational economics; requiring that the code for the projects be written in Fortran will help students to become proficient in this powerful and useful language.

The first project is due on Monday, November 14 and the second project is due at the end of the semester.
Occasional short programming problems may also be assigned as the course proceeds. The purpose of these assignments is to help students develop the skills they need to complete the projects; these assignments will not be graded.

**Approximate Schedule of Lectures (Part I)**

**I. INTRODUCTION**

**Lecture 1**  Introduction to numerical dynamic programming (built around the stochastic-growth model and the Aiyagari (1994) model). General considerations in numerical analysis: convergence, roundoff error, truncation error. Numerical differentiation.

*Readings:*


- *Numerical Recipes*: Chapters 1 and 5.7

- Judd: Chapters 1, 2, and 7.7

**II. BASIC NUMERICAL METHODS**

**Lecture 2**  Root-finding in one or more dimensions: bisection, secant method, Newton’s method, fixed-point iteration, Gauss-Jacobi, Gauss-Seidel, Brent’s method.

*Readings:*

- *Numerical Recipes*: Chapter 9

- Judd: Chapter 5
Lecture 3  Minimization in one or more dimensions: golden section search, Brent’s method with or without derivatives, simplex method, Newton-Raphson, variable metric methods.

Readings:

- Numerical Recipes: Chapter 10
- Judd: Chapter 4

Lectures 4–5  Interpolation and approximation of functions: linear interpolation in several dimensions, cubic splines, polynomial interpolation, orthogonal polynomials.

Readings:

- Numerical Recipes: Chapters 3 and 6
- Judd: Chapter 6

Lecture 6  Integration: cubic spline integration, Gaussian quadrature, Monte Carlo integration, integration of multivariate normal densities.

Readings:

- Numerical Recipes: Chapters 4 and 7
- Judd: Chapters 7 and 8

III. NUMERICAL DYNAMIC PROGRAMMING

Lecture 7  Linear-quadratic methods and second-order methods

Readings:


Lectures 8–11  Nonlinear methods for models with continuous choices: value iteration, Euler equation methods, rules of thumb, perturbation methods, Coleman’s method, parameterized expectations.

Readings:

- Judd: Chapters 12, 13, 16, and 17

IV. COMPUTATION OF EQUILIBRIA

Lectures 12–14  Computing Equilibria of Heterogeneous-Agent Models

Readings:


