Computational Economics
FALL 2021

Instructor: Prof. Aaron Hedlund (e-mail: hedlunda@missouri.edu)

Time and Location: T, R 2:00pm – 3:15pm, Strickland Hall 106

Office Hours: By Appointment, 226 Professional Building

Canvas: https://umsystem.instructure.com

Dropbox Link: https://www.dropbox.com/sh/ydtvop0lfxadnr5/AACrbpn-QtgK_p-LMfXYj9Pia?dl=0

Final Exam: N/A

Overview and Objectives

Course Description

This course has two primary objectives. First, the course aims to provide a solid understanding of modern computational techniques used in economics. The emphasis here is on developing efficient, accurate solution algorithms to solve a wide class of economic models. Second, the course will explore how to bring models to the data (and vice-versa), i.e. how to use economic models to answer research questions of a quantitative nature.

Prerequisites and What to Expect

This course is primarily an *applied tools* course. The course is a *tools* course in the sense that the fundamental objects of study are algorithms and techniques, rather than economic theory. However, it is *applied* because the tools are designed with specific types of economic questions and models in mind.

The course is designed as an upper-level PhD course; therefore, a background in core PhD microeconomics and macroeconomics is expected. Also, some background in computer programming (especially Matlab, Fortran, and/or C/C++) is helpful but not necessary. It is possible to pick up sufficient programming knowledge as the semester progresses, particularly in the case of the more user-friendly Matlab. In the long run, I recommend learning Fortran to students who anticipate heavy computational work in their research. **Important:** this course is *not* a programming course. From time to time, I expect to discuss code for different algorithms in class, but my focus will be on the algorithms and the models themselves, not on programming syntax.

Resources

The main reference book is *The Handbook of Computation Economics, Volume 3*, but I also suggest gradually adding the following books to your research library:

General texts:

- *Economic Dynamics in Discrete Time* (Miao)
- *Numerical Methods in Economics* (Judd)
- *Applied Computational Economics and Finance* (Miranda and Fackler)
- *Computational Methods for the Study of Dynamic Economies* (Marimon and Scott)

Geared toward macroeconomics (but still useful to non-macroeconomists):

- *Dynamic General Equilibrium Modeling* (Heer and Maussner)
- *Dynamic Economics* (Adda and Cooper)
- *Frontiers of Business Cycle Research* (Cooley)
- *The ABCs of RBCs* (McCandless)
- *Methods for Applied Macroeconomic Research* (Canova)
- *Structural Macroeconometrics* (Dejong and Dave)

Assessment

Your course grade will be based on three computational projects that are designed to develop your ability to use economic theory, data, and computational methods to conduct research. In these projects, you will compute economic models from class to see how well they explain data and to perform "computational experiments." You may use any computer language of your choice, though I suggest Matlab for people who are not well-versed in computer programming. You will need to turn in the output *and* source code (compiled so that I can run it) for each project.

Grading Scale Each project accounts for one third of your semester grade, and the grading scale is as follows: A (85 – 100), B (70 – 85), C (55 – 70), F (<55).

Course Outline

1. **Discrete Time Stochastic Dynamic Programming**

2. **Representative Agent Models**

   (a) Value Function Methods

   - Value Function Iteration
     Grid search, multi-grid, accelerators, monotonicity, concavity, multi-dimensional optimization (e.g. consumption/savings with endogenous labor; portfolio choice)
   - Policy Function Iteration
   - Endogenous Grid Method

   (b) Euler Equation Methods

   - Perturbation
   - Projection

   (c) Error Analysis

   Partial List of Numerical Tools: discretization of stochastic processes, interpolation, numerical integration/differentiation, root finding

3. **Heterogeneous Agent Models with Incomplete Markets**

   (a) Steady State of Infinite Horizon Models

   (b) Steady State of Life Cycle Models

   (c) Transitional Dynamics

   (d) Models with Default

4. **Heterogeneous Agent Models with Incomplete Markets and Aggregate Risk**

   (a) Solution Methods to Krusell-Smith Economies

   (b) Models with Multiple Assets

5. **Data and Identification**

   (a) Some Useful Data and Tools

   (b) Calibration and Estimation

Papers to investigate: Aiyagari 1994, Gourinchas Parker 2002, Kaplan Violante 2014, Krusell Smith 1997/1998, Krusell et al 2010, Chatterjee et al 2007, Arellano 2008, Shimer 2005, Hagedorn Manovskii 2008, Smets Wouters 2007, Christiano et al 2005, Epple et al 2006/2013, Gavazza et al 2014, etc.

MU Policies

Information on MU policies related to COVID-19 mitigation; academic integrity; academic inquiry, course discussion, and privacy; FERPA; intellectual pluralism; netiquette; religious holidays and accommodations; nondiscrimination; and students with disabilities is here: https://provost.missouri.edu/faculty-affairs/syllabus-information