**Georgetown University** **ECON 609, Fall 2019**

# Computation of Dynamic Models with Applications

## GENERAL INFORMATION

Professor Minsu Chang

**Class Time and Location:** Tuesdays 9:30AM - 12:00PM, WGR 407 except for two dates.

- There will be no class on November 26th (Thanksgiving week).
- The last class will be on December 10th at WGR 204 from 9:30AM.

**Office Hours and Location:** Tuesdays 12:30PM - 1:30PM, ICC 553

**Email:** minsu.chang@georgetown.edu

## COURSE DESCRIPTION

**Course Description:** This course is an introduction to computing dynamic models in economics. We will study tools to solve and estimate linear/nonlinear models that are useful to conduct substantive quantitative research. Although we will mostly cover applications in macroeconomics, the methods taught throughout the course will be applicable to various dynamic models in economics.

**Prerequisites:** Graduate level macroeconomics and econometrics.

**Course Website:** Canvas page at `https://georgetown.instructure.com/courses/89515`.

## COURSE REQUIREMENTS

**Problem Sets [50%]:** There will be four problem sets, assigned during the semester. Students can discuss the problem sets, but each student has to write his/her own solution and codes. The solution together with the codes must be submitted via Canvas by 6:00 pm on the specified due dates. These due dates are binding and late submissions will not be accepted.

- Problem Set 1 Monday September 23rd, 6:00 pm
- Problem Set 2 Monday October 14th, 6:00 pm
- Problem Set 3 Monday October 28th, 6:00 pm
- Problem Set 4 Monday November 18th, 6:00 pm

**Class Participation [20%]:** After each problem set is submitted, it will be discussed in class by students. A student will be asked to present his/her answer to a problem set question. If there is a volunteer to present his/her results, extra credit will be given to the person. A typical presentation will include the main result and the summary of computational approach taken (highlighting key parts of one's code, not going through it line by line).

**Paper Presentation [30%]** Students will be assigned research papers on recent advances in computational methods. Each student will have 30-40 minutes to present including questions and comments from other students and myself. Students should prepare for slides and send them to me by 6:00 pm the day before their presentation. A presentation should include the contribution of a paper and explain the gist of methodology so that everyone in class has something learned from each presentation. Your own presentation will account for 20%. The remaining 10% is determined based on your participation and discussion regarding other students' presentations. You are expected to attend both presentation dates.

- October 22nd List of papers uploaded (paper suggestion by October 21st)
- October 29th Papers and presentation dates assigned
- December 3rd Presentation (group 1)
- December 10th Presentation (group 2)

## TEXTBOOK AND SOFTWARE

**Course Text:** There is no official textbook for this course. My lecture slides, which will be posted online at the start of each week, are the final authority on course material.

**Required Software:** This course requires students to program in at least one programming language. MATLAB is recommended because it is commonly used in economics and some questions in problem sets will require software provided in MATLAB. I will talk more about this on the first day of class.

**Recommended Texts:** The following books and articles are suggested for your reference.

- Judd, Kenneth (1998): *Numerical Methods in Economics*, MIT Press.
- Marimon, Ramon and Andrew Scott (1999): *Computational Methods for the Study of Dynamic Economies*, Oxford University Press.
- Herbst, Edward and Frank Schorfheide (2015): *Bayesian Estimation of DSGE Models*, Princeton University Press.
- Fernandez-Villaverde, Jesus, Juan Rubio-Ramirez, and Frank Schorfheide (2016): *Solution and Estimation Methods for DSGE Models*, In: H. Uhlig and J. Taylor (eds.): Handbook of Macroeconomics, Vol 2, Elsevier.
- Krueger, Dirk, Kurt Mitman, and Fabrizio Perri (2016): *Macroeconomics and Household Heterogeneity*, In: H. Uhlig and J. Taylor (eds.): Handbook of Macroeconomics, Vol 2, Elsevier.

I will also refer to a list of published articles and working papers in our lectures.

## COURSE OUTLINE

- **Numerical optimization and a brief intro to Bayesian inference**:
  optimization methods with/without derivatives, mixed methods, simulation methods, Bayes theorem, Bayesian linear regression
- **Linear(ized) models and estimation**:
  linearization with a basic RBC model, solving a linearized system, estimation with Kalman filter
- **Value Function Iterations**:
  VFI with finite/infinite horizon, numerical implementation, discretization of stochastic processes, convergence assessment, endogenous grid method
- **Nonlinear models**:
  examples of nonlinear models, intro to functional equation
- **Perturbation methods:**
  perturbation with a RBC model, higher moment approximation, non-local accuracy test, perturbation on value function
- **Projection methods:**
  Chebyshev polynomials, multidimensional problem
- **Estimation with particle filter:**
  nonlinear state-space model, bootstrap particle filter, generic particle filter, application with a small-scale DSGE model
- **Heterogeneous-agent models:**
  models without aggregate uncertainty, unexpected aggregate shock and transition dynamics, models with aggregate uncertainty
- **Recent advances in solution and estimation methods:**
  presentations by students