Computational Macroeconomics

Module 3, 2019-2020

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Course description

Many, if not most, dynamic models used in modern macroeconomics do not have analytical (closed-form) solutions. For this reason, numerical methods and computer programming have become indispensable tools of the macroeconomic research. In this course we will discuss the main computational algorithms of the dynamic optimization problem. We will start with overview of the basic results from dynamic programming. Then, we will study the main numerical algorithms for its solution with application to a simple neoclassical growth model. In particular, we will consider linear-quadratic approximation, value and policy functions iterations algorithms and their modifications, perturbation and projection methods. Finally, we will discuss more complicated algorithms for solving heterogeneous agents' models. This course requires a basic knowledge of MATLAB, however programming skills in Fortran 90 or Python will be a plus.

Course requirements, grading, and attendance policies

There will be a few (maximum 4) home assignments (50% of the grade) asking for writing a code in MATLAB (or in GNU Octave, Fortran 90, Python, C++, etc.) to solve a simple dynamic programming problem. The exam (50% of the grade) will contain questions on a published macroeconomic article handed out in advance. All these components (including all home assignments), as well as at least 70% attendance, are mandatory for getting a passing grade.

Course contents

1. **Review of dynamic programming:** mathematical preliminaries, contraction mapping theorem, Blackwell's sufficient conditions, theorem of the maximum, dynamic programming under uncertainty

2. **Discrete-state dynamic programming:** value function iteration algorithm and its improvements, policy function iteration, interpolations and splines

3. **Linear approximation methods:** linear-quadratic (LQ) approximation algorithm, first-order perturbation methods

4. **Higher-order perturbation methods**

5. **Projection methods:** finite elements method, spectral methods (Chebyshev polynomials)

6. **Parameterized expectations algorithm**

7. **Heterogeneous agents models and incomplete market economies:** computation of stationary equilibrium, transitional dynamics, aggregate uncertainty in heterogeneous agents models, Krussel-Smith algorithm

Course materials

Required textbooks and materials

1. Heer, Burkhard & Maussner, Alfred, *Dynamic General Equilibrium Modeling: Computational Methods and Applications*, Springer, 2nd ed., 2009

2. Ljungqvist, Lars & Sargent, Thomas J., *Recursive Macroeconomic Theory*, The MIT Press, 2nd ed., 2004

Additional materials

1. Marimon, Ramon & Scott, Andrew, *Computational Methods for the Study of Dynamic Economies*, Oxford University Press, 1999

2. Adda, Jerome & Cooper, Russell W., *Dynamic Economics: Quantitative Methods and Applications*, The MIT Press, 2003

3. Judd, Kenneth L., *Numerical Methods in Economics*, The MIT Press, 1998

4. Stokey, Nancy L., Lucas, Robert E. & Prescott, Edward C., *Recursive Methods in Economic Dynamics*, Harvard University Press, 1989

5. DeJong, David N. & Dave, Chetan, *Structural Macroeconometrics*, Princeton University Press, 2nd ed., 2011

I will also provide a reading list of papers applying the quantitative methods discussed in the class, with the rate of about 2-3 per week.

Academic integrity policy

Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.