Computational Methods in Economics

Course Outline

This course provides a 15 hours (5 lectures) introduction to numerical methods in economics with a focus on macroeconomic applications. The course is intended for students with a good background in economics (at least a master degree), but it does not require any particular experience in computational economics or numerical analysis. Knowledge of a programming language will be a plus, but this is not a requirement. The idea of the class is to show how to use computational techniques to solve (macro)economic models with a particular emphasis on dynamic models. The lectures will be a mix between theory and practice, and every method will be illustrated by an example.

The course includes 5 problem sets with the associated codes. The correct code will be made available to the students after the course. The outline of the lectures and problem sets are provided below.

INTRODUCTION TO DYNAMIC PROGRAMMING

This lecture will review the basics of the Bellman principle of optimality both in the deterministic and in the stochastic case. Then, we will see how these theoretical insights can be used to solve models numerically using simple value iteration, but also some refinements such as policy iteration or the endogenous grid method. We will then see how the solution can be used to simulate the model and obtain, in the stochastic case, the unconditional distribution of endogenous variables. This lecture will also be used to review some basics of Matlab programming as the methods developed in this lecture do not require any sophisticated functions. During this lecture we will solve versions of the optimal growth model, and we will also solve a prototypical heterogenous agent model.

PERTURBATION METHODS

In this lecture, we will review the so-called perturbation method, as implemented, for example in Dynare. The purpose is twofold. First, understand what it exactly does and how it does it (with its particular implementation in Dynare), and second (and probably most importantly) what are its merits but also its perils.

APPROXIMATION, INTERPOLATION AND INTEGRATION TECHNIQUES

This second lecture will introduce useful tools for the computational economist. In particular, we will see how one can solve nonlinear systems of equations, but also how (smooth) functions can be approximated relying on simple polynomials, how one can use interpolation techniques to economize on the number of grid points in a dynamic programming problem. We will also discuss numerical integration techniques that are commonly used when solving models involving an integration step (for example models with rational expectations).

PARAMETERIZED EXPECTATIONS ALGORITHM

This lecture will introduce the so-called Parameterized Expectations Algorithm introduced by den-Haan and Marcet. This algorithm relies on simulation techniques and is very amenable to a relatively large class of models, including those with possibly binding constraints. We will rely on Monte-Carlo simulation techniques and polynomial approximation techniques to obtain solution to the model.

MINIMUM WEIGHTED RESIDUAL TECHNIQUES

In this lecture, we will review methods that attempt to directly approximate the solution of the model by guessing a (polynomial) functional form for the agents' decision rules. In particular, we will see how to solve models using 2 widely used techniques, the collocation method and the Galerkin method. In both cases, an explicit guess is formulated and the restrictions imposed by the model are directly used to find a solution. We will also see how the method can accommodate occasionally binding constraints.