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Computational Methods
Summer Semester 2017

Course Description

Micro- and Macroeconomic models generally lack closed form solutions and thus require numerical methods to get at least quantitative results for a particularly specified and parameterized model. The knowledge of numerical methods is therefore indispensable for applying economic models in policy and business consulting as well as in research. The objective of this course is to introduce same basic concepts of numerical analysis and to make the students familiar with solution methods for a broad class of economic models, including examples from finance, game theory, and macroeconomics. While most examples are used to illustrate the different algorithm and programming techniques, there will be a special focus on the quantitative macroeconomic workhorse model at the end of the lecture.

This course gives an introduction to computational economics. Starting point will be an introduction to Matlab, one of the most-widely used computer programs for simulating economic models. In the main part of the lecture basic numerical methods are presented, i.e. solving linear and nonlinear equations, numerical optimization, integration and differentiation as well as function approximation. All of the topics will be presented theoretically and will be accompanied by going through the computer code so that about half of the course will be applied. The lecture will be given in a computer lab where the students will be able to work on their own codes.

There are some textbooks that are helpful throughout the complete course. In particular, the book by Judd (1998) provides a comprehensive overview on numerical methods and applies them to various economic problems. The book by Miranda and Fackler (2004) considers a broader range of economic problems and comes together with a well programmed and very reliable Matlab toolbox that can be downloaded from the author's web page (some bottlenecks of the algorithm are programmed in C, which leads to substantial speed improvements).

The course outline is as follows

1. Introduction to Computational Economics and Matlab (approx. 2 session)
2. Numerical Foundations (approx. 8 session)
   - 2.1. Root Finding
     textbook treatment: Judd (1998) ch. 5, Miranda and Fackler (2004) ch. 3
   - 2.2. Optimization
     textbook treatment: Judd (1998) ch. 4, Miranda and Fackler (2004) ch. 4
   - 2.3. Function Approximation
     textbook treatment: Judd (1998) ch. 6, Miranda and Fackler (2004) ch. 6
   - 2.4. Integration and Differentiation
     textbook treatment: Judd (1998) ch. 7, Miranda and Fackler (2004) ch. 5

3. Neoclassical Growth Model / Real Business Cycle Model (4 sessions)

   3.1. Infinite Horizon Ramsey Model
   textbook treatment: Stokey and Lucas (1989) ch. 4, 9 &, 10 , Ljungqvist and Sargent (2004) ch. 12

   3.2. Value Function Iteration and Refinements
   textbook treatment: Heer and Maussner (2008) ch. 4

   3.3. Euler Function Iteration and Time Iteration
   textbook treatment: Judd (1998) ch. 16.4

   3.4. Calibration and Welfare Analysis
   textbook treatment: Cooley and Prescott (1995) and Lucas (1987)

Prerequisites

1. Intermediate macroeconomics, microeconomics, and mathematics.
2. There are no prerequisites in terms of programming experience. We will start from scratch with an introduction to MatLab in the first sessions.

Examination

1. For regular master students, there will be an exam at the end of the semester.
2. For research track master students, there will be problem sets, that have to be handed in before the the exercise session. The problem sets will be graded and add up to a substantial part of the final grade. Problem sets can be done in groups of up to 3 people (and not more, otherwise there will be a discount for the grade!). Furthermore, there will be a term paper at the end of the course. The paper requires you to perform a longer programming task with first steps towards own research ideas. The paper should be between 8 and 10 pages and in contrast to the assignments where you can hand in one answer sheet per group, everyone has to hand in her/his own unique term paper.

References

Cooley, T. F., and E. C. Prescott (1995): "Economic Growth and Business Cycles," in *Frontiers of Business Cycle Research*, ed. by T. F. Cooley, chap. 1, pp. 1–39. Princeton University Press.

Heer, B., and A. Maussner (2008): *Dynamic General Equilibrium Modelling: Computational Methods and Applications*. Springer.

Judd, K. L. (1998): *Numerical Methods in Economics*, vol. 1 of *MIT Press Books*. The MIT Press.

Ljungqvist, L., and T. J. Sargent (2004): *Recursive Macroeconomic Theory, 2nd Edition*, vol. 1 of *MIT Press Books*. The MIT Press.

Lucas, R. E. (1987): *Models of Business Cycles*, vol. 1. Basil Blackwell.

Miranda, M. J., and P. Fackler (2004): *Applied Computational Economics and Finance*. The MIT Press.

Stokey, N. L., and R. E. Lucas (1989): *Recursive Methods in Economic Dynamics*. Harvard University Press.