



## Computational Economics and Finance

(Draft 26.02.2015 – subject to change)

Course #: 590, MFOEC167

ETCS-Points: 6.0

Curricula: MA: Wahlpflichtbereich BWL 6

MQF08: Wahlpflichtmodule Mathematical Methods for Finance (MF)

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Class Times: Tuesday 14:00 – 15:45, KOL-G-221

Thursday 16:15 – 18:00, KOL-G-221

Office Hours: Tuesday, 16:00 – 18:00, and by appointment

Textbook: Numerical Methods in Economics

Kenneth L. Judd

The MIT Press, Cambridge MA (1998)

Software: Mathematica, Matlab, GAMS, SINGULAR, ... and whatever software gets the job done

Website:

<http://www.business.uzh.ch/professorships/qba/teaching/operationsResearch/lectures/CEF.html>



### Course Description

The objective of this course is to introduce graduate students to numerical methods and their computer implementations for solving economic models. We will formulate economic problems in computationally tractable form and apply numerical analysis techniques to solve them. We will study computational methods that have seen many applications in the economics literature as well as techniques that to this date have rarely been applied by economists but have great potential for applications in economics. In addition we study areas of economic analysis where numerical analysis may likely prove useful in future research. The economic applications will cover a wide range of problems including models from finance, macroeconomics, game theory, mechanism design, industrial organization, econometrics and other research areas.

### Course Prerequisites

Ideally students should have passed graduate level courses in microeconomics, macroeconomics and finance. Moreover students should have a good undergraduate background in linear algebra, calculus and probability theory.

### Software

Students will need to know some computer language. My suggestion is to learn at least Matlab and Mathematica. The University of Zurich has a campus license for Matlab, see <http://www.s3it.uzh.ch/software/matlab/>. The complete documentation of Matlab and its toolboxes can be freely downloaded at [www.mathworks.com](http://www.mathworks.com). For example, a very detailed tutorial to get you started is available at [www.mathworks.com/access/helpdesk/help/pdf\\_doc/matlab/getstart.pdf](http://www.mathworks.com/access/helpdesk/help/pdf_doc/matlab/getstart.pdf). Mario Miranda and Paul Fackler developed a Matlab toolbox called *CompEcon* that includes many useful routines for solving economic models. The toolbox can be freely downloaded at [www4.ncsu.edu/~pfackler/compecon/toolbox.html](http://www4.ncsu.edu/~pfackler/compecon/toolbox.html). The textbook by Miranda and Fackler (see supplemental textbooks) shows how to use this toolbox.

Those students who want to use Mathematica instead of Matlab can download the campus license from <http://www.s3it.uzh.ch/software/mathematica/>.

### Supplemental Textbooks

You may find it helpful to consult other textbooks in Computational Economics or Numerical Mathematics. Here is a list of suggestions for further readings.

Brandimarte, Paolo, 2006, "Numerical Methods in Finance and Economics: A MATLAB-Based Introduction", John Wiley & Sons, Inc., New York, NY.

Miranda, Mario J., and Paul L. Fackler, 2002, "Applied Computational Economics and Finance", The MIT Press, Cambridge, MA.

Nocedal, Jorge, and Stephen J. Wright, 2006, "Numerical Optimization", Springer-Verlag, New York, NY.



## Assignments

Doing computation is the only way to learn computation. To facilitate your learning you will receive homework assignments roughly every two to three weeks. You are welcome to work in groups of two or three and are strongly encouraged to discuss problem sets with your classmates. Classmates are also a valuable source for advice on software and programming as well as general computer advice.

Each group must submit a write-up of the solutions by the beginning of class on the date indicated on the problem set. The write-up should

- ✓ provide a concise verbal description of the methods employed;
- ✓ use tables or graphs (or both) to summarize the results;
- ✓ contain your computer programs in an appendix.

A submission of only computer programs and their outputs is not acceptable as a write-up. Please remember to list the names of all group members who contributed to the solution on the final write-up.

We will discuss the solutions to many exercises in class. If your group has been selected to present your solution for a particular exercise then you will explain your solution to your classmates and me and illustrate it on a computer. Therefore, you will have to bring your computer programs to class on a memory stick or on your laptop.

## Term Paper

You have considerable freedom to follow your interests in choosing a topic for a term paper. The paper should

- motivate and formulate a research question;
- present an economic model;
- explain why numerical methods are needed to solve the model;
- discuss a computational strategy for solving the model;
- present the results;
- evaluate the accuracy of the results.

The term paper should be at most 15 double-spaced pages excluding tables, graphs, and appendices (12 point font,  $\geq 2$  cm margins). You are welcome to work in groups of two or three but are encouraged to write the paper by yourself. Ideally this term paper will eventually turn into a master thesis or dissertation paper.

You should start thinking of a topic early in the semester. The term paper could involve replicating a computational paper. Another approach to find a topic is to think of a theoretical paper that does not compute any examples (with the exception of perhaps trivial ones) and to compute a set of interesting examples. Ideally, however, the term paper would ask (and answer) an original research question.



Once you have identified a topic, please write a short (at most two-page) proposal. Submit the proposal to me and make an appointment to discuss the suitability of the topic. All students should have found a suitable topic by the middle of May. You will present your research ideas and initial results for your term paper during the last week of classes. The goal of this presentation is to help you organize your thoughts and obtain feedback from your classmates.

The final version of the term paper is due TBA.

### **Course Grade**

Course grades will depend on your team assignments (50%) and the term paper (50%). There are no exams.

### **WWF Statutory Course Policies**

Academic dishonesty in any form will not be tolerated. Anyone caught cheating or engaging in unethical behavior will be reported to the Dean's office according to the guidelines on academic dishonesty set forth by the University of Zurich.

Don't forget to officially register for the course using the registration tool (Modulbuchungstool) of the University of Zurich.

Note: The information in this syllabus supports the official information in the VVZ. In cases of doubt, the official information in the VVZ is decisive.



**Class Schedule** (subject to change)

All chapter references in the reading lists refer to our textbook.

1. (Tuesday, February 18)

**Elementary Concepts of Numerical Analysis**

Readings: Chapters 1, 2.

Judd, Kenneth L., 1997, "Computational Economics and Economic Theory: Substitutes of Complements?" *Journal of Economic Dynamics and Control* 21, 907 – 942.

Goldberg, David, 1991, "What Every Computer Scientist Should Know About Floating-Point Arithmetic," *Computing Surveys*, 23, 5 – 48.

2. (Thursday, Feb 20)

**Introduction to Mathematica**

3. (Tue, Feb 25)

**Elementary Concepts of Numerical Analysis**

4. (Thu, Feb 27)

**Introduction to Mathematica**

5. (Tue, March 4)

**Linear Equations**

Readings: Chapter 3.

Judd, Kenneth L., Felix Kubler and Karl Schmedders, 2011, "Bond Ladders and Optimal Portfolios," *Review of Financial Studies* 24, 4123 – 4166.

6. (Thu, Mar 6)

**Linear Equations**

7. (Tue, Mar 11)

**Taylor's Theorem**

8. (Thu, Mar 13)

**Unconstrained Optimization**

Readings: Chapter 4.

And much more to come.