Econ 690: Computational Economics/Numerical Methods

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Overview of the Class
The purpose of this class is to give you a computational toolbox you can apply to economic questions. We will introduce and use numerical methods on computationally tractable problems. The goal of the course is to encourage Ph.D. students to be apply these techniques to their own research. Our in-class applications will primarily be public policy and macro-oriented, by solving and simulating the problems of microeconomic agents and aggregating the results.

Outline
All course applications will use Matlab: I'm fine with you using whatever program you're comfortable with, but support for other programs will be relatively limited. The course starts with the theory and simple empirics of solving for policy functions of Bellman equations and simulating agent behavior. The course will then slowly introduce new tools that make the problems we can tractably solve and simulate more and more complex and realistic. After simple discrete Bellman equations, the broad topics we will introduce are 1) numerical derivatives, 2) maximization techniques (derivative-based and derivative free, with local and global methods) 3) numerical interpolation, 4) quadrature methods 5) simulated maximum likelihood and simulated method of moments. These topics will allow us to extend our dynamic problems in interesting ways. Because the course is focused on your own research, we will have student presentations at the end of the quarter. A short paper or research proposal (with preliminary computational work) is the capstone of this course. I urge you to use this as your *first* stab at a dissertation topic. Failure will be a good learning opportunity.

Text
We will use Ken Judd's textbook, Numerical Methods in Economics. This textbook is not required, but is a wonderful reference and allows anyone interested to extend their toolbox far beyond the scope of this course. I have also made available Mario Miranda and Paul Fackler's Applied Computational Economics and Finance. This book introduces concepts in a clear way, and also serves as a vehicle for their Matlab toolbox (which we will not use, but is very good).

Logistics
This class meets on Mondays and Wednesday 9:50-11:20 a.m. in Rawls 2079. My office hours will be after class, from 11:30-12:30 on Mondays in KRAN 541.

Software
We will use Matlab, should be available on your Krannert office computers.

Paper
While this course discusses primarily public policy and macroeconomic applications, it should be useful for students with empirical or theoretical interests of any type. The main point of this course is to allow you to extend your research. To that end, I require you to find a topic by 4th week (I will set up a series of short consultation meetings with me) and work out a computational example of that topic and write up the results by the end of 8th week. You will give a short 15-20 minute presentation of your topic at the end of the quarter in front of the class. Your final paper should address any crucial problems, corrections, or

suggestions made during your presentation. However you code, your final paper submission will include code that can be run easily that will produce your discussed output.

Formal Requirements

The formal requirements for this course are two computational problem sets, a "midterm" paper suggestion, a final presentation, and a final paper. Your grade will be constructed using the naive average of:

- Two problem sets, weighted at 35%.
- Your paper suggestion (around 4th week) 10%.
- Your 20-minute paper/proposal presentation (around 7th/8th week) 20%.
- Class participation 5%.
- Your final paper/proposal and code (not to exceed 15 pages) 30%.

Extremely Tentative Schedule

Date	Topic	Reading	Homework
August 24th	Outline of course, Bellman Equations (theory)	·	·
August 26th	Bellman Equations (solutions)	Judd, Ch. 12 (espec. 12.1-12.6)	·
August 31st	Newton's Method	Judd, Ch. 4.1-4.3 Judd, Ch. 5.2	·
September 2nd	Other Maximization Methods	Judd, Ch. 4.4-4.8	Hwk. 1 Assigned
September 7th	Labor Day	·	·
September 9th	Interpolation/Chebychev Polynomials	Judd, Ch. 6.1-6.9	·
September 14th	Quadrature	Judd, Ch. 7.1-7.5	Hwk. 1 Due, Project Meetings
September 16th	Application: Unemployment Insurance	Sargent & Ljungqvist, 1998	Hwk. 2 Assigned, Project Meetings
September 21st	Application: Solving the NCG	Conesa, Kehoe and Ruhl 2005	·
September 23rd	CGE Models	Harberger, 1968 Shoven and Whalley, 1984	·
September 28th	Simulated Estimation - I	Rust, 1989, McFadden, 1989,	Hwk. 2 Due
September 30th	Simulated Estimation - II	Keane and Moffitt, 1995	·
October 5th	Heterogeneous Agents and Equilibrium	Krusell & Smith, 1998	·
October 7th	Monte Carlo Methods	Judd, Ch. 8.1-8.6	·
October 12th	October Break	·	·
October 14th	Student Presentation	·	·
October 19th	Student Presentation	·	·
October 25th	All Papers Due	·	Papers Due

References

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Conesa, J. C., Kehoe, T. J., and Ruhl, K. J. (2007). Modeling great depressions: the depression in Finland in the 1990s. *Quarterly Review*, (Nov):16–44.

Deaton, A. (1991). Saving and Liquidity Constraints. *Econometrica*, 59(5):1221–48.

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

Keane, M. and Moffitt, R. (1995). A structural model of multiple welfare program participation and labor supply. Technical report.

Krusell, P., Smith, A. A., and Jr. (1998). Income and Wealth Heterogeneity in the Macroeconomy. *Journal of Political Economy*, 106(5):867–896.

Ljungqvist, L. and Sargent, T. J. (1998). The European Unemployment Dilemma. *Journal of Political Economy*, 106(3):514–550.

McFadden, D. (1989). A Method of Simulated Moments for Estimation of Discrete Response Models without Numerical Integration. *Econometrica*, 57(5):995–1026.

Rust, J. (1987). Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher. *Econometrica*, 55(5):999–1033.

Shoven, J. B. and Whalley, J. (1984). Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey. *Journal of Economic Literature*, 22(3):1007–51.