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. We then slowly introduce new tools that make the problems we can tractably solve and simulate 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/written field exam. 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 "CompEcon" toolbox (which we will not use, but is very good).

Logistics
This class meets on Tuesdays and Thursdays 1:10-2:40 p.m. in Rawls 2077. My office hours will be on Thursdays, from 8:50-9:50 a.m. in KRAN 315.

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

Homework Philosophy
The homeworks in the course are designed to help you be a researcher, not someone who does homeworks. Many research problems are (initially) ill-posed, need additional assumptions, or don't have a clear way forward. The homeworks I assign attempt to give you this feel. Historically, they are too hard: people don't complete everything, nor are they expected to. Instead, the point of the homework is to dive headlong into trying to solve a problem and (1) learn the shape of the sorts of obstacles you have to overcome and (2) how to fill in the gaps yourself. Both are far more pertinent skills for either private or academic research than formulaic homeworks. If you can't solve one part of the homework, make the necessary assumptions to make progress (for instance, if a problem is stochastic, first solve the deterministic one! Or assume a continuous

choice is discrete, or that a state variable is inconsequential, and so on.)

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:

- Four 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 30%.

Extremely Tentative Schedule

Date	Topic	Reading	Homework
October 19th	Outline of course, Matlab Review	·	Hwk. 1 Assigned
October 24th	Bellman Equations (theory & solutions)	Judd, Ch. 12 (espec. 12.1-12.6)	
October 26th	Newton's Method	Judd, Ch. 4.1-4.3 Judd, Ch. 5.2	
October 31st	Other Maximization Methods	Judd, Ch. 4.4-4.8	Hwk. 1 due Hwk. 2 assigned
November 2nd	Interpolation/Chebychev Polynomials	Judd, Ch. 6.1-6.9	
November 7th	Neural Networks & Reinforcement Learning	Powell, Ch. 10	Hwk. 2 Due Hwk. 3 Assigned
November 9th	Application: Unemployment Insurance	Sargent & Ljungqvist, 1998	Project Meetings
November 14th	Application: Solving the NCG	Conesa, Kehoe and Ruhl 2005	Hwk. 3 Due, Project Meetings
November 16th	CGE Models-I	Gallen and Mulligan 2018 Shoven and Whalley, 1984	Hwk. 4 Assigned
November 22nd	CGE Models-II		
November 28th	Simulated Estimation - I	Rust, 1989 Shoven and Whalley, 1984	Hwk. 4 Due
December 1st	Simulated Estimation - II	Judd and Su 2012	
December 5th	Simulated Estimation - III	Keane and Moffitt, 1995, McFadden, 1989,	·
December 7th	Heterogeneous Agents and Equilibrium	Krusell & Smith, 1998	
TBD	Student Presentations (1-5 in KRAN 301)	·	
December 18th	All Papers Due	·	Papers Due

References

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