

Welcome to the ICE11 Summer Workshop
Initiative for Computational Economics

Sponsored by

University of Chicago
Argonne National Laboratories

Computation Institute
Becker Friedman Institute
Economics Research Center
Graduate Program, Chicago Booth School of Business

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Why ICE?

- Computational technologies are exploding in their ability to analyze scientific and mathematical problems in every science.
- Economics is different: In the opinion of an applied mathematician, “Economists will soon be so far behind they will not be able to catch up.”
- The computational approach has enormous potential for economic analysis, but very little is being exploited.
- The Initiative for Computational Economics is working to change this.

Attitude of Economics Towards Numerical Methods

- “Nothing in numerical analysis would be useful in economics” - statement made in October, 2009, to an audience of applied mathematicians by the chairman of a leading Economics Department.
- “[A new professor] can easily learn about computation after he finishes his thesis and starts his job” - comment on why an offer was made to a job candidate who understood nothing about his computations.
- Very few economics departments offer their students serious training in computational methods.
- A sample of what is taught in an actual “course”:
 - Use the simplest possible methods.
 - Use methods that are as transparent as possible (i.e., methods for which the computer code reflects as closely as possible the economic structure of the problem).
 - Watch the computations as they proceed.
 - Use one-dimensional algorithms as much as possible.
 - Avoid black boxes.

Conventional “Wisdom” versus ICE11

Optimization Methods

- CW: There have been no advances in optimization algorithms in the past 45 years that would be useful in economics (for example, see lead article of the diamond anniversary volume of *Econometrica*).
- ICE11: Todd Munson, author of the best CGE software available (presented in his University of Wisconsin Computer Science PhD thesis), and winner of a Presidential Early Career Award for Scientists and Engineers in 2006, will survey the advances going back to Robert Wilson's 1964 Ph. D. thesis and continuing through today.



Optimization Software

- CW: Stay with simple methods, motivated by economic intuition; stay away from “magical black boxes”
- ICE11: A box ceases to be black when you open your eyes and turn on the lights, which we will help you do in our software tutorial sessions.

Estimation

- CW: One has to sacrifice statistical efficiency and must use “computationally light” estimators in order to compute a consistent estimator for “large” problems.
- CW: The Nelder-Mead algorithm (often named “amoeba” after a slug with no nervous system) is good enough for empirical IO.
- ICE11: Prof. Che-Lin Su will show you how to use modern optimization methods to compute efficient estimators for both dynamic choice problems and for games.



Dynamic Programming

- CW: It is difficult to write DP code that is stable, efficient, and accurate, particularly for multidimensional problems.
- ICE11: It is easy to do this for concave problems once you learn a little math.

Models with Heterogeneity

- CW: It is difficult to solve problems with substantial heterogeneity.
- ICE11: We will present recent work on methods for solving models with hundreds of types of agents without aggregation.

Dynamic Games

- CW: Finding feedback equilibria (a.k.a. MPE) is very difficult.
- ICE11: Life is always hard if you use only Gauss-Jacobi and Gauss-Seidel methods. Karl Schmedders will show you how to use complementarity methods to solve dynamic games, even ones where players occasionally hit constraints such as zero output or zero investment.



Computer Architecture

- CW: It is difficult to use parallel systems.
- CW: Economists cannot get access to supercomputers.
- ICE11: Greg Thain will demonstrate Condor, a distributed computing system developed at the University of Wisconsin, and Philip Blood, from the Pittsburgh Supercomputing Center will introduce you to Teragrid.

Polynomial Equations

- CW: There are no closed-form solutions for polynomial systems of equations
- ICE11: Karl Schmedders and Felix Kubler will demonstrate tools from algebraic geometry that allow you to solve polynomial systems of equations, and prove theorems about economic models.



Numerical Integration

- CW: It is not tractable to accurately compute multidimensional integrals with numerical quadrature; you must use Monte Carlo.
- CW: Monte Carlo integration is good enough for econometrics
- CW: Asymptotic theory is valid in modern demand estimation.
- ICE11: Our answer is *BS!* Ben Skrainka.



Auctions

- CW: It is not tractable to solve auctions with heterogeneous bidders.
- ICE11: Tim Hubbard will describe stable and reliable methods to solve auctions.



Integrated Assessment Models for Climate Change Issues

- CW: In order to solve an interesting CGE model connecting the economy and the climate, one needs to assume that CO₂ emissions in 2040 will heat the atmosphere in 2030 - DICE.
- CW: It is beyond the "scientific frontier" to compute DSGE models with several goods - EPA.
- ICE11: I will describe DSICE, a DSGE extension of DICE with one year time periods, and no time travel for CO₂.

Why Chicago Economics?

- The Chicago tradition in economics is to do economics, using whatever tools are necessary.
 - If supply and demand curves suffice, then use them.
 - If you need to formulate a problem as a fixed point in L_∞ then learn the necessary functional analysis - Lucas
 - If you have a problem with censored data, then develop novel econometric methods - Heckman
 - If you can't find cute closed-form solutions to dynamic incentive problems, then compute - Townsend
 - If you want to explore alternatives to full rationality, then study and extend robustness theory - Hansen
- The University of Chicago has made a long-term commitment to give their students the training in computational methods they need in their economic research
- ICE is its way of sharing that expertise with the general economics community.

Why Chicago?

- The University of Chicago is about doing research.
- The University of Chicago, its partners, and the speakers have provided *all* the funding for *all* ICE workshops.

Why Argonne National Laboratories?

- Argonne Labs has an excellent center for computational research.
 - Computational mathematicians at Argonne are among the world's leading experts on the kind of computational tools that are most valuable for economists.
 - Scientists at Argonne are interested in working on problems in economics.
- What is the Computation Institute?
 - The Computation Institute helps stimulate collaboration between scientists at Argonne Labs and faculty and students at the University of Chicago.
 - An excellent example of this is CIM-EARTH, an effort to combine the expertise in economics and computation at Argonne and UC to create the next generation of models for assessing issues related to climate change

What Are You Going To Do?

- Lectures: Learn basic numerical methods and see them applied to economics problems.
- Software Tutorials: Learn how to use powerful software tools and apply them to economic problems.
- Projects: You will form groups of four or five, formulate an economics problem and solve it using the tools presented here.
- Office hours: Individuals may schedule appointments with the tutorial speakers to discuss their own research.
- Seminar presentations by economists who are using computational tools.

- Have fun
 - Eat and be merry
 - * Goose Island on Tuesday night, July 20
 - * Friday night, July 22, TGIF at Pub
 - * A special “Taste of Hyde Park” farewell dinner on Friday, July 30.
 - See Chicago (July 23-24)
 - * Art Institute
 - * Architectural Boat Trips
 - * Top of the Hancock Tower (not building-formerly-known-as-Sears)
 - * See Sue ... at the Field Museum
 - * See the only U-boat captured in battle ... Museum of Science and Industry
 - * Many other possibilities