

# ECON 509: Numerical Methods in Economics

Spring 2016: Monday/Wednesday/Friday 10:00 - 10:50

Room: 272 and 68 (Computer Lab)

<http://github.com/IASTATEECON509>

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## Course Overview

**Course Objective:** The objective of this course is to familiarize you with the fundamentals of computation, and a set of state-of-the-art methods, primarily for dynamic modeling. In this course you should learn why we need computational methods for certain types of problems, the theory behind the methods, and most importantly, how to use them in practice. The course begins with the basics of computing, then moves into optimization and methods for dynamic economic models, and if there is time we will cover Monte Carlo methods and empirical techniques. The beginning of the course is heavy on theory to understand what is happening inside your machine when solving numerical models. As we begin studying techniques to solve economic problems you will also apply them in practice. Keep in mind this is not a programming course. Beyond the first week or two we will be solely focusing on methodology and not programming.

**Prerequisites:** ECON 500 and ECON 501, or ECON 600 and ECON 601.

**Readings:** Miranda and Fackler (2002) will be referred to frequently and is recommended. Nocedal and Wright (2006) is highly useful as a detailed reference for optimization and Judd (1998) takes a more detailed look at the fundamental numerical methods in economics. Miranda and Fackler (2002) and Nocedal and Wright (2006) are available as eBooks in the ISU library. The remainder of the required readings will be from journal articles or excerpts from texts which will be accessible online.

**Grading:** 10% of your grade is class participation, 45% of your grade is the final project, and 45% of your grade is the problem sets.

**Lab Sessions:** We will occasionally hold lab sessions in class to implement the methods we learn. These classes will be located in the department computer lab. In the lab sessions we will be using MATLAB. MATLAB was selected due to its ease of learning for computing novices, and that many packages exist to employ the methods we will learn and practice. Much of what we do can be ported to R, Python, Julia, and C.\*

**Office Hours:** By appointment.

**Contacting Me:** Please put ECON 509 in the subject line of all e-mails and I will respond within 24 hours.

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\*See <http://quant-econ.net> for guides and packages for economics research in Python and Julia.

# Assignments

1. Problem sets will be due periodically. You must submit your code on Github (url above) to your group's repository as well as a separate pdf of your output and results. We will learn how to use Git during class. You may work in a group **no larger than three people**. Groups should turn in one assignment with all members' names on the front page of your submitted pdf. You may use any programming language you wish as long as the code is *clearly commented*.
2. There will be a final project for the course, due at the end of the semester, where each student will submit the beginning of a research paper. In week 9 each student will present a short proposal for the final project to obtain feedback from the class. During dead week, each student will present their completed work which should have a first-take at a numerical/computational model and preliminary results. The paper should be at least 4 pages including tables or graphs and should:
  - Have an introduction that clearly states the economic question you are answering
  - Analytically develop the model if there is a theoretical model. If your project is strictly empirical, then expand more on the next step.
  - Describe how you solve the model
  - Have preliminary results

## Tentative Course Schedule

### 1 Git and MATLAB Tutorial

### 2 Introduction to Computation

#### Theory

Miranda and Fackler (2002, Chapters 1, 2, and 5); Judd (1998, Chapters 2, 3 and 7)

### 3 Rootfinding and Optimization

#### Theory

Miranda and Fackler (2002, Chapters 3 and 4); Judd (1998, Chapter 4 and 5); Nocedal and Wright (2006, Chapters 2-6)

### 4 Dynamic Programming: Methods and Applications

#### Theory

Ljungqvist and Sargent (2004); Adda and Cooper (2003); Fernandez-Villaverde et al. (2016)

## **Application**

Rudik (2015); Lemoine and Traeger (2014); Traeger (2014); Springborn and Sanchirico (2013); Cai et al. (2015)

## **5 Final Project Proposals**

## **6 Optimal Control: Theory, Methods, and Applications**

### **Theory**

Caputo (2005); Judd (1998, Chapter 10); Trimborn et al. (2008); Brunner and Strulik (2002)

### **Application**

Goulder and Mathai (2000); Maler et al. (2003); Lemoine and Rudik (2014); Venables (2014)

## **7 Methods for Accelerating and Improving Approximation in Dynamic Programming**

### **Theory**

Smolyak (1963); Judd et al. (2014); Puterman and Shin (1978); Carroll (2006); Malin et al. (2011); Judd et al. (2011a,b, 2015); Winschel and Kratzig (2010); Maliar and Maliar (2015)

## **8 Markov Chain Monte Carlo**

### **Theory**

Chib and Greenberg (1995, 1996)

### **Application**

Orlik and Veldkamp (2014); Lieli and Springborn (2012)

## **9 Maximum Likelihood**

## **10 Final Project Presentations**

# References

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