Computational Methods for Economics
(220:560 or 220:420)

Lectures: Mondays and Wednesdays 2:00pm-3:20pm
Classroom: A1 Frelinghuysen Hall

Instructor: **Carlos Esquivel** email: carlos.esquivel@rutgers.edu
Virtual Office hour: Monday 10:00am-11:00am
Appointment: by email

TA: **Fernando Letelier** email: fal49@economics.rutgers.edu
Virtual Office hour: Wednesday 11:am-12:00pm
Appointment: by email

OBJECTIVE

After completing this course, you will be able to use computer programs to solve basic problems related to Economics and Finance. In general, you will have a computational toolbox to solve and analyze economic models applied to real world questions.

COURSE DESCRIPTION

This is a hands-on course. You will learn algorithms to solve mathematical problems related to economic applications, typically involving the solution of a model. Once we go over the theory and motivation, we will apply the algorithms to solve the problems using the computer. Students should bring their laptop to class in order to participate in the applications during lectures.

This is not a course about a particular computer language, so students may use any language they are most comfortable with (Matlab, Fortran, C++, Python, Julia, …). I will use Matlab during lectures, which is a good introductory language if you do not have much programming experience. If you are already acquainted with Matlab, my recommendation would be for you to use the course to learn a more advanced and faster language. Near the end of the semester, I will use some algorithms from our lectures to demonstrate how they can be implemented in Julia.

Course Materials. I will use Matlab in class; you can download it with your Netid using this link (please install the Econometrics/Optimization Toolbox). The course follows two books:

(**MF**): Mario J. Miranda and Paul L. Fackler, *Applied Computational Economics and Finance*, MIT Press

(**J**): Kenneth L. Judd, *Numerical Methods in Economics,* MIT Press

MF has a Matlab Toolbox called *CompEcon Toolbox* that will be useful to solve the problem sets. You can download it from Paul Fackler's webiste [link here].

Evaluation. Course grades will have three components: problem sets to keep you up to date, two take-home exams, and class participation. The weights on each component are:

- Problem Sets: 30%
- Two take-home exams: 50% (25% each)
- Class participation: 20%

For the graduate version of the course, the second exam will consist of a replication of the main results from a published paper that fall within the scope of the course material. I will provide you with a list of papers to choose from but I will also entertain suggestions of papers not on the list.

COURSE OUTLINE

1. **Introduction to the Course**. Motivation. Installing Matlab. Using *CompEcon Toolbox.*

2. **Math Review.** Vectors and matrices. Distance and norms. Derivatives and integrals. Optimization with calculus. Taylor Approximation.

3. **Introduction to MATLAB.** Basic commands. Conditional statements and looping. Scripts and functions. Debugging. Style. Applications.

4. **Linear Equations.** L-U factorization. Gaussian elimination. Special cases. Methods for large systems. Applications.

5. **Nonlinear Equations.** Bisection Method. Function iteration. Newton Method. Problems with Newton Method. Complementary problems and methods. Applications.

6. **Optimization**. Derivative Free Methods. Newton Methods. Constrained Optimization. Applications.

7. **Integration and Differentiation.** Integration methods: Quadrature methods and Monte-Carlo Integration. Numerical differentiation. Applications.

8. **Function Approximation.** Polynomial Interpolation**.** Splines**.** Linear interpolation. Multidimensional interpolation. Collocation Method. Applications**.**

9. **Application to Dynamic Economic Models**