UNIVERSITY OF
WATERLOO

Department of Economics
ECON474/673: Numerical methods for economists

Course Outline
(Winter 2017)

Instructor: Chaussé, Pierre
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Lecture Time: T-Th 2:30 to 3:50   **Lecture Location:** HH 336

Office Hours: Mondays, 3:30 to 5:30

Course description

The course covers important topics related to scientific computing through applications in either microeconomics, macroeconomics or econometrics. The topics include: floating point arithmetic, nonlinear equations, optimization, numerical derivatives and numerical integration, differential equations, and simulation of dynamic models. The course is entirely based on the open source statistical environment R (http://www.r-project.org/) and the use of that language by the students is mandatory.

The objective of the course is not only to teach the students how to program efficiently and accurately, but also to be organized. In order to achieve that goal, we will learn how to take advantage of the object-oriented aspect of R. This way of programming allows us to create environments in which functions behave according to our preference. For example, we can create an object of class "Macrodata" for which methods like summary() or plot() produce output commonly used by macro-economists. We could also create an object of class "Consumer" for which the method solve() would compute optimal choices and the method plot() would draw indifference curves. An introduction will be given during the first two weeks.

The student will practice the concepts covered in class through several small individual numerical projects. It is imperative that you practice writing codes continuously throughout the semester. The lecture notes include several programs for solving most of the problems we will cover. However, I strongly recommend that you try to write your own on a weekly basis. This is the only way to become good at solving problem by yourself.

Textbook

• The course is almost entirely based on the following textbook. Some copies are available at the bookstore and one copy is in reserve at Dana Porter library. It is, however, not required to purchase it. A set of lecture notes with examples in R is available on the course website.

 ○ Judd, Kenneth L., *Numerical Methods in Economics*, MIT Press (1999)

• The following links provide free manuals on how to use R. Choose the one that suits you most.

 ○ R for beginners:
  http://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf

 ○ Econometrics in R:
  http://cran.r-project.org/doc/contrib/Farnsworth-EconometricsInR.pdf

 ○ Several other manuals are available at http://cran.r-project.org/other-docs.html in many different languages. Of course, you can download the official manual on the main R web site.

Topics

1. Introduction: (Lecture Notes: Chapter 1)
   Programming with R

2. Floating point arithmetic (Chap. 1 and 2, and the article: Goldberg(1991))
   Understanding how computers compute

3. Linear equations (Chap. 3)
   Solving systems of linear equations

4. Optimization (Chap. 4)
   Solving univariate or multivariate optimization problems

5. Nonlinear equations (Chap. 5)
   Solving systems of nonlinear equations

6. Numerical calculus (Chap. 7)
   Computing numerical integrals and derivatives

7. Monte Carlo methods (Chap. 8)
   Introduction to simulation methods in statistics

8. Differential equations (Chap. 10 and 11)
   Solving differential equation by finite-difference methods

9. Dynamic Programming (Chap. 12)
   Simulating the solution to dynamic models

Evaluation

Biweekly projects: 60%
Final exam (Open book, on a computer): 40%

Final Exam: The final exam is 4.5 hours long and must take place before April 3 2017. Therefore, we will have to agree on a date and time in class. If everyone is comfortable working on his/her own laptop, we will do it in a regular classroom. If any of you do not have a laptop, we will reserve one of the computer lab.

Policy regarding assignments: You must submit your assignments in Learn's drop box before the due time. Past that time, the drop box will not accept any upload. Therefore, do not wait until the last minute to submit it. A late submission will result in a grade of 0. The format of the document(s) that you have to upload will be described in class.

Economics Department Deferred Final Exam Policy
Deferred Final Exam Policy found at https://uwaterloo.ca/economics/current-undergraduates /policies-and-resources/deferred-final-exam-policy.

Cross-listed course
Please note that a cross-listed course will count in all respective averages no matter under which rubric it has been taken. For example, a PHIL/PSCI cross-list will count in a Philosophy major average, even if the course was taken under the Political Science rubric.

Academic Integrity

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo are expected to promote honesty, trust, fairness, respect and responsibility.

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offences, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline (https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-71)

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances (https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-70), Section 4.

Appeals: A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals (https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-72).

Other sources of information for students:
Academic Integrity website (Arts)
https://uwaterloo.ca/arts/current-undergraduates/student-support/ethical-behaviour
Academic Integrity Office (UWaterloo)
https://uwaterloo.ca/academic-integrity/

Accommodation for Students with Disabilities

Note for students with disabilities: The AccessAbility Services office (https://uwaterloo.ca/disability-services), located on the first floor of the Needles Hall extension (NH 1401), collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AS office at the beginning of each academic term.