Agricultural and Applied Economics 770

Introduction to Quantitative Methods

Summer 2017

Overview

The purpose of this course is to (i) provide a foundation for other courses in the REDA program and (ii) ensure that everyone in the program has a minimum level of understanding of statistical and quantitative methods commonly used in applied economics.

There are two major sections to this course. The first covers some basic calculus concepts used in economic modeling and analysis. In the second section we review fundamental statistical ideas that are the foundation of data analysis methods used in economics.

Below is the outline of ***AAE770: Introduction to Quantitative Methods***. In preparing this course, I could have reinvented the wheel and made available my own lectures. Instead, I opted for you to take advantage of some great material already available on-line to achieve course objectives. Below is a summary of course material sources:

i. On-Line MIT probability and calculus course material (i.e., videos, notes, etc);
ii. Videos from a variety of other online sources centered on specific topics (e.g., Kahn Academy, Lynda,com, Gould, Miscellaneous special topic sources);
iii. PPT/PDF files of new material created by myself; and
iv. Notes from other courses to complement course material.

The course is designed around what we refer to as *modules*. These modules are defined with rather broad subject areas. There are 11 defined modules. A listing of the modules is provided to the right.

Module Number	Topic
1	Course Introduction
2	Review of Differential Calculus
3	Overview of Exponential and Logarithmic Functions/Review of Integral Calculus
4	The Calculus of Unconstrained Optimization
5	The Calculus of Constrained Optimization
6	Exploratory Data Analysis
7	Random Variables and Density Functions
8	The Normal Distribution: The Most Common Distriubtion Used in Economics
9	Multiple Discrete and Continuous Random Variables
10	Statistical Inference (Part 1)
11	Statistical Inference (Part 2)

Within each module there a number of what we refer to as *sessions*. Each session is concerned with a specific sub-topic within a module's subject area. There are from 2 to 4 sessions within each module with the mode being 3.

After each **session** there will be a **short exercise**, which you will submit for evaluation. At the end of each module there will be a slightly **longer exercise** or what referred to as Module Assessments. There

Item	% of Grade
Module Session Exercises	33%
Module Assessment	36%
Major Topic Exams	31%

will be two exams, one covering the calculus material and the second covering the statistical review. The exam covering the first half of the course is tentatively scheduled to be due July 29th. The second exam is tentatively scheduled to be due August 20th. In the table to the left is a summary of the system we will use for course evaluation.

Throughout the course when submitting your Session Exercise or Module Assessment to the appropriate course DropBox follow the following file naming convention:

*FirstName_LastName_Module_XX_Session_YY (*or *Assess).###* (docx, pdf, xls, jpg, etc).

The ***Learn@UW*** (Desire 2 Learn) course management system used for this course allows us to establish a class discussion board. We can use this forum to address questions to the class and to jointly resolve questions and issues. Video-based tutorials on how to use the ***Learn@UW*** system as a student can be found at the following URLs:

i. Overview of D2L tools; and
ii. D2L knowledge base homepage.

As noted above, within the ***Learn@UW*** is the ***Piazza*** on-line system that will allow you to interact with other students in class. As noted in the ***Piazza*** website:

> "*…Piazza gives students a space to ask and collaboratively answer course related questions in a timely manner…. A student (or instructor) posts a course-related question. Other students can then respond with an answer. Instead of each student providing their own answer, leading to a long string of potentially confusing posts, students work wiki-style on a single answer. If the instructor likes the answer he/she can endorse it to let students know that the answer is right. Instructors can also directly answer questions and "correct" any errors or misunderstandings."*

I have not used this system before but am confident that this will facilitate discussion with your peers. For more information about this system, refer to this URL.

I will also be holding two two-hour office hour sessions on Monday's (9am – 11am CDT) and Thursday's (1 pm – 3pm CDT), i.e., for a total of 4 hours per week to answer any questions. During office hours I will use the ***GoTo Meeting*** software system to enable us to communicate more effectively. You do not need to purchase this software as I will host the meetings. I have used this system in other classes for the purpose of instructional web-sessions as well as in my dairy industry extension activities. I have found this software system relatively easy to use and reliable. The following is the connection information to attend my weekly office hours. The connection information will be valid for the entire course:

i. Meeting URL: https://global.gotomeeting.com/join/524035725
ii. Use your microphone and speakers (VoIP) or call in using your telephone:

Dial +1 (646) 749-3122

iii. Access Code: 524-035-725

iv. Audio PIN: Shown after joining the meeting

v. Meeting ID: 524-035-725

Course TA

For the first time I will a TA for the course. His name is Mr. Ethan Young Below is his contact information. In addition to my office hours, he will also be offering office hours to answer any questions you may have. His two office hour sessions will be determined in the near future. I will send out a news item to the class when his office hours have been set. He also may be using the above web-meeting software system which can be accessed via the above system configuration.

TA: Mr. Ethan Young
Office Hours: TBD
Office: 315 Taylor Hall
Email Address: eryoung2@wisc.edu

Textbooks

I am always reluctant to assign textbooks for the classes I teach given outrageous prices for text hard copies or semester rentals. That said, I will be using two textbooks which will complement the course videos/other materials, one for the statistics review section and one for the optimization/calculus section.

Bertsekas, D.P. and J.N. Tsitsiklis, 2008. *Introduction to Probability*, 2nd ed., Athena Scientific, Belmont MA.

Chiang, A.C., and K. Wainwright, 2005. *Fundamental Methods of Mathematical Economics*, 4th ed., McGraw-Hill Irwin, New York.

The Bertsekas and Tsitsiklis text is a basic text on probability and is the assigned textbook for the MIT statistics class that is a source of some recorded lectures. I will refer to this text as **BT** in the course syllabus. If you already have an introductory probability text that may be sufficient. You will just have to find the corresponding pages encompassing a particular lecture topic. The 2nd text, Chiang and Wainwright (**CW**) is a good reference text to have on your bookshelf. It does a reasonable job of bridging the gap between mathematical theory and applied economics. There are many other mathematical economics texts available, but I feel this one does a good job on introducing the myriad of topics in which applied economists must confront. If you have a text that you would like to substitute for the **CW** text, feel free to drop me a note and I can give you feedback.

Course Module Description

I. Review of Differential/Integral Calculus and Constrained/Unconstrained Optimization

The recorded lectures for this section are contained in the following locations:

Single Variable: Specific sessions (i.e., part of a bigger lecture) noted below can be obtained from this URL.

Multiple Variable: Specific sessions (i.e., part of a bigger lecture) noted below can be obtained from this URL.

Below is a more complete listing of the module and session topics. The specific videos, readings, exercises, etc. for each module/sessions can be obtained from accessing relevant portions of the **class website**.

Module Number

1. ***Course Introduction***
2. ***Review of Differential Calculus***
   a. What are derivatives and how are they used in economics: single variable
   b. What are partial derivatives and how are they used in economics: multiple variable
   c. Standard rules of differentiation
   d. The Hessian matrix
   e. The Chain Rule
   f. Economic applications

3. ***Overview of Exponential and Logarithmic Functions/Review of Integral Calculus***
   a. Overview of exponential and logarithmic functions
   b. Evaluating derivatives of functions of exponential and logarithmic functions
   c. Indefinite vs. definite integrals and how are they used in economics
   d. Standard Rules of integration
   e. Integration and probability
   f. Economic applications of integration

Module Number

4. ***The Calculus of Unconstrained Optimization***
   a. Concavity/convexity and optimization
   b. Motivations of first-order conditions
   c. What do the second-order conditions tell us?
   d. Unconstrained revenue and profit maximization as an example

5. ***The Calculus of Constrained Optimization***
   a. Concavity/convexity and constrained optimization
   b. Interpretation of the Lagrange multiplier
   c. First-order conditions and constrained optimization (equality constraints)
   d. The bordered Hessian and constrained optimization (equality constraints)
   e. Economic examples:
      i. Cost minimization subject to achieving a production target
      ii. Output maximization subject to a known production function
      iii. Utility Maximization subject to budget constraint example

II. Review of Probability, Probability Distributions and Statistical Inference

The recorded lectures for the probability section of the course are contained within this URL. Below I identify the lectures associated with each topic.

Module Number

6. ***Exploratory Data Analysis (EDA)***
   i. Introduction to EDA
   ii. Getting to know your data
   iii. Basic concepts of data visualization

7. ***Random Variables and Density Functions***
   a. What are discrete random variables?
   b. Specific discrete distributions
   c. Discrete vs. continuous random variables
   d. Characteristics of PDF and CDF's
   e. Expected values of discrete and continuous random variables

Module Number

8. ***The Normal Distribution***
    a. Characteristics of the normal distribution
    b. The Central Limit Theorem
    c. Importance to applied economic analysis

9. ***Multiple Discrete and Continuous Random Variables***
    a. Multiple discrete and continuous random variables
    b. Joint PMF's, PDF's and CDF's
    c. Marginal, joint and conditional probabilities
    d. Conditional expectations and variances
    e. Population/sample covariance and correlation
    f. Importance to applied economic analyses

10. ***Classical Statistical Inference (Part 1)***
    a. Estimation of probability distribution parameters and estimator properties
        i. Maximum Likelihood
        ii. Least Squares
    b. Introduction to linear regression
    c. Interval estimation

11. ***Classical Statistical Inference (Part 2)***
    a. Fundamentals of hypothesis testing
    b. Hypothesis testing of linear and nonlinear functions of estimated parameters
    c. Example: Determining the variance of an electricity use/household size elasticity.