University of Georgia
Department of Public Administration and Policy
DPAP 8120: Data Analysis and Statistical Inference
Fall 2023

COURSE SYLLABUS

Professor: David Bradford
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Class Time: Monday, 4:10 – 6:55 PM
Class Location: Baldwin 302
Office Hours: by appointment

Description : This course is an introduction to the theory and application of linear modeling to economic and policy problems. The focus of this class will be to provide you with the theoretical and practical skills necessary to conduct your own empirical research. This will be accomplished by addressing two overarching sets of topics. First, the course will explore the mathematical bases for statistical analysis. Topics in this section will include introduction to calculus (both single variable and multivariate), linear (matrix) algebra, optimization, and measurement theory. Second the course will lay the groundwork for statistical inference. Topics in this section will include moments of distributions (mean and variance), forming hypotheses, simple bivariate hypothesis testing, and introduction to ordinary least squares regression. The course will also provide a basic introduction to the Stata software package for statistical analysis.

Goals: By the end of the course, students should be able to:

- Take derivatives of multi-variate functions and understand how those relate to marginal effects from regressions.
- Use matrixes effectively in statistical modeling.
- Optimize functions and understand how optimization relates to regression.
- Identify the most appropriate methodological techniques for analysis given a research question and available data, as well as identify, understand the implications, and offer resolution to various problems encountered during quantitative analysis.
- Conduct simple data analyses using the methodologies covered in the course. In particular, students should be able to test simple hypotheses and run a basic regression.
- Manage data and conduct analyses using Stata.

Optional Text: Wainwright, Kevin, Chiang, Alpha C. Fundamental *Methods of Mathematical Economics.* (NY: McGraw-Hill/Irwin, 2004). [**Note**: Nearly any edition of this book will be fine.]

Required Software: You will need to obtain your own copy of Stata for your own computer.

Organization of the Course: Class meetings will be primarily lecture and discussion. Class attendance is not required, though there is little prospect of success without it.

Grading: There are three components of the final grade:

- ***Homeworks – 30 points***: Homework will be assigned at key points during the semester. Students will have one week to complete each homework assignment.
- ***First Exam: 35 points (Administered online)***
- ***Second Exam***: ***35 points (Administered online)***

Academic Integrity: All students are responsible for maintaining the highest standards of honesty and integrity in every phase of their academic careers. The penalties for academic dishonesty are severe and ignorance is not an acceptable defense.

Mental Health and Wellness Resources:

- If you or someone you know needs assistance, you are encouraged to contact Student Care and Outreach in the Division of Student Affairs at 706-542-7774 or visit https://sco.uga.edu. They will help you navigate any difficult circumstances you may be facing by connecting you with the appropriate resources or services.
- UGA has several resources for a student seeking mental health services (https://www.uhs.uga.edu/bewelluga/bewelluga) or crisis support (https://www.uhs.uga.edu/info/emergencies).
- If you need help managing stress anxiety, relationships, etc., please visit BeWellUGA (https://www.uhs.uga.edu/bewelluga/bewelluga) for a list of FREE workshops, classes, mentoring, and health coaching led by licensed clinicians and health educators in the University Health Center.
- Additional resources can be accessed through the UGA App.

Course Outline and Schedule (Week / Module number in parentheses)

NOTE: The following schedule is a general plan for the course; changes may be required as the semester progresses to accommodate speed of learning or student interest. Changes will be announced in advance by the instructor.

(1) Introduction to the class and discussion of the semester (8/21)

(2) Functions (8/28)

Key Concepts: Real valued functions in one dimension; linear vs. non-linear functions; slopes (algebraically); tangent lines; limits; continuity.

(3) LABOR DAY – No Class (9/4)

(4) Introduction to derivatives (9/11)

Key Concepts: Review of limits; first order derivatives; higher order derivatives; extrema; logs and exponents; graphing lines with derivative, minimum and maximum information.

(5) Multivariate calculus (9/18)

Key Concepts: The chain rule; open, closed, bounded and compact sets; geometric representation of functions in N-dimensions.

(6) Multivariate calculus II (9/25)

Key Concepts: The total differential; chain rule in N-dimensions; partial differentiation; implicit functions and the Implicit Function Theorem.

(7) Matrices (10/2)

Key Concepts: matrices, vectors and scalars; transposes; matrix multiplication; matrix addition; square, diagonal, triangular, and identity matrices; the geometry of matrices in Euclidian space.

(8) Matrices continued (10/9)

(9) First Test (10/16)

(10) Advanced matrix manipulations, I (10/23)

Key Concepts: Determinants in $\Re^2$ and $\Re^N$; matrix inversion.

(11) Advanced matrix manipulations, II (10/30)

Key Concepts: Characteristic equations and roots; independence of rows; matrix rank; ill-conditioned matrices; solving simultaneous equations with matrices.

(12) Optimization (11/6)

Key Concepts: Extrema in quadratic functions; extrema in general two-variable functions; intuition of optimization; First Order Conditions in $\Re^N$ using matrices; Second Order Conditions in $\Re^N$ using matrices; OLS as an optimization problem.

(13) Random Variables (11/13)

Key Concepts: Random variable, probability distributions, cumulative probability functions, specific probability distributions.

(14) THANKSGIVING BREAK – No Class (11/20)

(15) Moments of distributions (11/27)

Key Concepts: Random sampling, descriptive statistics, statistics as estimators, correlation, covariance, null hypotheses, bivariate hypothesis tests,
Key Concepts: Least squares regression.

(16) Second Test (12/4)