Instructor Information

- Instructor: TBD
- Office: TBD
- Office Hours: TBD
- Phone: TBD
- Email: TBD

Class Information

- Location: TBD
- Time: TBD
- Website: DESIRE2LEARN – https://gsu.view.usg.edu/

Prerequisites: MRM and MSA students should follow the program guides at http://rmi.robinson.gsu.edu/academic-programs/. In general, you should have a solid background in uni- and multivariate calculus and taken a basic statistics course (potentially online). Moreover, familiarity with programming environments and particularly with R (http://www.r-project.org) will be assumed.

Catalog Description

The course covers basic probability and mathematical statistical theory, and provides a basic introduction to linear models, with an eye on application. The course starts with a primer on linear algebra, discussing the solution of linear equation systems, the rank of a matrix, determinants, eigenanalysis, and diagonalization; and basic probability theory, including probability spaces, dependence, random variables, (conditional) expectations, and sampling. It continues with the introduction of discrete and continuous distributions, and basic statistical theory of estimation and inference. Topics include consistency, unbiasedness, efficiency, maximum likelihood estimation, central limit theorem, confidence intervals, and hypothesis testing. The course concludes with a detailed discussion of single equation linear models and ordinary least squares estimation, and the application of the model for inference.

Lecture Notes and Textbooks

Lecture notes will be posted on Desire2Learn. Nevertheless, it is strongly advised that you take notes during lecture as there may be ideas presented in the class which are not included in the posted notes. Useful references will be given for certain concepts and further reading. Handouts as well as computer programs will also be posted there. Textbook options:
Course Objectives

This course introduces students to probability and basic statistical theory. The focus is on laying a solid foundation for advanced statistical courses the students will take in subsequent semesters, with an emphasis on the ability to understand, select and apply a given probabilistic model rather than mathematical rigor. By the end of the course, successful students will be able to:

2. Explain the basic mathematical framework that underlies modeling random phenomena.
3. List the most common probability distributions and their basic properties.
4. Appraise an estimator based on its properties, derive confidence intervals.
5. Using statistical/numerical software and for a given distribution, derive maximum likelihood estimates based on a data set of iid observations.
6. Using statistical/numerical software and given a data set, estimate a linear single equation model via ordinary least squares regression. Use this model for testing hypotheses.

Methods of Instruction

The course material is presented in lecture form. Weekly homework is assigned to clarify concepts and deepen the understanding. There will be a 90 minute in-class midterm examination and a take-home final project.

Attendance Policy

Attendance is not formally taken. However, it is strongly suggested that students do not miss class as most students will have difficulties completing the assignments without attending the lectures.
Homework

I will collect homework *every* week. Every student has to submit her/his own work – group submissions are *not* allowed. You may discuss the assignments among each other, but every student has to write up the assignment on his own. *Students copying from their classmates or from previous years’ assignments will receive a zero score. In addition, the student who let others copy from her/his assignment will receive a zero score. There are no exceptions to this rule! Further consequences are possible.*

Grading Criteria

The mid-term examination and the final project are each weighted as 35%, the homework counts for 30%. Make-up examinations are offered only under extraordinary circumstances. Students who miss examinations should contact me immediately. Grades will be awarded on a +/- basis, and the following guaranteed scale applies. Grades may be moved upward based on difficulty, but not downward:

<table>
<thead>
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<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
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<th>C-</th>
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Remarks

- Students exhibiting disruptive behavior, including talking, sleeping, talking on cell phones or disturbing other students will be asked to leave.

- Please advise the instructor if you have a documented disability that needs to be accommodated.

- As members of the academic community, students are expected to recognize and uphold standards of intellectual and academic integrity. See the Universitys policy on Academic Honesty (Section 409, [http://www2.gsu.edu/~wwwfhb/sec409.html](http://www2.gsu.edu/~wwwfhb/sec409.html)) for details.

Detailed Outline:

The material is subdivided into 6 Modules:

Module I: Primer on Linear Algebra

**Contents**

- Vector spaces, matrices as linear mappings, systems of linear equations.
- Rank, determinant, and eigenvalues/-vectors of matrices.
- Matrix diagonalization.

**Learning Outcomes**

- Ability to manipulate matrices and solve linear equation systems.
- Ability to diagonalize a matrix and interpret the resulting representation.

Module II: Probability Background.

**Contents**

- Probability spaces, Sigma-algebras, probability measures.
- Dependence and independence, conditional probability, Bayes formula.
- Conditional expectations.
- Random variables, expected values, variance.
- Sampling.

**Learning outcomes**
- State the basic definitions and solve basic problems. Manipulations of random variables.
- Familiarity with the concept and calculation rules for conditional expectations.
- Understand the basics of sampling and Monte Carlo estimation.

**Module III: Probability distributions**

**Contents**
- Discrete Distributions: uniform, Bernoulli/Binomial, Poisson, negative binomial, geometric, hypergeometric.
- Continuous Distributions: uniform, normal, exponential, gamma, beta, chi-squared, t (student), Pareto, Cauchy.
- Law of large numbers and central limit theorem.
- Multivariate distribution.

**Learning outcomes**
- Know the basic properties of distributions, familiarity with pdf, cdf, mgf, etc.

The course concludes with a detailed discussion of single equation linear models and ordinary least squares estimation, and the application of the model for inference.

**Module IV: Estimation**

**Contents**
- Properties of estimators: consistency, (un)biasedness, mean-square error, efficiency.
- Estimation approaches: (generalized) method of moments ((G)MM), maximum-likelihood (ML), least squares, Bayesian.

**Learning outcomes**
- Assess properties of estimators. Understand the difference between asymptotic and finite-sample properties.
- Derive estimators, particularly using numerical/statistical software (based on ML or (G)MM).

**Module V: Inference – hypothesis testing**

**Contents**
- Confidence intervals and statistical hypotheses. Relationship.
- Tests: properties, type I/II errors, p-values, power and size.

**Learning outcomes**
- Construct a test/confidence interval based on a given (joint) model. Test a hypothesis using numerical/statistical software (based on ML or (G)MM).
- Assess the quality of a test.
Module VI: Single Equation Linear Model

Contents

- Basic regression model, context.
- Ordinary least-squares (OLS) estimation, assumptions, properties.
- Inference based on estimated model.
- Understand endogeneity, reasons for endogeneity (missing variables, simultaneity, measurement error).

Learning outcomes

- Run an OLS regression using a numerical/statistical software, interpret the results.
- Test hypotheses based in estimated model.
- Be aware of pitfalls associated with endogeneity.

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<thead>
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<th>Date</th>
<th>Module</th>
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Note that this course syllabus provides a general plan for the course; deviations may be necessary.