

Course Information for STAT:7200 “Linear Models” Fall 2021

Instructor

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Class Hours and Location

Our course will meet **in person** on Mondays and Wednesdays, 11:30 am – 1:20 pm, in 150 SH.

Office Hours

Conducted in person at 1:00 – 3:00 pm Tuesdays and 1:00 – 2:00 pm Thursdays, or by appointment.

Department Information

Department of Statistics and Actuarial Science, 241 Schaeffer Hall, Phone 335-2082

Department Executive Officer

Professor Kung-Sik Chan, 241 SH, Phone 335-0712, E-mail kung-sik-chan@uiowa.edu

Textbook

Dr. Z recently (November 2020) published the content presented in lecture in previous years as a textbook, *Linear Model Theory: With Examples and Exercises* (published by Springer). Readings will be assigned from this book. An e-version of the book is available, free of charge, to all University of Iowa students. With one exception, the book is self-contained, i.e., there is no need to do any reading outside of it. The exception is the material on matrix algebra useful for linear models; for this, frequent reference will be made to *Matrix Algebra from a Statistician’s Perspective*, by David A. Harville (Springer). Purchasing this book is recommended because it will be a good resource for relevant matrix algebra results over the course of your career as a student and statistician, but it is not required because no reading will be assigned from it.

There is also available a book of solutions to exercises, *Linear Model Theory: Exercises and Solutions*.

Exams

- 2 two-hour, in-class, midterm exams; the first will be given in class on October 11 and the second will be given in class on November 17. These two exams are “closed-book,” except that Dr. Z will provide copies of Chapters 1–4 to each student at the beginning of each exam period. These copies may be used throughout the two exams.
- 1 final take-home exam, due at the end of our assigned final exam period. This exam will be distributed one week prior to the day of the final exam scheduled by the University. This exam is “open-book” but you are on your honor to communicate with nobody besides Dr. Z about it.

Lectures

Course lectures will feature some material from the textbook and some solutions to exercises in the textbook. In addition, some examples and exercises (and their solutions) not in the textbook will be presented.

Homework

Written assignments are an *essential* component of the course. Assignments generally consist of 8 or so exercises, some of which have multiple parts, and will be given at intervals of approximately 10-14 days. They may take considerable time to complete, so it is best to start the exercises as soon as we have covered the relevant material in lecture. Completed assignments should be turned in at the beginning of class on the day they are due. Unless prior arrangements are made, late homework will receive a score no higher than 50%. Students may work on homework problems together, provided that no outright plagiarism occurs. Dr. Z is more than willing to provide homework help during office hours and/or to give hints/guidance by email at any time.

Attendance

Attendance at lectures and participation in discussions are expected. Failure to attend class regularly will adversely affect your grade, and no help will be offered on homework problems requiring material in class that you miss (unless you have a valid excuse).

Grading

- Homework, 25%
- Midterm exams, 50% (25% each)
- Take-home final exam, 25%

A plus-minus grading system will be used. In the past, all students who have achieved a percentage of 50% or higher on exams have earned at least a B- grade, and all who have achieved a percentage of 75% or higher on exams have earned at least an A- grade.

Course Objectives

1. To provide a rigorous presentation of the theory underlying statistical applications of linear models (regression, ANOVA, BLUE, multiple comparisons, BLUP, variance component estimation, etc.).
2. To equip the Ph.D. student in Statistics (or related fields) to read journal articles and begin thesis research, possibly on some topic that overlaps with linear models.

Not a Course Objective

To analyze data or become familiar with “linear models methods” for data analysis and interpretation through the use of statistical computing packages.

Course Topics

1. Matrix preliminaries, e.g., basic results on vector spaces, linear independence, transposes, ranks, inverses, traces, determinants, nonnegative definite and positive definite matrices, optimization of functions of many variables
2. Generalized inverses and systems of linear equations
3. Expectations, variances, and covariances of linear and quadratic forms
4. Types of linear models
5. Estimability and unbiasedness
6. Ordinary least squares for classical (fixed-effects, unconstrained) linear models: Gauss-Markov Theorem, reparameterizations, orthogonal projections, algebraic and geometric structure of the analysis of variance, partitioning the ANOVA
7. Constrained least squares estimation
8. Generalized least squares
9. Model misspecification and its consequences
10. Best linear unbiased prediction (BLUP), random and mixed linear models
11. Multivariate normal, noncentral chi-square, noncentral F and t distributions
12. Distributions of linear and quadratic forms; independence of quadratic forms; Cochran's Theorem
13. Hypothesis testing, confidence intervals and regions, simultaneous confidence intervals and multiple comparisons
14. Estimation of variance components, including maximum likelihood and restricted maximum likelihood (REML) approaches
15. Empirical BLUE/BLUP

Reacting Safely to Severe Weather

In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit the Public Safety web site,

<http://www.uiowa.edu/~pubsfty/intlinks.htm>