Course Information for STAT:7200 "Linear Models"
Fall 2024

Instructor
Dale Zimmerman, a.k.a. "Dr. Z," 217 Schaeffer Hall, Office phone 5-0818, Home phone 351-0520, E-mail dale-zimmerman@uiowa.edu

Class Hours and Location
Our class will meet in 31 SH on Mondays and Wednesdays, 8:30 – 10:20 am.

Office (Drop-in) Hours
Conducted in person at 1:00 – 3:00 pm Tuesdays and 2:00 – 3:00 pm Thursdays, or by appointment.

Department Information
Department of Statistics and Actuarial Science, 241 Schaeffer Hall, Phone 335-2082, Webpage www.stat.uiowa.edu

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

Textbook
The textbook for the course is *Linear Model Theory: With Examples and Exercises*, by Dale L. Zimmerman, published by Springer in 2020. 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, so there is no need to do any reading outside of it. The exception is background 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 companion book of solutions to the textbook's exercises, which is *Linear Model Theory: Exercises and Solutions*, by Dale L. Zimmerman, published by Springer in 2020.

Exams

- 2 two-hour, in-class, midterm exams; the first will be given in class on October 10 and the second will be given in class on November 21. 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 may 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. Scores on homeworks and exams will be entered into a gradebook on the course ICON site, which you can log into using your Hawk ID and password.

Course Learning Objectives

1. To acquire a rigorous understanding of the theory underlying statistical applications of linear models (regression, ANOVA, BLUE, multiple comparisons, BLUP, variance component estimation, etc.).

2. To become equipped to read journal articles and begin thesis research, possibly on some topic that overlaps with linear models.

Not a Course Objective

To learn how to analyze data or become familiar with "linear models methods" for data analysis and interpretation through the use of statistical computing packages.

<u>Course Topics</u>

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

<u>Administrative Home</u>
The College of Liberal Arts and Sciences (CLAS) is the administrative home of this course and governs the policies and procedures for its courses. Graduate students, however, must adhere to the academic guidelines set by the Graduate College.

<u>Electronic Communication</u>
University policy specifies that students are responsible for all official correspondences sent to their standard University of Iowa e-mail address (`@uiowa.edu`). Students should check this account frequently. (Operations Manual, III.15.2. Scroll down to k.11.)

Academic Honesty and Misconduct
Plagiarism and any other activities when students present work that is not their own are academic fraud. Academic fraud is a serious matter and is reported to the departmental DEO and to the Associate Dean for Undergraduate Programs and Curriculum. Instructors and DEOs decide on appropriate consequences at the departmental level while the Associate Dean enforces additional consequences at the collegiate level. See the CLAS Student Academic Handbook.

Making a Suggestion or a Complaint
Students with a suggestion or complaint should first visit the instructor, then the course supervisor, and then the departmental DEO. Complaints must be made within six months of the incident. See the CLAS Student Academic Handbook.

Accommodations for Students with Disabilities
The University of Iowa is committed to providing an educational experience that is accessible to all students. A student may request academic accommodations for a disability (which include but are not limited to mental health, attention, learning, vision, and physical or health-related conditions). A student seeking academic accommodations should first register with Student Disability Services and then meet with the course instructor privately in the instructor's office to make particular arrangements. Reasonable accommodations are established through an interactive process between the student, instructor, and SDS. See http://sds.studentlife.uiowa.edu/ for more information.

Understanding Sexual Harassment
Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassment at
    http://www.uiowa.edu/~eod/policies/sexual-harassment-guide/index.html
for assistance, definitions, and the full University policy.

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

Nondiscrimination in the Classroom
The University of Iowa is committed to making the classroom a respectful and inclusive space for all people irrespective of their gender, sexual, racial, religious or other identities. Toward this goal, students are invited to optionally share their preferred names and pronouns with their instructors and classmates. Expressions of hate and bigotry directed at individuals or identities are not acceptable. For more information, contact the Office of Equal Opportunity and Diversity, diversity@uiowa.edu or visit diversity.uiowa.edu.