THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

SYLLABUS: STAT 7410
THEORY OF THE LINEAR MODEL
AUTUMN 2020

Course overview

Instructor

Instructor: Lo-Bin Chang
Email address: lobinchang@stat.osu.edu
Class website: https://osu.instructure.com/courses/84989
Lecture: On CarmenZoom, Monday, Wednesday, and Friday, 1:50pm-2:45pm (some of these lectures will be presented asynchronously; see Course delivery below)

Office hours: Virtual Hours via Carmen Zoom: Tuesday 12pm-1pm, Thursday 12pm-1pm

Grader

Meijia Shao
shao.390@osu.edu

Course description

This is a course on the theory of the linear model, the most commonly used statistical model. The course will present topics on the definition, estimation and hypothesis testing in this class of models. In addition, we will discuss statistical methods for multiple comparisons and issues related to a breakdown in the model assumptions. More advanced topics in this course include model selection, the discussion of blocking, random and mixed effects.

Prerequisites: STAT 6860 (Foundations of the Linear Model), as well as a solid course on linear algebra at the undergraduate level; STAT 6802 (Statistical Theory II), introducing the theory for statistical estimation; STAT 6910 and 6950 (Applied Statistics I and II) giving exposure to analysis of variance and experimental design, as well as regression modeling.

Course learning outcomes

Upon successful completion of the course, students will be able to:

- Familiarize the definitions, theorems, and applications related to the linear model;
- Carry out appropriate approaches for statistical inference in the linear model;
- Improve the technical skills for theoretical research with the linear model;
- Generalize or Modify the statistical methods for the linear model under atypical assumptions.

Course materials

Required

A First Course in Linear Model Theory by N. Ravishanker and D.K. Dey (2001)

Optional materials

I will highlight other useful references as the course progresses.

Course technology

For help with your password, university e-mail, Carmen, or any other technology issues, questions, or requests, contact the OSU IT Service Desk. Standard support hours are available at https://ocio.osu.edu/help/hours, and support for urgent issues is available 24x7.

- **Self-Service and Chat support:** http://ocio.osu.edu/selfservice
- **Phone:** 614-688-HELP (4357)
- **Email:** 8help@osu.edu
- **TDD:** 614-688-8743

Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Carmen

Technology skills necessary for this specific course

- CarmenZoom

Necessary equipment

- Computer: current Mac (OS X) or PC (Windows 10+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

Necessary software

- This class requires you to use the statistical software package called R (The R Project for Statistical Computing; http://www.r-project.org/). This software package is available as Free Software.
    - You can download R for Windows, Mac, and Linux, from the CRAN archive at https://cran.r-project.org.
    - An in-depth introduction to R is available at http://cran.r-project.org/doc/manuals/R-intro.pdf
    - Hands-on tutorials are available in the Swirl system, which you can learn about at http://swirlstats.com/. In particular, "R Programming: The basics of programming in R" is an appropriate first tutorial for students who have never used R.
- An easier to use interface to R is available in the software package RStudio. This package is available for Windows, Mac, and Linux and can be downloaded for free from http://rstudio.org. **Note that RStudio requires R to be installed.**
- More details will be given in live or recorded lectures and on the class website.

Course delivery

The course will be a mix of synchronous and asynchronous content. Synchronous content will be presented live over CarmenZoom, and asynchronous content will be delivered by recorded lectures posted on the class website. Detailed instructions for asynchronous learning will be posted prior to commencing of such activities.

Note that the live lectures and students' participation may be recorded and posted. If you would not like to be recorded, please discuss the materials after I stop recording or during my office hours.

Each week, we will cover approximately 165 minutes of content in total. You will responsible for watching any live content or recorded videos and studying the material that is assigned. In addition to the lecture videos, assignments will be posted on the class website. You will be given ample time to complete the assignments.

The instructor will hold weekly office hours via CarmenZoom. The times are given above.

Grading and faculty response

Homework and exams

Assignment or category	Percentage
Homework	15
Midterm 1	25
Midterm 2	25
Final exam	35
Total	100

Grades will be recorded on the class websites.

Homework will be assigned regularly. All homework must be submitted online as a PDF file through the class website. Typically, late assignments will not be accepted. However, If you are unable to complete an assignment on time, please get in touch with me *as soon as possible* so we can discuss your situation.

Students are required to write clear and detailed answers to all homework problems. You are encouraged to discuss homework problems with other students but you have to prepare and present your own solutions. Feel free to ask me for help after you have made an attempt to solve the problems.

The grader for the course does not have the time to provide detailed explanations on each question that is graded. To make up for this, I will endeavor to create homework solutions that are detailed enough to allow you to understand how the question could be approached.

Exams: Midterm 1 will be on Monday, September 28, 2020, 1:50pm-2:45pm
Midterm 2 will be on Monday, November 2, 2020, 1:50pm-2:45pm
The Final exam will be on Thursday, December 10, 2:00pm-3:45pm

All exams are closed book/closed notes and will be proctored online – there are no make-up exams. Further details will be given in advance of each exam.

Faculty feedback and response time

I am providing the following list to give you an idea of my intended availability throughout the course. (Remember that you can call **614-688-HELP** at any time if you have a technical problem.)

Grading and feedback

For large weekly assignments, you can generally expect feedback within 7-**14 days**.

E-mail

I will reply to e-mails within **24 hours on school days**.

Attendance, participation, and discussions

Students may miss class, for a variety of reasons related to COVID-19. As much as possible, please stay in contact with the instructor so that we can discuss accommodations should they be needed.

Student participation requirements

Because this is a distance-education course, your attendance is based on your online activity and participation. The following is a summary of everyone's expected participation:

- **In live lectures:**
  Students will be expected to participate, discuss, and answer questions in online live Lectures.
- **Logging in: AT LEAST THREE TIMES PER WEEK**
  Be sure you are logging in to the course in Carmen each week, including weeks with holidays. (During most weeks you will probably log in many times.) If you have a situation that might cause you to miss an entire week of class, discuss it with me as soon as possible.
- **Office hours: OPTIONAL OR FLEXIBLE**
  All office hours, are optional. If you are not available during my scheduled office hours, you can email me to schedule a different time to get my help.

Discussion and communication guidelines

The following are my expectations for how we should communicate as a class. Above all, please remember to be respectful and thoughtful.

- **Writing style**: While there is no need to participate in class discussions as if you were writing a research paper, you should remember to write using good grammar, spelling, and punctuation. Informality (including an occasional emoticon) is fine for non-academic topics.
- **Tone and civility**: Let's maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Remember that sarcasm doesn't always come across online.
- **Citing your sources**: When we have academic discussions, please cite your sources to back up what you say. (For the textbook or other course materials, list at least the title and page numbers. For online sources, include a link.)

- **Backing up your work**: Consider composing your academic posts in a word processor, where you can save your work, and then copying into the Carmen discussion.

Other course policies

Health and safety

The Ohio State University Wexner Medical Center's Cornavirus Outbreak site (https://wexnermedical.osu.edu/features/coronavirus) includes the latest information about COVID-19 as well as guidance for students, faculty and staff. Guidelines and requirements for campus safety from the University's COVID-19 Transition Task Force were published on July 1 on the Safe and Healthy website (https://safeandhealthy.osu.edu).

Potential disruptions to instruction

Contingencies to be addressed:

- As much as is possible, students will have access to material online if they are unable to attend class because of positive diagnosis, symptoms, or quarantine required following contact tracing.
- If the instructor is unable to be present in person because of positive diagnosis, symptoms, or quarantine following contact tracing a new instructor will be assigned to the course. Details will be given on the course website.

Student academic services

Student academic services offered on the OSU main campus
http://advising.osu.edu/welcome.shtml.

Student support services

Student support services offered on the OSU main campus http://ssc.osu.edu.

Academic integrity policy

Policies for this online course

- **Exams**: You must complete the midterm and final exams yourself, without any external help or communication.

- **Written assignments**: Your written assignments, including discussion posts, should be your own original work.
- **Reusing past work**: In general, you are prohibited in university courses from turning in work from a past class to your current class, even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, please discuss the situation with me.
- **Falsifying research or results**: All research you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your results or your library research look more successful than it was.

Ohio State's academic integrity policy

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

Copyright disclaimer

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Statement on title IX (Recommended)

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at titleix@osu.edu

Accessibility accommodations for students with disabilities

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

Accessibility of course technology

This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- Carmen (Canvas) accessibility
- Streaming audio and video
- Synchronous course tools

Your mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614- 292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273- TALK or at suicidepreventionlifeline.org

Disclaimer

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it and in particular we reserve the right to change due dates or the methods of grading and/or assessment if necessary. Any changes will be communicated to you through official course announcements.

Course schedule (tentative)

Week	Dates	Topics
1	Aug 26, 28	Linear models, Least squares estimation
2	Aug 31, Sep 2, 4	Least squares estimation, Fitted values and residuals
3	Sep 9, 11	Estimability and the Gauss Markov theorem, General least squares
4	Sep 14, 16, 18	General least squares, Least squares estimation subject to linear restrictions, Assuming normality in the full rank case
5	Sep 21, 23, 25	The multivariate (singular) normal and properties of least squares estimates, The Chi-squared distribution and statistical properties of quadratic forms
6	Sep 28, 30, Oct 2	Midterm 1 exam, The Chi-squared distribution and statistical properties of quadratic forms, Estimating means and linear combinations of means
7	Oct 5, 7, 9	Introducing the F test, Full and reduced tests, Other issues in testing
8	Oct 12, 14, 16	Other issues in testing, Joint confidence regions, multiple comparisons, and prediction intervals
9	Oct 19, 21, 23	Joint confidence regions, multiple comparisons, and prediction intervals, Departures in the normal linear model
10	Oct 26, 28, 30	Departures in the normal linear model, Model diagnostics for linear models
11	Nov 2, 4, 6	Midterm 2 exam, Model diagnostics for linear models, Model selection
12	Nov 9, 13	Model selection

13	Nov 16, 18, 20	Model selection, More advanced fixed effects models
14	Nov 23	Defining linear mixed effects models
15	Nov 30, Dec 2, 4	Inference for linear mixed effects models, Best linear unbiased prediction in linear mixed effects models