THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

SYLLABUS: STAT 6302

THEORY OF STATISTICAL ANALYSIS
SPRING 2021

Course overview

Instructor

Instructor: Yuan Zhang
Email address: yzhanghf@stat.osu.edu
Class hours: 100% asynchronously, lecture videos will be posted weekly
Office hours: Virtual Hours via Carmen Zoom, Mondays, 1—3pm, or by appointment

Grader

To be announced

Course description

Contents, organized by a tentative order in which they will be taught, list as follows:

1. Recap of STAT 6301 gist
2. Point estimation
    a. Method of moments and maximum likelihood estimation (MLE)
    b. Criteria for evaluating estimator performance
    c. Uniformly minimum-variance unbiased estimator (UMVUE)
    d. Sufficiency
    e. Exponential family distributions
3. Interval estimation
    a. Confidence interval
    b. Pivotal quantity

   c. One and two sample normal confidence intervals
   d. Non-normal confidence intervals
   e. Central Limit Theorem (CLT) and approximate confidence intervals
4. Hypothesis testing
   a. Concepts, simple versus simple test
   b. Tests for one and two sample normal distributions
   c. Large sample tests
   d. Duality of confidence interval and test
   e. Neyman-Pearson lemma
   f. Uniformly most powerful test (UMPT)
   g. Likelihood-ratio test
   h. Goodness-of-fit test

Prequisites: STAT 6301 or STAT 6801, Not open to students with credit for STAT 6802

Reminder to students who used their passage of actuarial Exam P in lieu of STAT 6301: please review Chapters 1—6 of the Rice textbook in advance to make sure you understand all the materials there. Any materials covered by those chapters but not required or not emphasized by Exam P ****ARE**** also among the prerequisites of STAT 6302.

This course assumes all students are proficient with Rice textbook Chapters 1--6 and course contents will build on them.

Course learning outcomes

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

- Understand the concept of, and be familiar with common examples of, random variables
- Understand in depth common distributions
- Calculate/understand expectation, (co)variance, conditional expectation, and moment-generating functions
- Understand the Law of Large Numbers and the Central Limit Theorem, and be able to apply both in proofs

Course materials

Required

John A. Rice. Mathematical Statistics and Data Analysis (Third Edition). Duxbury, 2007.

Robert W. Keener. Theoretical Statistics: Topics for a Core Course. Springer, 2010.

Optional

Robert V. Hogg, Joseph W. McKean, and Allen T. Craig. Introduction to Mathematical Statistics (Seventh Edition). Pearson, 2013.

Keener book can be downloaded for free at https://library.ohio-state.edu/record=b8653187

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

Course delivery

For the Spring 2021 offering, the course will be taught fully online, and no in-person meetings will take place. Each week, multiple videos and materials to study will be posted on the course website. You will be responsible for watching the videos, studying the new material and working through the examples presented in the videos or assigned as an exercise. There will be approximately 165 minutes of content per week. You will be responsible for watching any live CarmenZoom lectures or recorded videos and studying the material that is assigned. In addition to the lectures, weekly 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	**20**
Midterm Exam I	**20**
Midterm Exam II	**20**
Final Exam	**40**
Total	**100**

Grades will be recorded on the class website.

Homework Assignments are due on Fridays. Only part of each homework assignment will be graded, but all questions can be important for exams. Solutions will be posted shortly after the due date of each homework. Homework are due right before the beginning of Friday lecture time. **No late homework accepted.**

Exams: There will be two midterms and one final exam:

Midterm 1 Remote. Time to be announced in the tentative schedule posted on Carmen

Midterm 2 Remote. Time to be announced in the tentative schedule posted on Carmen

Final Remote. Time to be announced in the tentative schedule posted on Carmen

Policy: All exams are **open book** and you will sign an honor code for each of the exams to pledge no-cheating. You are permitted all means of assistance, excluding any that directly or indirectly discussing exam contents with anyone (including: directly consulting your peers, tutors, posting questions online seeking assistance, etc). I (professor) am the only person you are permitted to discuss exam contents with during the exam period. I will answer clarifying questions and may post Q&A as Carmen announcements, so please watch for those during the exam. You need to show detailed steps and justifications to support your conclusions to each exam question. A correct calculation result without sound supportive arguments will not receive credit.

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.)

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:

- **Recorded lectures: You are responsible for watching the lecture videos every week.**

- **Logging in**: **AT LEAST ONCE 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, let me know as soon as possible
- **Office hours**: **OPTIONAL OR FLEXIBLE**
  All office hours are optional. If you are required to discuss an assignment with me, please contact me at the beginning of the week if you need a time outside my scheduled office hours.

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

- 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 midterms and final exams yourself, without any external human 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.
- **Collaboration and informal peer-review**: The course will include opportunities for formal collaboration with your classmates. While study groups are encouraged, remember that comparing answers on a quiz or assignment is not permitted. If you're unsure about a particular situation, please feel free just to ask ahead of time.

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

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)

Tentative schedule STAT 6302 - SPRING 2020					
Subject to revision as course progresses					
Textbook reference: R+number = Rice book; K+number = Keener book					
#	Day	Week	Content	Textbook ch.	Homework due
1	11-Jan	1	Recap of 6301 contents	R1 - R6	
2	13-Jan	1	Recap of 6301 contents	R1 - R6	
3	15-Jan	1	Method of moments	R8.3, R8.4	
4	18-Jan	2	(No class)		
5	20-Jan	2	Method of moments	R8.3, R8.4	
6	22-Jan	2	Method of moments	R8.3, R8.4	HW1
7	25-Jan	3	MLE	R8.5	
8	27-Jan	3	MLE	R8.5	
9	29-Jan	3	MLE	R8.5	HW2
10	1-Feb	4	MLE	R8.5	
11	3-Feb	4	Cramer-Rao inequality and efficiency	R8.7	
12	5-Feb	4	Sufficiency	R8.8	HW3
13	8-Feb	5	Sufficiency	R8.8	
14	10-Feb	5	Rao-Blackewell Theorem	R8.8	
15	12-Feb	5	Exponential family	K2	HW4
16	15-Feb	6	Exponential family	K2	
17	17-Feb	6	Confidence interval	K9.4	
18	19-Feb	6	Confidence interval		
19	22-Feb	7	Review for Exam 1	Lecture notes	
20	24-Feb	7	Exam 1		
21	26-Feb	7	Confidence interval	Lecture notes	HW5
22	1-Mar	8	Confidence interval	Lecture notes	
23	3-Mar	8	CLT, approximate CI	K9.5	

24	5-Mar	8	CLT, approximate CI	K9.5, R8.5.3	**HW6**
25	8-Mar	9	Hypothesis testing	R9.1, R9.2 (intro), R9.2.1, R9.2.2	
26	10-Mar	9	Hypothesis testing	K12.1, K12.2	
27	12-Mar	9	Hypothesis testing	Lecture notes	**HW7**
28	15-Mar	10	Hypothesis testing	K12.4, R9.3	
29	17-Mar	10	UMPT	K12.2, R9.2 (intro)	
30	19-Mar	10	UMPT	K12.3, R9.2.3	**HW8**
31	22-Mar	11	Likelihood ratio test	R9.4, K17.1	
32	24-Mar	11	Likelihood ratio test	R9.5, K17.2 (skip proofs)	
33	26-Mar	11	Review for Exam 2		
34	29-Mar	12	Exam 2		
35	31-Mar	12	(No class)		
36	2-Apr	12	Likelihood ratio test	Lecture notes	
37	5-Apr	13	Likelihood ratio test	Lecture notes	
38	7-Apr	13	Goodness-of-fit tests	Lecture notes	**HW9**
39	9-Apr	13	Goodness-of-fit tests	Lecture notes	
40	12-Apr	14	Goodness-of-fit tests	Lecture notes	
41	14-Apr	14	Bootstrap	K19.1	**HW10 (possibly)**
42	16-Apr	14	Bootstrap	K19.3	
43	19-Apr	15	Review for Final 1		
44	21-Apr	15	Review for Final 2		
	Time to be announced		Final Exam		