THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

SYLLABUS: STAT 7301
ADVANCED STATISTICAL THEORY I
AUTUMN 2021

Course overview

Instructor

Instructor: Subhadeep Paul
Email address: paul.963@osu.edu
Lectures: Mondays, Wednesdays and Fridays, 9:10–10:05 am at Enarson Classroom Building 238.
Office hours: Simultaneous Virtual Hours via Carmen Zoom and In-person hours in my office at Cockins Hall 231 (Wednesdays 10:30 AM- Noon)

Grader or Teaching Assistant

Lingfei Zhao. (zhao.2412@buckeyemail.osu.edu)

Course description

Statistics 7301 is a course on statistical theory and is intended to provide students a holistic background on fundamentals of mathematical statistics and asymptotic theory. This course is primarily intended for second-year Ph.D. students in statistics. The topics to be covered include,

1. Fundamentals of Mathematical Statistics

- Statistics, Models, Decision Theory

- Sufficiency, Minimal Sufficiency, and Completeness

- Exponential families

- Rao-Blackwell theorem

- Fisher information

2. Methods of estimation
 - Unbiased estimation, UMVUE
 - Maximum likelihood
 - Minimum contrast estimation

3. Asymptotic approximations/ large sample theory
 - Consistency
 - Delta method
 - Asymptotic normality and efficiency

4. Nonparametric estimation
 - Estimating the CDF and statistical functionals
 - Influence functions and nonparametric Delta method

5. Some topics on statistical hypothesis testing as time permits.

Prerequisite or corequisite:

STAT 6802, or permission of the instructor

Course learning outcomes

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

- Understand important concepts of mathematical statistics
- Derive maximum likelihood and other estimators in a variety of statistical problems
- Theoretically analyze estimators in terms of consistency, asymptotic normality and efficiency properties.
- Apply nonparametric estimation techniques.

Course materials

Required

The required textbooks for this course is:

Keener, R.*: Theoretical Statistics: Topics for a Core Course.* Springer.
https://link.springer.com/book/10.1007%2F978-0-387-93839-4
Free e-book available from OSU library

Wasserman, L.*: All of Nonparametric Statistics.* Springer.
https://link.springer.com/book/10.1007%2F0-387-30623-4
Free e-book available from OSU library

Optional materials

Related text book (not required)

Lehman, E. L. and Casella, G.: *Theory of Point Estimation,* second edition.
https://link.springer.com/book/10.1007/b98854
Free e-book available from OSU library

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
- Recording a slide presentation with audio narration
- Recording, editing, and uploading video

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

Course delivery

The course will be primarily delivered in person (Please see this for details on the in-person delivery mode: https://keeplearning.osu.edu/understanding-instruction-modes). In accordance with the policy, we aim to keep approximately 80-90% of the classes in-person, with occasional recorded or synchronous online class delivered via CarmenZoom.

Each week we will cover approximately 165 minutes of content in total. You will be responsible for attending in person (or occasional recorder or live online) classes as well as studying the material that is assigned. You will be given ample time to complete the assignments.

The instructor will hold weekly office hours simultaneously via CarmenZoom and in-person at Cockins Hall 231. The times are given above.

Grading

Assignment or category	Percentage
Homework	30
Midterm Exam	25
Final Exam	30
Final take home assignment	15
Total	100

Assignment information

Homework: There will be a total of 5 homework assignments which will be assigned regularly throughout the course. It will consist of written problems. You are encouraged to work together on the problems, but each student must submit their own work, written in their own words. **All homework must be typed and submitted online as a PDF file through the class website (carmen). Please type your homework solution using either latex or any document processing software.**

Please note late submission of assignments will not be accepted unless prior exception has been sought. 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.

Exams: There will be two exams --**one in class midterm exam and a final exam**. Coverage includes lecture materials, assigned reading, and homework. All exams are closed book/closed notes. **Both the exams will be delivered in class in person.** Further details will be given in advance of each exam.

Tentative Date for midterm exam: Friday, October 22, 2021 during class time.
Final Exam Date (University scheduled): Monday Dec 13, between 10:00am-11:45am

Makeup exams require a valid excuse, official proof (in some cases), and an advanced notice.

Final take home assignment: There is a final take home assignment which is a paper-reading assignment. You will be asked to choose a paper in mathematical statistics and summarize it in a specific format. More details will be provided through Carmen course website.

Grading scale

93–100: A
90–92.9: A-
87–89.9: B+
83–86.9: B
80–82.9: B-
77–79.9: C+
73–76.9: C
70 –72.9: C-
67 –69.9: D+
60 –66.9: D
Below 60: E

There will be additional bonus points with most assignments and exams. However, the above scale will be strictly followed for final grades.

Attendance, participation, and discussions

Students are expected to regularly participate, discuss, and answer questions in in-person lectures. However, students may miss class, for a variety of reasons, including those related to COVID-19 pandemic. As much as possible, please stay in contact with the instructor so that we can discuss accommodations should they be needed.

Other course policies

Academic integrity policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the University's Code of Student Conduct, and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the University's Code of Student Conduct and this syllabus may constitute Academic Misconduct.

The Ohio State University's Code of Student Conduct (Section 3335-23-04) defines academic misconduct as: Any activity that tends to compromise the academic integrity of the University, or subvert the educational process. Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the University's Code of Student Conduct is never considered an excuse for academic misconduct, so I recommend that you review the Code of Student Conduct and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by University Rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the University's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the University.

If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

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. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process (slds.osu.edu/covid-19-info/covid-related-accommodation-requests/), managed by Student Life Disability Services. 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 25, 27	Statistical Model, Decision Theory
2	Aug 30, Sep 1, 3	Decision Theory, Sufficient statistics
3	Sep 8, 10	Sufficient statistics, Minimal Sufficiency
4	Sep 13, 15, 17	Exponential families
5	Sep 20, 22, 24	Convex loss functions, Rao Blackwell theorem
6	Sep 27, 29, Oct 1	Ancillary Statistics, completeness, UMVUE
7	Oct 4, 6, 8	UMVUE, Fisher information, Cramer-Rao bound
8	Oct 11, 13	Asymptotic analysis, consistency
9	Oct 18, 20, 22	Convergence in distribution, Midterm Exam
10	Oct 25, 27, 29	Delta method
11	Nov 1, 3, 5	Maximum likelihood estimation
12	Nov 8, 10, 12	Consistency of M estimators and MLE
13	Nov 15, 17, 19	Asymptotic normality of Z estimators, asymptotic efficiency
14	Nov 22	Nonparametric estimation, influence functions
15	Nov 29, Dec 1, 3	Nonparametric delta method, bootstrap
16	Dec 6, 8	Additional topics (possibly hypothesis testing), sample final