Statistics 312: Introduction to Theory and Methods of Mathematical Statistics II

Fall 2020

People

Instructors:

Name	Tedward Erker	Derek Bean
Lecture:	001	002
Office:	Online	Online
Email:	erker@wisc.edu	bean3@wisc.edu
Office Hours:	T 1-3p, W 2-4p, and by appt.	M 10a-12p, R 5-7p,and by appt.

Note: Office hours will be held remotely via Blackboard Collaborate in Canvas. In order to make up for some of the lost interaction due to the asynchronous nature of instruction, instructors' office hour opportunities are extended beyond what is typical for in-person classes. Both Dr. Bean's and Dr. Erker's office hours are open to all students in lectures 001 and 002 of the course.

Teaching Assistants:

Name:	John Fogg	Taiyu Ye
Office:	Online	Online
Email:	fogg@wisc.edu	tye33@wisc.edu
Office Hours:	F 2-4p	F 2-4p

Note: Office hours will be held remotely via Blackboard Collaborate in Canvas. TA office hours will begin in Week 2 of the course. There will be one office hours session held at 2-4pm on Fridays led by one TA, which will be open to all students in lectures 001 and 002 of the course; TAs will alternate leading the session week to week.

Basic Course Information

Description:

Unbiased estimation, maximum likelihood estimation, confidence intervals, tests of hypotheses, Neyman-Pearson lemma, likelihood ratio test, regression, analysis of variance with applications.

Learning Objectives:

Upon completion of this course, successful students will be able to comprehend, construct, and critique fundamental statistical methods of science and engineering. Specifically, students will:

- Be able to use probability theory to understand and utilize three principal tools of statistical inference: point estimators, confidence intervals, and hypothesis tests.

- Using the tools in objective 1, understand and be able to carry out, where appropriate, the standard statistical inference procedures based on approximate normality of the target population(s) in the following statistical contexts: inference based on a single random sample; comparing two independent random samples; comparing two paired random samples; Analysis of Variance (with one or more factors); simple linear regression.

- Using the tools of objective 1, understand and be able to carry out, where appropriate, statistical inference procedures for certain types of non-normal data. These procedures primarily include: (i) techniques for analyzing categorical data (inference for population proportion(s) and goodness-of-fit tests for multicategory data) and (ii) alternative nonparametric methods for numerical non-normal data (large-sample methods, Wilcoxon methods, Kruskal-Wallis).

Credit Information:

This course is 3 credits. Ordinarily, this would mean the class meets for two 75-minute lecture class periods each week, and carries the expectation that students will work on course learning activities (readings, homeworks, studying, etc.) for about 3 hours for every class period. In the remote asynchronous format, we plan to provide 150 minutes of recorded lectures in place of the in person lectures.

Designations:

> Level - Advanced
> Breadth - Natural Science
> L&S Credit Type: Counts as LAS credit (L&S)

Requisites:

MATH/STAT 309, STAT 311, MATH/STAT 431, or graduate/professional standing

Instructional Mode

Remote asynchronous lecture

Course Policies

Integration of Lectures 001 and 002

We have decided to integrate Lectures 001 and 002 of the course for Fall 2020. All course materials (including lecture videos, homeworks, and exams) will be common to both sections. Students from both lecture sections are encouraged to approach any instructor or TA for help with the course. The time saved by instructors integrating the two courses will be used to increase opportunities for student-instructor interaction, which we think is necessary to overcome the challenges posed by remote learning.

Required Materials

- Access to a computer with a reliable internet connection

- The textbook: *Probability and Statistics for Engineering and the Sciences, 9th edition* by Jay L. Devore

Online Materials

Canvas will be used to post all necessary materials, including lecture videos, readings, homework assignments, announcements, and any other materials. Canvas will also serve as a gradebook. Piazza (embedded in Canvas) will be used for asking questions and discussion. It is recommended that you check Canvas regularly.

Communication

Sharing important information and announcements:

Important course information and deadlines (as well as updates or changes) will be shared via the Announcements feature via Canvas – each time an instructor creates an announcement, you will receive an email notification (Be sure to set you canvas email preferences correctly so as to recieve these announcements).

Questions:

As the main platform for asking and answering questions asynchronously, we are going to use Piazza (an app that is available through Canvas).

We think that the Piazza forum will be the most efficient way for students to ask general questions and we strongly encourage its use. Piazza allows for asynchronous communication, and for having discussions if a similar question should arise multiple times. The forum will be monitored regularly by the instructors and the TAs. Students are also encouraged to help other students on Piazza.

E-mail policy:

Responding to e-mails can be very time-consuming. We will strive to respond to all e-mails within one business day. Before e-mailing us, however, we strongly recommend you do the following: (1) If your question relates to course policies or logistics, read the syllabus and all Canvas announcements first to see if your question is answered there; (2) If your question relates to course content or a homework question, please post it to Piazza in lieu of e-mailing us, so the whole class may benefit; (3) if you are e-mailing to schedule an appointment with an instructor, please do so at least 24 hours prior to your proposed meeting time.

Virtual office hours:

For the virtual office hours, we are going to use BB Collaborate through Canvas.

Lecture time and location:

Lectures will be delivered online via videos posted to the course Canvas. The lectures in a given week will be made available Sunday night, with the exception of week 1. Instructors will work as a team to deliver lecture content to all students. This approach will afford the instructors more time to devote to instructor-student interactions which are critical for learning.

Homework Policy

There will be 10 homework assignments throughout the semester. These assignments are very important and much of your learning will take place while you are working the homework problems. Often the assignments are quite time consuming, so plan ahead.

Note: Homework 1 will be assigned in Week 2 on Thursday, September 10th, and will be due on Friday, September 18th at 4pm Central Standard Time (CST - Chicago time).
Details about homework guidelines, expectations, and submission are below.

- All assignments will be posted to Canvas on Thursdays. Typically, assignments will be due 8 days later by 4:00pm Central Standard Time (CST - Chicago time) on Friday the following week. Some assignments may be due more than 8 days after being posted, if necessary. Homeworks are to be submitted electronically via Canvas.

- Credit will not be given for homework turned in late.

- Homework can be hand-written, or typed, or a combination of both. Homework must be well organized, neat, legible and with all of your work shown to receive full credit.

- You may discuss homework problems with others including your peers, your TA and instructor, but you must write up your homework solutions by yourself in order to receive credit.

- The lowest score will be dropped when computing an average score for your homework at the end of the semester. Please use this "Drop One" policy wisely and contact the instructor if you have a concern that is not adequately covered by this policy.

- Submit your homework electronically on Canvas. To submit, click on the Assignments tab, then click the assignment you want to submit. Click the blue box near the top right labeled 'Submit Assignment.' On the 'Select Submission Type' screen, click on the 'File Upload' tab, then click 'Choose File' to browse for the file. You may add comments for the grader if desired, then click the 'Submit Assignment' box. Give Canvas a little time, then look in the top right for confirmation that the assignment was received.

- Your submission should be a single PDF document. If you have scanned written pages, printed output, graphs, etc., please use a program such as Adobe Acrobat to combine the separate pages into a single document before submitting. Handwritten pages can be scanned (e.g. with phone apps, such as CamScanner) and combined into a single PDF.

- You will not be able to submit an assignment after the submission deadline, so please plan ahead. It is recommended you begin the submission process at least 5 minutes prior to the submission deadline, since it sometimes takes some time for Canvas to accept an assignment. Any assignments that are not received by the submission deadline will earn zero points.

- Assignments will be graded electronically. You can view any comments or annotations on graded homeworks in Canvas by clicking on Grades, then the assignment. For comments, click on the comments icon, or for annotations, click the assignment name, then 'View Feedback.' Homeworks will be graded, and any comments/annotations made available for viewing, no later than the first Friday after following the due date.

- After the homework submission deadline, one randomly selected problem from the homework will be dropped from grading (the same problem shall be dropped for every student). The assignment will be graded based on the remaining undropped problems. The TAs and the instructors greatly appreciate your understanding about this, as this policy allows us to grade and return your assignments promptly.

- Unless otherwise specified by a problem, you can always use a calculator, a computer program, or the tables in the Appendix of the textbook to calculate probabilities.

- If you believe you received an incorrect grade on a homework assignment, please take your grade appeal to a TA first (note that, if necessary, you may be referred to the TA who graded the disputed assignment). The TA will act to resolve your appeal. If you still disagree with the TAs decision, then you may take your appeal to the SIS-designated instructor of the course section (001 or 002) in which you are officially registered.

Exams

There will be two mid-term exams and a final exam. The two midterms will be on **Tuesday, October 6th** and **Tuesday, November 10th**. The final exam is **December 18th**.

Alternate dates for the in-class midterms will be offered only in extenuating circumstances. There will be no make-ups allowed for the final exam. Block the time for the exams now. Vacation travel does not constitute an acceptable reason for missing an exam. Please plan ahead accordingly!

Both midterms and the final exam will be take-home exams. The exams will be available for download beginning at 12:00am Central Standard Time (Chicago time) on the scheduled day of the exam, and

you will have until 11:59pm CST to submit the exam through Canvas. **Make sure you have reliable internet access on all three exam days.** We recommend submitting the exam at least 5 minutes prior to 11:59pm to allow time to upload to Canvas. Late exams will receive a 0.

For all exams, you may use your notes, the textbook, and any other relevant materials (e.g. Wikipedia entries, journal articles, other textbooks, other course materials) you can locate, as a reference while solving the problems. However, you may **not** collaborate with each other, and you may **not** ask any living person for any kind of aid in solving the problems. You may ask Dr. Bean and Dr. Erker questions that you could reasonably ask of a proctor in an in-person exam (e.g. for clarification about what is going on in an exam problem, the definition of unfamiliar non-Statistical terms, if you suspect a typo, etc.); see the next paragraph for more detail.

The Piazza discussion forum will be disabled on exam days. On exam days, please e-mail any questions you have about the exam to **both** Dr. Erker **and** Dr. Bean; the teaching assistants will not answer questions about the exams. We the instructors will be available to answer questions between 8am and 10pm CST on exam days: please allow a reasonable time for us to respond, and plan your time wisely!

If you believe you received an incorrect grade on an exam, you may appeal your exam grade to the instructors of the course (TAs will not hear grade appeals involving exams). Appeals must be made to both Dr. Erker and Dr. Bean in writing **and** within 14 days of receiving the exam grade. Appeals which do not satisfy both conditions will not be heard. In your written appeal, please clearly explain exactly why you think the exam was graded in error, with as much detail and supporting evidence as you can supply.

UPDATE 11/6/20. To curtail incidences of academic misconduct on the exam, the following updated exam policies and procedures will be adhered to henceforth in the class. If there are any conflicts between these updates and any previous exam policies/procedures above this paragraph, the updated policies/procedures shall supersede.

- Use of subscription-based homework helping services such as Chegg in order to post the exam questions, search for the exam questions, or access solutions to the exam questions, is strictly prohibited.

- Use of social media sites such as Reddit or Discord to post information from, or to discuss any part of, the exam is strictly prohibited.

  Basically, don't post the exam problems to the internet, don't discuss the exam problems on the internet, and don't search for the specific exam problems on the internet. Furthermore, the above two bullet points should not be construed as a modification to previous syllabus policies surrounding use of resources on the exam; rather, they are explicit clarifications of the existing policy.

- Each exam question will be a separate Canvas quiz. You may start a question at any time between midnight and 11:59pm CST on November 10, 2020. But once you commence one of the quizzes, you will have an average of 45 minutes to complete it. Depending on the length of the question, some may have a longer submission period and some shorter. Overall, the exam is designed to be completed in approximately 80 minutes total; the extra time per question is intended to afford you ample time to upload your written solutions to Canvas.

- If you need to submit a solution to an exam problem after the time expires, please e-mail the solution to Dr. Erker and Dr. Bean. Note that e-mailed submissions can only earn at most

67% of the question's value. This cap will decrease by 6.67% of the exam's total value for each additional minute the submission is late. We recommend that you allow yourself at least ten minutes to upload your solution to an exam problem to avoid penalties for late submissions.

- You will be asked to sign a statement of integrity on all exam submissions.

Grading

The homework will count 20%, the in-class midterm exams will count 25% each, and the final will count 30%. The exams, homework, policies, and grading will be identical for the two sections.

COVID-19 Information

During the global COVID-19 pandemic, we must prioritize our collective health and safety to keep ourselves, our campus, and our community safe. As a university community, we must work together to prevent the spread of the virus and to promote the collective health and welfare of our campus and surrounding community.

Information on COVID-19 is constantly changing. Students should be attentive to University communications regarding COVID-19 that may alter instruction and supersede parts of this syllabus.

UW-Madison Badger Pledge

https://smartrestart.wisc.edu/badgerpledge/

UW-Madison Face Covering Guidelines

While on campus all employees and students are required to wear appropriate and properly fitting face coverings while present in any campus building unless working alone in a laboratory or office space.

Face Coverings During In-person Instruction Statement (COVID-19)

Individuals are expected to wear a face covering while inside any university building. Face coverings must be worn correctly (i.e., covering both your mouth and nose) in the building if you are attending class in person. If any student is unable to wear a face-covering, an accommodation may be provided due to disability, medical condition, or other legitimate reason. Students with disabilities or medical conditions who are unable to wear a face covering should contact the McBurney Disability Resource Center or their Access Consultant if they are already affiliated. Students requesting an accommodation unrelated to disability or medical condition, should contact the Dean of Students Office. Students who choose not to wear a face covering may not attend in-person classes, unless they are approved for an accommodation or exemption. All other students not wearing a face covering will be asked to put one on or leave the classroom. Students who refuse to wear face coverings appropriately or adhere to other stated requirements will be reported to the Office of Student Conduct and Community Standards and will not be allowed to return to the classroom until they agree to comply with the face covering policy. An instructor may cancel or suspend a course in-person meeting if a person is in the classroom without an approved face covering in position over their nose and mouth and refuses to immediately comply.

Quarantine or Isolation Due to COVID-19

Students should continually monitor themselves for COVID-19 symptoms and get tested for the virus if they have symptoms or have been in close contact with someone with COVID-19. Students should reach out to instructors as soon as possible if they become ill or need to isolate or quarantine, in order to make alternate plans for how to proceed with the course. Students are strongly encouraged to communicate with their instructor concerning their illness and the anticipated extent of their absence from the course (either in-person or remote). The instructor will work with the student to provide alternative ways to complete the course work.

University Policies

Rules, Rights, and Responsibilities:

See: `https://guide.wisc.edu/undergraduate/#rulesrightsandresponsibilitiestext`

Academic Calendar and Religious Observances

See: `https://secfac.wisc.edu/academic-calendar/#religious-observances`

Academic Integrity

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but are not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion. For detailed information, please see: `https://conduct.students.wisc.edu/academic-misconduct/`.

Accommodations for Students with Disabilities

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform instructors of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Instructors will work either directly with the student or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA.

Diversity and Inclusion

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status,

abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background - people who as students, faculty, and staff serve Wisconsin and the world.

Statistics Department Policies

Standards of Ethical Conduct in Data Analysis and Data Privacy

The members of the faculty of the Department of Statistics at UW-Madison uphold the highest ethical standards of teaching, data, and research. They expect their students to uphold the same standards of ethical conduct. Standards of ethical conduct in data analysis and data privacy are detailed on the ASA website: `https://www.amstat.org/ASA/Your-Career/Ethical-Guidelines-for-Statistical-Practice.aspx`, and include:

- Use methodology and data that are relevant and appropriate; without favoritism or prejudice; and in a manner intended to produce valid, interpretable, and reproducible results.

- Be candid about any known or suspected limitations, defects, or biases in the data that may affect the integrity or reliability of the analysis. Obviously, never modify or falsify data.

- Protect the privacy and confidentiality of research subjects and data concerning them, whether obtained from the subjects directly, other persons, or existing records.

By registering for this course, you are implicitly agreeing to conduct yourself with the utmost integrity throughout the semester.

Complaints

If you have a complaint about a TA or course instructor, you should feel free to discuss the matter directly with the TA or instructor. If the complaint is about the TA and you do not feel comfortable discussing it with him or her, you should discuss it with the course instructor. Complaints about mistakes in grading should be resolved with the instructor or TA, as appropriate, in the great majority of cases. If the complaint is about the instructor (other than ordinary grading questions) and you do not feel comfortable discussing it with him or her, contact the Director of Undergraduate Studies, Professor Cecile Ane, cecile.ane@wisc.edu. If your complaint concerns sexual harassment, please see campus resources listed at `https://compliance.wisc.edu/titleix/resources/`. In particular, there are a number of options to speak to someone confidentially. If you have concerns about climate or bias in this class, or if you wish to report an incident of bias or hate that has occurred in class, you may contact the Chair of the Statistics Department Climate and Diversity Committee, Professor Po-Ling Loh (ploh@stat.wisc.edu). You may also use the University's bias incident reporting system, which you can reach at `https://doso.students.wisc.edu/bias-or-hate-reporting/`.

1 List of topics (with selected subtopics and estimated times and durations)*

1. **Probability review.** Axioms of probability; random variables; important probability distributions: normal, binomial, and chi-square; random samples. *Weeks 1-2*

2. **Point estimation.** Bias; standard error; minimum variance unbiased estimators; maximum likelihood estimators. *Weeks 2-3*

3. **Hypothesis testing for one sample.** Basics: hypotheses, types of errors, significance level, power, hypothesis tests for a population mean: parametric and nonparametric approaches; tests for population proportions. *Weeks 3-5*

4. **Confidence intervals for one sample.** Relationship to hypothesis tests; confidence intervals for population means: parametric and nonparametric methods; confidence intervals for population proportions. *Weeks 6-7*

5. **Two-sample inference.** Hypothesis tests and confidence intervals for two independent samples: parametric and nonparametric approaches; tests and intervals for paired samples: parametric and nonparametric approaches. *Weeks 7-9*

6. **One-way ANOVA.** Sums of squares and F-tests; pairwise comparisons; nonparametric alternatives. *Weeks 9-11*

7. **Simple linear regression.** The linear model; least squares estimation; inference for the slope; prediction intervals. *Weeks 11-13*

8. **Categorical data analysis.** Goodness-of-fit tests for a single category variable; chi-square test of independence. *Weeks 13-15*

*Topics and subtopics subject to revision by the instructors at any time. Times and durations are estimates and may change throughout the semester.