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

Spring 2021

People

Instructors:

Name	Tedward Erker	Derek Bean
Lecture:	001	002
Office:	Online	Online
Email:	erker@wisc.edu	bean3@wisc.edu
Office Hours:	T 11a-1p, W 1-3p, and by appt.	M 9-11a, F 1-3p,and by appt.

Note: Weekly scheduled office hours will be held remotely via Blackboard Collaborate (BB Collaborate) in Canvas. Office hours scheduled by appointment may be held in BBCollaborate or via WebEx or Zoom, depending on the nature of the appointment; this will be determined when the appointment is made. 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 Assistant:

Name:	Ilia Sorvachev
Office:	Online
Email:	sorvachev@wisc.edu
Office Hours:	R 11a-1p

Note: TA fffice hours will be held remotely via Blackboard Collaborate in Canvas. TA office hours are open to all students in lectures 001 and 002 of the course.

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; single-factor Analysis of Variance; (time permitting) multifactor Analysis of Variance; 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 include primarily: (i) techniques for analyzing categorical data (inference for population proportion(s) and, time-permitting, goodness-of-fit tests for multicategory data) and (ii) alternative nonparametric methods for analyzing 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 around 150 minutes of recorded lectures in place of the in person lectures per week.

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 Operation and Policies

Integration of Lectures 001 and 002

We have decided to integrate Lectures 001 and 002 of the course for Spring 2021. All course materials (including lecture videos, reading assignments, quizzes, homeworks, and exams) will be common to both sections. Students from both lecture sections are encouraged to approach either instructor or the 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 serve as the course website. It will be used to post all necessary materials, including lecture videos, readings, quizzes, homework assignments, announcements, and any other materials. Canvas will also host the grade book. Piazza (embedded in Canvas) will be used for asking questions and discussion. It is recommended that you check Canvas regularly, at least a couple times per week.

Communication

Sharing important information and announcements:

Important course information 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 your canvas email preferences so that you receive notification of these announcements).

Questions:

Piazza (an app that is available through Canvas) will serve as the primary platform for posting and responding to student questions.

We think that the Piazza forum will be the most efficient way for students to ask questions about the course (clarification of course material, homework problems, questions about quizzes) and we strongly encourage its use. Piazza allows for asynchronous communication, and for having back-and-forth discussions. It is also more efficient for addressing questions that arise multiple times. The forum will be monitored regularly by the instructors and the TA. Students are also encouraged to help other students on Piazza.

Questions specific to an individual student's situation in the course may not be appropriate for Piazza, particularly if it involves sensitive information. If such questions arise, students should e-mail both instructors. Please see the e-mail policy, below.

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 weekly virtual office hours, we are going to use BBCollaborate through Canvas.

Office hours held by appointment may be conducted through BBCollaborate or on another webconferencing platform like WebEx or Zoom, depending on the requirements of the appointment and/or the preferences of its participants.

Lecture time and location:

Lectures will be delivered online via videos posted to the course Canvas. The lectures for a given week will be posted to Canvas on Thursday of the prior week, with the exceptions of: (i) Week 1, whose videos will be posted on Monday, January 25th; (ii) Week 8, the week of the midterm examination, where there will be no lecture videos; (iii) Final Exam week. The lecture videos will become available to a student only after they submit that week's reading quiz, with the exceptions of Week 1 (where the videos will be immediately available without taking a quiz) and Week 8 (where no lecture videos will be posted). Go to the following section of the syllabus for more information on weekly reading assignments and quizzes.

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.

Reading assignments and quizzes

Weekly readings will be assigned out of the Devore textbook. A given week's reading assignment, together with a short quiz in Canvas, will be assigned on the Thursday of the prior week. The reading quiz will be due on the following Tuesday at 11:59pm Central Standard Time (CST - Chicago time). The only exceptions are in Week 1, where the reading quiz (over this syllabus) will be assigned on Monday Jan. 25th and due Tuesday Jan. 26th at 11:59 CST; and in Week 8, the week of the midterm examination, where there will be no new readings or quizzes assigned.

The reading assignments are intended to be a student's initial exposure to that week's material. The lecture videos for a given week will only become available once the reading quiz is submitted. Our

goal is to instill in students the habit of reading and learning out of the Devore textbook, which is an excellent resource.

Homeworks and homework policy

New homework will be assigned nearly every week. A given week's assigned homework will generally become available to students once they submit that week's reading quiz, and will be due on the Friday of the following week at 4:00pm CST. The only exceptions are: Homework 1, which will be assigned on Monday, January 25th (without taking a quiz first) and due Friday, January 29th at 4pm CST; Homework 2, which will become available on Tuesday, January 26th (without taking a quiz first) and due Friday, February 5 at 4:00pm CST; and Homework 8, which will cover material from Week 7 but won't be due until Friday, March 26th (the Friday of Week 9) at 4:00pm CST due to the Midterm Exam taking place in Week 8.

There will be about 13 homework assignments throughout the semester. With the exception of Homework 1, all homework problems will be assigned from the textbook. These assignments are very important and much of your learning will take place while you are working the homework problems. They are intended to afford an opportunity for students to practice applying the specific course concepts learned in a given week. Often the assignments are quite time consuming, so plan ahead.

Details about homework guidelines, expectations, and submission procedures are below.

- All homeworks will be due on Fridays by 4:00pm Central Standard Time (CST - Chicago time). Homeworks are to be submitted electronically via Canvas.
- No credit will be given to homework turned in late!
- Homework can be hand-written, or typed, or a combination of both. Homework must be well organized, neat, and legible and with all of your work shown to receive full credit. Make sure to show the steps leading up to your final calculations. Beware: unreadable work will not be graded and will not be awarded any credit!
- You may discuss homework problems with the instructors, TA, and your peers; in fact, collaboration between students is encouraged in order to enhance your learning and bond with fellow students in the class. Nevertheless, to receive any credit on an assignment, you must submit your own individual work written in your own words. You are also expected to fully understand the work you are submitting.
- The two lowest homework scores will be dropped when computing an average score for your homework at the end of the semester. Please use this "Drop Two" 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 following the due date.
- 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 the TA first. The TA will act to resolve your appeal. If you still disagree with the TA's 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.

(IMPORTANT) A typical week

This section will describe the sequence of events, including the activities the student will undertake, in a typical week. Each week's specific activities will be provided on Canvas in a module for that week. The aim of this section of the syllabus is to give the student a sense of how the weekly reading assignments & quizzes, weekly lecture videos, and weekly homeworks fit together in most* weeks. Please read it carefully!

Events and activities for Week N

1. **Thursday of Week N-1:** First module for Week N becomes available to students. This includes the Week N reading assignment and reading quiz.
2. **Tuesday of Week N:** Reading quiz for Week N is due.
3. **Upon submission of Week N reading quiz:** the second module for Week N becomes available. This includes the lecture videos for Week N and the homework assignment covering Week N material. We strongly recommend students submit the reading quiz by Monday, watch the lecture videos Tuesday through Thursday, and begin the homework on Friday, leaving themselves one week to complete and submit the homework.
4. **Friday of Week N+1** Homework covering Week N material is due.

*The two exceptional weeks are Week 1 (where the module will become available on Monday January 25th, and Homework 1 and 2 and the lecture videos will be made available without taking the reading quiz), and Week 8 (the week of the Midterm Examination, where there will be no reading quiz, lecture videos, or new homework assigned). There is a calendar of assessments (homework, quizzes, and exams) included at the end of this syllabus for further reference.

Exams

There is one Midterm Examination and one Final Examination. The dates of the examinations are given below, along with the dates and times of the review sessions we will hold prior to the exams. **Please mark these dates in your calendar!**

Exam	Date	Notes	Review Date/Time	Notes
Midterm	R March 18th	Exam available to take any time during day but will be timed!	W March 17th 3pm CST	Via BBCollaborate. Recording will be made available
Final	F May 7th	Exam available to take at any time during day but will be timed!	W April 28th 3pm CST	Via BB Collaborate. Recording will be made available.

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 the midterm and final exams will be administered through Canvas. They will be available on Canvas beginning at 12:00am Central Standard Time (Chicago time) on the scheduled day of the exam, and may be started at any time during the following 24 hours. The sections of an exam will be given as separate Canvas quizzes (or Canvas assignments). Each section will have a time limit; you may commence an exam section at any time during the exam day, but once you begin a section you will have a certain amount of time in which to submit your work. For problems where you must upload written work, we strongly recommend leaving yourself at least 5 minutes prior to the time limit to allow time to upload to Canvas. **Make sure you have reliable internet access on both exam days.** All sections of the exam are due in by 11:59pm CST of exam day. If the time limit (or 11:59pm CST) is reached while you are taking an exam section, what you have saved will be automatically submitted. Exam work submitted late may be subject to severe penalties, up to and including receiving zero credit.

The midterm exam is designed to be completed within a typical class period (75 minutes) and the final exam is designed to be completed within a final exam period (120 minutes). We the instructors recognize, however, that internet connections are not always 100% reliable. Thus, the aggregate time limit of all sections of the midterm will exceed 75 minutes, and that of the final will exceed 120 minutes.

A section of an exam will either be in a free response format or in a multiple choice format. Free response sections will formally resemble homework assignments, however, being that they are part of the exam, the problems will tend to be more comprehensive, synthesizing different sections of the material, and will require a deeper level of reasoning to solve. Similarly, multiple choice sections will have the same format as quizzes, but the questions will be more challenging. Homeworks and quizzes are intended as practice for more narrow slices of the material, while exams are meant to test your knowledge of the material in a comprehensive manner.

For all exams, you may use your notes, the textbook, and 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, Dr. Bean and Dr. Erker can only vouch for their lecture notes and the material found in Devore, so be careful when using outside references! Furthermore, the following practices during exams are strictly prohibited:

1. Collaboration on the exam with another Stat 312 student, or any other person.

2. Communication (of any form) about exam content to anyone besides Dr. Erker and Dr. Bean.
3. 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.
4. Use of social media sites such as Reddit or Discord to post information from, or to discuss any part of, the exam.
5. 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!

The actions on the enumerated list above constitute academic misconduct, and the prohibitions against them will be strictly enforced. We will also strictly enforce prohibitions against any and all other forms of academic misconduct recognized by UW-Madison, whether or not they are specifically enumerated in this syllabus. Dr. Erker and Dr. Bean take their duty to protect the integrity of exams very seriously. Thus, you may be asked to sign a statement of integrity on exam submissions.

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 of how to contact them.

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 TA 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 may 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.

Grading

Numerical grades will be calculated according to the following weights:

- **Reading quizzes:** 20%
- **Homework:** 25%
- **Midterm:** 25%
- **Final:** 30%

Thresholds for assigning letter grades based on numerical grades will be announced after the Midterm is graded. These thresholds will be partly determined by the distribution of the class's numerical grades at the time of the announcement.

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

Course evaluations

Students will be provided with an opportunity to evaluate this course and their learning experience. Student participation is an integral component of this course, and your feedback is important to us. I strongly encourage you to participate in the course evaluation.

UW-Madion now uses an online course evaluation survey tool, AEFIS. In most instances, you will receive an official e-mail two weeks prior to the end of the semester when your course evaluation is available. You will receive a link to log into the course evaluation with your NetID where you can complete the evaluation and submit it, anonymously. Your participation is an integral component of this course, and your feedback is important to me. I strongly encourage you to participate in the course evaluation.

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/`.

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

1. **Point estimation.** Bias; standard error; minimum variance unbiased estimators; maximum likelihood estimators. *Weeks 1-2*
2. **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*
3. **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*
4. **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*
5. **ANOVA.** Sums of squares and F-tests; pairwise comparisons; nonparametric alternatives; multifactor ANOVA. *Weeks 9-10*
6. **Simple linear regression.** The linear model; least squares estimation; inference for the slope; prediction intervals; regression diagnostics. *Weeks 11-12*
7. **Categorical data analysis.** Goodness-of-fit tests for a single category variable; chi-square test of independence. *Weeks 13-14*

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