![The Ohio State University — College of Arts and Sciences]

Stat 3202: Statistical Inference for Data Analytics   Spring 2025

Course Overview
Instructor: R. Scott Linder (linder.5@osu.edu , always send email through Carmen page)
In-person office hours: T and R 3:45pm– 4:45pm in Smith Hall (room tba)
Zoom office hours: M 5pm–6pm, W 4pm–5pm (link is on Carmen page)

Recitation instructor: Jae Chang (chang.2090@osu.edu)
Zoom office hour: TBA (link is on Carmen page)

Prerequisite: C- or better in Stat 3201, or permission of instructor. Not open to students with credit for Stat 4202.2.

Course Description and Delivery
This course introduces foundational inferential methods for learning about populations from samples, including point and interval estimation, and the formulation and testing of hypotheses. Statistical theory is introduced to justify the approaches. The course emphasizes challenges that arise when applying these ideas with large and complex data, and offers approaches both to diagnosis and remediation of such challenges, particularly through the use of computational and simulation techniques.

Course material will be discussed in class lectures on Tuesdays and Thursdays (2:20pm–3:40pm, Smith Lab 1005). Lecture notes will be provided on the Carmen page prior to class meetings to assist in organizing your notes, but they will not be complete. This is not a "remote" course, and students are required to attend class meetings. Recordings of class meetings will not be posted to the Carmen page. The instructor will occasionally post supplemental recordings on course content to serve as review and support.

On Mondays you'll also meet for a recitation meeting (Pomerene Hall 155). This is also a required class meeting time. During these meetings, you'll receive lab tutorials and supplemental problems to support learning of course concepts. Lab assignments will be due at the end of each week.

Carmen

As mentioned above, this class will use Carmen. The class Carmen page will be our central hub for all course materials, and you should be looking in on it several times per week. Here you will find the syllabus, lab and homework assignments, class notes, review materials for exams, and other important documents. You'll also find a record of your grades for various assessments.

Course learning outcomes

By the end of this course, students should successfully be able to:
• Compare the performance of estimators by the criteria of bias, variance, mean squared error, asymptotic unbiasedness and consistency; and understand how sufficient statistics relate to optimal estimation.
• Use Monte Carlo simulation to model the performance of estimators and testing procedures.
• Construct (propose) estimators via method of moments and maximum likelihood paradigms.
• Use the Central Limit Theorem to model the sampling distribution of a sample mean.
• Conduct hypothesis tests on mean and variance parameters, including t-tests, chi-square tests, and F tests.
• Use theory or simulation to determine and interpret the power and type-II error rate of a significance test.
• Use bootstrapping to conduct inference.
• Perform nonparametric hypothesis tests on mean parameters.

Course grades

Your total course average (TCA) will be computed using the following assessment category weights:

Assessment category	Percentage
Homework assignment average	20
Recitation Labs and assignments	20
Midterm Exam 1	20
Midterm Exam 2	20
Final Exam	20

Grading scale
[93–100]: A   [90–93): A-
[87–90): B+   [83–87): B   [80–83): B-
[77–80): C+   [73–77): C   [70 –73): C-
[67 –70: D+   [60 –67): D
[0–60): E

This is a "guaranteed minimum grade" scale. For example, if your total course average is 88.8%, you are guaranteed to earn a course grade of B+ or higher.

Course materials
• Required text: Stat 3202 Course Notes (electronic, on Carmen)
• Recommended text: Mathematical Statistics with Applications, 7th edition, by Wackerly, Mendenhall, and Scheaffer (Brooks/Cole, Cengage Learning, 2008).
eBook PDFs are much cheaper and are highly encouraged.

Course technology
Required software:
R. We will use the statistical software package R extensively. You can freely download R for Windows, Mac, and Linux at the R CRAN. An in-depth introduction to R is available at R Tutorial. Tutorials are available in the Swirl system, which you can learn about at Swirlstats. "R Programming: The basics of programming in R" is an appropriate first tutorial for students who have never used R.

RStudio. We will also use the R interface RStudio. This package is available for Windows, Mac, and Linux and can be downloaded for free from RStudio. Note that RStudio requires R to be installed.

R Markdown. Finally, this class also requires the use of the (free) R Markdown authoring framework to complete assignments. Information about R Markdown will be provided in class; an online guide with overview information can be found at R Markdown.

Microsoft Office 365 ProPlus. All Ohio State students are now eligible for free Microsoft Office 365 ProPlus through Microsoft's Student Advantage program. Office 365 is installed through your BuckeyeMail account. Full instructions for downloading and installation can be found here.

Technology skills necessary for this course
• Basic computer and web-browsing skills
• Navigating Carmen

Necessary computing equipment
• Computer: current Mac (OS X) or PC (Windows 10+) with high-speed internet connection
• Webcam: built-in or external webcam, fully installed (for virtual office hours).
• Microphone: built-in laptop or tablet mic or external microphone

Technology help
For help with your password, university e-mail, Carmen, or any other technology issues, contact the OSU IT Service Desk. Standard support hours are available at OSU OCIO HELP, and support for urgent issues is available 24x7.

• Self-Service and Chat support is available here.
• Phone: 614-688-HELP (4357)4   • Email: 8help@osu.edu   • TDD: 614-688-8743

<u>Exams</u>:
There will be two midterm exams and a final exam. The dates for these exams are listed in the course calendar included with this syllabus. Midterm exam dates are unlikely to change, but the instructor reserves the right to change them with at least 1 week notice ahead of time. The final exam date is fixed, and is established by the University Registrar. Information about the exams will be posted well in advance on Carmen. Exams must be completed without any external help or communication. The information about the exams given below.

<u>Makeup exam policies</u>:
Makeup exams may be given in case of emergency or exceptional circumstances (e.g. severe illness) or due to conflict with other university activities (travel with a team, participation in a university artistic performance, etc.). Conflicts not directly related to university business (e.g. a job shift) won't be accommodated, so plan accordingly. Makeup exams will only be accommodated with satisfactory documentation of need for a rescheduled exam, and any rescheduled exam must adhere to two restrictions: (1) You must make up any exam within four business days of the originally scheduled exam; (2) You must make up any exam within 24 hours of any conflict.

Exam forgiveness policy: If you are able to provide documented evidence of medical incapacity to take an exam within four business days of the exam's originally scheduled date, you will need to vacate the exam and reweight the other midterm exam and final exam to 30% each.

Example 1: A student plays on the Lacrosse team. The team travels for an away game, and will return two days after the original scheduled exam date. This student must complete the exam the day after the team returns because of (2) above.

Example 2: A student becomes ill and provides documentation from the Healthcare center of incapacity to take the exam. She's recovered well enough three days after the originally scheduled exam date. This student must take the exam the day after she's recovered – four days after the original exam date.

Example 3: A student becomes ill and provides documentation from the Healthcare center of incapacity to take the exam. He remains ill for an entire week. This student will *not* be able to make up the exam at all, and will have the other midterm exam and final exam reweighted under the exam forgiveness policy described above.

Makeup exams will only be permitted by the course instructor, no the recitation instructor.

<u>Homework assignments:</u>
Homework will be assigned periodically and will be due on Carmen as a single pdf file that you will "knit" together with R Markdown. Your lowest assignment score will be dropped. Late assignments will be accepted only with prior instructor approval, and never after assignment solutions have been posted. You are encouraged to work together with fellow students. However, each student must produce their own assignment to submit, and no part of this work should be copied from another's.

<u>Recitation Labs and Assignments:</u>
Each week you'll work through a lab or assignment connected with the weekly recitation meeting. Most weeks this lab assignment will be introduced during recitation, with a goal of incorporating recent lecture topics with R coding. You are encouraged to collaborate on lab assignments, but ultimately the work you submit must be your own. Labs will be completed in R Markdown and must be compiled into organized, professional PDF documents. Relevant plots should be included and labeled, code should be organized clearly, and supporting answers and text should be properly formatted and neatly written.

<u>Recitation Assignments and Recitation Attendance:</u>
The purpose of recitation meetings is to explore and develop better understanding of course concepts computationally (using R). It's not to simply review course material that was covered previously in lecture. Usually, time in recitation meetings will be spent on recitation lab or assignment problems. Absence from lecture will hinder your ability to complete lab recitation work, and it is not the responsibility of the recitation instructor to get you caught up. It's important to come to recitation sections with complete lecture notes from the preceding week. Annotated lecture notes will be posted after class lectures.

You are not expected to be able to work through a recitation lab assignment in class. You should anticipate needing to work on this assignment or lab during the week, as all recitation labs or assignments will be due the following Saturday (by 11:59pm). Use your time in recitation class to get started on the assignment, talk through the relevant activities with peers, and get immediate assistance from your teaching assistant.

Policies about recitation labs and assignments:
   a.) Your two lowest recitation lab or assignment grades will be dropped. These two dropped assignments will cover any reasons for any missed assignments. Plan accordingly.
   b.) Late assignments will not be accepted without instructor approval, which will be granted only with evidence of need. Under no circumstance will more than two late lab or assignments be accepted for any student.
   c.) You must be present at the recitation meeting in order to get credit for that week's lab or assignment. Labs and assignments cannot be made up, nor will they be excused. If you miss an assignment or lab for any reason, it will need to be one of the two that are dropped.

<u>"Excused" absences</u>.

As stated above, if you're not in your recitation class meeting, your recitation instructor will not grade and will not accept your recitation lab for that week. It doesn't matter that you turn it in on time: Attendance in recitation class is part of the recitation lab assignment, and if you are not in class, you will not get credit for it. However, if you're able to provide documentation of inability to attend recitation class, then you'll be able to turn the work in on time for full credit, even if you were not able to attend the recitation class meeting. This will require instructor (not recitation instructor) approval.

Other policies

<u>Grade Disputes</u>:

If you feel that a homework assignment, lab assignment or exam question was graded incorrectly or unfairly, please bring it to the attention of the instructor (Linder for exams, Chang for labs or homework assignments) within 5 business days of the score's posting.

- Requests for regrading will not be accepted more than 5 business days after a score has posted.
- If you ask for a problem to be regraded, the entire assignment or exam will be regraded. This may result in other changes to your assignment or exam grade.

Remember that all communication with either instructor should be made through Carmen email. If you send email outside of Carmen, it may take <u>much</u> longer to get a response.

<u>Expectations for student engagement (and advice)</u>

You're expected to attend every class meeting and every recitation meeting. If you have a headache, come to class anyway. If you're sick with flu, don't. The point is, you need to be in class virtually every day. If you're missing one class every three to four weeks... it isn't good enough, and you're not doing your job!

You should be looking over the Carmen page for this class *several* times every week. Try contributing to optional Carmen discussions.

Start your assignments early enough so that you can get help through office hours. Don't send email to the instructor asking for an extension just because you started your work too late to get help you didn't anticipate needing.

Take pride in your work by submitting assignments that are neat, well written, and well organized. Sloppy and incomplete work conveys a message of disinterest.

Apart from working assignments and recitation labs, you should be reviewing course notes and thinking about material a few times per week. Questions about course concepts should be cleared up by attending office hours.

Course policies on collaboration
• Exams: You must complete the midterm and final exams yourself, without any external help or communication. You may use only materials approved of by the instructor.

• Written assignments (homework and recitation assignments): You're permitted to discuss assignment problems and lab problems with fellow students, but your written assignments should be substantively your own original work. If another student told you how to solve a problem, you need to cite this in your solution. Under no circumstance are you permitted to use another student's work in your own written solution.

Accessibility accommodations for students with disabilities

"The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let the instructor know immediately so that options can be discussed. To establish reasonable accommodations you should register with Student Life Disability Services. After registration, make arrangements with the instructor as soon as possible to discuss accommodations so that they may be implemented in a timely fashion.

Accessibility of course technology

This 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.

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 www.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 .

Weather or other short-term closing University

Should in-person classes be canceled, I will notify you via class announcement and email as to which alternative methods of teaching (Zoom lectures or other modes) will be offered to ensure continuity of instruction for this class.

Religious Accommodations

Our inclusive environment allows for religious expression. If you need to request accommodations based on faith, religious or a spiritual belief system in regard to examinations, other academic requirements or absences, please provide your course instructor with written notice of specific dates for which you need alternative accommodations at the earliest possible date. *It is Ohio State's policy to reasonably accommodate the sincerely held religious beliefs and practices of all students. The policy permits a student to be absent for up to three days each academic semester for reasons of faith or religious or spiritual belief. Students planning to use religious beliefs or practices accommodations for course requirements must inform the instructor in writing no later than 14 days after the course begins. The instructor is then responsible for scheduling an alternative time and date for the course requirement, after the original time and date of the course requirement. These alternative accommodations will remain confidential. It is the student's responsibility to ensure that all course assessments are completed.*

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 the instructor reserves 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)

Date	Meeting	Topic
Week 1		
M 1.06	Recitation 1	Creating R Markdown documents lab
T 1.07	Lecture 1	Course intro; statistics vocab; expectation and variance
R 1.09	Lecture 2	Common probability distributions
Week 2		
M 1.13	Recitation 2	Simple Monte Carlo and Sampling distributions lab
T 1.14	Lecture 3	Sampling distributions; the CLT
R 1.16	Lecture 4	Monte Carlo and custom R functions; Intro to estimators
Week 3		
M 1.20	MLK day	No class
T 1.21	Lecture 5	Bias and Mean Squared Error
R 1.23	Lecture 6	Common unbiased point estimators
Week 4		
M 1.27	Recitation 3	Illustrating the CLT, Bias and MSE lab
T 1.28	Lecture 7	Consistency
R 1.30	Lecture 8	Likelihood I
Week 5		
M 2.03	Recitation 4	Exam 1 review; no lab assignment
T 2.04	Lecture 9	Sufficiency
R 2.06	**Exam 1**	**Exam 1** (covers Lectures 1-8)
Week 6		
M 2.10	Recitation 5	Consistency lab
T 2.11	Lecture 10	Method of moments estimation
R 2.13	Lecture 11	Maximum likelihood estimation
Week 7		
M 2.17	Recitation 6	Computational maximum likelihood lab
T 2.18	Lecture 12	Introduction to statistical inference and confidence intervals
R 2.20	Lecture 13	Small-sample CIs for a mean and for paired data
Week 8		
M 2.24	Recitation 7	Mean confidence interval coverage lab
T 2.25	Lecture 14	Small-sample CIs for a difference in means
R 2.27	Lecture 15	CIs for proportions and differences in proportions

Week 9

M 3.03	Recitation 8	Exam 2 review; no lab
T 3.04	Lecture 16	CIs for variances and ratios of variances
R 3.06	**Exam 2**	**Exam 2** (Lectures 9-15)

Week 10

M 3.17	Recitation 9	Small-sample Confidence intervals lab
T 3.18	Lecture 17	One-sided confidence intervals and practice
R 3.20	Lecture 18	Introduction to hypothesis testing

Week 11

M 3.24	Recitation 10	One-sided confidence intervals lab
T 3.25	Lecture 19	Rejection regions and p-values
R 3.27	Lecture 20	Type-I and Type II errors

Week 12

M 3.31	Recitation 11	Type-I error lab
T 4.01	Lecture 21	p-values, Power and type-II error
R 4.03	Lecture 22	Hypothesis tests on variances and ratios of variances

Week 13

M 4.07	Recitation 12	p-values, Type I and Type II errors.
T 4.08	Lecture 23	Hypothesis tests on variances and ratios of variances
R 4.10	Lecture 24	Hypothesis tests on variances and ratios of variances

Week 14

M 4.14	Recitation 13	Power and Type II error lab
T 4.15	Lecture 25	Hypothesis tests (continued)
R 4.17	Lecture 26	The bootstrap method

Week 15

M 4.21	Exam 3	Final Exam Review
W 4.23	**Final Exam**	**Final Exam** 2:00pm–3:45pm