

STT 231: Statistics for Scientists

Introduction & Syllabus

To the student

STT 231 is an introduction to statistical analysis for students with zero- to one-year of prior experience in statistics or calculus. This audience includes undergraduate students in science, engineering, and medicine.

My approach includes almost no statistical theory; notation is kept as simple as possible so that the material remains accessible to the less mathematical reader. Instead, this course focuses on applications of statistics – its uses, misuses, and occasional abuses. The assumptions made by various models and procedures are investigated at length and criticism of procedures' performances under various conditions is encouraged. The idea of random variation, one of the most important and perhaps most misunderstood aspects of statistics, is made immediate and real through many exercises.

The relationship between statistics & the sciences

A widely recognized law of nature, proposed by Einstein in 1905, is $E = mc^2$, which relates $E = \text{energy}$ to $m = \text{mass}$ in terms of the constant c^2 , the speed of light in a vacuum. The consequence of this equivalence between mass and energy cannot be understated – it has directly and indirectly led to many technological advances. There are many such laws describing the observed world around us. Generally, these laws express some exact relationship among two or more variables. Other examples include:

$A = \pi r^2$	The area of a circle, relating $A = \text{area}$ to $r = \text{radius}$.
$kT = PV$	The Ideal Gas Law relating the absolute temperature (T) of a confined gas to its volume (V) and pressure (O).
$d = \frac{1}{2}gt^2$	Newton's expression for the $d = \text{distance}$ traveled by free-falling object under the acceleration of gravity for a period of time (t).

Each of these equations is a triumph of science. To bastardize a famous quote of Ernst Mach (after whom 'Mach speed' is named), "[Science] is experience arranged in economical order." Every science can be situated in the pursuit of arranging and making sense of our lived experience. **Statistics** is not a science in this sense, because it is more concerned with the process of arranging than the results themselves. Statistics as a field of study is best described as the science of reaching conclusions from observed data. More generally, statistics can be regarded as a body of methods for helping us learn from experience.

It follows, then, that the material presented to you in this course *should make sense*. If it does not, you are likely misunderstanding something, insofar as statistics is often an extension of commonsense. If you find that your appraisal of observed data differs from the results of a statistical procedure, you very likely misapplied a method or made an arithmetic mistake.

Finally, remember that statistics is *not* an avenue to 'the Truth' with a capital 'T.' Some sets of data contain too little information to answer our questions. Perhaps the data was poorly recorded or the number of observations were too few to answer a research conclusion. My hope is that you'll recognize these situations by the semester's end. Some scientific questions can't yet be answered at all and their opacity cannot be remedied by some statistical formula or incantation. The fact is that to "prove" anything at all – in any way at all – is typically quite difficult (this is among the reasons the scientific laws above are such triumphs!). Statistics is often used as a way of telling us how much or how little can be learned from our observations and when we do arrive at a conclusion, just how certain or uncertain we should be about it.

Syllabus

Instructor: John Keane, keanejoh@msu.edu

Lecture: MW 9:10AM-10:00AM, G008 Holden Hall

Office hours: Mondays 11:00AM – 12:00PM or by appointment, Wells Hall C427

Description and prerequisites

Calculus-based course in probability and statistics. Probability models and random variables. Estimation, confidence intervals, tests of hypotheses, and simple linear regression with applications in sciences.

Prerequisites: MTH 124 or MTH 132 or MTH 152H or LB 118

Course Materials

- **Required – WebWork subscription:** The WebWork platform will be used for most homework assignments. Students will be required to purchase a subscription via CashNet at a cost of \$50.00. WebWork will start accepting payments for the FS19 semester at the start of the second week of the semester.
- **Required – Course pack:** STT 231 uses an interactive course pack in lieu of a hardcover textbook that includes reading assignments and in-class activities. Students may either purchase, print, or work with a digital copy of the course pack as they prefer. In any case, being able to annotate this course pack during lecture is usually an important aspect of the course.
- **Required – Graphing-Calculator:** Any basic graphing calculator (has basic STATS functions) is fine, although student support is offered for Texas Instrument models (for example: 83, 84, 89, Inspire). No cell phones (or other devices with access to data plans) allowed during exams.
- **Required – Top Hat account:** The Top Hat Response System will be used regularly during and between lectures as a method of taking attendance and gauging how students are engaging with content. Students can register for a Top Hat account on TopHat.com for approximately \$24 per semester, or \$72 for a lifetime subscription.
- **Required – R and RStudio:** This course uses a free statistical programming language ('R'¹) and a convenient interface ('RStudio'²) as an aid in exploring statistical concepts and practicing various procedures.
- **Optional – Textbook:** This course uses *Introductory Statistics with Randomization and Simulation*, David M Diez, Christopher D Barr, Mine Çetinkaya-Rundel, 2014 as a guide for many of its lectures. It is a free, open source textbook available as a tablet-friendly PDF https://www.openintro.org/download.php?file=isrs1_tablet&referrer=/stat/textbook.php or for ~\$10.00 at local / online bookstores.

Grading Policy

Your grade will be based on a weighted scale. Your percentage score on each component of the course will contribute to your grade according to the breakdown provided in the table.

Component	WebWork	In-class participation	Recitation activities	At-home Readings	Exams	Total
Percentage	20%	5%	10%	10%	55%	100%

Grades are rounded to the nearest percentage. If your final percentage is 89.49%, your final grade will be a 3.5. If your final percentage is 89.50%, your final grade will be a 4.0. Many people end up close to cutoffs, but moving cutoffs only creates more people being close to the new cutoffs, etc. Email requests to round grades or change the cutoffs at the end of the semester will not receive a response.

Grade	Range	Grade	Range
4.0	100% - 90%	2.0	70% - 74.99%
3.5	85% - 89.99%	1.5	65% - 69.99%
3.0	80% - 84.99%	1.0	60% - 64.99%
2.5	75% - 79.99%	0	0% - 59.99%

¹ Download R here: <https://www.r-project.org/>

²After downloading R, RStudio is available here: <https://www.rstudio.com/products/rstudio/download/>

An I-Incomplete may be given only when: the student (a) has completed at least 6/7 of the term of instruction, but is unable to complete the class work and/or take the final examination because of illness or other compelling reason; and (b) has done satisfactory work in the course; and (c) in the instructor's judgment can complete the required work without repeating the course.

In-class participation & recitation

- Top Hat questions are frequently posed in-lecture. Your answers to these questions are evaluated evenly on completion and accuracy and are worth a total of 5% of your grade.
- On occasion, device connections can lag and you will miss a Top Hat question. I typically won't reopen questions in these cases. To recoup these points, or points you miss because of absence from lecture, you can complete Make-Up questions available every weekend. The course is designed such that a student to completes weekly Make-Up questions is guaranteed to earn the full 5% associated with in-class participation.
- Recitation attendance is a required component of the course. Each week, you'll complete an activity that either reviews previous course concepts or previews upcoming concepts. Submitted activities are evaluated on completion.

WebWork & At-home readings

- There will be homework assignments due via Webwork most weeks throughout the semester. Homework assignments will open on Wednesdays at 9:00 PM EST and remain open for exactly 8 days [i.e., they will be due the following Thursday, 9:00 PM EST]. **They are graded on accuracy.**
- When a HW assignment is posted, you will have seen most corresponding material. Start HW early when it opens. Past students have found out too late that starting HW a few hours before it is due means too little time to think about the questions, review material, do statistical analyses, or ask questions. *Do not wait until the night before.*
- HW assignments must reflect your own work — you can talk to others [in fact, I encourage it!], but calculations and final answers must be your own, explanations must be in your own words.
- Copying HW from past solutions or submitting work identical to others is considered a violation of academic integrity (see the Academic Integrity statement in this syllabus).
- Once the HW due date/time has passed, the solutions will become immediately available online through WebWork. Your HW will be graded over the weekend using a combination of automated and by-hand methods.
- Although no late HW will be accepted (solutions are provided immediately), I do know things can come up. Your one lowest HW score will be dropped at the end of the semester before computing the HW part of your semester grade.
- *At home* reading assignments are interwoven with lectures throughout the course. They typically constitute a short reading assignment that prepares you for upcoming lectures and integrates RStudio exercises. For each exercise, you'll submit solutions via Top Hat, which will be evenly evaluated on completion and accuracy.

Exams

You will have three non-cumulative exams throughout the semester. Each exam will cover *only* the content covered since the previous exam [be aware that concepts in the course *are* cumulative and that some questions will make use indirectly of concepts from previous chapters]. Although exams are closed-book, relevant statistical formulas will be provided.

Exam 1: Wednesday, Oct. 9, 2019, 7:00 pm – 8:20 pm, location TBD

Exam 2: Wednesday, Nov. 20, 2019, 7:00 pm – 8:20 pm, location TBD

Exam 3: Thursday, Dec. 12 2019, 7:45 am – 9:45 am in 116 G008 Holden Hall

There will be **no make-ups, so check your calendars now**. Students with exam conflicts or documented accommodations for testing must email keanejoh@msu.edu, include details, and turn in any documentation by the last Wednesday of September.

Full Credit Policy

Full credit for graded exercises (on HW, exams) will only be offered when justification is shown. Answers that require work but have none will not receive full credit. With all assignments in STT 231, show any work beyond trivial calculations, and, if needed, round answers to 4 decimal places. Also make sure to include units and to make conclusions in the context of the problem (where appropriate).

Academic Integrity

Michigan State University affirms the principle that all individuals associated with the academic community have a responsibility for establishing, maintaining, and fostering an understanding and appreciation for academic integrity. Academic integrity is the foundation for university success. Learning how to express original ideas, cite works, work independently, and report results accurately and honestly are skills that carry students beyond their academic career. In addition, the Statistics and Probability department adheres to the policies on academic honesty as specified in General Student Regulations 1.0, Protection of Scholarship and Grades; the all-University Policy on Integrity of Scholarship and Grades; and Ordinance 17.00, Examinations. (See [Spartan Life: Student Handbook and Resource Guide](#) and/or the [MSU Web site](#).)

Therefore, unless authorized by your instructor, you are expected to complete all course assignments, including homework, projects, and exams, without assistance from any source. You are expected to develop original work for this course; therefore, you may not submit course work you completed for another course to satisfy the requirements for this course. Also, you are not authorized to use the www.allmsu.com Web site to complete any course work in this course. Students who violate MSU academic integrity rules may receive a penalty grade, including a failing grade on the assignment or in the course. Contact your instructor if you are unsure about the appropriateness of your course work. (See also the [Academic Integrity](#) webpage.)

Limits to confidentiality

All conversations and course materials submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees, including instructors and TAs, may not be able to maintain confidentiality when it conflicts with their responsibility to report certain issues to protect the health and safety of MSU community members and others. As the instructor, I must report the following information to other University offices (including the Department of Police and Public Safety) if you share it with me:

- Suspected child abuse/neglect, even if this maltreatment happened when you were a child,
- Allegations of sexual assault or sexual harassment when they involve MSU students, faculty, or staff, and
- Credible threats of harm to oneself or to others.

These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In almost all cases, it will be your decision whether you wish to speak with that individual. If you would like to talk about these events in a more confidential setting you are encouraged to make an appointment with the MSU Counseling Center.

Inform Your Instructor of Any Accommodations Needed

From the Resource Center for Persons with Disabilities (RCPD): Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the [Resource Center for Persons with Disabilities](#) at 517-884-RCPD or online. Once your eligibility for an accommodation has been determined, you will be issued a Verified Individual Services Accommodation ("VISA") form. Please present this form to the instructor at the start of the term and/or two weeks prior to the accommodation date (test, project, etc.). Requests received after this date may not be honored.

Commercialized Lecture Notes

Commercialization of lecture notes and university-provided course materials is not permitted in this course.

Attendance

Students whose names do not appear on the official class list for this course may not attend this class. Students who fail to attend the first four class sessions or class by the fifth day of the semester, whichever occurs first, may be dropped from the course.

Build Rapport

If you find that you have any trouble keeping up with assignments or other aspects of the course, make sure you let your instructor know as early as possible. As you will find, building rapport and effective relationships are key to becoming an effective professional. Make sure that you are proactive in informing your instructor when difficulties arise during the semester so that we can help you find a solution.