STATISTICS 512: Experimental Statistics for Biological Sciences II
Fall 2018
TuTh 10:15 – 11:30 • 159 Kilgore Hall
Course homepage: www.stat.ncsu.edu/people/gross/courses/ST512/
Moodle (for gradebook only): wolfware.ncsu.edu

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Office Hours: Weds 1:30 – 2:30, 4246 SAS Hall

TAs: Can Cui (ccui@ncsu.edu), Yunshu Zhang (yzhan234@ncsu.edu)
Office Hours: Cui: Mon 3:30 – 4:30. Zhang: Thurs 3:00 – 4:00. TA office hours will be held in 1101 SAS Hall.

Course texts: There is no required course text. The optional course text is *A First Course in Design and Analysis of Experiments* by Gary W. Oehlert. The book is available for free in PDF form at
http://users.stat.umn.edu/~gary/Book.html.

Oehlert does not cover regression. Readings from the text will be suggested when we begin discussing ANOVA in the second half of the course.   Course notes provided on the course web page plus suggested readings from Oehlert will form the basis for the course.

Not every topic that we cover in class is discussed in Oehlert. If you wish to consult a text for these topics, there are many good references available. Some good alternative texts are:

An Introduction to Statistical Methods and Data Analysis by R.L. Ott and M. Longnecker.
Experimental Design and Data Analysis for Biologists by Gerry P. Quinn and Michael J. Keough.
Statistical Research Methods in the Life Sciences by P.V. Rao
The Statistical Sleuth by F.L. Ramsey and D.W. Schafer.

Pre-requisites: ST 511 or equivalent. I expect incoming students to be familiar with the basics of statistical inference, including point estimation, confidence intervals, and hypothesis testing. Although we will review these ideas briefly in class, the expectation is that this review is a refresher, not a first exposure. Students wishing to brush up on their elementary statistics may consult the excellent on-line (and free) textbook at
http://www.openintro.org/stat/.

Course objectives, philosophy and overview: The goal of this course is to introduce statistical methods and concepts that are fundamental to analyzing data that arise in the biological sciences. The pedagogy of the course is based on the view that a practical knowledge of statistics requires mastery of three separate types of understanding. They are:

Logical understanding. Ultimately, statistics does not exist for its own sake. Instead, statistics provides a tool for using data to evaluate and illuminate scientific ideas. The logical connections between statistical methods and scientific thinking are a fundamental component of contemporary scientific discourse. Understanding this logic is central to intelligent data analysis.

Mathematical understanding. Statistical methods are rooted in mathematics. Although it is conceivable to take a 'black box' approach to statistics, such an approach has serious drawbacks. At the least, treating statistical methods as a black box results in fragmented understanding that hides the common theory underlying the methods. Understanding the mathematical theory behind statistical methods illuminates the deep connections among the methods, which in turn provides a more enduring understanding. In addition, understanding mathematics makes the assumptions and limitations of statistical methods clear, as they arise as a logical consequence of the mathematics.

Computational understanding: In today's world, nearly everyone analyzes data with statistical software – very few do statistical calculations by hand. Although practical constrains limit the number of software packages that we can examine in class, most software packages share several common denominators. We will gain exposure to two contemporary statistical software packages, R and SAS.

Most disciplines within the biological sciences have specific methods that are commonly used or favored. We will not cover these discipline-specific methods. Instead, the goal of an applied statistics class with a diverse clientele is to teach the fundamental statistical concepts and models from which more specialized methods are derived.   An understanding of these basic models empowers students to master the specialized techniques that are specific to their own research fields.

Are you in the right class? While all students are welcome in ST512, ST512 emphasizes topics that are most pertinent to the biological sciences.   When in doubt, consult with your advisor to make sure that this is the right class for you.

> If you are an engineer, there is a parallel sequence (ST515 / ST516) specifically designed for engineering graduate students.
> If you are rusty or uncomfortable with any of the following topics --- basic probability calculations, estimates of means and variances, confidence intervals for means, hypothesis tests, *p*-values --- then you may want to consider taking ST511 before ST512.

Brief course outline: (A more detailed schedule will evolve on the course webpage)

Topic	Timing
Review: Simple linear regression	weeks 1 – 3
Multiple regression	weeks 4 – 7
Analysis of variance	weeks 8 – 10
Analysis of covariance	week 11
Blocked designs and variations	weeks 12 – 14
Logistic regression	week 15

Exams: There will be 2 mid-terms and a final. The exam schedule is:

> Mid-term 1: Thursday, October 11 (changed Sept 14)
> Mid-term 2: Tuesday, November 20
> Cumulative final exam: Thursday, December 13, 8-11 am

Exams will cover material from lecture and lab. Because of time constraints, the mid-terms are unavoidably a test of fluency as well as mastery. Be prepared. Re-grade requests must be made in writing and must be submitted by the assigned date. Exams will be closed book. You will be allowed to bring one single-sided page (8.5 inch by 11 inch letter-sized paper) of hand-written notes to each midterm, and two single-sided pages of hand-written notes to the final. **Unlike ST511, notes for exams must be hand-written**. Some elementary calculations may be required on exams. Students should bring a calculator to an exam. Additional calculators will be provided for students who may need them. Cell phones, iPhones, or any other device with wireless capabilities may not be used as a calculator.

Lab assignments: There will be 10 graded lab assignments throughout the semester. Lab assignments will consist of pencil-and-paper problems and/or computer-based problems. Lab assignments will be available from the course website by 5:00 pm Monday of the week that lab is assigned. Students should be able to make substantial progress on lab assignments during their regularly scheduled lab period. Attendance at lab periods is not required, but is encouraged. Lab assignments are due at the beginning of lecture on the Tuesday of the week after the lab is assigned. Do not work on labs during lecture. If you cannot attend lecture, labs may be placed under Dr. Gross's office door (4246 SAS Hall) by the scheduled end of lecture on the due date. Labs turned in after class but within 24 hours after the due date will incur a 3-point deduction. Labs will not be accepted beyond 24 hours after the due date. Lab assignments are worth 10 points each. Each student *is expected* to earn at least 85 points on lab assignments. Your final lab score is a percentage out of 85, with a maximum of 100%.

Update because of hurricane-related cancellations: There are now 9 graded labs, worth a total of 95 points. Your final lab score will be a percentage out of 80, with a maximum of 100%.

Working together on lab assignments to overcome obstacles is permitted. However, any work that is handed in must reflect that student's own understanding. (Put another way, students should be able to explain their own answers in full if asked.) Each student must compose and write his or her own programs, analyses, and reports. Be sure to put your name on your assignment when you hand it in. Failure to do so will incur a one-point penalty.

Lab schedule: (changes because of Hurricane Florence cancellations in blue)

Week of:	Lab task:
Aug 27	Lab 1
Sept 3	Lab 2
Sept 10	Lab 3
Sept 17	Lab 3, continued

Sept 24	Lab 4
Oct 1	ungraded lab
Oct 8	no lab – midterm
Oct 15	Lab 5
Oct 22	Lab 6
Oct 29	Lab 7
Nov 5	Lab 8
Nov 12	ungraded lab
Nov 19	no lab – midterm / Thanksgiving
Nov 26	Lab 9
Dec 3	ungraded lab

Lab attendance and registration: All students registered for lecture *must* also register for a lab. Attendance at labs is encouraged but is not required. Scheduled lab times are the only guaranteed opportunity to interact with members of the teaching staff individually. Although office hours also provide an opportunity to interact with the teaching staff on an individual or small-group basis, it is inevitable that office hours will be scheduled at times that are inconvenient for some students.

Grading: *Short explanation*: Final grades will be based on exams and labs, using the following weighting scheme:

Mid-term average:	45 %
Weekly assignments:	20 %
Cumulative final:	35 %

Letter grades will be assigned on a curve. +/- grading will be used. A+'s will not be awarded. There is no extra credit. Students are expected to earn homework grades of 100%. Homework rarely improves a final grade, but it can lower it substantially. Grades will be posted on WolfWare. Students are responsible for ensuring that their grades are recorded correctly. Partial credit will be awarded on exams. *Partial credit is not necessarily proportional credit.*

Longer explanation, for those who care: Ranges corresponding to letter grades will be announced after each exam. For example, suppose that the dividing line between an A and a B falls at the following cutoffs:

Midterm 1:	80%
Midterm 2:	85 %
Final:	86 %

A final score is then calculated for a hypothetical student whose grade fell exactly on this cutoff for each exam, and who earned a lab score of 100%. (Remember, a lab score of 100% does not mean getting 100% on every assignment. It means earning at least 85 points over the course of ten 10-point labs.) Here, this hypothetical student would have a final score of

$$.225 * 80\% + .225 * 85\% + .35 * 86\% + .20 * 100\% = 87.225\%$$

Thus, when determining final grades, the cutoff between A's and B's will initially be set at 87.225%. This cutoff can be (and usually is) lowered slightly to find a gap in the grade distribution. The cutoff will never be raised. (Note that in the above discussion, A's encompass both A's and A-'s, so a student with a final score slightly above the A/B cutoff will likely earn an A-.) The same procedure will be used to determine the B/C cutoff, as well as cutoffs for any lower grades if necessary. *Cutoffs always assume a lab score of 100%.*

Communication: Students are expected to check their NCSU email regularly to receive course announcements. The appropriate time to ask for additional explanations of course material or assistance on assignments is during lab or office hours.   Course-related e-mail to the instructor or the TAs should be used sparingly, and primarily for administrative purposes.

Absentee policy for exams: If you know in advance that you will not be able to attend an exam, tell the instructor as soon as possible. If feasible, you will be given the chance to take the exam in advance. Make-up exams for unexpected absences will be given rarely, and at the instructor's discretion.

Feedback: Online class evaluations will be available for students to complete during the last two weeks of class. Students will receive an email message directing them to a website where they can login using their NCSU ID and complete evaluations. All evaluations are confidential. The evaluation website is https://classeval.ncsu.edu. Clearly, feedback provided at the end of the term will benefit students in subsequent semesters, but cannot benefit students in this semester. Informal feedback during the course of the semester is encouraged.

Lecture attendance and participation: The instructor reserves the right to adjust grades upward for students who enhance the learning experience for others by their participation or behavior. By the same token, the instructor reserves the right to lower grades for students whose behaviors distract others from learning. Among the latter, these include doing any of the following during class: leaving in the middle of class, texting (or any other on-line activity) in a blatant, conspicuous or distracting manner, or letting one's cell phone ring.

In-class computer use: Laptop computers may not be used in class. Tablets or tablet computers may be used to take notes, as long as they do not distract other students.

Auditing: Students may register for auditor credit. Auditors must accumulate at least 70 points on the weekly assignments, and attend lecture regularly. Auditors do not take exams.

Copyrights and use of course materials: Course materials, including class notes, labs and lectures, are intended for the sole use of students currently enrolled in ST512. Reproduction and dissemination of course materials for purposes other than those that pertain directly to ST512 is prohibited without the prior consent of the instructor. Audio recording of lectures is permitted, but audio recordings may be used only by students enrolled in ST512 and may not be disseminated. Video recordings or photographs of lecture are strictly prohibited.

Statement for students with disabilities: Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653, on the web at dso.dasa.ncsu.edu. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at http://policies.ncsu.edu/regulation/reg-02-20-01.

Non-discrimination policy: NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at http://policies.ncsu.edu/policy/pol-04-25-05 or http://www.ncsu.edu/equalop/. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 919-515-3148.

Supporting fellow students in distress: As members of the NCSU community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remains a safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you. When this is the case, you are encouraged to report this behavior to the NC State Students of Concern website: http://studentsofconcern.dasa.ncsu.edu/. Although you can report anonymously, it is preferred that you share your contact information so they can follow-up with you personally.