BME 5703 Statistical Methods for BME
Fall, 2023

Catalog Description:

This course covers statistical methods needed for experimental biomedical engineering research. Students will be acquainted with a variety of techniques for analyzing and modeling data arising in molecular, cellular, physiological, and pathological systems encountered in typical laboratory and clinical settings.

Credits: 03

Prerequisites and Expectations:

Knowledge of linear algebra and basic statistics is required. A previous course in statistical methods is expected, but not explicitly required.

On the 1st day, a pre-requisite quiz will be provided. If your performance on the pre-requisite quiz is not in the high A range (>90) and/or your understanding of the review material is deficient, it is very important that you catch up quickly. The course is predicated on a basic knowledge of statistics and cannot be diluted to an undergraduate level and still reach the learning objectives for the class. Additional material (see Section 0) is provided to assist in this process. Questions on the pre-requisite quiz are associated with specific Section 0 lectures - please review those lectures that you may need some refreshers in.

This course will use R, and the BME graduate program requires prior programming experience as an entry requirement (i.e. common variable structures, functions, etc.). While prior experience with R is not required, programming experience is. Please discuss with the instructor if you think there may be concerns in this area.

Students are expected to have a computer capable of running the required statistical software.

Course Information:

Instructor: Kyle D. Allen, Ph.D.
Office: BMS J389
Office Hours: Tuesday until 12:30 (after class); Thursday until 1:30 (after class)
Slack: See CANVAS Site or Request a Link from the STS
Email: kyle.allen@bme.ufl.edu

Notes: All discussions related to grades and re-grade requests will be exclusively handled through CANVAS; this creates a log of the request such that it is tracked using a FERPA compliant and UF approved system.

For questions related to HW (help with code, understanding the data structure, confusion over the wording of the question, etc), Slack is the preferred communication format for this course. You may use the #general channel for this, because if you're confused, it is probable that most of the class is also confused. This allows us to get answers to everyone as quickly as possible, and helps us to assure that help is as equitable as possible.

Finally, you should know that I only check email once a day, and it tends to be first thing in the morning; so, while this is an acceptable form of communication, it is unlikely to be fast and it is not very equitable. What can be done in 15 emails to individuals is often solved by 1 Slack message to the class. Thus, use Slack when possible.

Supervised Teaching Student: Min Du
Office Hours: TBD
Email: mdu@bme.ufl.edu

Substitute Instructor: Michael Strinden, Ph.D.
Email: Michael.Strinden@ufl.edu

Note: Dr. Strinden is a molecular informatics post-doctoral fellow in my group, who will be shadowing me during the semester and occasionally helping with the class. He is an expert in R and may provide a few guest lectures.

Class Meeting:

This course will be taught in a flipped classroom environment. The philosophy is 'see do, do it, test it'. Pre-recorded lectures are the see it; in class is the do it part overlapped with testing; homeworks are the 'test it' part.

Lectures: Pre-recorded lectures will be available in advance of the module to which they correspond. These are required. Students should view these and engage with the material in advance of the corresponding live meetings.

- Tuesday Period 4 (10:40 AM - 11:30 AM), Thursday Periods 4-5 (10:40 AM - 12:35 PM)

Required Textbook, Documentation and Software (free, but required):

- R for Data Science by Wickham and Grolemund, https://r4ds.had.co.nz/ (free online)
- R version 4.02 (64 bit preferred) https://cran.r-project.org/
- RStudio Desktop/Free version 1.3.1056 (or more recent) https://rstudio.com/
- A LaTeX compiler, e.g. MikTeX or MacTeX or TeXShop
- The tidyverse documentation (https://www.tidyverse.org/) especially the cheat sheets and reference sections for each subcomponent, e.g. https://ggplot2.tidyverse.org/reference/index.html.
- R Markdown documentation (https://rmarkdown.rstudio.com/)

Resources and Recommended Texts (not necessarily free, but not required):

- Textbooks & R documentation
  - *Applied Regression Analysis and Generalized Linear Models*, John Fox
  - *A second course in statistics: Regression analysis,* Mendenhall and Sincich
  - *The Grammar of Graphics,* Wilkinson
  - A Layered Grammar of Graphics, Wickham http://vita.had.co.nz/papers/layered-grammar.pdf
  - RDocumentation https://www.rdocumentation.org/

Introductory texts if you need to brush up on the basics
- *A Concise Guide to Statistics – Ebook,* Hans-Michael Kaltenbach
- *Statistics for Non-statisticians – Ebook,* Birgir Madsen
Both are available through the library

Some warnings on learning resources:

Google, stackoverflow, stackexchange, Quora, etc., can be very useful resources for learning how to use R - I use these all the time. They can be super helpful for explaining how certain functions work or common errors in the R coding language. **However, there are risks to overly relying on these resources**. See Below:

The most significant risk is that you will find many simply wrong answers. Or more likely, you will find answers that are technically correct within their nuanced scope, but will lead you astray for your problems and HWs in this class. This is exceptionally common in this course, where the context matters to the statistics you are running. The most common risk is that you will find code that is out of date or does not use the tidyverse framework. For these reasons, **copy-pasting code will result in many wrong answers and poor scores on your homework; it will be marked as incorrect**.

Related to this issue, explaining why code that is outside of the tidyverse framework is incorrect will markedly limit the productivity and bandwidth for the instructor and STS, and pulls time and resources away from the students that are working within the confines of this course. On homework, we will only accept functions and code that are covered in class or in the recorded lectures; all variants of the R language that are outside this framework will be marked wrong. We also reserve the right to pass on questions related to code outside of the frameworks covered in class; we are always happy to cover and recover functions covered in the class, but R is a vast language that is constantly evolving. It is not practical for us to understand all functions in this space.

Related to this issue, the R community is very large and there are countless libraries which may help you achieve all manner of objectives. This is great for research! Some of your labs may use alternate libraries or may be developing this code for the R community - if so, awesome! And thank you! But, we simply cannot manage all possible R solutions. It is brutal on our graders and us when you venture outside of the libraries we are using. To keep this course focused, and to ensure you build a solid foundation, we are limiting the libraries and approaches you may use in the context of this course. **If you venture outside of these libraries, it will negatively affect your grade and will be counted as wrong**.

Important Teaching Philosophy Note:

First, please engage in the forums, in class discussions, office hours, and other avenues that we provide to communicate, teach, and mentor. This material is best taught through conversations and experiential learning. As such, we teach this class in a manner that is more closely related to a computer programming lab. Being here, assisting others, troubleshooting code, etc. are all part of this class. Be here and be ready to help others!

Second, this course has a very broad name, but it is impossible to cover all of statistics for BME in a single semester. Our goal is to ensure all students are prepared with fundamental skills in regression-based models, with an understanding of the theory and application of some of the most common regression-based techniques. This is to prepare students to extend into new domains of data analysis to meet the challenges they will face in their graduate training and beyond. For other approaches, our department offers multiple our data science classes; I'm happy to help guide you to some of these other courses, but this course will focus on regression-based statistical models.

Format and Grade Determination:

This class is intended to be 'applied statistics' that emphasizes HOW things are done. In class activities will be given to test a student's understanding of these principles; homework will be given to test a student's ability to apply those principles; projects will be assigned to identify a student's ability to make choices based on a statistical analysis.

Grade Breakdown
60% Homework
12% Quizzes
24% Project
4% Class Participation / In-class activities

Homework: Your HW score will be calculated two ways – you will receive whichever score is higher:
    METHOD 1: Each HW is worth 10% of your final grade (equal weighting)
    METHOD 2: HW1 is worth 6%, HW2 is worth 8%, HW3 is worth 10%, HW4 is worth 12%,
        HW5 is worth 14%, and HW6 is worth 10%
        Note: HW1-5 are progressive, so this weighting will help student that are in the category of "I started slow, but I got it in the end". It is not uncommon for HW1 scores to be quite variable. HW6 is an introduction to non-parametric approaches, and thus is not progressive off of HW 1-5 and is not included in this weighting.

Quizzes: Quizzes are online outside of course time. They consist of multiple choice or fill in the blank questions that are based upon the lectures. They are meant to be fairly quick (~10 mins) and review your retention of the lecture material; quizzes are timed (30 mins) but time should not be a major issue. Most students complete the quiz in under 10 minutes and the timer has never expired on a student in the course outside of an internet connectivity issue; I can reset the quiz for you, if you experience a connection issue.

Project: Working with a team of 4-5 students, you will –
1) Acquire a scientific data set
2) Ask a question with a testable hypothesis (one question per team member – questions may be sequential)
3) Visualize the data
4) Analyze the data
5) Make a conclusion
Teams will be finalized after Section 4.

Class Participation: Your participation grade will be calculated based on the percentage of in-class assignments that you turn in and show a reasonable level of effort (Students get all credit or no credit for an assignment based on questions attempted, not answers correct). Note, participation is not attendance. Attendance will not be taken, but if you fail to show up to class, you will obviously miss opportunities to get participation credits.
- <u>You are allowed to miss up to 5 in-class assignments without an excuse, but you may not earn greater than 100% in this category</u>.
  - There are 25 in-class assignments; you must turn in at least 20 for full credit.
  - So [20-25] out of 20 = 100%
  - 19 out of 20 = 95%
  - 18 out of 20 = 90%, etc.

If you are sick, please do not come to class and discuss options to attend the course remotely with the instructor. <u>You may attend remotely with an excused absence; you may not attend remotely without an excused absence.</u> Please message me via slack to discuss remote attendance. We'll hold a waiting room and will only admit students who have been excused for sickness, travel, or other work-related excuses.

Grading Scale

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
90.0-100	87.0-89.9	84.0-86.9	81.0-83.9	78.0-80.9	75.0-77.9	72.0-74.9	69.0-71.9	66.0-68.9	63.0-65.9	60.0-62.9	0-59.9

We will round your grade to the nearest tenth of a point; then, your letter grade will be assigned based on the above table. Grades are not curved, however, if the majority of the class is unable to answer a question, we may consider make-up problems that augment the scores on an assignment. To assure fairness, make-up problems are issued to the entire class - not to individuals.

Course Policies:

Policy on Working Together and Group Work:

Peer-to-peer learning enhances learning; thus, students are highly encouraged to ask general questions both in class, through the slack channel, and for the final project. However, <u>direct copying is against the honor code of this institution and is not allowed. If identified, all students involved–those that copied and those that allowed the copying to take place–will receive a grade of zero and will be reported to the university for review</u>.

To facilitate questions, I have set up a Slack channel. This channel should be used for homework questions only, and use of the channel for other purposes is not allowed. Questions should be posted on the relevant discussion channel (e.g., homework 1 questions under homework. <u>Students are highly encouraged to answer questions from other students</u>.

On the final project, working together is defined as each and every student contributing intellectually to all sections of the report. Every student should be able to explain the entirety of the final project. Work with and be fair with your group. Strive to be neither a martyr nor slacker. The report will be graded for the team as a collective; however, grades for the final project are individually assigned, not group assigned.

Policy on Attendance

We expect students to attend the class regularly. However, attendance in class is not strictly required for full credit in the participation section of the course. Absences do need to be excused by the professors - please ask. I understand that, in this environment, you may have additional constraints to manage. I will work with you to the best of my ability, but I also need to respect the training that we, as faculty, have been tasked to provide to the students in our department and college. As such, I expect students to be in class, ready to learn, engaged, and overall contributors to the learning environment. This is clearly not possible if you cannot regularly attend class.

I will maintain a zoom link for students that have been excused from class. Unexcused absences will not be admitted to the zoom room. If you are sick, stay home and plan to attend via zoom if possible. If you are traveling for a conference, you may also attend via zoom. If you are able to be in class, you should be in class.

Policy on the Course Evaluation

Part of our job as instructors is to constructively evaluate you as a student. Part of your job as a student is to constructively evaluate us as instructors. The only metric we can see before grades are due is percentage of the students that evaluated the course–we cannot see scores, comments, or any other content until grades are submitted. Thus, you should write your honest, constructive opinion of the course. I do value this feedback and this feedback is used by our department, college, and university.

Policy on Late Coursework

Unless **prior arrangements** have been made with an instructor, students will be deducted 15% per day (24h) for late coursework, with deductions occurring at the time associated with the due date. E.g., 24.001 hours after the due date and time results in a 30% (3 letter grade) reduction.

Policy on Grade Corrections

Students have 1 week after receiving a grade to challenge errors or grading mistakes. 1 week after students have been informed of their grade, the grade will become final and will not be changed. Do not wait for the end of the semester; we will not adjust your grade for assignments that are beyond this deadline.

To challenge a grade: Students must attach a cover page and write up of why the re-grade is being request, explaining what they want to be re-graded and why they think the grade is incorrect. We do occasionally make mistakes, but re-grades will not be issued following verbal debates over grades. We can discuss the problems, our solutions, and the key, but I will only regrade when we have adequate time, space, and focus to assess the issue in order to be equitable across all students. ***This policy is strictly enforced—no exceptions.***

Policy on Course Recordings

For online content and recorded materials, I retain the copyright of this material. It is yours to use for your own personal education, but it may not be redistributed to others without my consent.

A statement informing students of privacy related issues for online zoom rooms is as follows:

Our in-class and zoom sessions may be audio visually recorded. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a

profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment
The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Program Coordinator
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t***, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://care.dso.ufl.edu.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.