BIOS 20172: Mathematical Modeling for Pre-Med Students, Spring 2022

Instructor: Esmael Haddadian, Ph.D. E-mail: haddadian@uchicago.edu
Office hours: Monday, Wednesday, 4:30 – 6:30 pm CST or by appointment BSLC Room 222

Course TAs:
Fabi Sepulveda (head TA) fabisepulveda@uchicago.edu
Tiffanie Huang thuang5@uchicago.edu
Grace Hu gracehu03@uchicago.edu
Neema Darabi neema01123@uchicago.edu
Emma Ricks emmaricks@uchicago.edu

Lab TAs:
Michael Ibrahim mibrahim@uchicago.edu
Annie Wang anniewang188@uchicago.edu
Adi Orlyanchik adiorly@uchicago.edu
Tess Chang tessorachang@uchicago.edu

Course TA office hours:
Mondays 3:00-4:00 pm
Tuesday 6:00-7:00 pm
Wednesday 5:30-6:30 pm
Thursday 6:30-8:30 pm
Friday 3:30-5:30 pm

Lab TA office hours: Tue, Th: 5-6 pm; Wed, Friday: 5:30-6:30 pm; Sunday: 3:30-4:30; **BSLC room 401.** Feel free to email Dr. Haddadian or any of the TAs at any time you have a question outside of lecture.

Lectures: Monday, Wednesday, Friday, 12:30-1:20 pm CST, BSLC Room 001
Attending lectures and participating in the class activities is mandatory and will count toward your participation grade. Lecture slides will be posted on Canvas before the start of the lecture. Weekly check-in activities will also be posted after lecture on Fridays to be submitted by Sunday at 6pm CST every week for participation credit.

Computer labs: Tue, Th, 12:30-4:20 pm; Wed, Friday, 2-6:00 pm; BSLC Room 004
Labs start **the first week of the quarter** and alternate weekly with the BIOS 20171 Genetics labs. Your lab day for this class will be at the same time and day as your Genetics lab section but will meet every other week to alternate with that class. **Attending labs is mandatory and will count toward your participation grade.**

Course objectives: Modern biology generates massive amounts of data; handling and analysis of these data require mathematical and computational methods. This course is designed to provide a stimulating introduction to the applications of mathematical methods and modeling to biology with the goal of providing future healthcare professionals with powerful tools of data analysis and modeling used in modern biological research. Bioinformatics analysis and personal genomics are becoming an important part of medical practice, and we will cover some basics of these new methods. After taking this class, students will:
A) Be able to perform, interpret, and communicate findings of statistical analyses of biological and health data, including descriptions, confidence intervals, estimations, and hypothesis testing
B) Be able to apply Markov chains in prediction of events, such as diseases
C) Know how to evaluate the correlation between numerical variables and regression

D) Be able to apply algorithms for genomics sequence analysis to obtain biological information from sequences
E) Be able to contribute quantitative knowledge to future experimental biological projects (ex. in pharmaceutical, information retrieval, or medical device industries)
F) Learn how to implement computational algorithms using R for biological data analysis and modeling.

Grading:
18% Computer labs and pre-lab quizzes
15% Weekly post-lab quizzes
12% Weekly homework assignments due by Friday 11:59 pm CST
2% Lecture and lab participation, in-class activities, and weekly check in
14% First exam, **Friday April 14th; Starting at 5:30 pm; Room TBA**
16% Second exam, **Th May 4th; Starting at 5:30 pm; Room TBA**
19% Final exam, TBA
4% Final project

Computer labs and quizzes: A video describing the lab material for each week will be released on Sundays. Students need to watch the video and take a Canvas quiz covering pre-lab video content before the start of their lab period. **Pre-lab quizzes are untimed and allow multiple attempts. These quizzes are due by 12:29 pm CST before your lab period.**

The post-lab quizzes will be available on Canvas at 8:00 am CST each Thursday after each lab week; you will have until Friday 11:59 pm CST to complete the quiz. Post-lab quizzes are timed and allow only **one** attempt. Retroactive arrangements may be made only in cases of genuine emergencies.

Computer lab reports: The computer assignments must be completed and submitted to Canvas by **11:59 pm CST the day after your lab period**. A 20% late penalty per day will be applied for any late submission. **No report will be accepted 3 days after the due date.**

Homework: Problem sets will be assigned every Friday and are due by 11:59 pm CST the following Friday. You can either type or scan your answers. Collaboration is encouraged but submission of your own, original work is required. A 20% late penalty per day will be applied for any late submission. **No homework will be accepted 3 days after the due date.**

Exams should be completed during the given period. Retroactive arrangements may be made only in cases of genuine emergency.

Final project: The project will involve a genome analysis, completed in groups. The details of the project will be announced later in the quarter.

Textbook: Whitlock & Schluter, *The Analysis of Biological Data*, third edition.

Lab Software: R http://www.r-project.org/
R-studio https://rstudio.com/products/rstudio/

You need to first install R and then R-studio by the start of your first lab.
For extra coding practice problems, please see.

Quantitative Biology Center: students can get extra coding help in this center. It is located in BSLC room 401; for the hours please check.

Students without access to computers or internet please fill out the following survey, which will alert the Dean of Students. The link is https://collegesurveys.uchicago.edu/ccss-laptop-request
The DoS office is providing loaner equipment to everyone who needs it.

Grade checking: Students are responsible for checking their homework and lab grades on Canvas and reporting a missing grade no later than a week after the graded homework or lab is returned.
Online class Q&A: We will use Piazza (in the sidebar of our Canvas page) to have class discussions and Q&A. Students can post questions and collaborate to answer questions.

Academic Honesty: I expect students to follow the university's academic honesty code, and the vast majority of students do that. In this course, academic honesty mostly involves writing your own answers in your own words for the problem sets, exams, and lab assignments. Note that paraphrasing is plagiarism without mentioning the source. Please be aware that cheating always causes a lower grade, and in most cases the cheater will be referred to the office of Dean of Students.

Diversity Statement: The University of Chicago is committed to diversity and rigorous inquiry that arises from multiple perspectives. I concur with this commitment and also believe that we have the highest quality interactions and can creatively solve more problems when we recognize and share our diversity. I thus expect to maintain a productive learning environment based on open communication, mutual respect, and non-discrimination. I view the diversity that students bring to this class as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of many dimensions of diversity including gender, sexuality, disability, generational status, socioeconomic status, ethnicity, race, religious background, native language, and immigration status. Any suggestions for promoting a positive and open environment will be appreciated and given serious consideration. Please let me know your preferred name and gender pronouns. If there are circumstances that make our learning environment difficult and adjustments that I can make, please let me know. I promise to maintain confidentiality of these discussions. If you require a specific accommodation due to a disability, please contact Student Disability Services (see below).

Accommodations Statement: Students with disabilities who have been approved for the use of academic accommodations by Student Disability Services (SDS) and need a reasonable accommodation(s) to participate fully in this course should follow the procedures established by SDS for using accommodations. **Timely notifications are required in order to ensure that your accommodations can be implemented.** Please meet with me to discuss your access needs in this class after you have completed the SDS procedures for requesting accommodations. Please contact the Student Disability Services at 773-702-6000, or disabilities@uchicago.edu to begin this process.

Religious Accommodation Policy: Developed in conjunction with a faculty committee and reviewed by the Committee of the Council and the Council of the Senate, the new policy states that students who miss class, assignments, or exams to observe a religious holiday must be accommodated as follows: (i) absences may not be counted as a missed class in any course in which attendance is a measure of academic performance; (ii) reasonable extensions of time must be given, without academic penalty, for missed assignments; and (iii) exams must be reasonably rescheduled without academic penalty.
https://provost.uchicago.edu/announcements/new-policy-religious-accommodation-students

A Note on sexual misconduct: Our school is committed to fostering a safe, productive learning environment. Title IX and our school policy prohibits discrimination on the basis of sex. Sexual misconduct — including harassment, domestic and dating violence, sexual assault, and stalking — is also prohibited at our school. Our school encourages anyone experiencing sexual misconduct to talk to someone about what happened, so they can get the support they need, and our school can respond appropriately. If you wish to speak confidentially about an incident of sexual misconduct, want more information about filing a report, or have questions about school policies and procedures, please contact our Title IX Coordinator, which can be found on our school's website. Our school is legally obligated to investigate reports of sexual misconduct after a formal complaint is filed or signed by the Title IX Coordinator, but a request for confidentiality will be respected to the extent possible.

Date	Lecture	Topic	Labs
Week-1 March 20 – 24	Reading: Chapters 1	Introduction to modeling and statistics; displaying data	**Lab-1:** Graphics and descriptive statistics, functions; and sampling in R
Week-2 March 27 –31	Reading: Chapters 2 & 3	Describing data; Estimating with uncertainty	**Genetics Lab**
Week-3 April 3 – 7	Reading: Chapter 3 &4	Probability and medical testing	**Lab-2:** Confidence intervals, two-way tables, and Chi-square Tests
Week-4 April 10 – 14	Reading: Chapter 4 &5	Hypothesis testing **Exam 1: Th April 14th; 5:00 pm CST**	**Genetics Lab**
Week-5 April 17 – 21	Reading: Chapter 5	Goodness-of-fit test Contingency analysis: association between categorical variables	Lab-3: Genome Wide Association (GWAS) on data collected on dogs
Week-6 April 24 – 28	Reading: Chapter 6	Random transitions between states: Markov models	**Genetics Lab**
Week-7 May 9 – 13	Scans will be provided	Markov models continued. Correlation between numerical variables **Exam 2: Th May 4th 5:00 pm CST**	Lab-4: Markov models in R
Week-8 May 8 – 12	Reading: Chapters 17	Regression, non-linear fitting of the data Tue discussion: Genetics exam 2	**Genetics Lab**
Week-9 May 15 –19	Scans will be provided	Genomics data analysis; open reading frame (ORF)	**Lab-5:** Correlation and Regression in R; PTC significance analysis
Finals Week May 22 – May 26	**Final Exam, TBA** **Final Project, Due: Tue, May 23rd 11:59 pm CST**		

Extra readings will be posted on Canvas, accompanied by an announcement.