

CSE 5370: Bioinformatics

Instructor: Jacob M. Lubber, Ph.D.

Spring, 2022

E-mail: jacob.lubber@uta.edu

Web: [Faculty Profile](#)

Office Hours: M/Tu 5-7pm (ERB), M 9-10am (SEIR) Class Hours: M/W/F 11-11:50pm

Office: ERB 348 (office hours), SEIR 417 (research) Class Room: Woolf Hall 210

Office Phone: 817-272-5391

TA: Avishek Das

TA Email: axd9014@mavs.uta.edu

Course Description & Learning Outcomes

CSE 5370: Bioinformatics has the goal of giving students the skills needed to apply for AI jobs at pharmaceutical companies with a graduate degree in CSE or pursue further graduate education in computational biology. Topics covered will include sequence analysis, graph algorithms for biological data, computer vision for spatial 'omics, applying deep learning models to biological data, and technologies for handling petabyte scale omics data. The course will be designed so that any student that has taken data structures and algorithms will be able to succeed. The majority of the coursework will consist of projects that students will be able to include in a github portfolio when applying to computational biology jobs in the future.

The course will have five modules:

1. Skills Bootcamp
2. Genomics
3. Transcriptomics
4. Proteomics
5. Group Final Project

Topics that will be covered will include graph algorithms for genome assembly, alignment algorithms for transcriptomics, machine learning algorithms such as hidden markov models and their applications to biology, and how deep learning techniques can be applied to proteomics.

Logistics

This course is an in-person course with group project components. However, all class periods will also be live-streamed on Echo360, allowing students to participate in class remotely if they so desire (this excludes the midterm exam, which will be in person on paper). Classes will meet on Mondays, Wednesdays, and Fridays from 11:00am to 11:50am in Woolf Hall 210. Until February 4th, classes will be streamed on echo 360.

Office hours will be by appointment only during their normal time (please schedule 24 hours in advance) until February 4th due to UTA Covid-19 policy. To account for the difficulties of classes being remote, there will also be a class discord channel where Dr. Lubner and the TA will be available to answer questions. Ample "Flipped Classroom" (denoted in schedule) time will be provided to work on homework assignments to make the focus of the course more about learning the material and reducing stress about grades. Normal office hours are first come, first served, except for Monday morning office hours in SEIR, which are by appointment only (schedule by 5pm the preceding Friday).

Required Materials

There are no required materials, which have a cost of \$0.00.

Prerequisites

Prerequisites: Data Structures, Algorithms

Course Structure

Grading Policy

I reserve the right to curve the scale dependent on overall class scores at the end of the semester. Any curve will only ever make it easier to obtain a certain letter grade. The grade will count the assessments using the following proportions:

- 40% of your grade will be determined by homework assignments in the first four modules.
- 10% of your grade will be determined by the midterm exam.
- 10% of your grade will be determined by the final exam.
- 30% of your grade will be determined by the final project.
- 10% of your grade will be determined by quizzes in each of the four modules.

Assessments

The quizzes and the exams will be designed to be extremely easy if you have made an earnest attempt to complete the homework assignments. Quizzes will be all multiple choice. I will utilize a large bank of questions on canvas, and every student will receive a random portion of these in random order. I will throw out any questions that many students performed poorly on. Group work will be allowed on homework assignments and the final project.

Final Exam

The final exam will be on Wednesday, May 11th from 11-1:30pm.

Technology Requirements

Every student will have to have access to a computer and Microsoft Teams, Canvas, Discord, and Echo360 to be able to participate in the lectures until February 4 (or during any quarantine period or other excused in-class absence). In addition, students will have to have access to a computer to perform the programming components of the assignments and projects. For the latter, programming must use either Python 3 or R. If the instructor or GTA can not compile and/or run code, the student is responsible to provide an appropriate environment to evaluate the code.

Canvas

All changes and supplementary course materials will be made available through Canvas and usually through the web site. In addition, necessary changes or important announcements will also be distributed by through Canvas.

Late Submission Policy

All assignments and Projects are graded out of 100 points. Assignments submitted late will be penalized, at a rate of 4 penalty points per hour. The submission time will be the time shown on Canvas. Any assignment submitted more than 25 hours late will receive no credit for the assignment.

Exceptions to late submission penalties will only be made for emergencies documented in writing, in strict adherence to UTA policy. For all such exception requests, the student must demonstrate that he or she made all efforts to notify the instructor as early as possible.

Computer crashes, network crashes, software or hardware failure, temporary Canvas failure, email failure, will NOT be accepted as justification for late submissions. If you want to minimize chances of a late submission, aim to submit early.

Schedule

The schedule is tentative and subject to change. The learning goals below should be viewed as the key concepts you should grasp after each week.

Week 01, 01/17 - 01/21: Module 1: Review/Bootcamps

- Wednesday: Intro to Course
- Friday: Molecular Biology Bootcamp/Review

Week 02, 01/24 - 01/28: Module 1: Review/Bootcamps

- Monday: Programming Bootcamp/Review; HW1 assigned
- Wednesday: Statistics Bootcamp/Review
- Friday: Quiz 1; Flipped Classroom Coding

Week 03, 01/31 - 02/04: Module 2: Genomics

- Monday: Sequencing; HW1 Due; HW2 assigned
- Wednesday: Graph Algorithms/Genome Assembly
- Friday: Flipped Classroom Coding OR Guest Lecture

Week 04, 02/07 - 02/11: Module 2: Genomics

- Monday: Hidden Markov Models
- Wednesday: Gene Finding
- Friday: Flipped Classroom Coding; HW2 Due, Quiz 2

Week 05, 02/14 - 02/18: Module 3: Transcriptomics

- Monday: Next-Gen Sequencing
- Wednesday: Needleman–Wunsch & Smith Waterman algorithms
- Friday: Flipped Classroom Coding or Guest Lecture

Week 06, 02/21 - 02/25: Module 3: Transcriptomics

- Monday: BLAST
- Wednesday: Sequence Databases; HW3 assigned
- Friday: Flipped Classroom Coding or Guest Lecture, Quiz 3

Week 07, 02/28 - 03/04: Module 3: Transcriptomics

- Monday: RNA-Seq Analysis Pipelines
- Wednesday: DE-Seq Analysis
- Friday: Flipped Classroom Coding or Guest Lecture

Week 08, 03/07 - 03/11: Module 3: Transcriptomics and **Mid-term Exam**

- Monday: scRNA-Seq
- Wednesday: Spatial Omics, Cite-Seq, TCR-Seq
- Friday: Midterm Exam

Week 09, 03/14 - 03/18: Spring Break**Week 10, 03/21 - 03/25:** Module 4: Proteomics

- Monday: Biology Overview; HW4 Assigned; HW3 Due
- Wednesday: Pathology
- Friday: Flipped Classroom Coding or Guest Lecture

Week 11, 03/28 - 04/01: Module 4: Proteomics

- Monday: CODEX
- Wednesday: Segmentation Algorithms
- Friday: Flipped Classroom Coding or Guest Lecture

Week 12, 04/04 - 04/08: Module 4: Proteomics

- Monday: Computer Vision/Deep Learning Algorithms
- Wednesday: Registration Algorithms; Quiz 4
- Friday: Flipped Classroom Coding or Guest Lecture

Week 13, 04/11 - 04/15: Module 5: Final Project

- Monday: Overview of Final Projects; Final Project Groups Determined
- Wednesday: Petabyte Scale Data; HW4 Due
- Friday: Compression & Scaling Beyond Hadoop

Week 14, 04/18 - 04/22: Module 5: Final Project

- Monday: Flipped Classroom working on Final Projects
- Wednesday: Final Project Presentations
- Friday: Final Project Presentations

Week 15, 04/25 - 04/29: Module 5: Final Project

- Monday: Final Project Presentations
- Wednesday: New Technologies in 'omics
- Friday: Guest Lecture

Week 16, 05/02 - 05/06: Final Exam Review

- Monday: Final Exam Review

Week 17, 05/09 - 05/13: Final Exam

- Wednesday: Final Exam

1 Attendance

At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator in student success. Each faculty member is free to develop his or her own methods of evaluating students' academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, I will require course attendance for days in which there is a guest speaker, quiz, project presentation, or exam. Note that you are responsible for any course content covered in class. However, while UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients begin attendance in a course. UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Canvas. This date is reported to the Department of Education for federal financial aid recipients.

2 University Policies

2.1 Institution Information

UTA students are encouraged to review the below institutional policies and informational sections and reach out to the specific office with any questions. To view this institutional information, please visit the Institutional Information page (<https://resources.uta.edu/provost/course-related-info/institutional-policies.php>) which includes the following policies among others:

- Drop Policy
- Disability Accommodations
- Title IX Policy
- Academic Integrity
- Student Feedback Survey
- Final Exam Schedule

2.2 Emergency Exit Procedures

Should we experience an emergency event that requires evacuation of the building, students should exit the room and move toward the nearest exit, which is located to the left or right once exiting the room. When exiting the building during an emergency, do not take an elevator but use the stairwells instead. Write the word "chihuahua" on the back of the first page of the midterm exam for an extra 1% grade boost in the course. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

2.3 Grade Grievances

Any appeal of a grade in this course must follow the procedures and deadlines for grade-related grievances as published in the current undergraduate catalog.

2.4 Drop Policy

Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. Students will not be automatically dropped for non-attendance. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (<http://web.uta.edu/aao/fao/>).

2.5 Disability Accommodations

UT Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including The Americans with Disabilities Act (ADA), The Americans with Disabilities Amendments Act (ADAAA), and Section 504 of the Rehabilitation Act. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of a letter certified by the Office for

Students with Disabilities (OSD). Only those students who have officially documented a need for an accommodation will have their request honored. Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting: The Office for Students with Disabilities, (OSD) www.uta.edu/disability or calling 817-272-3364. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability. Counseling and Psychological Services, (CAPS) www.uta.edu/caps/ or calling 817-272-3671 is also available to all students to help increase their understanding of personal issues, address mental and behavioral health problems and make positive changes in their lives.

2.6 Non-Discrimination Policy

The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit uta.edu/eos.

2.7 Title IX Policy

The University of Texas at Arlington ("University") is committed to maintaining a learning and working environment that is free from discrimination based on sex in accordance with Title IX of the Higher Education Amendments of 1972 (Title IX), which prohibits discrimination on the basis of sex in educational programs or activities; Title VII of the Civil Rights Act of 1964 (Title VII), which prohibits sex discrimination in employment; and the Campus Sexual Violence Elimination Act (SaVE Act). Sexual misconduct is a form of sex discrimination and will not be tolerated. For information regarding Title IX, visit www.uta.edu/titleIX or contact Ms. Michelle Willbanks, Title IX Coordinator at (817) 272-4585 or titleix@uta.edu

2.8 Academic Integrity

Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code: *I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence. I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.* UT Arlington faculty members may employ the Honor Code in their courses by having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System Regents' Rule 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University. Additional information is available at <https://www.uta.edu/conduct/>.

2.9 Electronic Communication

UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at <http://www.uta.edu/oit/cs/email/mavmail.php>.

2.10 Campus Carry

Effective August 1, 2016, the Campus Carry law (Senate Bill 11) allows those licensed individuals to carry a concealed handgun in buildings on public university campuses, except in locations the University establishes as prohibited. Under the new law, openly carrying handguns is not allowed on college campuses. For more information, visit <http://www.uta.edu/news/info/campus-carry/>

2.11 Student Feedback Survey

At the end of each term, students enrolled in face-to-face and online classes categorized as "lecture", "seminar", or "laboratory" are directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback via the SFS database is aggregated with that of other students enrolled in the course. Students' anonymity will be protected to the extent that the law allows. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law and aggregate results are posted online. Data from SFS is also used for faculty and program evaluations. For more information, visit <http://www.uta.edu/sfs>.

2.12 Final Review Week

A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabus. During Final Review Week, an instructor shall not give any examinations constituting 10% of the grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

2.13 Student Support Services

UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information

related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817- 272-6107, send a message to resources@uta.edu, or view the information at <http://www.uta.edu/universitycollege/resources/index.php>.

2.13.1 The IDEAS Center

(2nd Floor of Central Library) offers FREE tutoring to all students with a focus on transfer students, sophomores, veterans and others undergoing a transition to UT Arlington. Students can drop in, or check the schedule of available peer tutors at www.uta.edu/IDEAS, or call (817) 272-6593.

2.13.2 The English Writing Center

(411LIBR): The Writing Center offers FREE tutoring in 15-, 30-, 45-, and 60-minute face-to-face and online sessions to all UTA students on any phase of their UTA coursework. Register and make appointments online at <https://uta.mywconline.com>. Classroom visits, workshops, and specialized services for graduate students and faculty are also available. Please see www.uta.edu/owl for detailed information on all our programs and services. The Library's 2nd floor Academic Plaza offers students a central hub of support services, including IDEAS Center, University Advising Services, Transfer UTA and various college/school advising hours. Services are available during the library's hours of operation. <http://library.uta.edu/academic-plaza>