QBIO 401 Introduction to Computational Analysis of Biological Data

Units: 4
Spring 2025 Semester
Lecture: Mondays and Wednesdays, 2:00-3:20 pm
Discussion: Fridays, 10:00-10:50 am
Location: RRI 101

Instructor: Tsu-Pei Chiu, PhD
Office: RRI 413J
Office Hours: Fridays, 4:00-5:00 pm, or by appointment
Contact Info: tsupeich@usc.edu

Teaching Assistant: TBD
Office: TBD
Office Hours: TBD
Contact Info: TBD

Course Description

This course introduces a broad range of topics in quantitative and computational biology through hands-on learning experiences. This course integrates the multidisciplinary training of the QBIO major, touching on biology, computer science, and statistical concepts. Our class will cover fundamental techniques such as statistical analysis, machine learning, and algorithm design, and students will work directly with large-scale biological datasets.

Learning Objectives

Topics covered in the course include principles and methods for sequence alignment, genome assembly, phylogenetic trees, next generation sequencing, meta-genomics, population genetics, system biology, structural biology, machine learning, as well as currently emerging research areas. The general programming language Python and the statistical programming language R will be introduced in the lecture as well (no prior knowledge of either language is required). Students will use these languages to analyze biological datasets and implement algorithms for their weekly computing assignments and an end-of-the-semester project. Students will be required to write their own code without solely using off-the-shelf programs. Students can expect to gain a broad understanding of the principles of computational biology and the skills to analyze and model biological data through the lecture and exercises.

Prerequisite(s): none
Recommended Preparation: No prerequisites or co-requisites are required for this course. Prior programming experience will be helpful but is not required.

Course Notes

This course is taken for a letter grade. Lecture slides will be posted on Brightspace.

Technological Proficiency and Hardware/Software Required

Students will need access to a computer. It will be helpful (but not required) if students have a laptop that they can bring it to class.

Suggested Readings and Supplementary Materials

There is no textbook for this course. However, we provide suggested readings and supplementary materials below. Additional supplemental readings will be posted on Brightspace before or after each lecture.

Assignments

The assignments include weekly computing assignment and an end-of-the-semester project. Computer-based problem sets in Python or R will be assigned every week. These assignments are designed to promote a deeper understanding of the principles discussed in lecture as well as provide hands-on experience with computing methods. The end-of-the-semester project will require students to design and carry out a research project. Students will write a report explaining their project and results in a 5 page due at the end of the semester. Students will have the freedom to choose their project topic related to the lectures. I can suggest topics to students if they need, and graduate students can use their thesis data if they wish. Students should discuss the topic of their research project with me by week 10.

Grading Breakdown

Assessment	Points	% of Grade
In-class quizzes	0.4 each, 8 in total	8
Weekly computing assignments	7 each, 70 in total	70
Final project proposal	2	2
End-of-semester project	20	20

Assignment Submission Policy

Most weeks there will be a computing assignment. Assignments will both be posted and submitted on Brightspace.

Course Specific Policies

Late assignments will not be accepted without prior approval. Every student must submit their own assignment.

The professor reserves the right to make changes to the syllabus; these changes will be announced as early as possible so that students can adjust their schedules.

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Course Schedule

	Topic	Reading
Week 1	Introduction to Python	Posted on Blackboard
Week 2	Sequence Alignment	Posted on Blackboard
Week 3	Genome Assembly	Posted on Blackboard
Week 4	Phylogenetic Trees	Posted on Blackboard
Week 5	Next Generation Sequencing Data	Posted on Blackboard
Week 6	Meta-Genomics	Posted on Blackboard
Week 7	Introduction to R	Posted on Blackboard
Week 8	Population Biology	Posted on Blackboard
Week 9	System Biology	Posted on Blackboard
Week 10	Structural Biology	Posted on Blackboard
Week 11	Machine Learning - Regression	Posted on Blackboard
Week 12	Machine Learning - Classification	Posted on Blackboard
Week 13	Machine Learning - Neural Networks	Posted on Blackboard
Week 14	Machine Learning - Applications to Biology	Posted on Blackboard

Week 15	Currently emerging research	Posted on Blackboard
Week 16	Final Project and written report due	

Statement on Academic Conduct and Support Systems

Academic Integrity:
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, compromises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - *(213) 740-9355 – 24/7 on call*
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - *988 for both calls and text messages – 24/7 on call*

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - *(213) 740-9355(WELL) – 24/7 on call*
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - *(213) 740-5086*
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - *(213) 740-5086 or (213) 821-8298*
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - *(213) 740-0776*
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - *(213) 740-0411*
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - *(213) 740-2101*
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - *UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - *UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call*
Non-emergency assistance or information.

Office of the Ombuds - *(213) 821-9556 (UPC) / (323-442-0382 (HSC)*
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - *(323) 442-2850 or* otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.