QBIO 401 Introduction to Computational Analysis of Biological Data

Units: 4
Fall 2024 Semester
Lecture: Mondays and Wednesdays, 2:00 – 3:20pm
Location: DMC 150
Discussion: Thursdays 3:00 – 3:50pm (SOS B48)
or Thursdays 4:00 – 4:50 (WPH 101)

Instructor: Peter Calabrese
Office: RRI 404B
Office Hours: Mondays 3:40 – 4:30,
   Tuesdays 12:40 – 1:30,
   Wednesdays 3:40 – 4:30,
   Thursdays 12:40 – 1:30,
   Immediately after lecture, or by appointment

Contact Info: petercal@usc.edu, 213-740-2434
For office hours, I will be in my office and I will also be on Zoom (https://usc.zoom.us/j/4898518195). It is up to you if you want to meet in person or online.

Teaching Assistant: TBD
Course Description
This course is intended for students who are interested in computational biology. This course will integrate
the biology, computer science, and statistics training in the QBIO major. We will do this by analyzing
genomic datasets.

Learning Objectives
In lecture, students will be introduced to the general programming language Python (no prior knowledge of
this language is required). Students will use Python when doing weekly computing assignments and two
take-home exams. There will be an emphasis on writing original code and not using off-the-shelf programs.
Students will “get their hands dirty” by analyzing genomic datasets. The assignments and exams will be
based on topics covered in lecture. Topics will include: next generation sequencing, hidden Markov models,
sequence alignment, phylogenetic trees, RNA-seq, multiple testing, dimension reduction, population
genetics, GWAS, meta-genomics, structural biology, systems biology, and machine learning.

Prerequisite(s): none
Co-Requisite(s): none
Concurrent Enrollment: none
Recommended Preparation: There are no prerequisites or co-requisites for this course. Experience
writing computer code (or a willingness to learn) will be helpful.

Course Notes
This course can be taken either for a letter grade or for credit/no credit. Lecture slides will be posted on
Blackboard.

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 to class.

Required Readings and Supplementary Materials
There is no textbook for this course. Lectures will be supplemented by readings posted on Blackboard.

Assignments
Most weeks there will be a computing assignment. Assignments will both be posted and submitted on
Blackboard. The assignments will be due before midnight (California time) on Wednesday. The next day
(Thursday) in discussion, the TA will review the solutions. The TA will grade the assignments for accuracy.

Exams
There will be a take-home midterm exam and a take-home final exam.
Grading Breakdown

<table>
<thead>
<tr>
<th>Assessment Tool (assignments)</th>
<th>% of Grade</th>
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<tbody>
<tr>
<td>Weekly computing assignments</td>
<td>75</td>
</tr>
<tr>
<td>Mid-term take-home exam</td>
<td>10</td>
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<tr>
<td>Final take-home exam</td>
<td>15</td>
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Grading Timeline
Assignments will be graded within one to two weeks of submission. Grades will be entered on Blackboard.

Additional Policies
Late assignments will not be accepted without prior approval. You can work together on the assignments (every student must submit their own assignment). You **cannot** work together on the exams.

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.
## Course Schedule: A Weekly Breakdown

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics/Daily Activities</th>
<th>Readings/Preparation</th>
<th>Deliverables</th>
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<tbody>
<tr>
<td><strong>Week 1</strong>&lt;br&gt;8/26-8/30</td>
<td>Next Generation Sequencing&lt;br&gt;Introduction to Python</td>
<td>Posted on Blackboard</td>
<td>(none)</td>
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<tr>
<td><strong>Week 2</strong>&lt;br&gt;9/2-9/6</td>
<td>Labor Day (no lecture on Monday)&lt;br&gt;Python Continued</td>
<td>Posted on Blackboard</td>
<td>(none)</td>
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<tr>
<td><strong>Week 3</strong>&lt;br&gt;9/9-9/13</td>
<td>Python Continued&lt;br&gt;Hidden Markov Models</td>
<td>Posted on Blackboard</td>
<td>Assignment #1</td>
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<tr>
<td><strong>Week 4</strong>&lt;br&gt;9/16-9/20</td>
<td>Sequence Alignment&lt;br&gt;E-scores</td>
<td>Posted on Blackboard</td>
<td>Assignment #2</td>
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<tr>
<td><strong>Week 5</strong>&lt;br&gt;9/23-9/27</td>
<td>Phylogenetic Trees&lt;br&gt;More Advanced Python</td>
<td>Posted on Blackboard</td>
<td>Assignment #3</td>
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<tr>
<td><strong>Week 6</strong>&lt;br&gt;9/30-10/4</td>
<td>More Advanced Python&lt;br&gt;More Advanced Python</td>
<td>Posted on Blackboard</td>
<td>Assignment #4</td>
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<tr>
<td><strong>Week 7</strong>&lt;br&gt;10/7-10/11</td>
<td>RNA-Seq&lt;br&gt;Multiple Testing&lt;br&gt;&lt;b&gt;Fall Recess (no discussion on Thursday)&lt;/b&gt;</td>
<td>Posted on Blackboard</td>
<td>Assignment #5</td>
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<td><strong>Week 8</strong>&lt;br&gt;10/14-10/18</td>
<td>Dimension Reduction&lt;br&gt;Population Genetics</td>
<td>Posted on Blackboard</td>
<td>Mid-term take-home exam due Wed., Oct. 16</td>
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<td><strong>Week 9</strong>&lt;br&gt;10/21-10/25</td>
<td>GWAS&lt;br&gt;Meta-genomics</td>
<td>Posted on Blackboard</td>
<td>Assignment #6</td>
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<td><strong>Week 10</strong>&lt;br&gt;10/28-11/1</td>
<td>Machine Learning: Regression&lt;br&gt;Machine Learning: Regression</td>
<td>Posted on Blackboard</td>
<td>Assignment #7</td>
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<td><strong>Week 11</strong>&lt;br&gt;11/4-11/8</td>
<td>Machine Learning: Classification&lt;br&gt;Machine Learning: Classification</td>
<td>Posted on Blackboard</td>
<td>Assignment #8</td>
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<td><strong>Week 12</strong>&lt;br&gt;11/11-11/15</td>
<td>Veteran’s Day (no lecture on Monday)&lt;br&gt;Machine Learning: Neural Networks</td>
<td>Posted on Blackboard</td>
<td>Assignment #9</td>
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<td><strong>Week 13</strong>&lt;br&gt;11/18-11/22</td>
<td>Machine Learning: Neural Networks&lt;br&gt;Machine Learning: Trees</td>
<td>Posted on Blackboard</td>
<td>Assignment #10</td>
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<td><strong>Week 14</strong>&lt;br&gt;11/25-11/29</td>
<td>Machine Learning: Unbalanced Data&lt;br&gt;Thanksgiving (no lecture on Wednesday and no discussion on Thursday)</td>
<td>Posted on Blackboard</td>
<td>(none)</td>
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<td><strong>Week 15</strong>&lt;br&gt;12/2-12/6</td>
<td>Structural Biology (guest lecturer)&lt;br&gt;Systems Biology (guest lecturer)</td>
<td>Posted on Blackboard</td>
<td>Assignment #11</td>
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<td><strong>FINAL</strong></td>
<td>Final take-home exam due Friday, Dec. 13</td>
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Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

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

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298 equity.usc.edu, titleix.usc.edu
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 usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776 dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.
USC Campus Support and Intervention - (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
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
dps.usc.edu, emergency.usc.edu
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) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.