QBIO 478, BISC 478.
Computational Genome Analysis

Units: 4
Spring 2020 —Tu,Th—9:30-10:50

Location: RRI 301.

Instructor: Andrew Smith
Office: RRI 408 E
Office Hours: 10AM-12PM, Fridays, or by appointment.
Contact Info: andrewds@usc.edu, replies within 24 hours.

Instructor: Mark Chaisson
Office: RRI 408 H
Office Hours: 10AM-12PM, Wednesdays, or by appointment.
Contact Info: mchaisso@usc.edu, replies within 24 hours.

Teaching Assistant:
Office: Amal Thomas
Office Hours: 3PM-3:50, VKC 257, Thursday.
Contact Info: amalthom@usc.edu

Short Description
Introduction to algorithms and statistics for genome analysis, and their applications. Topics include analysis of DNA sequencing, sequence comparison, genetic variation, gene expression, disease association, and evolution.

Course Description
Over the next decade, millions of genomes will be sequenced (likely including yours), and genetic analysis will be a cornerstone of medical care. The goals of this course are to provide students with (1) broad knowledge of computational genome analysis, (2) biological questions that motivate computational analysis, and (3) specific technical skills of immediate practical use. This course covers DNA sequencing technology, and computational methods to analyze: sequence data, individual genomes, disease studies, inter species comparison, functional genomics, and gene expression. The data analysis techniques covered in this course are founded in computer science and statistics,and motivated by real examples from modern studies.

Learning Objectives
Students will learn:

Technology of modern sequencing methods, and the characteristics of the data produced by different technologies. Probability and statistics for sequence analysis. Algorithms for searching DNA databases and assembling genomes. Methods to discover genome variation, and application to discovering etiology of disease. How to use software for high-performance computing and sequence analysis. Models for sequence evolution. Algorithms for pairwise sequence alignment. Statistical methods for detecting differential gene expression and genomic regulatory regions.

Prerequisite(s):
Co-Requisite(s):
Concurrent Enrollment:
Recommended Preparation: BIO305

Course Notes
Letter grade, 4 credits. Lectures and sample material posted on Blackboard.

Technological Proficiency and Hardware/Software Required
Assignments required access to a personal computer and network connection.

Required Readings and Supplementary Materials
All
Required reading:
(**DTW**) Richard C. Deonier, Simon Tavare, and Michael S. Waterman, Computational Genome Analysis, an Introduction. e-book available from the USC library.

Recommended reading:
(**BA**): Harris, Simon, Ross, James, Beginning Algorithms
https://uosc.primo.exlibrisgroup.com/permalink/01USC_INST/tt7nj9/alma991043009073103731

(**GMS**): Griffiths AJF, Miller JH, Suzuki DT, et al. An Introduction to Genetic Analysis. 7th edition.
https://www.ncbi.nlm.nih.gov/books/NBK21766/?

Description and Assessment of Assignments

Assignments will require a combination of pencil/paper problem solving, and computational projects involving running online software, interacting with public biological databases, and writing a report with a summary of results. Problems and reports will be graded on correctness.

Grading Breakdown

Assessment Tool (assignments)	Points	% of Grade
Homework (5)	6	30
Midterm	30	30
Final	40	40
TOTAL	100	100

Assignment Submission Policy

Written assignments are due at the beginning of lecture on the due date. Electronic reports are due by midnight on the due date, and must be sent to the TA.

Grading Timeline

Homework tests will be graded within one week of submission.

Additional Policies

Cell phone use is not allowed in class except in case of emergency or with prior permission.

Course Schedule:

	Topics/Daily Activities	Readings/Preparation	Deliverables
Week 1	Biology for Computational Genome Analysis, sequencing technologies (1)	Reading 1, DTW Chapter 2	
Week 2	Probability for genetic analysis	DTW Chapter 3 BA Chapter 1, section 3.	
Week 3	Googling a genome with sequence mapping	DTW Chapter 7	Homework 1
Week 4	Genome assembly, a DNA jigsaw puzzle	DTW Chapter 8	
Week 5	Our 0.1% differences: Single nucleotide variation	Reading 2.	
Week 6	Genetic testing, DNA databases	Reading 3.	Homework 2
Week 7	Precision medicine	Reading 4.	
Week 8	Implementing software for genomic analysis		
Week 9	Sequence evolution and function		Homework 3
Week 10	Spring break		
Week 11	Pairwise sequence alignment	DTW Chapter 6	
Week 12	Comparative genomics	GMS Chapter 11	Homework 4
Week 13	Expression analysis with RNA-seq	DTW Chapter 11, Reading 5	
Week 14	Clustering and genome regulation	DTW Chapter 10.	
Week 15	DNA Methylation	Reading 6	Homework 5
FINAL			Refer to the final exam schedule in the USC *Schedule of Classes* at classes.usc.edu.

Reading:
1. Coming of age: ten years of next-generation sequencing technologies. Sara Goodwin, John D. McPherson & W. Richard McCombie Nature Reviews Genetics volume 17, 333–351(2016)
2. https://learn.genetics.utah.edu/content/precision/snips/
3. Privacy: The myth of anonymity, Neil Savage, Nature volume 537, S70–S72(2016), https://www.nature.com/articles/537S70a
4. Towards precision medicine, Euan A. Ashley, Nature Reviews Genetics volume 17, 507–522(2016) https://www.nature.com/articles/nrg.2016.86
5. RNA-Seq: a revolutionary tool for transcriptomics, Zhong Wang, Mark Gerstein & Michael Snyder, Nature Reviews Genetics volume 10, 57–63(2009)Cite thihttps://www.nature.com/articles/nrg2484

6. Functions of DNA methylation: islands, start sites, gene bodies and beyond, Peter A. Jones, Nature Reviews Genetics volume 13, pages 484–492(2012) https://www.nature.com/articles/nrg3230

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 and 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. The university prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

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.

Campus Support & 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.