BIOSTATS 690MS: Applied Stochastic Models in Population Genomics
Fall 2016, MoWe 2:30PM-3:45PM, Room LGRT 1322

INSTRUCTOR:
  Prof. Matthias Steinrücken, Ph. D.
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  Office Hours: Tu 10:00AM-12:00PM

REQUIREMENTS:
  – STAT 515 & 516
  – Programming experience (R, C++, Java, Python, ...)
    [level: completion of http://www.codecademy.com/en/tracks/python or equivalent for other languages]
  – Working knowledge of LaTeX (or willingness to aquire)

COURSE DESCRIPTION: This lecture will introduce stochastic models used in Population Genomics to study the evolutionary forces that shape genetic variation. We will introduce these models in the neutral setting, and extend them to incorporate biological phenomena like natural selection, recombination, and changes in population size and structure. We will learn how to use these models for simulation, as well as applying them to modern genomic datasets to learn about the underlying evolutionary processes.

COURSE OBJECTIVES:
  – Learn theoretical foundations of stochastic models used in population genomics.
  – Implement these models for simulation and analysis of genetic data.

RECOMMENDED SUPPLEMENTAL MATERIAL:
  – Probability Models for DNA Sequence Evolution by R. Durrett; Springer (2007). http://www.math.duke.edu/~rtd/Gbook/PM4DNA_0317.pdf
  – Gene Genealogies, Variation and Evolution by J. Hein, M. Schierup, and C. Wiuf; Oxford University Press (2002).
  – Mathematical Population Genetics (2nd Edition) by W. Ewens; Springer (2004).
  – Coalescent Theory by J. Wakeley; Roberts & Co. (2008).
  – Principles of Population Genetics (4th Edition) by D. Hartl and A. Clark; Sinauer Associates, Inc. (2006).

MOODLE:
  A moodle course is associated with this lecture. Please log into moodle at https://moodle.umass.edu/ and confirm that the course **BIOSTATS690MS** is listed under your courses for this semester. The lecture notes and supplemental material for the class will be posted here. The homework sets will be posted on moodle and have to be submitted through moodle.

GRADING:
  4 Homework assignments: 70%
  Presentation: 30%

HOMEWORK:
  The homework sets will consist of problem-set-style assignments and implementation exercises. Four homework sets will be posted on moodle at the indicated dates. The solutions have to be submitted through moodle in electronic form (pdf, word, ...) two weeks after the day they are posted by 1:30 PM. Homework solutions turned in up to 48 hours after the time they are due will be scored with a multiplier of 0.5. Homeworks handed in later than 48 hours after the due date will not be graded. Submit a textual answer

to each problem. Additionally, for problems that require implementation, a working implementation of the solution has to be submitted (in R, C++, Java, or Python; different language by request). Collaboration on homework is encouraged, although every student must write up and submit their own assignment (no copy and paste). The level of expected programming proficiency is that after completion of the online tutorial at http://www.codecademy.com/en/tracks/python or equivalent for other languages.

PRESENTATION:
As part of the final grade, students are expected to give a short presentation in class about a specific application of the different methods and models that we will discuss in class. In addition, a three-page summary of the chosen topic should be handed in. The instructor will provide a list of potential applications, but students are welcome to suggest their own topics. The instructor will supply or help in acquiring the necessary materials to prepare for the presentation. Depending on class size, the presentations might be prepared and given in groups. All presentations will be given on the last day of class (December 14).

Course Outline (26 Lectures)

Date	Day	Note	Content
9/5	M	No Class	Labor Day
9/7	W		Syllabus, Course overview
9/12	M		Review: Mathematical Background
9/14	W		1. Background & Wright-Fisher Model
9/19	M		
9/21	W	Homework 1 posted	2. Ancestral Process
9/26	M		
9/28	W		3. The Coalescent Process
10/3	M		
10/5	W	Homework 1 due	
10/10	M	No Class	Columbus Day
10/11	Tu	Monday class	3. The Coalescent Process (cont'd)
10/12	W	Homework 2 posted	
10/17	M		
10/19	W		4. Site-Frequency Spectrum & Variable Population Size
10/24	M		
10/26	W	Homework 2 due	
10/31	M		5. Coalescent with Recombination
11/2	W	Homework 3 posted	
11/7	M		
11/9	W		
11/14	M		6. Sequentially Markov Coalescent
11/16	W	No Class / Homework 3 due	Veterans day substitute
11/21	M	No Class	Thanksgiving recess
11/23	W	No Class	

Date	Day	Note	Content
11/28	M	Homework 4 posted	6. Sequentially Markov Coalescent (cont'd)
11/30	W		
12/5	M		7. Structured Coalescent
12/7	W		8. Wright-Fisher Diffusion
12/12	M	Homework 4 due	
12/14	W		Student Presentations
12/19	M	No Class	Final Week
12/21	M	No Class	Final Exam

ACADEMIC HONESTY POLICY STATEMENT:

Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst.

Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. The procedures outlined below are intended to provide an efficient and orderly process by which action may be taken if it appears that academic dishonesty has occurred and by which students may appeal such actions.

Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent. For more information about what constitutes academic dishonesty, please see the Dean of Students' website: http://umass.edu/dean_students/codeofconduct/acadhonesty/

DISABILITY STATEMENT

The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological, or learning disability on file with Disability Services (DS), Learning Disabilities Support Services (LDSS), or Psychological Disabilities Services (PDS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements.