The Mathematics of Evolution
BIOS 13141

Winter 2019, TuTh 9:30AM - 10:50AM,
Biological Sciences Learning Center (BSLC), Room 205

INSTRUCTORS:

Matthias Steinrücken
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TEACHING ASSISTANT:

Rahul Subramanian
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Office Hours: We 1:00 PM - 3:00 PM

REQUIREMENTS:
- BIOS 10130
- STAT 22000
- MATH 13300 or higher

COURSE DESCRIPTION:
In this course, students will learn fundamental concepts and models of population dynamics, selection and evolution. The course will emphasize the importance of population thinking, information, chance, competition and selection in finite populations in determining dynamical outcomes. We will show how genetic information can be modeled and transmitted under variation and selection across generations, providing a modern framework to understand mathematical theories of evolution by natural selection. This then leads to the central theme of the course, creating a general view of evolution as learning in populations, which establishes connections between ecology and evolution and computer science, economics and complex systems.

RECOMMENDED SUPPLEMENTAL READING:
- On the Origin of Species by C Darwin (1859). http://www.gutenberg.org/ebooks/1228
- Evolution by Carl T. Bergstrom, Lee Alan Dugatkin, W W Norton & Co Inc (2011).
- Population Genetics – A Concise Guide (2nd Edition) by J. Gillespie (2004).
- Probability Models for DNA Sequence Evolution by R. Durrett (2008). http://www.math.duke.edu/~rtd/Gbook/PM4DNA_0317.pdf
- Mathematical Population Genetics (2nd Edition) by W. Ewens; Springer (2004).

CANVAS:
A Canvas course is associated with this lecture. Please log into Canvas at https://canvas.uchicago.edu/ and confirm that the course **BIOS 13141** is listed under your courses for Winter 2019. The homework sets will be posted on Canvas and have to be submitted through Canvas. Slides from the lectures, additional reading and supplemental material for the class will be posted on Canvas as well.

GRADING:
7 Homework assignments: 100%

Homework:

The homework sets will consist of problem-set-style assignments and implementation exercises. Seven homework sets will be posted on Canvas at the indicated dates. The solutions have to be submitted through Canvas in electronic form (pdf, word, ...) one week after the day they are posted by 3:00 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 in Python has to be submitted. Collaboration on homework is encouraged, although every student must write up and submit their own assignment (no copy and paste).

Discussion section:

The course will be accompanied by a weekly hour-long discussion section lead by the Teaching Assistant. The purpose of this section is to introduce some mathematical background, clarify questions about the lecture or the homework sets, and discuss reading material related to the lectures. A suitable time for this section will be determined via a doodle poll.

Course Outline:

Date	Day	Note	Content
1/8	Tu		Course overview, Introduction to general concepts
1/10	Th		Single population dynamics, Malthusian difference equation
1/15	Tu		
1/17	Th	HW 1 posted	Interacting population dynamics, Predator-Prey, Lotka-Volterra, Stability of dynamical systems
1/22	Tu		
1/24	Th	HW 1 due / HW 2 posted	Population genetics, Discrete Wright-Fisher model, Allele frequency changes, Mutation, Selection
1/29	Tu		
1/31	Th	HW 2 due / HW 3 posted	Wright-Fisher diffusion as limit of discrete model
2/5	Tu		
2/7	Th	HW 3 due / HW 4 posted	Quantitative genetics, Population dynamics of quantitative traits
2/12	Tu		
2/14	Th	HW 4 due / HW 5 posted	Phylogenetics, Building Tree of Life from genetic data
2/19	Tu		
2/21	Th	HW 5 due / HW 6 posted	Evolution as learning
2/26	Tu		
2/28	Th	HW 6 due / HW 7 posted	Synthesis, Connections to Computer Science, Economics, and Complex Systems
3/5	Tu		
3/7	Th	HW 7 due	
3/8	Th	No Class	Reading Period
3/13	Tu	No Class	Reading Period
3/15	Th	No Class	Reading Period