EEMB 180/280: Evolutionary Theory

Spring 2023

Scope and Requirements of the Course

This course takes a mathematical approach to understanding the process of evolutionary change. We will begin by studying natural selection, frequency dependent selection, sex ratio, and selection for local adaptation. Random elements of evolution will be incorporated leading to concepts of genetic drift, random loss of beneficial mutations, and evolution in fluctuating environments. The long-term outcome of evolutionary processes will be analyzed and applied to gene duplication, genome expansion, and the evolution of genetic networks.

Course Instructor:

Stephen Proulx sproul@ucsb.edu

Office: LSB 4109 Zoom ID 353-292-9778

Office hours: Tuesday 11-12, courtyard by class. Wednesday 11:30-12:30, zoom or office (check to see which)

Teaching Assistant:

Taom Sakal tsakal@ucsb.edu

Required Text

Otto and Day A Biologist's Guide to Mathematical Modeling in Ecology and Evolution. The book can be purchased through the bookstore or online in various formats. It is also available through the UCSB library: library e-copy.

Getting the course materials

Course materials will be available on Gauchospace and via github. The github version will have materials organized by type, while GS is organized by date.

You can use the web interface to github or just clone the repository to your own machine and use it locally.

Depending on your operating system, something like the following from the command line will clone (download) the entire repository into a new directory `git clone https://github.com/ucsb/EEMB180`
This creates a directory named `EEMB180` with subdirectories containing the course materials.

To refresh with new material from the terminal you need to first "change directory":
`cd ~/EEMB180/`
and then "pull" the updated material:
`git pull https://github.com/ucsb/EEMB180`

Coursework and grading

Coursework will include homework, lab reports, worksheets, two midterm assessment exercises, and a final project. Roughly, the breakdown is:

Category	Percentage
Homework	15%
Lab Reports	30%
Worksheets	20%
Midterms	20%
Final Project	15%

Homework

Homework assignments will be assinged from the textbook or provided as supplementary assignments. These homeworks will be graded based on attempted completion, not correctness of the answers. To get credit you will have to explain your answer or describe, as best you can, where you got lost and were unable to finish the assignment. (But if you do get stuck we encourage you to work with your classmates to get unstuck.) Assignments will be due on Tuesday mornings at class time. If there is some reason that you are unable to complete the assignment by the due date, please contact us and let us know so that we can work with you to ensure that you can stay up to speed in the course.

Lab Assignments

Much of the work for this class involves applying concepts using mathematical tools and computer programming. We will use the software system Mathematica for much of this, and this will be woven into the regular class meeting times. The dedicated lab class period is from 2-3:50. You will need to attend this whole session. Taom and Stephen will both be available in lab to help you with Mathematica issues and answer questions about the lab assignments. If you have a conflict with the lab time period please let us know so we can arrange alternatives.

Later in the quarter we will use the lab time to work on your independent projects.

Outline of the dates and subjects for the term

Lecture topics

(These will be updated with dates/subects for the remainder of the quarter)

Date	Subject	Reading
4/4/23	Intro to course, principles of modeling	Cohen: Mathematics Is Biology's Next Microscope . . .
4/6/23	Flow diagrams, model building, Mathematica	O&D 1-14
4/6/23	Lab: Intro to Mathematica	O&D 1-14
4/11/23	Population growth	O&D 17-33
4/13/23	Probability of invasion	Introduced Beetles
4/18/23	Haploid selection	O&D 54-72
4/20/23	Diploid selection	Gillespie 56-69
4/25/23	Stability analysis	O&D 124-133
4/27/23	Mutation/selection balance, exam review	
5/2/23	Midterm Assessment	
5/4/23	Final Project Discussion	
5/9/23	Evolutionary Invasion	O&D 454-460

Date	Subject	Reading
5/11/23	Sex Ratio Evolution	See GS
5/16/23	Migration/selection balance	See GS
5/18/23	Local Adaptation	See GS
5/23/23	Genetic Drift	See GS
5/25/23	Fixation Probability	See GS
5/30/23	Variable Environments	See GS
6/1/23	Midterm Assessment	
6/6/23	The Price Equation	
6/8/23	Project Presentations	

Lab Projects

Date is the date of the lab meeting, project write-ups are due one week later.

Date	Lab
4/6/23	Intro to Mathematica
4/13/23	Extinction probability simulation
4/20/23	Population genetic dynamics
4/27/23	Stability and mutation/selection balance
5/4/23	Monopoly!
5/11/23	Evolutionary invasion analysis
5/18/23	Sex ratio evolution

Final Projects Benchmarks

Date	Component
5/11/23	Project Description
5/23/23	Report Introduciton and Bibliography
6/1/23	Model Results
6/8/23	Written Report
6/8/23	Presentations

A note on our current circumstance

We are all experiencing difficult and unusual times right now. I understand that each of you has your own unique circumstance and that this will affect how you participate in the course this quarter. There will be due dates for homework and lab assignments and sticking to the due dates will help you to keep up to speed in the course and not fall behind. That said, we will not be taking off points for late homework or lab assignments. Please reach out to either Professor Proulx (sproul@ucsb.edu) or Taom Sakal (tsakal@ucsb.edu) if you need to let us know about changes in your circumstances, have concerns about your ability to stay up to speed in the course, or have any other issues we can help with.