BIOL 214H

Mathematics of Evolutionary Processes

An overwhelming proportion of the topics in Evolution and Ecology have a mathematical underpinning, and mathematical models are commonly encountered in the major journals in these fields. In this class, we will use mathematics to better understand some of the most fundamental processes in these areas.

The goal of this class is to make a mathematical approach to these topics as accessible as possible. To accomplish that goal, we will use a number of techniques to remove some of the anxiety that many students experience when dealing with mathematical problems. This will include using an intuitive approach, eliminating time constraints as much as possible, encouraging lots of questions, and offering lots of feedback. The mathematical techniques we use will predominantly consist of algebra, but will also include some calculus and elementary linear algebra and probability. There will be plenty of opportunities for refreshers in class if you have forgotten some of these approaches! We will also go over the biology behind the topics that are discussed. The course is has a large research component, and includes two group projects. I expect the class to be low-stress (though not necessarily a low workload).

The instructor reserves the right to make changes to the syllabus.

Class Meetings:

Tues, Thurs 9:30-10:45
Wilson Hall 213

Prerequisites:

Biol 101 or equivalent
Math 231 or equivalent

Instructor:

Dr. Maria Servedio
Office hours: M 1-2, Th 11-12, in GSB2258
Phone: 843-2692
E-mail: servedio@email.unc.edu

Dr. Servedio has been studying questions in Behavioral Ecology and Evolution since she was an undergraduate (though she completed her undergraduate thesis in a functional morphology lab). In grad school she turned to mathematical models to study mate choice copying, speciation, and the evolution of warning coloration. Her work at UNC has focused on sexual selection and speciation, and the effects of learning on both of these processes.

Grading:

This class is largely problem based and research intensive. It includes two group projects, one that consists of developing and analyzing an original mathematical model.

Homework (6 computer-based assignments):	30%
Group Project 1 (Poster):	20%
Group Project 2 (Research project):	40%
Final Exam:	10%

Homework:

During class you will often be using the program Mathematica to work on problems. These problems will be finished as homework assignments (see *Course Policies*).

You can get Mathematica for free. To order Mathematica go to the website http://software.unc.edu/ and click on "Order Software" on the top bar. Fill in the form, and they will contact you when your order is ready (they say 1-5 days at the beginning of the semester).

Honor code:

Students are encouraged to work together on homework assignments, but must submit an independent write-up. **Students are not allowed to use keys for the homework assignments from previous years.** Violations of this policy will have honor code consequences.

Group Projects:

There are two group projects in this course (groups will consist of 3-4 students).

Group Project 1:

In the first project your group will present a poster interpreting and explaining a mathematical model from the primary literature, which you will pick from among several papers that I will offer as options. For this exercise we will use models of speciation, which incorporate a wide sampling of the microevolutionary processes that you will have learned to model in the class. The posters will be printed in the photoshop and we will have a poster session on 10/17.

To print your poster please bring it on a thumb drive to Brian Nalley in 211 Wilson Hall on Thursday, 10/12, between 8-11:45am or 1-3:30pm. Posters should be 48" wide by 36" tall. PowerPoint, Photoshop or Illustrator are preferred (Illustrator must have embedded images or linked images must be included in the same folder) (a pdf is possible, but you won't be able to make corrections). Please tell him that it will be printed for Biol 214H (there will be no charge).

Group Project 2:

In the second project your group will develop an original mathematical model on the topic of your choice (be creative!). Brief abstracts describing the topics for your project will be due early in the course of the project, and there will be two in-class project workdays, by which point you will be expected to have accomplished certain modeling goals (see Schedule below). During the workdays you will be receiving extensive feedback from me on your projects. Your group project will be presented in two ways, in 1) in-class presentations (11/30 and 12/5) and 2) a written paper (due 12/7).

In this course, you will be working with a Graduate Research Consultant (GRC), Justin Yeh <djyeh@live.unc.edu>, who will assist you with your research project. The GRC Program is sponsored by the Office for Undergraduate Research (www.unc.edu/depts/our). I encourage you to visit this website to see other ways that you might engage in research, scholarship and creative performance while you are at UNC.

Course Policies:

Discussion:

You are expected to be courteous in class discussions at all times. We would like to have a welcoming atmosphere where all are comfortable speaking, regardless of any aspect of their background. Students are entering this class with various degrees of prior knowledge of evolution (some have taken Biol 201 or other evolution classes and some have not) and mathematics. Please keep that in mind.

Homework:

Homework assignments are due on **Tuesdays** at class time (time stamp taken on Sakai). The key for each assignment is posted at the time it is due. Students assign an initial grade to their own homework assignment using the key, and can correct any error (explaining the logic of the correction) to earn back up to half of the missed points, at the discretion of the instructor. The self-graded versions are due on the **Thursday** after the key is posted, at class time (9:30am).

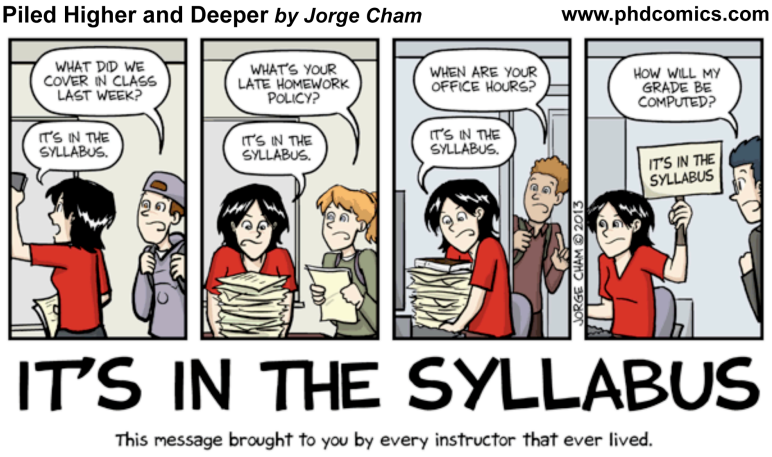
Homework turned in after the key is posted but before the Thursday deadline for the self-graded version will incur a 50% late penalty (students are expected to follow the honor code and not look at the key if they are turning their homework in late). Graded files turned in after the Thursday deadline will not be eligible to earn back points from corrections. Self-assessment grading is meant to be a learning experience, so if you do not turn in your graded version 20% will be taken off of the assignment. If you know that you will need to turn in an assignment late and have a reasonable excuse please contact me for a possible exception to these policies.

Group Projects:

All group members are expected to contribute as equally as possible to the group projects. Each member of the group should submit a brief summary to me describing the participation of each group member to the project. If there is overwhelming consensus that a student is delinquent in participation a penalty may be applied at the discretion of the instructor.

Final Exam:

The final exam will consist largely or wholly of Mathematica-based problem solving of the types that you will have had a lot of experience with in class. It will be open note and open file.



Schedule:

Week	Date	Activity	Reading
1	Tues 8/22	Welcome Pre-course survey Basics of Biological Modeling Basics of Evolution	
	Thurs 8/24	Introduction to Mathematica	
2	Tues 8/29	Natural selection and Equilibria Discuss Orr 2009	Orr 2009
	Thurs 8/31	Natural selection and Equilibria - *Assignment 1* *Due - Initial: Tues 9/5 Self-graded: Thurs 9/7*	
3	Tues 9/5	Natural selection and Stability Discuss Servedio et al 2014	Servedio et al. 2014
	Thurs 9/7	Natural selection and Stability - *Assignment 2* *Due - Initial: Tues 9/12, Self-graded: Thurs 9/14*	
4	Tues 9/12	Natural selection at two-loci - Genotypes begin *Assignment 3*	
	Thurs 9/14	Natural selection at two-loci - continued complete *Assignment 3* *Due - Initial: Tues 9/19, Self-graded: Thurs 9/21*	
5	Tues 9/19	Sexual selection Discuss Kirkpatrick 1982	Kirkpatrick 1982
	Thurs 9/21	Sexual selection - *Assignment 4* *Due - Initial: Tues 9/26, Self-graded: Thurs 9/28*	
6	Tues 9/26	Types of models Discuss Lande 1981	Lande 1981
	Thurs 9/28	Speciation Discuss Futuyma 2002	Futuyma 2002 Turelli et al 2001 (opt)
7	Tues 10/3	Mutation and Migration	
	Thurs 10/5	Poster session workday	
8	Tues 10/10	Natural and sexual selection Discuss Chunco et al 2007	Chunco et al 2007
	Thurs 10/12	UNIVERSITY DAY (no class)	
	Thurs 10/12	***POSTERS DUE TO PHOTOSHOP by 3:30pm***	
9	Tues 10/17	*POSTER SESSION* *Assignment - modeling question - Due 10/24* *Group project - choose groups*	
	Thurs 10/19	FALL BREAK (no class	

10	*any day*	*meet with GRC to check project ideas*	
	Tues 10/24	Modeling exercise	
	Thurs 10/26	Logistic growth - Eco-evo models – *Assign. 5 Due - Initial: Tues 10/31, Self-graded: Thurs 11/2*	
	Fri 10/27	*Group project - abstracts due*	
11	Tues 10/31	Cultural Evolution Discuss Feldman and Laland 1996, Aoki 1984	Feldman & Laland 1996, Aoki 1984
	Thurs 11/2	Project workday 1 - *Initial equations due*	
12	*any day*	*meet with GRC to address project questions*	
	Tues 11/7	Stochasticity	
	Thurs 11/9	Disease model	
13	Tues 11/14	Project workday 2 - *Initial analyses due*	
	Thurs 11/16	Class structure models - *Assignment 6 Due - Initial: Tues 11/21, Self-graded: Tues 11/28*	
14	Tues 11/21	Host-parasitoid model	
	Thurs 11/23	THANKSGIVING BREAK (no class)	
15	Tues 11/28	Probability trees (brood parasitism example)	Servedio & Lande 2003
	Thurs 11/30	*PROJECT PRESENTATIONS (1)*	
16	Tues 12/5	*PROJECT PRESENTATIONS (2)* Post-class survey	
	Thurs 12/7	*PROJECT PAPERS DUE 9:30AM* (no class)	
	Tues 12/12	Final exam (open notes and files - bring MMA)	