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 or not previously been exposed to 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 in Coker 404
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.

Research and Discovery:

In a research and discovery course, students immerse themselves in a research project and experience the reflection and revision involved in producing and disseminating original scholarship or creative works. Please think about the following questions and learning outcomes as you participate in the course.

Questions for Students

1. How do I establish my point of view, take intellectual risks, and begin producing original scholarship or creative works?
2. How do I narrow my topic, critique current scholarship, and gather evidence in systematic and responsible ways?
3. How do I evaluate my findings and communicate my conclusions?

Learning Outcomes

1. Frame a topic, develop an original research question or creative goal, and establish a point of view, creative approach, or hypothesis.
2. Obtain a procedural understanding of how conclusions can be reached in a field and gather appropriate evidence.
3. Evaluate the quality of the arguments and/or evidence in support of the emerging product.
4. Communicate findings in a clear and compelling ways.
5. Critique and identify the limits of the conclusions of the project and generate ideas for future work.

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):	50%

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 https://sa.unc.edu/shop and log in using your Onyen. Fill in the form, and the software should be available by download.

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 3/5.

To print your poster please bring it on a thumb drive to Brian Nalley in 211 Wilson Hall on Monday 3/2, 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 (4/21 and 4/23) and 2) a written paper (due 4/27).

In this research-exposure course, you will be working with a Graduate Research Consultant (GRC), Brian Lerch <blerch@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.

Finally, students will receive extra credit for if they present their project as a poster at the QEP Office of Undergraduate Research's Celebration of Research, from 2-5pm on Wed, April 22 in the Blue Zone, Kenan Memorial Stadium. More details to follow.

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.

Schedule:

Week	Date	Activity	Reading
1	Thurs 1/9	Welcome Pre-course survey Basics of Biological Modeling Basics of Evolution	
2	Tues 1/14	Probability Trees	Servedio & Lande 2003 (excerpt)
	Thurs 1/16	Introduction to *Mathematica*	
3	Tues 1/21	Natural selection and Equilibria Discuss Orr 2009	Orr 2009
	Thurs 1/23	Natural selection and Equilibria - *Assignment 1* *Due - Initial: Tues 1/28 Self-graded: Thurs 1/30*	
4	Tues 1/28	Natural selection and Stability Discuss Servedio et al 2014	Servedio et al. 2014
	Thurs 1/30	Natural selection and Stability - *Assignment 2* *Due - Initial: Tues 2/4, Self-graded: Thurs 2/6*	
5	Tues 2/4	Natural selection at two-loci - Genotypes begin *Assignment 3*	
	Thurs 2/6	Natural selection at two-loci - continued complete *Assignment 3* *Due - Initial: Tues 2/11, Self-graded: Thurs 2/13*	
6	Tues 2/11	Sexual selection Discuss Kirkpatrick 1982	Kirkpatrick 1982
	Thurs 2/13	Sexual selection - *Assignment 4* *Due - Initial: Tues 2/18, Self-graded: Thurs 2/20*	
7	Tues 2/18	Types of models Discuss Lande 1981	Lande 1981
	Thurs 2/20	Speciation Discuss Futuyma 2002	Futuyma 2002 Turelli et al 2001 (latter optional)
8	Tues 2/25	Mutation and Migration	
	Thurs 2/27	Poster session workday	
	MON 3/2	***POSTERS DUE TO PHOTOSHOP by 3:30pm***	
9	Tues 3/3	Natural and sexual selection Discuss Chunco et al 2007	Chunco et al 2007
	Thurs 3/5	*POSTER SESSION* *Assignment - modeling question - Due 3/17* *Group project - choose groups*	

	Spring Break		
10	*any day*	*meet with GRC to check project ideas*	
	Tues 3/17	Modeling exercise	
	Thurs 3/19	Logistic growth - Eco-evo models – *Assign. 5 Due - Initial: Tues 3/24, Self-graded: Thurs 3/26*	
	Fri 3/20	*Group project - abstracts due 5pm by email*	
11	Tues 3/24	Stochasticity	
	Thurs 3/26	Project workday 1 - *Initial equations due*	
12	*any day*	*meet with GRC to address project questions*	
	Tues 3/31	Cultural Evolution Discuss Feldman and Laland 1996, Aoki 1984	Feldman & Laland 1996, Aoki 1984
	Thurs 4/2	Disease model	
13	Tues 4/7	Project workday 2 - *Initial analyses due*	
	Thurs 4/9	Class structure models - *Assignment 6 Due - Initial: Tues 4/13, Self-graded: Tues 4/16*	
14	Tues 4/13	Host-parasitoid model	
	Thurs 4/16	Guest lecture – Brian Lerch	TBA
15	Tues 4/21	*PROJECT PRESENTATIONS (1)*	
	Wed 4/22	QEP Expo 2-5pm, Kenan Memorial Stadium	
	Thurs 4/23	*PROJECT PRESENTATIONS (2)*	
	Mon 4/27	*PROJECT PAPERS DUE 5pm* (no class)