Biology 504: Modeling Evolutionary Dynamics

Instructors:

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The goal of this course is to familiarize you with the basic analytical and numerical techniques necessary for developing and analyzing your own models of evolutionary processes.

Lectures and Homework
The first five weeks of the course will consist of interactive lectures where models of specific evolutionary processes are developed and analyzed using *Mathematica*. At the end of each lecture, a specific analysis of the model developed in lecture will be assigned as homework and "due" the next class period. Randomly selected students (2-3) will start the next lecture by presenting their analysis of the homework.

Final Mathematica Notebook
The remainder of the semester will be used for the development and analysis of student models. Students can work as individuals or as groups of any size. The only requirement is a shared interest in a particular evolutionary question. Instructors will be available by appointment throughout the remainder of the semester to work with students on their modeling and analysis. We strongly recommend meeting with one of the instructors at least every other week to make sure you are on the right track. The minimum level of interaction is to turn in a draft notebook by April 13 for the instructors to evaluate and make suggestions/corrections. The final notebook is due April 27, and should include the following sections: 1) Introduction to the problem and why we should care; 2) Thorough discussion of model assumptions; 3) Table of parameters/variables and their biological definitions; 3) Derivation of dynamical equations showing all steps; 4) Analysis of dynamical equations; 5) Biological interpretation of mathematical results; 6) Discussion of biological implications/relevance of mathematical results; 7) References.

Week 1

Organizational meeting

Week 2

Lecture 1: Philosophy of modeling

Lecture 2: Single locus models: introduction to *Mathematica*, finding equilibria, local stability analyses, and weak selection approximations

→ Homework: analyze single locus model with intraspecific competition/facilitation

Week 3

Lecture 1: Single trait quantitative genetics (QG) models: assumptions, two different approaches approximation, and abstract integration.
→ Homework: analyze the single trait QG model under stabilizing selection

Lecture 2: Two trait quantitative genetics models: assumptions, approximating fitness functions, and abstract integration.
→ Homework: analyze the two trait QG model under stabilizing selection

Week 4

Lecture 1: Two locus population genetic models and quasi-linkage equilibrium (QLE) approximation
→Homework: analyze two loci under stabilizing selection.

Lecture 2: Modifier models and QLE approximation
→Homework: when would a modifier of dominance spread?

Week 5

Lecture 1: Spatial Structure: single locus and single trait models
→Homework: how much genetic variation is maintained?

Lecture 2: Multi-locus models: moment based approaches (intra-specific competition) and QLE approximations
→ Homework: intraspecific competition

Week 6

Lecture 1: Students choice or overflow

Lecture 2: Students choice or overflow

Weeks 7-14

Working on independent or group projects.

Important Deadlines:

March 2: Topics and Groups due
April 13: Draft *Mathematica* notebooks due
April 27: Final *Mathematica* notebooks due

Grading:

Homework: 50%
Final *Mathematica* notebook 50%