Fundamental mathematical models in evolution

Credit points: 7.5 ECTS

Start date: April 12th

Level: PhD

Grading scale: Pass/Fail

Teacher: Eric Libby

Description

Evolutionary biology is home to a broad diversity of mathematical models and techniques. For those new to modeling biological systems it can be challenging to identify what models are available and which are appropriate to particular scenarios. The purpose of this course is to provide a broad survey of well-known mathematical models in evolution, i.e. the "usual suspects". Emphasis is placed on understanding the basic formulation of each model, its underlying assumptions, its key results, and possible extensions.

Below are a sample of the topics the course will likely cover.

- The price equation, as a statistical theorem of evolutionary change
- The prisoner's dilemma and evolutionary game theory
- Conway's game of life and cellular automata models
- Wright-Fisher and Kimura models for genetic drift
- Moran model for fixation probability of mutations, and evolutionary graph theory
- Hamilton's rule in social evolution
- Error threshold and information theory
- Kauffman's NK model and boolean networks

Depending on the interests/backgrounds of the participating students, we may cover additional topics including multi-level selection, Markov chains, adaptive dynamics, branching processes, phylogenetic tree construction, trait group models, etc.

Prerequisites

This course is inherently interdisciplinary and its intended audience is PhD students from mathematical and computational sciences as well as those from evolution and/or ecology. The main prerequisite is some comfort and familiarity with early university mathematics, especially calculus. Also some familiarity with computer programming can be beneficial.

Course structure and examination

The course is likely to be offered online with meetings over Zoom or a similar video conferencing application. The precise structure will depend in part on the number and academic background of the students. Generally, there will be introductions provided to each topic with some relevant papers for reading. Students will have the opportunity to engage with the models and explore their potential. Examination will be based primarily on projects and include presentations of models with scientific/critical analyses. It is hoped that a diverse group of students will participate to share expertise and facilitate understanding.