Basic Population Genetics

Abstract

An essential question in the study of evolutionary ecology is how the "genetic structure" of a population varies through time, and what sorts of forces influence it. In this project we will create mathematical models to explore the dynamics of gene frequencies in a population for a single locus with two alleles. Our goal will be to observe forces on genetic structure (natural selection, recurrent mutation, and genetic drift), and explore how population size, gene dominance, selective strength, and other factors impact our predicted long term gene frequencies.

Prerequisites

- MTH 309 (Linear Algebra) and MTH 306 (Differential Equations) are strongly recommended
- MTH 446 (Stochastic Processes) would be helpful but is not necessary
- Programming experience with Python is recommended but not necessary

References

Theory of Population Genetics and Evolutionary Ecology: An Introduction – Joan Roughgarden

Population Genetics – W.J. Ewens

Tentative Schedule

Week 1: Gene frequencies and the Hardy-Weinberg Law

Week 2: Selection coefficients and selection against dominant and recessive alleles

Week 3: Heterozygotic superiority/inferiority and steady polymorphic states

Week 4: One-way recurrent mutation vs natural selection

Week 5: Adaptive topographies

Week 6: Sampling error and transition probability matrices

Week 7/8: Wright's model and genetic drift's impact on genetic variation

Week 9/10: Diffusion as an approximation for stochastic processes and equilibrium gene frequencies with the presence of selection, mutation, and drift