Syllabus: Population Genetics (BIOL 694)

September 4, 2009

1 Instructor contact information

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Office hour: any time but please drop me an e-mail before you come
E-mail is the best way to contact me.

2 Meeting time and place

MWF, 10:30-11:30AM, Irving I Rm 208
3 credits

3 Course Description

This course is designed to familiarize you with the field of population genetics, the branch of evolutionary biology concerned with the genetic structure of populations and how it changes through time. Population genetics is the backbone of evolutionary biology because changes in the genetic composition of a population are the basis for the most of other evolutionary changes.

Population genetics abstracts evolutionary phenomena to enlighten the processes of evolution. Mathematics is a good way to abstract a problem, and formalize logical arguments. Consequently, population genetics involves a fair amount of mathematics. At times, I will get into the nitty-gritty details of derivations of equations and mathematical tools needed for them. Working with basic mathematical tools in the class should help you to understand the other theoretical papers you read for your own research. But the good news is that the mathematical techniques are relatively simple (algebra, linear algebra, calculus, and probability theory). Those willing to spend some time learning these techniques can be rewarded with a clearer understanding of the “principles” of evolutionary processes.

Knowledge of mathematics is helpful, but only basic algebra and calculus is needed to take this course. Students who are scared of mathematics should come to see me frequently throughout the semester, and
I will help to remove your math-phobia as long as you are determined to learn. It may not be an easy course, but I promise that it is POSSIBLE to learn the basic theoretical population genetics.

4 Approximate weekly schedules

Week 1. Foundations
- Introduction to Population Genetics, elements of population genetics.
- Genetic variation.
- Characterization of DNA sequence variations
- Algebra of Probabilities.

Week 2. Genetic Drift
- Algebra of Probabilities continued
- Wright-Fisher model
- Mutation-Drift balance

Week 3-4. Coalescent theory
- Basic Coalescent Process
- Tajima’s D
- Coancestry coefficient and moment generating function
- Migration

Week 5. Population substructure
- F statistics. migration
- Hierarchical F, derived from coalescent theory
- AMOVA
- Likelihood, Bayesian statistics
- Bayesian Clustering

Week 6-8. Selection
- Fitness, modes of selection, one-locus selection models
- Mean Population Fitness
- drift-selection balance
- Balancing selection
- Average excess and effects
- Fisher’s fundamental theorem
- Genetic Load
- Adaptive Landscape
- Shifting-Balance Theory

Week 9. Inbreeding depression and mating systems
- Evolution of selfing rate
- Modifier models
- Breeding system evolution - Game Theory
Week 10. Evolution of Sex

Week 11. Multi-locus evolution
- Linkage and recombination
- Evolution of recombinations
- Epistasis

Week 12-13. Statistical Phylogeography - Approximate Bayesian Computation - msBayes

Thanks-giving

Week 14-15. Advanced topics

5 Course readings/materials

No textbook is required. Recent research papers will be provided and required to read. We’ll read approximately 1-2 papers per every two weeks and discuss them in details.

But here are a couple of standard textbooks used for a graduate-level population genetics course. No need to get these for my course, but they may be useful for your future references:


6 Course goals

Students will learn basic mathematical skills to understand theoretical population genetics. After the completion of the course, students should feel comfortable in understanding theoretical research papers in modern population genetics.
7 Instructional methods

Students will learn through lecture, reading, and group discussion.

8 Course policies

You are expected to attend lectures and participate in discussion. You are expected to arrive at lecture on time.

9 Requirements

All students will be required to do weekly readings and homework assignments. I encourage students to work on the homework assignments together. You are likely to “feel” the real meanings of concepts or techniques by exchanging different ways of interpreting them with your colleagues. Additionally, part of the grade is based on two take-home exams.

10 Evaluation/Grading

Student performance will be evaluated with the following factors

15% homework assignments
15% participation to group discussion
35% Mid-term exam
35% Final exam

Midterm exam questions will be handed out Week 7 (Oct 24 Fri), and due Week 8 (Oct 28, Wed 10:30 AM before the class). Final exam questions will be handed out Week 14 (Dec 9, Wed), and due Week 15 (Dec 14, Mon. 10:30 AM before the class).

11 Support Services

If you require more assistance than can be provided in class, lab and office hours, you may want to contact Student Support Services (http://www.uaf.edu/sssp/).

12 Disability Services

If you have a disability, or think you may have a disability, please contact the Office of Disabilities Services (203 WHIT, 474-7043). We will work with this office to provide reasonable and appropriate accommodation to students with disabilities.