Syllabus
Phylogenetics
BI 456/556

Location: TR 1000-1150 in CORDLEY 1070.

Course Credits: 4 credits. The course will consist of two, two-hour interactive sessions each week, which will consist of lectures, individual exercises, and group tasks that reinforce the learning outcomes.

Course Description: Explores the theory and practice of modern phylogenetic analysis. Emphasis placed on tree reconstruction algorithms, assessment of statistical support, and contemporary issues in phylogenetics. Lab will focus on the use of phylogenetic software and the analysis of molecular data sets.

Prerequisites, Co-requisites and Enforced Prerequisites: (((ST 351 or 351H) and 352) or ((351 or 351H) and 411)) and ((BI 311 or BI 311H) or BI 445)

Course Content

In this course you will learn the concepts and methods of modern phylogenetics. You will learn “tree-thinking”, and the importance of understanding the shape of the evolutionary Tree of Life. The branching pattern of the tree is the roadmap of life, as the similarities and differences of living organisms and how they came to be can only be fully understood through knowledge of the tree’s shape; phylogeny is thus vital for any research in comparative biology.

The first part of the course will focus on phylogeny inference using basic likelihood, Bayesian, and parsimony methods, as well as more recently developed methods such as SVDQuartets. The remainder will cover analysis of gene trees and species trees, an introduction to phylogenomics, dating of divergence events, patterns and processes of character evolution, and hypothesis testing, among other topics. Although no particular mathematics knowledge other than the most basic probability theory is required for this course, many of the topics require the ability to think clearly in abstract concepts.

In addition to gaining general knowledge about the theory of phylogenetics, you will also gain working knowledge of some of the more popular software packages. It is thus both a theoretical and practical course.

Course Specific Measurable Student Learning Outcomes

In successfully completing in this course, the student will be able to
1. Describe and illustrate the nature of a phylogenetic tree and the diagrams we use to represent them
2. Discuss contexts in comparative biology in which knowledge of the phylogenetic tree is important
3. Compare and mentally manipulate trees, and calculate various statistics about them
4. Explain distinction between gene trees and species trees, and the sources of discord between them
5. Evaluate methods of phylogenetic inference, including their strengths and weaknesses
6. Describe and evaluate methods to analyze data using the phylogeny, such as analyses of character evolution
7. Create and perform statistical tests of hypotheses
8. Use modern phylogenetic software tools

In addition to the outcomes above, BOT/Z556 students will also:
1. Critically evaluate the literature in empirical phylogenetics
2. Synthesize results from primary literature in phylogenetic theory in order to make decisions about analytical methods that are appropriate in research
Evaluation of Student Performance

**Weekly Exercises:** There will be weekly exercises throughout the term. These will consist of a mixture of exercises to do by hand, and those to do using phylogenetic software.

**Analysis Projects:** There will be two analysis projects during the term. For these, you will be given data, and your goal will be to infer specified things. The first project will focus on inferring phylogeny. The second project will involve both inferring the phylogeny as well as some other aspect of evolution, such as some aspect of correlated character evolution.

**Midterm exam:** A midterm exam will cover the material covered to date, including concepts learned in using the software and reading literature.

**Final exam:** A comprehensive final exam will cover all aspects of the course, including all learning outcomes.

**Term Project:** Students taking BOT/Z556 will be required to complete a term project that covers an aspect of phylogenetic biology. The topic is subject to approval by the instructor. The project can be a term paper on some subject in phylogenetics, including a review of a conceptual issue. It could instead be a thorough reanalysis of data from the literature. The term paper must be *single-spaced*, and be 5-8 pages, not including figures, tables, and references. Alternatively, the project could be some piece of software you create during the term that does a phylogenetic analysis; again, the topic is subject to approval by the instructor. If you design some software, then a report (3-6 single-spaced pages) documenting the tool, and its options, as well as providing an example of its use, should be submitted along with the tool and source code. The written part of your project should be in the form of a scientific paper, with proper Introduction, Methods, Results, Discussion, and References. The style of writing should befit a scientific paper that could appear in the journal. Please number the pages. Provide a PDF version of your report consisting of a single file. In addition, if you did any analyses, please turn in all electronic files generated during your analyses. Each BOT/Z556 student will be required to give a 5-minute lightning talk summarizing their project at the end of term, which will count for 20% of the term project grade.

**Marks will be distributed among assignments as follows:**

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<th>BOT/Z 456 points</th>
<th>BOT/Z 556 points</th>
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<tbody>
<tr>
<td>Weekly Exercises</td>
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<td>10</td>
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<td>First analysis</td>
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<tr>
<td>Second Analysis</td>
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<tr>
<td>Midterm</td>
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<td>15</td>
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<td>Final exam</td>
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<td>Term Project</td>
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Marks will be taken off for late assignments, at a rate of 5% of that assignment's total possible value per day. Grades will be assigned using the standard A 90-100%, B 80-89.9%, C 70-79.9%, D 60-69.9%, F <60%.

**Learning resources**

A primer (a short book) of phylogenetic biology will be handed out in class, which will be required reading. In addition, although not required, students may wish to acquire a copy of the book “Tree Thinking”, by Baum and Smith, as this is a very good introduction to the subject.
Course requirements

Laptop computers: Students are required to bring a laptop computer to each session. This laptop will need to be a relatively modern laptop, with the capability of running the relevant phylogenetics software, including Mesquite, MrBayes, PAUP*, RAxML, among others. It should run either Windows 7 or later, MacOS X 10.8 or later, or a modern Linux variant. You will need to be able to install software on this computer; thus, you will need "administrator" access. When you come to class, please make sure the battery is fully charged or that you have a power adapter.

E-mail: Please check email regularly regarding the course, especially before class.

Asking questions: In this class, students should ask questions when they are uncertain about something. Email is an excellent way to ask. There are no questions that are silly questions: any confusions you might have about the material are important to clarify; some of the material is difficult conceptually and you should be asking questions about it.

If you are concerned about your progress in the class, please come and talk to the instructor. People differ in how they learn best, and sometimes it helps to talk things over to see if alternative strategies would work better.

Classroom Behavior: The classroom should be a place of dignity, civility and respect. At OSU, a number of behaviors, such as reading the paper and always being late for class, are considered disruptive behaviors. For the sake of all students taking the class, talking during lectures should be kept to a bare minimum, cell phones and pagers should be turned off before entering the classroom. See: http://studentlife.oregonstate.edu/studentconduct/disruptive-behavior

Ethical Behavior: Students are expected to be honest and ethical in their academic work. Academic dishonesty, such as cheating or plagiarism, will not be tolerated and students will be subject to disciplinary processes outlined in the Student Conduct Regulations: http://oregonstate.edu/studentconduct/offenses-0

Students with Disabilities: Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval please contact DAS immediately at 541-737-4098 or at http://ds.oregonstate.edu. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

Diversity Statement: The College of Health and Human Sciences strives to create an affirming climate for all students including underrepresented and marginalized individuals and groups. Diversity encompasses differences in age, color, ethnicity, national origin, gender, physical or mental ability, religion, socioeconomic background, veteran status, sexual orientation, and marginalized groups. We believe diversity is the synergy, connection, acceptance, and mutual learning fostered by the interaction of different human characteristics.

Religious Holiday Statement: Oregon State University strives to respect all religious practices. If you have religious holidays that are in conflict with any of the requirements of this class, please see me immediately so that we can make alternative arrangements.