SYSTEMATICS

Class Meeting Times: Mon & Thu 12:30 AM – 1:50 PM

Instructors

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Office Location

TBD

Brief Summary of Systematics

The biodiversity of Earth consists of a wide variety of organisms. How do we quantify this biodiversity in a way that makes sense using evolutionary theory? How do we hierarchically categorize life? These are the backbone questions we will target in *Systematics*, which is loosely defined here as quantifying and qualifying Earth's biodiversity. In this course, we will review the history of the field of systematics and explore phylogenetic methods. Using a comparative approach of multiple organismal systems (e.g., reptiles, amphibians, mammals, birds, fish, and many invertebrates), you will identify how we categorize life using evolutionary thinking (or 'tree-thinking'). Using the phylogenetic background that students will learn in the first portion of the class, individual and group exercises will subsequently be used to teach students coding skills and evolutionary analysis. Students are strongly encouraged to use their own data from their current research, but empirical datasets from published studies will be used as well. Students will finish this course with an increased understanding of evolutionary theory (systematics, phylogenetics, taxonomy), and a suite of tangible skills like coding in multiple computer languages.

Course Objectives.

This course will teach students concepts in the evolutionary subdiscipline of systematics. Course sessions will involve a combination of PowerPoint lectures, quizzes, and evolutionary analysis exercises that serve to teach topics and methods in phylogenetics. Students will also have the opportunity to work with their own data and investigate patterns that pertain to research questions of interest. The main objectives of this course are to:

(i) Learn how the field of systematics has evolved in theory and practice.

(ii) Gain coding skills that specifically cater to evolutionary and phylogenetic analysis.

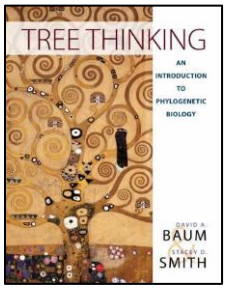
(iii) Obtain a deep understanding of evolutionary theory and practice for one's own research.

Section Objectives.
Weekly sessions will serve to:

(i) Have students understand a new key topic or analysis in systematics.

(ii) Learn a new computer skill and a new phylogenetic analysis that emphasizes the weekly topic.

(ii) Have engaging group discussions pertaining to primary literature and the respective systematics of different organismal groups.



Textbook. There is no mandatory textbook for this course, but the book Tree Thinking by David A. Baum and Stacey D. Smith is an excellent introduction to phylogenetics, and includes explanations for many topics and analyses you will see in this course.

Grading. This course will be graded through a combination of participation and attendance (20%) and the completion of course projects (80%). Note, the course will involve weekly discussions of primary literature, in which everyone is expected to participate. Projects that involve phylogenetic analysis will have individual and group-based components. I will administer worksheets to assess your understanding of course material or students will show my phylogenetic results based off analysis tutorials that I will provide. The focus of this course is to use phylogenetics to answer questions in evolutionary biology. I will guide students how to use computer code to a level that is required in this course. We are here to learn, together.

1) 20% participation and attendance
2) 80% course assignments
- a) 60% phylogenetic analysis assignments
- b) 10% worksheets reviewing key topics (5–10 questions)
- c) 10% brief, written summaries of primary literature through class discussions (group-based)

Lecture Attendance (20%): Students are strongly encouraged to attend lecture. While phylogenetic analyses can be done at home and on the computer, classes will, in part, be spent explaining systematics and evolutionary theory. While students can read about these concepts at home, the coding we will do are niche software that can be difficult to run on your system. Coding should never be done on your own or any computer system without the knowledge of what code does, as this can risk the functioning of your own computer(s).

Phylogenetic assignments (60%) – This course will heavily focus on methods used in the discipline of systematics. Students will learn the theory of a variety of methods, such as Bayesian Inference and Maximum Likelihood (to name a few), before learning how to perform these methods with their own data or provided datasets. The purpose of these assignments is to demonstrate you have obtained an understanding of what these methods do, and when they are appropriate to use based on the respective study or research question.

Weekly worksheets reviewing key topics (10%) – In addition to the phylogenetic analysis assignments, students will be given a weekly worksheet towards the end of the week. These will review concepts in evolutionary biology, with an emphasis on systematics, or definitions in computer science/bioinformatics. The goal of these worksheets is to make sure students are understanding the weekly topics and are prepared for the subsequent week's work.

Written primary literature review and class discussions (10%) – While students will learn new topics, definitions, and methods in class, it is important to know how to search and understand primary literature. I will provide scientific publications for students to read, or students will find research papers of their choosing that pertains to the week's topic. I expect all students to write a ***brief*** (1–2 paragraphs) summary of this paper. Each week, two students will, together, present the paper to the class for group discussion. The students that present on a given week must also ***lead*** the class and keep the group engaged in discussion. These will be graded as a group (student pairs), and groups will do this twice in the semester. The groups will change between the first and second presentation so to ensure students are learning with new classmates each time.

Assignment Submission Policy. Assignments will be turned in on given dates for phylogenetic methods exercises. For these assignments, 1–2 weeks (depending on the analysis) will be given to complete the activity, which is enough time for students to ask questions during class time or office hours. Points will be deducted per late day for these assignments. Weekly review worksheets will be done during class time and handed in at the end of class. Group-based discussions summaries will be given 1 week to complete after the discussion, but groups and presentation days will be decided on the first week of class to provide ample preparation time. I understand that students may require extension times or there may be unexpected illnesses or emergences that affect the submission of assignments. In these cases, please contact the Office of the Dean of Students (URL). To ensure student privacy and confidentiality, if you require resources and extensions due to personal reasons, please contact the Office of the Dean of Students, and let me know you have done so. You need not provide me any information other than that you contacted the Office of the Dean of Students. This office is located on (Location), and can be contacted at (Phone Number).

Students with Documented Disabilities

Students that may need academic accommodations based on disability impacts must reach out to the Disability Services office of (Institution) (URL). This will allow me to obtain the pertinent level of information from the university to provide these accommodations for you. This office is located at (Location), and can be reached at (Email) or (Phone Number).

Course Conduct and Community Learning

The overarching goal of this course is to work together to enhance our understanding of biological concepts and learn new skills. The key here is that we will be learning together, even through individual exercises. I encourage students to be themselves and be comfortable in class, and I have an expectation that all will maintain courtesy and respect for your fellow classmates and all other individuals. All students are required to follow the principles and guidelines of (Institution)'s Student Conduct (URL). By communicating with one another, respecting one another, and learning with one another, this course will progress through the semester in fun and collaborative ways!

Course Schedule:

Date	Day	Topic	Type
8/19	Tuesday	Systematics Course Introduction and Syllabus	Group
8/21	Thursday	What is Systematics and Phylogenetics?	Individual
8/26	Tuesday	The History of Systematics and Phylogenetics – Part I	Individual
8/28	Thursday	The History of Systematics and Phylogenetics – Part II	Individual
9/2	Tuesday	Tree Thinking: How do we read phylogenies? – Part I	Individual

9/4	Thursday	Tree Thinking: How do we read phylogenies? – Part II	Individual
9/9	Tuesday	Species Concepts – Part I	Individual
9/11	Thursday	Introduction to Computer Hierarchy	Individual
9/16	Tuesday	Bash Coding for Beginners	Individual
9/19	Thursday	R Coding for Beginners	Individual
9/23	Tuesday	Phylogenetics Analysis: Maximum Parsimony	Group
9/25	Thursday	Phylogenetics Analysis: Maximum Likelihood	Group
9/30	Tuesday	Phylogenetics Analysis: Bayesian Inference	Group
10/2	Thursday	Divergence Dating and Calibrations – Part I	Individual
10/7	Tuesday	Divergence Dating and Calibrations – Part I	Individual
10/9	Thursday	Divergence Dating and Calibrations – Part III	Group

10/14	Tuesday	Species Trees and Gene Trees – Part I	Individual
10/16	Thursday	Species Trees and Gene Trees – Part II	Individual
10/21	Tuesday	Estimating Species Trees – Part I	Individual
10/23	Thursday	Estimating Species Trees – Part II	Group
10/28	Tuesday	Phylogeography: Biogeographic Interpretations with Phylogenies – Part I	Individual
10/30	Thursday	Phylogeography: Biogeographic Interpretations with Phylogenies – Part II	Individual
11/4	Tuesday	Estimating Evolutionary Rates	Group
11/6	Thursday	Ancestral State Reconstructions	Group
11/11	Tuesday	Estimating Migration Rates – Part I	Individual
11/13	Thursday	Estimating Migration Rates – Part II	Individual

11/18	Tuesday	Population Demographic Models – Part I	Group
11/20	Thursday	Population Demographic Models – Part II	Group
11/25	Tuesday	Phylogenetics vs. Phylogenomics – Part I	Group
11/27	Thursday	Phylogenetics vs. Phylogenomics – Part II	Group
12/2	Tuesday	Open Class for Analysis Using Thesis/Dissertation Data (or published data)	Individual
12/4	Thursday	Open Class for Analysis Using Thesis/Dissertation Data (or published data)	Individual
12/9	Tuesday	Open Class for Analysis Using Thesis/Dissertation Data (or published data)	Individual
12/11	Thursday	Open Class for Analysis Using Thesis/Dissertation Data (or published data)	Individual