SIO147-Applications in Phylogenetics: 6 units Winter 2023: Mon. & Wed. Eckart Computer Lab 225 Lecture: 0900-1020 am; Lab: 1030-1430 pm Course Instructor: Greg Rouse: <u>grouse@ucsd.edu</u> Office hour Friday 1430-1530; Zoom schedule via email Teaching Assistants: Avery Hiley: <u>ahiley@ucsd.edu</u>; Office hour TBA; Schedule via Zoom Kiirah Green: <u>k4green@ucsd.edu</u> (Class time only)

I think



This course will review some of the tremendous variety of methods for constructing phylogenetic trees using morphological and molecular data. The various options are outlined and critically examined, along with relevant software. There will be a lectures on a series of relevant topics followed by practical classes where both morphological and molecular data will be explored through a series of exercises. The uses of the resulting phylogenetic trees (e.g., evolutionary and ecological transformations, biodiversity measurements, biogeography, systematics and taxonomy) are further examined through an independent project. A presentation, as a talk, and a short write-up of the project are required in the last week of class.

There is no textbook. Reading will be assigned as needed. If you want to do some background reading, have a look at the free electronic resource through the UCSD library: E.O. Wiley & Bruce S. Lieberman 2011. Phylogenetics: theory and practice of phylogenetics systematics. 2nd edition http://roger.ucsd.edu/record=b7094662~S9

Assessment

Midterm exam in Week 5 = 10%; there will be a short 'practice' (no marks) quiz in week 4 to familiarize students with exam question style and content.

Project (~5 page max.= 30%); presentation (=10%) = 40%.

Final exam = 50%. Two sections, theory (20%) and practical (30%). You my use your lab notes for the practical section. March 22: 8-11 am.

The project writeup is due Friday March 17 (end of week 10).

"Academic Integrity is expected of everyone at UC San Diego. This means that you must be honest, fair, responsible, respectful, and trustworthy in all of your actions. Lying, cheating or any other forms of dishonesty will not be tolerated because they undermine learning and the University's ability to certify students' knowledge and abilities. Thus, any attempt to get, or help another get, a grade by cheating, lying or dishonesty will be reported to the Academic Integrity Office and will result sanctions. Sanctions can include an F in this class and suspension or dismissal from the University. So, think carefully before you act by asking yourself: a) is what I'm about to do or submit for credit an honest, fair, respectful, responsible & trustworthy representation of my knowledge and abilities at this time and, b) would my instructor approve of my action? You are ultimately the only person responsible for your behavior. So, if you are unsure, don't ask a friend—ask your instructor, instructional assistant, or the Academic Integrity Office. You can learn more about academic integrity at <u>academicintegrity.ucsd.edu</u>"

Lectures

Week 1.

January 9 Introduction to systematics, tree-thinking, basic terminology. January 11 Morphology, characters and parsimony analysis, similarity and homologystatements, basic tree calculations, tree rooting.

Week 2.

January 16 Martin Luther King, Jr. Holiday January 18 Parsimony, tree searching, multiple equally parsimonious trees & consensus.

Week 3.

January 23 Assessing support for trees; bootstrap, jackknife. Character coding. Transformations, AccTran, DelTran.January 25 Molecular sequence data 1. Alignment, Clustal Muscle, MAFFT

Week 4.

January 30 Molecular Sequence Data 2. Alternatives to Parsimony: Distance methods, Models and Maximum Likelihood.

February 1 Molecular sequence data 3. Bayesian methods. (Practice quiz)

Week 5.

February 6 Combining data; causes and issues with incongruence **February 8** Hypothesis testing (and Midterm Quiz =10%).

Week 6.

February 13 The comparative method and phylogenetic trees. **February 15** Historical biogeography

Week 7.

February 20 Presidents' Day Holiday.February 22 Phylogeography.

Week 8.February 27 Fossils, molecular clocks and dating on trees.March 1 Key innovations/diversification rates/cospeciation.

Week 9. March 6 Species and DNA barcoding. March 8 Biodiversity

Week 10. March 13 Uses of Phylogenetics March 15 Presentations

Practicals

Week 1

January 9. Parsimony analysis. Hand exercises using Caminalacules & Parrots;Taxonomy exercises involving trees.

January 11. Introduction to PAUP* and Mesquite. Data entry, Nexus format, Tree manipulation, Character tracing. Executing files, Managing data (include exclude taxa, characters, annotations footnotes and images). Defining assumptions, Searching for trees. Describing trees, Searching methods under parsimony, Saving trees. Rooting trees. Vertebrates, Parrots.

Week 2

January 16. Martin Luther King, Jr. Holiday

January 18. Continue using PAUP, Mesquite & FigTree to become familiar with the programs. Tree Searching, Consensus trees and Tree support methods; Bootstrap and Jackknife analysis; Beardworms and Ventworms, Vertebrates, Parrots.

Week 3

January 23. Tracing the history of character evolution. Cirratuliform worms; Sharks and Rays. Fruit forms and habitats; Spiders mutilation and cannibalism.

January 25. Molecular data 1. Basic Alignment and Parsimony Analysis. GenBank. Using MUSCLE and MAAFT in Mesquite. Species exercise.What is the status of the Polar bear?

Week 4

January 30. Molecular data 2. Distance and Neighbor-Joining. Incorporating models of molecular evolution into datasets. Maximum Likelihood in RaXML-NG. Long branch attraction. Ursidae; Strepsiptera.

February 1. (Practice quiz) Phylogenetic analysis of molecular data 3. MP and Likelihood (Anglerfish) and then Bayesian Statistical approaches to tree building; jModelTest and Bayesian approaches (MrBayes). Primates.

Week 5

February 6. Review of methods to date. Giant clams.

February 8. Midterm Exam for 10%. Combining Data and Hypothesis testing. Featherworms.

Week 6

February 13. Comparative method and trees exercises. Correlated evolution revisited.

Syngnathidae and Sea dragons.

February 15. Integrating geography & DNA I: Historical biogeography Crayfish and Iguanas.

Week 7

February 20. Presidents' Day Holiday

February 22. Integrating geography and & DNA II: Phylogeography. Sea slugs, featherstars, seastars.

Week 8

February 27. Molecular clocks and divergence times (Primates and boneworms). March 1. Diversification rates (Conus), and cospeciation.

Week 9

March 6. Revise methods session: Penguins/ Start Individual projects. March 8. Individual projects and consultation with Greg, Avery and Kiirah.

Week 10

March 13. Individual projects and consultation with Greg, Avery and Kiirah. March 15. Presentations: ~10 minutes each.



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