BIOL 697 Special Topics in Biological Data Analysis: Meta-Analysis

Weekly Schedule: Wednesdays from 1-4

Office Hours: Prof. Byrnes will hold office hours Tuesday and Thursday from 2-4

Overview: In *Special Topics in Biological Data Analysis*, we will take a semester and explore a particular topic or concept in data analysis in detail. Students will come to the course either with a project in mind that requires this technique, or, within one week of beginning the course will start a new collaborative project using the technique.

For this course, we will focus on meta-analysis. Meta-analysis is the statistical technique used to synthesize results in the literature in order to evaluate an overarching hypothesis or theory. It allows scientists to evaluate the weight of evidence across the entire literature, rather than relying on the results of any single study. While it has its origins in the social sciences, meta-analysis is now used in all of the biological disciplines from drug development to community ecology to oceanography, etc.

The course will emphasize good practices in the identification of appropriate data, considerations of weighting schemes, evaluating bias in the literature, mixed model versus fixed effects approaches, and how to deal with questions or data that fall outside of traditional response ratio approaches (e.g., meta-meta-analysis, median based statistics, etc.). Students will also be given an introduction to meta-analytic packages in the statistical software R.

Students will lead discussions on topics every week with sample code provided where appropriate. At the end of the semester, students – singly or in groups – will be evaluated on a final paper. The goal that it will be used as the basis for a scholarly publication. Towards that end, there will be weekly assignments that will move students on the road towards writing and completing the paper.

Objectives:

1) Develop an understanding of the role of meta-analysis in the scholarly literature.
2) Learn to implement meta-analysis for one's own work.

3) Conduct a publication quality meta-analysis that contributes to the development of students' research objectives.

Prerequisites: Previous experience with statistical data analysis at an advanced level or permission of the instructor. Experience with mixed models helpful. Students who are not familiar with R should work through at least one of the tutorials at http://pairach.com/2012/02/26/r-tutorials-from-universities-around-the-world/ OR through the introductory modules in the ***swirl*** package at http://ncarchedi.github.io/swirl/ before taking the course. Advanced undergraduates welcome at instructor's discretion.

Required Texts:

While the topic covered in this course is general to all sciences, we'll use a textbook that was produced by a group of ecologists and evolutionary biologists. Despite it's title, the text is a general book for many disciplinary audiences with some additional material at the start and finish that are specific to EEB.

Handbook of Meta-Analysis in Ecology and Evolution. 2013. Edited by Julia Koricheva, Jessica Gurevitch, Kerrie Mengersen. Princeton University Press. http://www.amazon.com/Handbook-Meta-analysis-Ecology-Evolution-ebook/dp/B00CC3N17C/

Recommended Texts:

These two books are some of the standards in the field. We'll have them available as reference as needed and some chapters may be used as readings.

Introduction to Meta-Analysis. 2009. Michael Borenstein, Larry Hedges, Julian Higgins, and Hannah R. Rothstein. Wiley. http://www.amazon.com/Introduction-Meta-Analysis-Statistics-Practice-Borenstein/dp/0470057246/

The Handbook of Research and Synthesis and Meta-Analysis, 2nd Edition. Edited by Harris Cooper, Larry Hedges, and Jeffry Valentine. Russel Sage Foundation. http://www.amazon.com/The-Handbook-Research-Synthesis-Meta-Analysis/dp/0871541637/

Software:

For data extraction we will use WebPlotDigitizer http://arohatgi.info/WebPlotDigitizer/ as it is free and fairly full featured.

Students are free to use other software such as Graph Click http://www.arizona-software.ch/graphclick/ or Data Thief http://www.datathief.org/ if they would like. ImageJ also works well.

For analysis, I will give examples in R using the *metafor*, *robustMeta*, and and *rmeta* packages, among others. Students are also recommended to install the *plyr*, *reshape2*, and *ggplot2* packages. If students wish to work in other languages, they are more than welcome to do so.

Grading:

Students will be graded on presentations, class participation, and the final paper. Students will each present at one to two chapters during the course. This presentation will be worth 30% of their grade. Participation in classroom discussions about the material will be worth 20%. The final paper (written up either singly or in groups) and its concomitant public presentation will be worth 50% of the grade. Strong evidence of intent to submit for publication will give students an extra 10%.

Teaching approach:

The course will be a mix of lecture from both students and the professor as well as discussion about the material and how it relates to the projects conducted by students.

Final Paper:

For the final paper, students will be asked to define a question answerable by meta-analysis and write a paper that addresses it by the end of the semester. This work should be publication quality, contributing to the students' intellectual advancement. Students can do the project in groups or by themselves (e.g., there may be one class project, two different projects dividing the class in half, everyone can do their own project, etc.). Groups are encouraged, as data gathering can take some time, and many hands make light work. In addition, different members of the group may be able to better lend their expertise to different parts of the project (e.g., data gathering, analysis, writing). It is the students' choice as to how work is partitioned within a group. Every week we will take some class time to discuss project progress, particularly in the context of the topic of the week.

By the end of week two, students must have approval of the topic by the course instructor. Data gathering should be complete by the middle of the semester,

and students will be asked to present a mid-semester update. Students will present the final results in a talk open to the school at the end of the semester.

Course Material:

Students presenting chapters will be chosen at the beginning of the semester. Additional papers will be assigned as needed.

Date	Topic	Chapters	Assignment Due
Jan 29th	What is Meta-Analysis, Project Discussions	1-2,25	Bring potential meta-analysis research ideas
Feb 5th	Finding and Gathering Data	3-4,20	Discuss and finalize research project questions
Feb 12th	Assessing Data Quality, Data Extraction	5,23	Create search strategies and bring an initial prospective literature list
Feb 19th	Metrics of Effect	6-7	Randomly sample prospective studies to evaluate feasibility, refine study list
Feb 26th	Publication Bias	14	Present metrics that will be used for evaluation, demonstrate feasibility
March 5th	Missing Data	13	Gather data
March 12th	Introduction to Visualization & Statistical Inference in Meta-Analysis	8,12,21	Gather data
March 26th	Moment Based Approaches	9	Gather data
April 2nd	Maximum Likelihood Based Approaches	10	Perform one to two analyses on data gathered to date
April 9th	Bayesian Approaches	11	
April 16th	Power Analysis & Other forms of Validation	22	Compare multiple forms of analysis with gathered data. Ask, which is appropriate?
April 23rd	Temporal & Spatial Trends in Data	15, 19	Evaluate power of analyses
April 20th	Non-Independent Data	16	
May 7th	Phylogenetic Non-Independence	17	

May 14th	Dealing with Raw Data	18	Present results corrected and not corrected for non-independence
May 21st	Final Presentations!		Invite guests
May 28th	Final Projects Due		

Cell Phones: Cell phones must be POWERED OFF during class.

Much of this class is discussion, and use of phones in class is disruptive and disrespectful to your fellow students to withdraw from the conversation. I will give you one warning outside of class, and then ask you to please leave in any future classes if it happens again.

Accommodations for Students with Disabilities:

The University of Massachusetts Boston is committed to providing appropriate academic accommodations for all students with disabilities. If you have a disability and feel you will need accommodations in this course, please contact:

The Ross Center for Disability Services
Campus Center, Upper Level, Room 211 (617-287-7430).
http://www.umb.edu/academics/vpass/disability/

After registering with the Ross Center, a student should present and discuss the accommodations with the professor. Although a student can request accommodations at any time, we recommend that students inform the professor of the need for accommodations by the end of the Add/Drop period to ensure that accommodations are available for the entirety of the course.

Code of Conduct and Academic Integrity: It is the expressed policy of the University that every aspect of academic life--not only formal coursework situations, but all relationships and interactions connected to the educational process--shall be conducted in an absolutely and uncompromisingly honest manner. The University requires that any work submitted for academic credit is the student's own and complies with University policies, including policies on appropriate citation and plagiarism. These policies are spelled out in the Code of Student Conduct, which can be found at this website: http://www.umb.edu/life_on_campus/policies/code.

Students are required to adhere to the Code of Student Conduct, including requirements for academic honesty. Penalties for academic misconduct in the course, including plagiarism and cheating, are strictly enforced, and the penalties are very serious. Penalties include an F in the assignment or exam, an F in the course, or suspension from the University. If you have questions about what constitutes plagiarism or other forms of academic misconduct, see Prof. Byrnes **before** completing an assignment or exam.

Ignorance of the rules does not excuse any academic conduct violation.

The University defines violations to include, but not be limited to, the following:

- Submitting as one's own an author's published or unpublished work (e.g. material from a journal, Internet site, newspaper, encyclopedia), in whole, in part, or in paraphrase, without fully and properly crediting the author.
- Submitting as one's own work or materials obtained from another student, individual, or agency without full and proper attribution.
- Submitting as one's own work material that has been produced through unacknowledged or unauthorized collaboration with others.
- Submitting substantially the same work to more than one course (i.e., dual or multiple submission) without prior approval from all instructors involved.
- Using any unauthorized material during an examination, such as notes, tests, calculators, cell phones, or other electronic devices.
- Obtaining answers to examination questions from another person with or without that person's knowledge; furnishing answers to examination questions to another student; using or distributing unauthorized copies of or notes from an examination.
- Submitting as one's own an examination taken by another person; or taking an examination in another person's place.
- Interfering with an instructor's ability to evaluate accurately a student's competence or performance; misleading any person in connection with one's academic work.