ANTH 5403: QUANTITATIVE METHODS IN BIOLOGICAL ANTHROPOLOGY

T/Th: 9:00 – 10:40pm lectures (zoom): 994 8908 6184, v@r1ance

Instructor: Dr. Kieran McNulty
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Texts:
- Zelditch, Swiderski, Sheets, 2012. *Geometric morphometrics for biologists, 2nd edition*. Academic Press.
- Neff, N.A. & Marcus, L.F. 1980. *A survey of multivariate methods for systematics*. American Museum of Natural History, New York.
- Additional readings by topic

Prerequisites: A basic univariate statistics class or permission from the instructor

Overview: This course covers basic quantitative methods important to biological anthropology, evolutionary biology, and other natural sciences. It will provide you with background to evaluate these methods and help you integrate quantitative analysis with your own research. The semester begins by reviewing univariate concepts as a foundation to discuss multivariate techniques including ordination and discrimination. You will also be introduced to shape analysis and geometric morphometrics, including discussion of landmarks, basic Procrustean approaches, and thin-plate splines. The semester will end with an overview of additional quantitative techniques and ideas that are relevant to analyses of biological data. Tuesday meetings will consist of lectures, whereas Thursdays will focus on implementing methods in the R statistical platform and other software packages. By the end of the course, students will be able to design, execute, and interpret their own multivariate statistical analyses.

Student Learning Outcomes: This course addresses the following learning outcomes:
- **Can identify, define, and solve problems**. Students will learn how to define specific research questions, generate testable hypotheses, and design analytical methods to test those hypotheses and generate new ones.
- **Have mastered a body of knowledge and a mode of inquiry**. Students will master the basic methods of multivariate statistics, ordinations, and geometric morphometrics as tools to explore variation and covariation.
- **Can communicate effectively**. Students will learn to communication through scientific writing. This will be emphasized in a series of short exercises and culminate in a methods-driven research paper written in the style of a journal article.

Statement of delivery method and attendance: Lectures and labs will be held synchronously online; exceptions may be made for student with accessibility issues. Lectures and aspects of labs will also be recorded so that students can view them at other times, as needed. In an online environment, attendance consists of 1) participating in live activities **or** viewing recorded versions prior to the next class meeting, and 2) turning in assignments on time. Students will not be penalized for lack of attendance for legitimate excuses (as specified by university policy) and with proper documentation. However, accumulating four "absences" must consult the professor as to whether or not they should take a Withdrawal. Failing to do so within two days after the fourth absence will automatically result in an **F** for the semester. Incompletes will only be given

in rare circumstances and require consultation and a contract with the professor **prior** to the last day of class. Most importantly, **communicate** with the instructors! We want all students to succeed in this course and get worried when we notice reductions in participation. For complete information, please see: https://policy.umn.edu/education/makeupwork.

Instructional Time & Student Effort: Students are expected to spend at least 600 minutes each week on all class activities (including lectures and labs) for this four-credit course. The instructors will spend at least 200 minutes per week giving lectures, administering labs, facilitating discussion boards, conducting office hours, and writing and grading assignments. engaging you with recorded lectures, video tutorials for assignments, weekly overview videos, creating discussion board prompts, weekly quizzes, and unit exams, and through weekly office hours (online and in person as requested). The balance of student effort, then, will involve completing course readings, finishing assignments, conducting research projects, and otherwise engaging the course material. According to university standards, this effort should be sufficient to earn a C in this class. Earning higher marks may require additional time spent on the course.

Course content and intellectual property: Lectures, lectures slides, transcripts, lab exercises and code, and other course materials are the intellectual property of the course instructors. We have made all of it digital to facilitate student use and reuse, but none of these materials, or portions of them, can be distributed or shared in any manner without permission from the instructors. For additional information, please see: https://policy.umn.edu/education/studentresp.

Statement of technology: Students will need a computer capable of running R and Rstudio, word processing and spreadsheet software (available in google drive), a web browser, Zoom, and high-speed internet access (see https://it.umn.edu/working-learning-campus/get-internet-access-campus). The course will be administered through Canvas and all students will need to access the canvas course site regularly. It is recommended that students use a computer less than six years old with at least 1GB of RAM. Students are not required to turn on their computer cameras during lectures/labs, but it is encouraged to help generate classroom community.

Statement of assessment:

- **Examinations (40%).** Two exams will be given, each worth 20% of the final grade. These will be broadly but not specifically cumulative. The exact nature of the exams has not yet been determined.
- **Laboratory exercises (20%).** Students will be evaluated on how well they implement different methods in the lab section. Labs will include exercises to be completed, but additional assessment will be based on participation and performance in the lab itself.
- **Research paper (40%).** Each student will design an original research project involving data collection (?), analysis, and interpretation. Students are encouraged to use the osteological, zooarchaeological, and archaeological collections in the department, but may gather data from other sources. Data will be written up as a journal article.

Assessments will be conducted in an online format consistent with the other course activities. Because all assessments will be due outside of synchronous meetings, temporary disruptions in technology should not affect students' ability to complete them. If there are longer technology issues these should be communicated with the instructor immediately.

University grading scales: The course follows standard university grading scales, as outlined at https://policy.umn.edu/education/gradingtranscripts.

Sexual harassment, sexual assault, stalking and relationship violence: The University prohibits sexual misconduct, and encourages anyone experiencing sexual misconduct to access resources for personal support and reporting. If you want to speak confidentially with someone about sexual misconduct, please contact the Aurora Center, Boynton Mental Health or Student Counseling Services (https://eoaa.umn.edu/report-misconduct). If you want to report sexual misconduct, or have questions about the University's policies and procedures related to sexual misconduct, please contact your campus Title IX office or relevant policy contacts. Instructors are required to share information they learn about possible sexual misconduct with the campus Title IX office that addresses these concerns. You may talk to instructors about concerns related to sexual misconduct, and they will provide support and keep the information you share private to the extent possible given their University role. For more information, please see: https://regents.umn.edu/sites/regents.umn.edu/files/2019-09/policy_sexual_harassment_sexual_assault_stalking_and_relationship_violence.pdf

Equity, Diversity, Equal Opportunity, and Affirmative Action: I wholeheartedly support University policies providing equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, membership or activity in a local commission created for the purpose of dealing with discrimination, veteran status, sexual orientation, gender identity, or gender expression. If you have any suggestions, concerns, or feedback in this regard I would be happy to hear them. You can also consult the Board of Regents Policy: https://regents.umn.edu/sites/regents.umn.edu/files/2019-09/policy_equity_diversity_equal_opportunity_and_affirmative_action.pdf.

Disability Accommodations
The University views disability as an important aspect of diversity, and is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (DRC) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations. If you have, or think you have, a disability in any area please contact the DRC office (612-626-1333, drc@umn.edu) to arrange a confidential discussion regarding equitable access and reasonable accommodations. Students with short-term disabilities can often work with instructors to minimize classroom barriers. In situations where additional assistance is needed, students should contact the DRC as noted above.
If you are registered with the DRC and have a disability accommodation letter dated for this semester or this year, please contact the instructor early in the semester to review how the accommodations will be applied in the course.

Mental Health and Stress Management: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University services available to assist you can be found at the Student Mental Health Website: http://www.mentalhealth.umn.edu.

Academic Freedom and Responsibility: Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.

[Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".] Reports of concerns about academic freedom can be sent to the instructor (kmcnulty@umn.edu), your adviser, Department Chair Karen-Sue Taussig (taussig@umn.edu), Associate Dean Steve Manson (manson@umn.edu), or Vice Provost Rebecca Ropers (ropers@umn.edu).

Readings: Readings for each class meeting should be completed *before* class time. The texts have been used in this class for more than a decade, and were chosen based on their capacity to convey the course material at the appropriate level (not to mention being free for UMN students). Although both books have women as lead authors, these readings do not meaningfully reflect diversity in scholarship; STEM disciplines have been especially problematic about training and supporting scholars from underrepresented groups, and this is reflected in the academic literature. In addition to textbook readings each week, I will also provide readings that showcase how these methods are applied. This will give students concrete examples of how to utilize these approaches in their own research. It will also create a mechanism for highlighting scientists from underrepresented groups, in the hope of inspiring a new generation of researchers that is more representative of human diversity.

	Lecture	**Lab**	**Readings**	**Notes**
SEP 08,10	**Rev. univariate stats** **Bivariate stats**: covariances, correlation, regression, ANCOVA **Simple permutation tests**	**Introduction to R and R Markdown**: language, commands, objects, datasets in R **Summary statistics** **Basic plotting**	Z 189-199	Lab 00 and Lab 01
SEP 15,17	**Matrix algebra**: matrices and vectors, matrix properties, matrix multiplication **Multidimensional thinking** **Data collection**	**Data collection**: software **Basic Statistical tests**: t-tests, ANOVA, ANCOVA, correlation, regression	NM 1-50 handout	Lab 02
SEP 22,24	**Principal component analysis** **Singular value decomposition** **Multivariate regression**	**Principal component analysis**	NM 51-69 Z 135-150 194-199	Lab 03
SEP 29 OCT 01	**PC-related analyses**: rotating and projecting; BGPCA; PCoA; non-metric MDS	**Applications in R**	NM 70-93 Z 164-166 handouts	Lab 04
OCT 06,08	**Partial Least Squares Analysis**	**Partial Least Squares Analysis**	Z 169-188 handouts	Lab 05
OCT 13,15	**Geometric Morphometrics**: landmarks, semi- and pseudo; shape spaces; GPA; TPS	**Applications in geomorph:** GPA on landmark data **Other software**	Z 1-132 handouts	Lab 06
OCT 20,22	**Procrustean issues**: variables; distance **Visualization** **Analysis**	**Applications in geomorph:** modeling shape differences, allometry, tangent space vs. shape space	Z 1-132 handouts	Lab 07
OCT 27,29	**Midterm Exam**	**Work on student projects**		**Some data due**
NOV 03,05	**More GM**: integration and modularity	**Applications in geomorph:** Thin Plate Splines, Integration, Modularity	Z 373-393 handouts	Lab 09

NOV 10,12	**Discrimination and Mahalanobis**: CVA/DFA; MANOVA **Multiple Regression and GLM** **Other distances**	**Applications in R:** CVA, MANOVA, Hotelling's T^2	NM 145-176 Z 151-164, 199-210, 225-259	Lab 10
NOV 17,19	**Categorical data**: chi-square analysis; correspondence analysis; contingency tables	**Applications in R:** Chi ^2, correspondence analysis	NM 141-144 handouts	Lab 11 **Project data due**
NOV 24,26	**Size**: effects of size in biology; accounting for size in data	**<Thanksgiving Break>**	Z 269-270, 304-316	**No lab this week**
DEC 01,03	**Cluster analysis** **Resampling analyses** **Other outline methods**	**Applications in R:** Resampling analyses, cluster analysis	NM 193-208 Z 210-224, 286-293	Lab 13
DEC 08,10	**Phylogenetic methods**: Why relatedness matters, Introduction to phylogenies and how they can be used with morphometric data	**Applications in R:** working with trees, pPCA, pANOVA, ancestral State reconstruction, phylomorphospace, Phylo signal	Z 263-269 handouts	Lab 14 **Hejmadi guest lecture**
DEC 15	**Ethics in Science and Statistics**		TBD	**Paper due**
DEC 21	**Final Exam: 8:00 - 10:00 am**			

NM = Neff & Marcus; Z = Zelditch et al.