Anthropology 4592
GEOMETRIC MORPHOMETRICS

Spring 2004

Instructor:
Robert McCarthy
McMillan 131A
935-9813
rcmccart@artsci.wustl.edu

Class times: W 2 – 4:30pm
Location: Lopata House Rm. 22
Office Hours: Tues. 4 – 6pm and by appt.

Structure and goals of the course: After completing this course, students will be knowledgable in the terminology, theory, basic literature and practical applications of geometric morphometric analysis. The course is evenly split between weekly seminars on geometric morphometric techniques, with an even mixture of lecture and discussion of assigned readings; and a computer lab focusing on using available computer programs to implement these techniques. For seminars, students will be assigned 3-5 papers covering a particular geometric morphometric technique or problem; for computer labs, students are expected to download and read users' manuals and to complete class assignments.

Grading: Grades will be determined by class participation (~20%), completion of weekly homework assignments (~40), and a final paper (~40%). The final paper will present results from a semester-long geometric morphometric project that will be largely completed in lab. Students are expected to read articles and users' manuals in advance of class and come prepared with questions and comments. Attendance is required.

Labs and homework assignments: Students are expected to complete weekly lab exercises associated with learning particular geometric morphometric techniques. In addition, students are expected to complete homework assignments largely concerned with organizing and manipulating their personal data sets, and to write a final paper based on the results of these exercises.

Online resources: Computer programs and users' manuals can be downloaded from one of two websites:

The SUNY Stony Brook Morphometrics website: http://life.bio.sunysb.edu/morph/
Joan Richtsmeier's personal website: http://oshima.anthro.psu.edu/

These websites are also great sources of information for geometric morphometric history, bibliography, user support, updates, newsgroups, etc., and should be referred to frequently.

Week 1 Jan. 21 Introduction

Week 2 Jan. 28 History and data acquisition I
Introduction to the history of geometric morphometric analysis, from D'Arcy Thompson-style transformation grids to currrent controversies and issues; uses and abuses of geometric

morphometrics in biology; types of datasets; introduction to data acquisition hardware and software; theory of landmarks and coordinates.
Homework: think hard about landmark data you'd like to collect.

Week 3 Feb. 4 Data acquisition II
General introduction to the "tps series" of programs and specifically to **tpsDIG32**, a Windows program for digitizing landmarks and outlines from image files, scanner or video; introduction to **MacMorph**, a Mac program for digitizing landmarks from image files, scanner or video, in 2- and 3-D; computing areas of enclosed regions, perimeters, linear distances, and angles using the above programs; using **Excel** to archive and analyze coordinate data; general overview of data acquisition from other sources, such as computerized tomography (CT) and magnetic resonance imaging (MRI) scans.
Homework: Begin data acquisition using one of the above programs.

Week 4 Feb. 11 Scaling
Introduction to scaling and allometry; Model I and Model II regression; overview of multivariate allometry, including multiple regression, partial least-squares, principal components and discriminant functions.
Homework: Continue data acquisition.

Week 5 Feb. 18 Superimposition I
Theory; early techniques, including Bookstein shape coordinates; Procrustes superimposition, including least-squares theta rho analysis (LSTRA) and resistant-fit theta rho analysis (RFTRA); strengths and weaknesses of superimposition and rotational fit.
Homework: Put coordinate data into appropriate format; familiarize yourself with the **Morphometrika** users manual.

Week 6 Feb. 25 Superimposition II
Formatting files; application of Procrustes superimposition using **Morpheus** (for AIX, DOS/WIN, LINUX, and SGI) and **Morphometrika** (for Mac); introduction to theory of thin-plate splines; deciding on an adequate number of landmarks (using **tpsSuper**); interpreting results.
Homework: Perform a Procrustes analysis using one of the above programs, and explore the thin-plate splines options.

Week 7 Mar. 3 Thin-plate splines
Theory and applications; implementation using **tpsSplin** and **Morphometrika**; introduction to multivariate techniques useful for analyzing Procrustes and thin-plate spline data, including multiple regression, relative and partial warps, and partial least-squares analysis.
Homework: Perform a thin-plate spline analysis of your data; familiarize yourself with the **tps** users' manuals listed below.

Week 8 Mar. 8 Spring break

Week 9 Mar. 17 Multivariate analysis of superimposition data
Multivariate analysis of Procrustes and thin-plate spline data using **tpsRegr** (for multiple regression), **tpsRelw** (for relative warps), and **tpsPLS** (for partial least-squares analysis); interpreting results.
Homework: Perform one of the above multivariate analyses on your thin-plate spline data.

Week 10 Mar. 24 Outline techniques
Theory and application of outline techniques, including semilandmarks and Fourier analysis; interpreting results.
Homework: None.

Week 11 Mar. 31 Euclidean Distance Matrix Analysis (EDMA) I
Theory and application of EDMA; introduction to the procedure for analyzing coordinate data using EDMA; differences between form, growth and shape analyses, and how to compute matrices for each.
Homework: Familiarize yourself with the **winEDMA** users manual, and format your files for use with that program.

Week 12 Apr. 7 EDMA II
Formatting files; bootstrapping; identifying influential landmarks; clustering; introduction to multivariate analysis of EDMA data.
Homework: Perform the EDMA analysis appropriate to your dataset, and interpret your results.

Week 13 Apr. 14 Multivariate analysis of EDMA data
Principal coordinate (PCOORD) analysis.
Homework: Perform a PCOORD analysis of your EDMA data matrix.

Week 14 Apr. 21 Integration
Theory and applications; implementing cluster, principal component, common principal component, discriminant function and factor analysis in geometric morphometrics.
Homework: Compare results from Procrustes and thin-plate spline analyses to those from EDMA and PCOORD analyses. Work on final paper.

Week 15 Apr. 28 Other techniques
A survey and overview of other useful techniques, including finite element scaling analysis and eigenshapes.
Homework: Final papers due!