Syllabus for STAT 8820: Shape Data Analysis

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Lecture Location: Derby Hall 024
Lecture Time: 10:20AM-11:15AM TR

Course description: Due to recent developments in science and technology, novel types of structured data under nonlinear constraints are now prevalent in various application domains. Such data naturally take values on nonlinear manifolds rather than Euclidean spaces, where the type of nonlinear constraint determines the manifold structure. Due to this nonlinearity of data representation spaces, standard statistical techniques cannot be applied directly, prompting developments of new theoretical and computational tools for statistical analyses. A prominent example of such data is the shape of two- and three-dimensional objects. Shape is an important physical property of objects that characterizes their appearance, and plays a key role in the detection, tracking and recognition of objects in images and videos. Statistical shape analysis represents shape as a random object and develops tools for shape registrations, comparisons, averages, probability models, hypothesis tests, Bayesian estimates, and other statistical procedures on shape spaces. One is usually concerned with analyzing object boundaries, which leads to shape analysis of parameterized curves and surfaces.

STAT 8820 will introduce students to modern methods in statistical shape analysis and will closely follow the recent book of Srivastava and Klassen (2016) titled *Functional and Shape Data Analysis*. There will be a significant computational component where students will be asked to implement the various mathematical and statistical tools covered in class, and apply them to real datasets in computer vision, biology, medical imaging and other disciplines. The main topics covered in this course will include: (1) Geometry background, (2) Previous techniques including point-based methods, (3) Shapes of open and closed planar curves, and (4) Statistics on shape spaces including background in statistical modeling on nonlinear manifolds. We may additionally cover concepts in functional data analysis and shape analysis of surfaces (time permitting).

Additional useful books: Dryden and Mardia (2016), *Statistical Shape Analysis, with Applications in R;* Ramsay and Silverman (2005), *Functional Data Analysis*

Pre-requisites: STAT 6802 or permission from instructor. Additionally, working knowledge of linear algebra, advanced calculus, and some programming background is helpful.

Grading policy: The final course grade will be based on homework assignments, class participation, and a final project.

Academic misconduct: Academic misconduct will not be tolerated and will be dealt with procedurally in accordance with university policy, which can be found at http://oaa.osu.edu/coam.html. Students are allowed to consult with each other on homework assignments. However, each student must complete and turn in his or her own work. The

discussions should be at the ideas level and not the details level. DO NOT copy or use computer code written by another student.

E-mail correspondence: In order to protect your privacy, all course e-mail correspondence must be done through a valid OSU name.# account.

Special Accommodations: All students who feel they may need accommodations based on the impact of a disability should contact the instructor privately to discuss their specific needs. Students with documented disabilities must also contact the Office of Disability Services (ODS) in 098 Baker Hall (phone: 292-3307) to coordinate reasonable accommodations for the course. ODS forms must be given to your instructor as early in the semester as possible to be filled out and returned to you.

Note: Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advanced notice.