Advance Topics in Prob and Statistics
Function and Shape Data Analysis
STA 6468, Section 1: Fall 2015

Instructor: Dr. Anuj Srivastava (Office: Room OSB 106D)
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Office hours: Tu-Th 10:00 – 11:00am or by appointment.

Location: Room OSB 215, Monday and Wednesday 2:00-3:15pm

Class Website: Blackboard access

Course Objective:

To understand some basic and applied ideas in statistical methods for modeling and analyzing functional and shape (curves) data.

Prerequisites: Linear algebra, advanced calculus, Computational Statistics I and II.

Reference Texts:

1. *Statistical Modeling of Shapes of Functions and Curves*, Anuj Srivastava and Eric Klassen, manuscript in preparation, 2015, provided on class website. (https://www.dropbox.com/s/4ckk56cahw7f73p/book_July14_2015.pdf?dl=0)
2. Not required but useful: *Functional Data Analysis*, J. O. Ramsay and B. W. Silverman, Springer, Second Edition, 2005.

Topics Covered:

1. **Chapter 3: Background Material**
   Equivalence relation; Riemannian structure and geodesics (unit sphere, GL(n)); Groups, Group actions on manifolds, and their Quotient spaces.

2. **Appendix C**: The Dynamic Programming Algorithm.

3. **Chapter 4: Functional Data and Elastic Registration**
   (a) Estimating functions from discrete data; Geometry of Hilbert spaces; Function PCA; Unit Hilbert sphere; Group of warping functions,
   (b) Registration problem; L2 norm and the pinching effect; square-root slope framework and elastic pairwise registration; growth curves and other examples.
   (c) Fisher-Rao metric; applications to pdfs, half pdfs, and cdfs; Extensions to function spaces.

4. **Chapter 7: Statistical Modeling on Nonlinear Manifolds**
   Intrinsic and extrinsic statistics; statistical summaries on unit spheres; space of pdfs; space of warping functions;

5. **Chapter 8: Statistical Modeling of Function Data**

Definition of phase and amplitude components; template-based alignment; L2 metric and pinching effect; Elastic phase-amplitude separation; Phase-amplitude separation after transformation; penalized alignment; FPCA of phase-amplitude components; Joint FPCA and phase-amplitude separation: L2 and elastic metrics.

6. **Chapter 5: Shapes of Planar Curves**
   Parametric representation of curves; shape preserving transformations; preshape and shape spaces; Elastic metric; Curve registration; Geodesics in shape spaces.

7. **(Possibly) Chapter 9: Statistical Modeling of Planar Curves**
   Shape clustering; A finite-dimensional representation; Models for planar curves; TWN model; Modeling nuisance variables; Shape classification with contour data; Shape classification with point cloud data.

Approximate Timeline:

Topic 1: Week 1 and 2.
Topic 2: Week 2.5
Topic 3: Week 2.5 – 6.
Topic 4: Week 7 - 8
Topic 5: Week 9 - 10
Topic 6: Week 11 -- 12

Remaining weeks: Additional topics

Grading Policy:

Grades will be calculated using the weights: 60% projects/homeworks, 20% class participation, and 20% final project.
I will assign bi-weekly homework using problems from the textbook.

Attendance Policy:

It is strictly required to attend all the classes. It is the student's responsibility to make up for the material covered in the class during any absence.

Academic Honor System:

"The Academic Honor System of The Florida State University is based on the premise that each student has the responsibility to: 1) Uphold the highest standards of academic integrity in the student's work, 2) Refuse to tolerate violations of academic integrity in the academic community, and 3) Foster a high sense of integrity and social responsibility on the part of University community."

Please note that violations of this Academic Honor System will not be tolerated in this class. Specifically, incidents of plagiarism of any type or referring to any unauthorized material during examinations will be rigorously pursued by this instructor. Before submitting any work for this class, please read the "Academic Honor System" in its entirety (as found in the FSU General Bulletin and in the FSU Student Handbook) and ask the instructor to clarify any of its expectations that you do not understand).

Students with disabilities needing academic accommodation should: (1) register with and provide documentation to the Student Disability Resource Center; (2) bring a letter to the instructor indicating the need for accommodation and what type. This should be done during the first week of class.