STAT718A SHAPE AND IMAGE ANALYSIS Spring Session 2009

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Office Hours: Monday and Weds 3-4pm or by appointment

Summary of content: Statistical shape analysis involves methods for the geometrical study of random objects where location, rotation and scale information can be removed. The subject is a new and exciting area of statistics, offering many fresh challenges. There have been many advances made in the past 20 years, and there is a huge variety of applications. We shall focus on landmark shape analysis, where key points of correspondence are located on each object. Topics include shape co-ordinates, shape distances, Procrustes registration, geodesics, mean shapes and shape variability. Multivariate statistical procedures, such as principal components analysis, need to be adapted to cope with the invariances of shapes. Various applications will be given throughout, including in biology, medicine, bioinformatics, and image analysis. Shape analysis is of particular importance in image analysis, and we shall explore this topic in further detail, including thresholding, segmentation, morphology, Markov random field models and deformable templates. We shall make good use of the 'shapes' package in R and the image processing package ImageJ.

Class Meetings: Monday and Wednesday 4:00 to 5:15pm in LeConte 210B

Learning outcomes: By the end of this course the student will be able to state and prove standard results relating to statistical shape and image analysis; apply the theory and methods to a range of appropriate examples; use a statistical package for practical shape analysis; and use an image analysis package.

Course topics:

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I. Statistical shape analysis [5 weeks (approx)]
  Landmarks, shape and applications.
  Size measures and shape co-ordinates.
  Planar shape analysis.
  Shape space and distances.
  General Procrustes methods.
  Tangent space inference.
  Using the shapes package in R.

II. Statistical image analysis [5 weeks (approx)]
  Filters, thresholding and elementary segmentation.
  Morphology.
  Using the ImageJ software package.
  Markov Random Field models, Ising model and MCMC.
  Image restoration and simulated annealing.

III. Further topics [4 weeks (approx)]
  Shape models and inference.
  Size-and-shape.
  Deformations and shape change.
  Deformable templates.
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Books: Lecture notes will be provided. The shape analysis notes are based heavily on: Dryden, I.L. and Mardia, K.V. (1998). Statistical shape analysis, Wiley, Chichester.

Use of computers: Some exercises will require you to use the statistical software, specifically R and ImageJ. You will be instructed on the use of the software.

Assessment: 50% Coursework, Mid-term exam (take home) 25%, Final Exam 25%

50% will be from coursework during the semester. Five sets of exercises will be given out worth 10% each, some of which will involve practical computer-based work.

Deadlines and dates:

	Handed Out	Collected In
Assignment 1	January 26	February 4
Assignment 2	February 9	February 18
Assignment 3	February 23	March 6*
Mid-term exam	March 18	March 25
Assignment 4	March 30*	April 8*
Assignment 5	April 13*	April 20*
Final exam	April 20*	April 27*

* Denotes a change from the initial schedule.

Grading:

A	90 -100%
B+	87-89.9%
B	80 -86.9%
C+	77-79.9%
C	70 -76.9%
D+	67-69.9%
D	60 -66.9%
F	$<$60%

Course web page: `http://www.stat.sc.edu/~dryden/STAT718A`

Pre-requisites: STAT 517, 704, and 712 (or the equivalent, by permission).