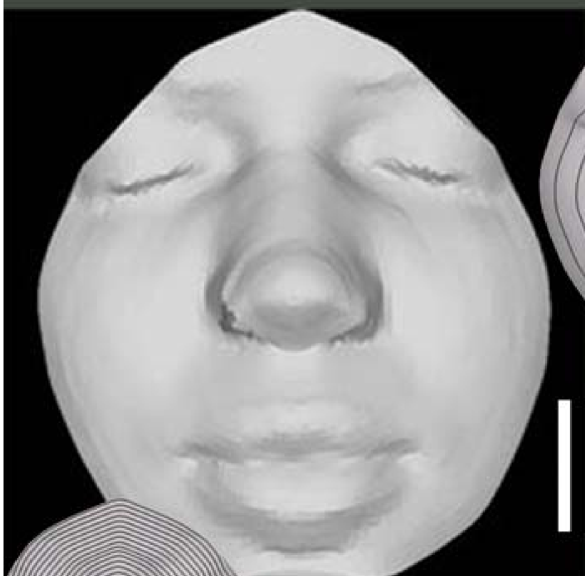
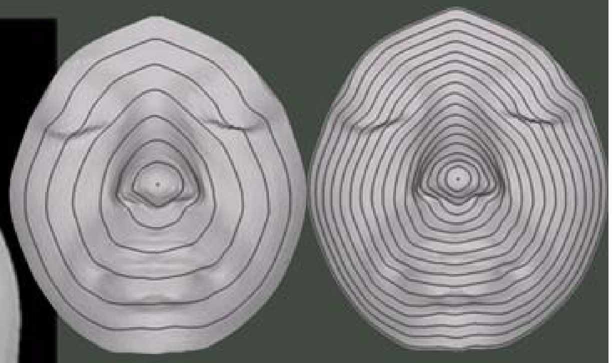
SHAPE DAY





IN STATISTICS

Friday, April 6, 2007
499 Dirac Science Library

ORGANIZERS:

Anuj Srivastava • Vic Patrangenaru

FLORIDA STATE UNIVERSITY DEPARTMENT OF STATISTICS

INVITED SPEAKERS:

Ian Jermyn
INRIA, FRANCE

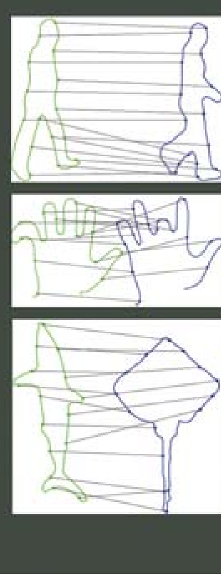
Xavier Descombes
INRIA, FRANCE

Hamid Krim
NORTH CAROLINA STATE

Eric Klassen
MATHEMATICS, FSU

Kim Van de Linde
BIOLOGY, FSU

Vic Patrangenaru
STATISTICS, FSU



PLENARY SPEAKER:

Kanti V. Mardia
UNIVERSITY OF LEEDS
UNITED KINGDOM

TECHNICAL PROGRAM

(All the Talks and the Posters will be presented in the Room 499 DSL)

SHAPE DAY IN STATISTICS

April 6th, Friday, 2007
Location: DSL 499

Organizers: Anuj Srivastava, Statistics
Vic Patrangenaru, Statistics

Shape analysis is an important tool in many branches of science, including pattern recognition, biology, medicine, biochemistry, and computer vision. In this half-day workshop, we will have presentations of state-of-the-art techniques in shape analysis using ideas from geometry, statistics, and computing. The plenary speaker will be Prof. Kanti Mardia from University of Leeds, UK, a world leader in statistical analysis of shapes and a co-author, with Ian Dryden, of the famous textbook Statistical Shape Analysis (John Wiley & Sons, 1998). Additionally, the workshop will feature shape experts from INRIA, Sophis-Antipolis, France, North Carolina State University, and FSU.

8:30 – 8:45 am	Welcome Remarks by Dan McGee, Chair, Statistics
8:45 - 9:30 am	**Kanti Mardia** (LEEDS, UK), Plenary Talk *Challenges in Statistical Protein Bioinformatics*
9:30 - 10:00 am	**Ian Jermyn** (INRIA, France) *Shape Modeling, Higher-Order Active Contours, and Phase Fields*
10:00 - 10:30 am	**Xavier Descombes** (INRIA, France) *Image Analysis: From Markov Random Fields to Marked Point Process*
10:30 – 10:45 am	**Coffee Break**
10:45 - 11:15 am	**Hamid Krim** (NC State) *Topo-Geometric Modeling of 3D Objects*
11:15 - 11:45 am	**Eric Klassen** (Mathematics, FSU) *Shapes of n-dimensional Elastic Curves*
11:45 - 12:15pm	**Kim Van de Linde/David Houle** (Biology, FSU) *Procrustes and Many Noses of Pinocchio*
12:15 - 12:45pm	**Vic Patrangenaru** (Statistics, FSU) *Nonparametric Estimation of 3D Scenes From Bilateral Views*
12:45 - 2:00pm	**Lunch Break**

Afternoon session will highlight poster presentations by different groups. It will be held in the same room from 2:00 – 3:30pm.

ABSTRACTS

Kanti Mardia, University of Leeds

Title: **Challenges in Statistical Protein Bioinformatics**

Abstract:
An organism's DNA, including its genes, holds almost all the information required for its development and function. Human understanding of this information is at an early stage, but is accumulating rapidly due to new high-throughput forms of experimentation. This has led to large and rapidly expanding databases of DNA sequence, and related databases of the structure and function of biomolecules such as proteins. Bioinformatics is concerned with the development of these databases, and tools for deciphering and exploiting the information they contain.

Statistics is will provide a brief introduction to some biological fundamentals, some bioinformatics questions, and some statistical solutions including protein structure and prediction. This will be approached through three selected biological problems with their bioinformatics solutions and statistical research framework:

- Protein structure and Bayesian methods (Green and Mardia, 2006)
- Statistical distribution of conformational angles and Ramachandran plots (Mardia, Taylor and Subramaniam, 2007)
- Prediction and simulation of protein structure (Boomsma, et al, 2006).

We will discuss also various open problems including the nobel-prize-type problem related to protein folding.

Ian Jermyn, INRIA, France

Title: **Region Modelling via Higher-Order Active Contours and Phase Fields**

Abstract:
For the most part, shape modelling has focused on modelling families of regions consisting of deviations around a given reference shape, which usually has a simple topology. There are applications, however, where the family of regions to be modelled does not have such a constrained behaviour. Cases where the number of objects is unknown a priori, or where the topology of the region may be otherwise complex (for example network shapes), require new techniques. 'Higher-order active contours' (HOACs) represent one approach to modelling such families of regions. By introducing

explicit long-range interactions between region boundary points, HOACs can model families of regions sharing geometric properties without overly constraining region topology. Representing regions by their boundaries is often inconvenient, however, both analytically and numerically, especially for complex topologies. An alternative is the approach known as 'phase field' modelling. The phase field representation and modelling framework offers a number of advantages, both for the simplest region models and for HOACs. By way of illustration, the use of HOAC and HOAC phase field models to estimate the regions corresponding to road networks and tree crowns in satellite and aerial images will be described.

Xavier Descombes, INRIA, France

Title: **Image Analysis : From Markov Random Fields to Marked Point Process**

Abstract:
After having briefly recalled the Markov Random Fied modeling for performing tasks such as image segmentation, I will highlight the limitation of this approach, especially when dealing with high-resolution images. I will then describe an alternative modeling which allows embeding geometrical information in the prior. This model consists in considering configurations of objects instead of modeling the pixel value itself. Prior information on the objects and on their mutual localization are modeled by a marked point process. Some applications on concrete problems such object detection and population counting will be detailed.

Hamid Krim, North Carolina State University

Title: **Topo-geometric Representation of Objects for Analysis and Classification**

Abstract:

Shape analysis is playing an increasingly important role in many applications where object analysis and classification is of interest. Solutions to many existing as well as new emerging applied problems (e.g., functional MRI, target recognition) crucially depend on object modeling and their parsimonious representation. Our focus in this work is on 3D object representation. This effort is inspired by Morse Theory, which is well known in singularity theory for its capacity to characterize the topology of varieties in general and surfaces in particular. We hence propose a solid framework for combining the topological

information together with geometric information to fully represent 3D objects. A resulting weighted graph representation of a 3D object may then be used in classification problems.

Eric Klassen, Mathematics, FSU

Title: **Shapes of n-dimensional Elastic Curves**

Abstract:

We describe a method for making spaces of curves in R^n into Riemannian manifolds. The Riemannian metric we use encodes the energy required both to stretch and bend the curves. We give an efficient algorithm for computing geodesics and distances in these manifolds by a path-straightening procedure. We also show how to mod out by the group of reparametrizations. We use these methods to study the space of closed curves of unit length.

Kim Van de Linde, Biology, FSU

Title: **Procrustes and Many Noses of Pinocchio**

Abstract:
The form of an object is the combination of its size and its shape. When form is characterized as the spatial locations of homologous points, analysis is facilitated by superimposing the forms, while size variation is estimated and removed. The result is shape data, but size and shape can interact, resulting in allometry. The resulting size and shape data are well known to be influenced by the algorithm used to superimpose the forms, a problem usually thought to preclude any formal statistical inference about the nature of shape differences between forms. We argue that understanding the nature and the causes of variation is an important goal and that superimposition techniques that maximize our ability to make such inferences should be developed. We propose two such techniques that will improve the ability to estimate variation when some of the points on a form are more allometric than others. In subset alignment, landmarks are progressively discarded from the superimposition algorithm if they result in significant decreases in the variation among the remaining landmarks. In outline alignment, regularly distributed semilandmarks on the continuous outline of a form are used as the basis for superimposition of the landmarks contained within it. We use simulations to show that these techniques can result in dramatic improvements in the accuracy of

estimated variance-covariance matrices among landmarks when our assumptions are roughly satisfied. The pattern of shape variation in the wings of drosophilid flies appears to meet these assumptions, and the pattern of variation inferred by means of our superimposition techniques are quite different from that recovered from the standard generalized Procrustes superimposition. In particular, allometric variation appears to be much more strongly localized than previously realized.

Vic Patrangenaru, Statistics, FSU

Title: **Nonparametric Estimation of 3D Scenes From Bilateral Views**

Abstract:
One gives a statistical method of estimating with confidence the shape of a polyhedral scene, in absence of obstructions, from its bilateral views.
