Programme on
“Infinite-dimensional Riemannian geometry with applications to image matching and shape analysis”
January 7 – February 27, 2015

organized by

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Week 7
“Statistics on shape spaces”
February 23 – 27, 2015

• Monday, February 23, 2015
10:00 – 11:00
Analyzing the changing anatomy
Sarang Joshi
University of Utah

In this talk I will present computational and analytical tools we have been developing at University of Utah for the analysis of anatomical image ensembles that are designed to capture changes in anatomy. The fundamental analytical framework we have been using is that of regression analysis where the dependent variable is the anatomical configuration while the independent variable is application domain specific. I will exemplify the application of this general methodology to various medical imaging applications ranging from the analysis of internal organ motion as imaged in 4D respiratory correlated CT imaging spanning few minutes to that of the study changes in brain anatomy associated with normal aging and neurodegenerative diseases such as Alzheimer’s spanning decades.

• Tuesday, February 24, 2015
10:00 – 11:00
Shape statistics in Weitzenböck space
Stephen Marsland
Massey University

When analyzing or modeling a group of shapes, the issue of correspondence is one that arises very naturally. If we consider the example of faces, then it is obvious that structures such as the mouth and eyes should correspond between examples, and in parametric shape descriptors or in groupwise image registration, this correspondence is typically dense and indicated by corresponding points. Much work has been published on how to determine this correspondence automatically, for both shapes and images.

Establishing correspondence requires the ability to take a direction defined at one point/for one shape in shape space, and transfer this direction to other shapes/points in shape space using parallel transport. Unfortunately, curvature of the shape manifold means that this is not unique. In this talk I will introduce
the Weitzenböck space, which has torsion but not curvature, and demonstrate how this can be used to construct a PCA-like algorithm for analysis of directional data.

This is joint work with Carole Twining.

- **Wednesday, February 25, 2015**

  10:00 – 11:00
  **msPOAS - an adaptive denoising procedure for dMRI data**
  *Karsten Tabelow*
  Weierstraß-Institut Berlin

  In this talk we present a new method msPOAS for adaptive smoothing diffusion magnetic resonance imaging data. The procedure is based on the propagation-separation approach and uses the geometry of the measurement space of (voxel) positions and (gradient) orientations to reduce noise in the measured image volumes. We will elaborate on the principles of the algorithm and show applications to high resolution diffusion MRI data.

- **Thursday, February 26, 2015**

  10:00 – 11:00
  **Precise matching of piecewise linear curves using the square root velocity function, part II**
  *Eric Klassen*
  Florida State University

  This is a continuation of the talk given during the workshop in week 6.

  The square root velocity function (SRVF) has proved to be an effective method for comparing curves in $\mathbb{R}^n$ modulo reparametrization. However, the choice of optimal parametrization has usually been found using dynamic programming, which can only provide an approximation of the correct result. In this talk we discuss an algorithm that finds the precise optimal parametrizations needed to compare two curves in the case that the curves are piecewise linear (PL). This is of special interest because the set of PL curves is dense in the complete space of all absolutely continuous curves with respect to the SRVF metric. We also demonstrate the implementation of this algorithm.

  This is joint work with Daniel Robinson and Sayani Lahiri.

  11:00 – 11:45
  **Optimal reparametrizations in the square root velocity framework**
  *Martins Bruveris*
  Brunel University London

  In this talk I want to present some recent results about the geodesic distance on the space of open curves, that appears in the square root velocity framework. Denoting the geodesic distance by $\text{dist}$, we look at the induced metric on the space of unparametrized curves, which is given as the infimum

  $$\text{dist}([b], [c]) = \inf_{\beta, \gamma} \text{dist}(b \circ \beta, c \circ \gamma),$$

  over a suitable group of reparametrizations. Of interest is the question, whether for a given pair of curves this infimum is realized. I will show, that the answer is positive, if $b$ and $c$ are at least $C^1$ and construct a pair of Lipschitz curves, for which there exist is no optimal reparametrizations.

All talks take place at the ESI, Boltzmann Lecture Hall.