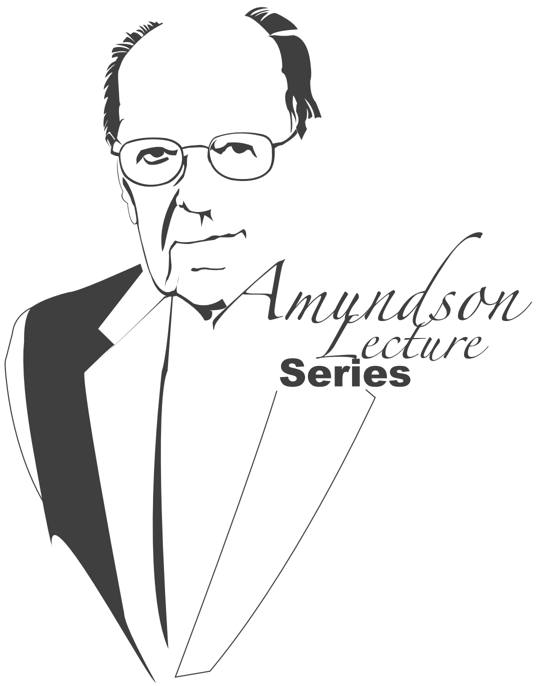

In loving memory of Professor Neal Amundson

UNIVERSITY of HOUSTON

YOU ARE THE PRIDE

Amundson Lecture Series 2011

Abstracts

Presented by: Professor Laurent Younes

Lectures

Wednesday, March 23rd
4:00-5:00 p.m.
General Colloquium:
Shape Spaces and Computational Anatomy
(UH Hilton, Shamrock Room)

Thursday, March 24th
4:00-5:00 p.m.
Seminar Lecture:
Diffeomorphic Optimal Control
(UH Hilton, Shamrock Room)

Friday, March 25th
2:00-3:00 p.m.
Graduate Student Lecture:
An Interesting Space of Plane Curves
(343 Philip G. Hoffman Hall)

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Colloquium Lecture: Shape Spaces and Computational Anatomy

A fundamental question in Computational Anatomy addresses how the shapes of human organs are affected by disease. This is motivated by the fact that, most cognitive disorders, for example, result in selective atrophy of various structures in the brain. Similarly, heart disease typically involves significant remodeling of the cardiac muscle. Describing how and where such shape changes occur can provide clinicians with essential information on the nature of the disease.

We will show how these issues can be addressed within the framework of Grenander's Metric Pattern Theory, and more specifically by building Riemannian spaces of shapes. This will be illustrated by two case studies, the first one on the analysis of atrophy in the striatum and connected brain structure in relation with Huntington's disease, and the second on the analysis of shape variation in cardiac disease, and its relation with different forms of cardiomyopathy.

Seminar Lecture: Diffeomorphic Optimal Control

In the framework of the "large deformation diffeomorphic metric matching" family of algorithms, one formulates the problem of finding an optimal registration between two shapes, or two images, as an optimal control problem where the control specifies an Eulerian velocity associated to a time-dependent diffeomorphism, with a cost represented by the norm of the velocity in a suitably chosen Hilbert space of vector fields. Because this Hilbert norm can also interpreted as the expression of a right-invariant Riemannian metric in the Lie algebra of the diffeomorphism group, this directly relates to the well-known geodesic equation, often called EPDiff, that expresses momentum conservation.

We will describe this approach, with a special focus on the situation in which additional constraints are placed on the Eulerian velocity to ensure that it belongs to a finite dimensional subspace of the originally considered Hilbert space. This subspace, which is shape-dependent, is generated by a finite number of well chosen time-dependent vector fields that we call diffeons. Based on the resulting maximum principle, we will provide optimization algorithms for the registration problems (and a few related issues), with some preliminary numerical experiments in two dimensions.

Lecture for Graduate Students: An Interesting Space of Plane Curves

The definition and study of spaces of plane shapes has met a large amount of interest over the last ten years or so. It has important applications in object recognition (for the analysis of shape databases), and in medical imaging. The theoretical background involves the construction of infinite-dimensional manifolds of curves, in a Riemannian framework, which is appealing, because it provides shapes spaces with a rich structure, which is also useful for applications.

The presentation focuses on a particular Riemannian metric that has very a specific property, in that it can be characterized as an image of a Grassmann manifold by a suitably chosen Riemannian submersion. A consequence of this is that its analysis becomes relatively easy, with, for example, the possibility to compute geodesics explicitly.