IP/DIFFERENTIAL GEOMETRY/PDE SEMINAR

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A class of Riemannian metrics for shape deformation analysis

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In recent years the rapid development of precise acquisition techniques for medical data has prompted mathematical work on the description and quantification of geometric deformation, and in fact for the metrization of "shape spaces"; examples of shapes are curves in two or three dimensions, surfaces, scalar images, tensor fields,measures, or sets of feature points. This is done in order to be able to perform statistical analysis on such spaces (e.g. template estimation, classification of shapes, temporal regression analysis, etc.), with the ultimate purpose of creating diagnostic software for illnesses that alter the shape of organic tissue in a characteristic way (such as Alzheimer's disease). An approach that has gained popularity involves the action of groups of diffeomorphisms on shape spaces, which induces Riemannian metrics on these; such approach is known as Large Deformation Diffeomorphic Metric Mapping (LDDMM) and was spearheaded by Alain Trouv, Michael I. Miller, Laurent Younes, and David Mumford. One may choose different metrics (inner products of vector fields) on the tangent space of the diffeomorphisms group, and these will correspondingly induce different metrics and geometries on the shape spaces they act on. After an introduction to the topic, in this talk we shall characterize the class of translation- and rotation-invariant metrics on group of diffeomorphisms. Also, we will provide several examples of metrics whose geodesics in the group are generated by curl-free or divergence-free vector fields. The latter are especially useful in medical applications where deformations are known to preserve volume (for example, for deformations of the tissues of the heart). We will conclude the talk by showing numerical visualizations of the geodesics and exponential maps in the group of diffeomorphisms.

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