Machine Learning, Fibre Bundles and Biological Morphology

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At present, evolutionary anthropologists using physical traits to study evolutionary relationships among living and extinct animals use carefully defined anatomical landmarks to extract information from morphological samples (such as bones and teeth). Identifying and recording these landmarks is time consuming. We are collaborating with evolutionary anthropologists, and in particular building numerical algorithms, to automatically determine biologically relevant distances between pairs of two-dimensional morphological surfaces (embedded in three-dimensional space) that use local structures and global information contained in their geometric relationships. Along with these distance computation, we also obtain geometric correspondences between anatomical surfaces, and analyze morphological data sets using this extra information in a machine learning framework, motivated by the geometric intuition of horizontal diffusion processes on a fibre bundle.