Estimation of the mean of a set of noisy images using a random diffeomorphic matching parametric model

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Abstract

Originating in Grenander's pattern theory, the problem of defining appropriate distances between shapes or images and the use of transformation groups to model the variability of natural images is now an active field of research. However, most of the existing results are stated in a deterministic setting while results in a random framework that are concerned with the estimation of deformations or a template image are scarce. In this talk, we consider a set of images randomly warped from a mean pattern which has to be recovered. For this, we define an appropriate statistical parametric model to generate random diffeomophic deformations in two-dimensions. Then, we focus on the problem of estimating the mean pattern when the images are observed with noise. This problem is challenging both from a theoretical and a practical point of view. M-estimation theory enables us to build an estimator defined as a minimizer of a well-taylored empirical criterion. We prove the convergence of our estimator and we propose an iterative algorithm to compute our M-estimator in practice. Some simulated images and a problem of image classification are used to illustrate the methodology.