A Bayesian Approach to Shape Registration

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With the advent of more advanced prenatal scanning technologies, there is a need for diagnostic tools for certain congenital conditions. This problem amounts to finding the distance in shape space between a noisily observed scan of a particular organ, be it brain or heart etc, and a library of shapes of organs from babies that had particular conditions.
We frame the problem as a Bayesian inverse problem on function space, where the functions of interest relate to the geodesic flow fields that deform one shape into the other. This is analogous to finding the velocity field in a Lagrangian data assimilation problem. Using regularity results regarding the forward problem, we identify minimal-regularity priors in order to make the inverse problem well-posed. We then present some numerics for simple 2D examples on closed curves, which show how the posterior distributions on function space can be sampled using MCMC methods.