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Diffeomorphic image matching with a preference for “simple” transformations

Image alignment, i.e. registration, is a fundamental problem in computer vision, including in medical imaging, where it allows comparison of images from different subjects or different times. While deep learning has made an important impact on this problem, the gold standard is still the geometric, or variational, approach which is based on geodesic flows in a diffeomorphism group (or in the group orbit of a particular image). A right-invariant Riemannian metric is used both to define the geodesics and to regularize the optimization problem by penalizing larger deformations.

We consider variants of diffeomorphic image registration that prefer “simple” deformations, defined as those in a pre-specified subgroup G , for example the affine group or a projective linear group. One approach is to use a Riemannian metric (or degenerate metric) that penalizes velocities tangent to G only very mildly (or not at all). While theoretically satisfying, this makes computing geodesics more difficult, so we also consider flows of fixed vector fields.