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Geometric Measures as Brain Shape Descriptors

Classification and identification of differences in brain anatomy (*i.e.*, differences in shape) can play an important role in Neuroscience. Methods such as Magnetic Resonance Imaging (MRI) are used to correlate brain structure and function, and to measure changes during development and disease.

Given a set of polygonal curves (not necessarily closed or connected), geometric measures involving combinations of writhe and average crossing numbers of subcurves, as well as ropelength and thickness, can be computed to obtain a set of features for the purpose of shape characterization. These measures, originally given for simple closed curves, can be defined in a natural way for a set of polygonal curves.

We apply these geometric measures to a set of curves obtained by tracing sulcal paths on the gray matter surface of human brains. These surfaces are extracted from MRI scans of human brains. We then compute these geometric measures to construct a feature vector which is used in a machine learning process. A clustering technique called multiple discriminant analysis is used to find an optimal projection of the feature space into a plane. This optimal planar projection minimizes the variance within a cluster, and maximizes the distance between distinct clusters.

In our preliminary results, an automatic differentiation between sulcal paths from the left or right hemispheres was possible. Also a male-female classification and younger-older classification was achievable.