

Geometric Methods for Curve Classification

Stephen M. Watt (smwatt@uwaterloo.ca)
Cheriton School of Computer Science
University of Waterloo, Canada

Abstract.

We consider the problem of classifying curves. Given points sampled from a curve γ in \mathbb{R}^n and a set Σ of similarly sampled curves, find the curve in Σ most closely matching the shape of γ . This problem arises in computer vision, trajectory analysis, biological morphometrics, high frequency trading and many other areas. We apply it to handwriting recognition. Rather than the usual point-matching strategies, we work with curves as geometric objects.

We consider an ink trace to be a segment of a plane curve $(x(s), y(s))$ parameterized by arc-length, $s \in [0, L]$. Approximating $x(s)$ and $y(s)$ as degree d polynomials gives a low-dimensional representation that depends neither on device resolution nor on writing speed. This allows a wide range of tools from numerical analysis and algebraic geometry to be brought to bear. In particular, expressing $x(s)$ and $y(s)$ in an orthogonal polynomial basis allows integral norms to be calculated as euclidean distances in coefficient space and accelerates shape matching from thousands of machine instructions to mere dozens.

In this talk we present the general orthogonal polynomial framework and algorithms that employ it. These include distance-based methods in coefficient space and symbolic-numeric algorithms for feature identification.