Non-linear dimensionality reduction: Riemannian metric estimation and the problem of geometric discovery

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In recent years, manifold learning has become increasingly popular as a tool for performing non-linear dimensionality reduction. This has led to the development of numerous algorithms of varying degrees of complexity that aim to recover man ifold geometry using either local or global features of the data.
Building on the Laplacian Eigenmap and Diffusionmaps framework, we propose a new paradigm that offers a guarantee, under reasonable assumptions, that any manifo ld learning algorithm will preserve the geometry of a data set. Our approach is based on augmenting the output of embedding algorithms with geometric informatio n embodied in the Riemannian metric of the manifold. We provide an algorithm for estimating the Riemannian metric from data and demonstrate possible application s of our approach in a variety of examples.

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