Mathematics > Numerical Analysis

Inverting Non-Linear Dimensionality Reduction with Scale-Free Radial Basis Interpolation

Nathan D. Monnig, Bengt Fornberg, Francois G. Meyer

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A numerical method is proposed to approximate the inverse of a general bi-Lipschitz nonlinear dimensionality reduction mapping, where the forward and consequently the inverse mappings are only explicitly defined on a discrete dataset. A radial basis function (RBF) interpolant is used to independently interpolate each component of the high-dimensional representation of the data as a function of its low-dimensional representation. The scale-free cubic RBF kernel is shown to perform better than the Gaussian kernel, as it does not require the difficult-to-choose scale parameter as an input, and does not suffer from ill-conditioning. The proposed numerical inverse is shown to be mathematically similar to the eigenvector interpolation known as the Nystr\"om method, a commonly used numerical method for rapid approximation of eigenvectors of a dense weight matrix. Based on this observation, a critique of the Nystr\"om method is provided, with suggestions for improvement.

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