Isometric sliced inverse regression for nonlinear manifolds learning

Wei-Ting Yao and Han-Ming Wu*
Department of Mathematics, Tamkang University

Abstract

Sliced inverse regression (SIR) was introduced to find an effective linear dimension-reduction direction to explore the intrinsic structure of high dimensional data. In this study, we present isometric SIR for nonlinear dimension reduction − a hybrid of the SIR method using the geodesic distance approximation. First, the proposed method computes the isometric distance between data points; the resulting distance matrix is then sliced according to hierarchical clustering results with rank-two ellipse seriation, and the classical SIR algorithm is applied. We show that the isometric SIR can recover the embedded dimensionality and geometric structure of a nonlinear manifold dataset (e.g., the Swiss-roll). We illustrate how isometric SIR features can further be used for the classification problems. Finally, we report and discuss this novel method in comparison to several existing dimension-reduction techniques.

Keywords: Hierarchical clustering, Isometric feature mapping (ISOMAP), Nonlinear dimension reduction, Nonlinear manifold, Rank-two ellipse seriation, Sliced inverse regression.

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*hmwu@mail.tku.edu.tw