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Kernel-Based Double Nearest Proportion Feature Extraction for Hyperspectral Image Classification

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Abstract : Over the past few years, kernel-based algorithms have been widely used to extend some linear feature extraction methods such as principal component analysis (PCA), linear discriminate analysis (LDA), and nonparametric weighted feature extraction (NWFE) to their nonlinear versions, kernel principal component analysis (KPCA), generalized discriminate analysis (GDA), and kernel nonparametric weighted feature extraction (KNWFE), respectively. These nonlinear feature extraction methods can detect nonlinear directions with the largest nonlinear variance or the largest class separability based on the given kernel function. Moreover, they have been applied to improve the target detection or the image classification of hyperspectral images. The double nearest proportion feature extraction (DNP) can effectively reduce the overlap effect and have good performance in hyperspectral image classification. The DNP structure is an extension of the k-nearest neighbor technique. For each sample, there are two corresponding nearest proportions of samples, the self-class nearest proportion and the other-class nearest proportion. The term “nearest proportion” used here consider both the local information and other more global information. With these settings, the effect of the overlap between the sample distributions can be reduced. Usually, the maximum likelihood estimator and the related unbiased estimator are not ideal estimators in high dimensional inference problems, particularly in small data-size situation. Hence, an improved estimator by shrinkage estimation (regularization) is proposed. Based on the DNP structure, LDA is included as a special case. In this paper, the kernel method is applied to extend DNP to kernel-based DNP (KDNP). In addition to the advantages of DNP, KDNP surpasses DNP in the experimental results. According to the experiments on the real hyperspectral image data sets, the classification performance of KDNP is better than that of PCA, LDA, NWFE, and their kernel versions, KPCA, GDA, and KNWFE.

Keywords : feature extraction, kernel method, double nearest proportion feature extraction, kernel double nearest feature extraction
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