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Self-Paced Nonnegative Matrix Factorization for Hyperspectral Unmixing

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Abstract

The presence of mixed pixels in the hyperspectral data makes unmixing to be a key step for many applications. Unsupervised unmixing needs to estimate the number of endmembers, their spectral signatures, and their abundances at each pixel. Since both endmember and abundance matrices are unknown, unsupervised unmixing can be considered as a blind source separation problem and can be solved by nonnegative matrix factorization (NMF). However, most of the existing NMF unmixing methods use a least-squares objective function that is sensitive to the noise and outliers. To deal with different types of noises in hyperspectral data, such as the noise in different bands (band noise), the noise in different pixels (pixel noise), and the noise in different elements of hyperspectral data matrix (element noise), we propose three self-paced learning based NMF (SpNMF) unmixing models in this article. The SpNMF models replace the least-squares loss in the standard NMF model with weighted least-squares losses and adopt a self-paced learning (SPL) strategy to learn the weights adaptively. In each iteration of SPL, atoms (bands or pixels or elements) with weight zero are considered as complex atoms and are excluded, while atoms with nonzero weights are considered as easy atoms and are included in the current unmixing model. By gradually enlarging the size of the current model set, SpNMF can select atoms from easy to complex. Usually, noisy or outlying atoms are complex atoms that are excluded from the unmixing model. Thus, SpNMF models are robust to noise and outliers. Experimental results on the simulated and two real hyperspectral data sets demonstrate that our proposed SpNMF methods are more accurate and robust than the existing NMF methods, especially in the case of heavy noise.

Keywords

Author Keywords: [Hyperspectral imaging](#); [Adaptation models](#); [Measurement](#); [Data models](#); [Data mining](#); [Sun](#); [Hyperspectral unmixing](#); [nonnegative matrix factorization \(NMF\)](#); [self-paced learning \(SPL\)](#)

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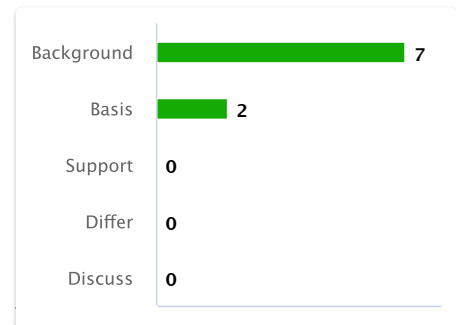
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