Hyperspectral Imagery (HSI) is an important remote sensing modality which gathers spectral data of ground scenes with high resolutions (both spectral and spatial) and high dynamic ranges. Typically, HSI is described in terms of a generative model given by:

\[ x_{i,j} = \sum_{l=1}^{M} \phi_l(\lambda) a_{i,j,l} \]

Contribution of \( k \)th Dictionary Element
Under the assumption that each material in any given scene has a distinct spectrum, and that each pixel contains few materials, HSI can be modeled as sparse, i.e. most coefficients are exactly zero. To find the materials which resulted in the measured spectrum, the pixel is unmixed, a process which recovers the coefficients under non-negativity constraints, given a known material spectrum dictionary. We propose using a statistical method to learn dictionaries suitable for sparse coding of HSI originally proposed by Olshausen and Field for natural images. As opposed to endmember analysis, which models the convex hull the data, sparse decomposition dictionaries attempt to directly align to the data manifold.

We test here the application of statistical dictionary learning to uncover spectral shapes suitable for sparse encoding of HSI data. We find that:

1) The learned dictionaries closely resemble true material spectra.
2) Decompositions of HSI data into these spectra are spatially consistent and capture subtleties within classes.
3) These dictionaries locally approximate segments of the underlying manifold.
4) The representation of the data in these learned spectra are useful as a dimensionality reduction tool for material classification.

We believe that these results could provide insight and computationally feasible approaches to further analysis using HSI data, such as path navigability based on water depth and shrubbery type.

Contact Information:
acharles6@gatech.edu, baolshausen@berkeley.edu, crozell@gatech.edu