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# Spatial data mining to extract land cover fractions using constrained SUnSAL

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Spatial data provide land cover (LC) information that describes how much of a region is covered by forests, wetlands, impervious surfaces, etc. Generally, LC features occur at finer spatial scales than the resolution of most remote sensing sensors mounted either on space borne satellites or aircrafts. Therefore, classification at subpixel level is required to extract LC information from these data through linear mixture model (LMM). Two constraints are imposed on the abundance fractions obtained from a LMM: 1) abundance non negativity constraint (ANC) and 2) abundance sum-to-one constraint (ASC). ANC restricts the abundance values from being negative and ASC confines the sum of the abundance values of all the classes to one.

In this paper, we discuss about constrained SUnSAL (Sparse unmixing via variable splitting and augmented Lagrangian) (Bioucas-Dias and Figueiredo, 2010), which enforces both ANC and ASC on the solution to obtain LC class information at subpixel level. It is based on the alternating direction method of multipliers, which can be derived as a variable splitting procedure followed by the adoption of an augmented Lagrangian method to solve the constrained problem. Sparse techniques are meant to fundamentally look for the endmembers in a spectral library containing spectra of many materials (available a priori), with only a few of them present in a pixel, i.e., the vector of fractional abundances is sparse. However, in this study constrained SUnSAL is applied with lower number of endmembers.

Firstly, computer simulated noise-free and noisy data (Gaussian noise of different noise variance: 2, 4, 8, 16, 32, 64, 128 and 256) were unmixed with a set of global endmembers (substrate – S, vegetation – V and dark objects – D) in the NASA Earth Exchange. In the second set of experiments, a spectrally diverse collection of 11 cloud free scenes of Landsat-5 TM data representing an agricultural scenario in Fresno, California, USA were unmixed and validated using ground vegetation cover. Finally, Landsat-5 TM data for an area of San Francisco (an urbanized landscape), USA was classified and compared with the fractional estimates of World View-2 data (2 m spatial resolution) for validation. The results were evaluated by using descriptive statistics, correlation coefficient (cc), RMSE, probability of success, boxplot and bivariate distribution function. With computer simulated data, constrained SUnSAL rendered a cc (statistically significant at 0.99 confidence level, p-value < 2.2e-16) of 0.74 for endmember 1, 0.87 for endmember 2, and 0.83 for endmember 3 at 256 noise variance (highest noise level). For an agricultural setup, mean absolute error (MAE) of vegetation fraction between actual and estimated values was 0.08 and cc was 0.98. For the urban landscape, MAE was 0.09 for S, 0.06 for V and 0.06 for D and cc were 0.87, 0.88 and 0.63 for S, V, and D respectively.

## Biography

Uttam Kumar holds a Bachelor's Degree in Computer Science, Master's Degree in Geoinformation Science, and Ph.D. in Algorithms for Geospatial Data Analysis. Currently he is a NASA Postdoctoral Fellow at the NASA Ames Research Center, Moffett Field, California, USA. He has published 24 research papers in International Journals, 4 Book chapters, and 35 papers in Conference Proceedings. His areas of research are remote sensing, digital image processing, data mining, free and open source software and geospatial data analysis. He is a member of IEEE.

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