Graph-based approaches to analysis of complex spectral imagery

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Quantitative information extraction from remotely sensed spectral imagery requires models for the "background" and "foreground" image signatures. Given these models, one can then make decisions per-pixel as to the likelihood of the presence of a signature of interest, the likelihood that a particular pixel has undergone significant, abnormal changes, or that the pixel of interest is somehow an anomaly as compared to the rest of the image. Traditional processing schemes rely on statistical or linear subspace models and have been successful in several applications. However, the new generation of sensors has a significant improvement in spatial and spectral coverage and resolution. For example, the space-based Worldview-2 sensor has spatial resolution of ~2m in 8 spectral bands in the visible - near infrared spectrum, while airborne hyperspectral imagery has similar or better spatial resolution with ~200 contiguous, narrow spectral channels in the visible - short wave infrared. These sensors image the Earth's surface at ever-greater levels of detail making it simple to show that assumptions of normality, or that the data are well-defined by linear subspaces, are not well-met. New approaches based on graphical data models and graphical operators will be introduced as a basis for novel algorithms. However, these approaches also present significant computational challenges for efficient implementation. We will describe new data-driven algorithms for applications such as non-linear data transformations, spectral clustering and detection with the intent of showing the promise of such approaches for analysis of complex imagery.