Contribution ID: **9** Type: **Spotlight talk**

Analyzing Remote Sensing Data With Knowing Few

Monday 6 December 2021 11:00 (15 minutes)

The emerging advances in imaging technologies pave the way for the availability of a multitude of complementary data (e.g., spectral, spatial, elevation) in Earth sciences. Recently, hyperspectral imaging techniques have arisen as the most important tool to remotely acquire fine-spectral information from different materials/organisms. Nonetheless, such datasets require dedicated processing for most applications due to the 1) high-dimensionality of an HSI and 2) highly-mixed nature of pixels within an HSI. In addition, fine-spectral information usually comes at the cost of coarse spatial resolution due to the trade-off between spectral and spatial resolutions in hyperspectral imaging systems. Therefore, several machine learning techniques (e.g., supervised learning and unsupervised learning) were proposed in the last decades to alleviate such challenges.

Unsupervised learning techniques have become popular among the proposed machine learning techniques since they do not rely on labeled samples for clustering. Data points in a high-dimensional dataset can be drawn from a union of lower-dimensional subspaces, thus subspace-based clustering approaches, specifically, sparse subspace clustering (SSC) concept has drawn special attention to cluster high-dimensional data into meaningful groups. SSC-based approaches benefit from the so-called "self-expressiveness" property, where each data point can be written as a linear combination of other data points from the same subspace. Such algorithms, hence are able to process and tackle high-dimensional and highly-mixed nature of HSIs, as is the case in real-world applications (e.g., urban-, land-cover-, and mineral-mapping). However, the superior performance of SSC is counterbalanced with demanding high computational power and being time-consuming compared to traditional clustering approaches. In addition, the number of clusters of interest needs to be predefined prior to the clustering procedure.

We proposed the following studies to mitigate the aforementioned challenges and develop automatic, robust, and fast clustering approaches to analyze remote sensing datasets.

- We studied the performance of different sparse subspace-based clustering algorithms on drill-core hyperspectral domaining [1];
- We developed a fast, robust, and automatic sparse subspace-based clustering algorithm, the "hierarchical sparse subspace clustering (HESSC)" to analyze HSIs " [2];
- To incorporate spatial information in the clustering procedure, we proposed a hidden-Markov random subspace-based clustering algorithm for HSI analysis [3];
- To improve the final clustering result and fully exploit spatial information in the clustering procedure, we proposed a multi-sensor hidden-Markov random subspace-based clustering and multi-sensor sparse-based clustering (Multi-SSC) algorithms, where the former utilizes a post-processing step to refine the generated in accordance with spatial information, while the latter uses the spatial and contextual information within the clustering structure schema. Worthy to indicate that the spatial and contextual information is derived from high spatial-resolution images, whereas the rich spectral information is extracted from an HSI [4], [5].
- Prior to any analysis procedure, one needs to conduct preprocessing steps to decrease the effect of the noise (e.g., atmospheric effects, instrumental noises) contaminating the data. It is crucial to precisely carry on the preprocessing steps. We studied the impact of applying a denoising technique before and after atmospheric corrections. The observations challenge the current *de facto paradigm* of denoising in a processing chain of spaceborne and airborne remotely sensed images [6].

References

[1] Shahi, K. R., Khodadadzadeh, M., Tolosana-Delgado, R., Tusa, L., and Gloaguen, R. (2019, September). The Application Of Subspace Clustering Algorithms In Drill-Core Hyperspectral Domaining. In 2019 10\textit{th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS)} (pp. 1-5). IEEE.
[2] Rafiezadeh Shahi, K., Khodadadzadeh, M., Tusa, L., Ghamisi, P., Tolosana-Delgado, R., and Gloaguen, R. (2020). Hierarchical Sparse Subspace Clustering (HESSC): An Automatic Approach for Hyperspectral Image Analysis. \textit{Remote Sensing}, 12(15), 2421.
[3] Rafiezadeh Shahi, K., Ghamisi, P., Jackisch, R., Khodadadzadeh, M., Lorenz, S., and Gloaguen, R. (2020). A New Spectral-Spatial Subspace Clustering Algorithm For Hyperspectral Image Analysis. \textit{ISPRS Annals

of Photogrammetry, Remote Sensing and Spatial Information Sciences}. V-3-2020. 185-191. 10.5194/isprs-annals-V-3-2020-185-2020.
[4] Rafiezadeh Shahi, K., Ghamisi, P., Jackisch, R., Rasti, B., Scheunders, P., and Gloaguen, R. A multi-sensor subspace-based clustering algorithm using RGB and hyperspectral data. In 2021 11\textit{th Workshop on Hyperspectral Imaging and Signal Processing: Evolution in Remote Sensing (WHISPERS)}(pp. 1-5). IEEE.
[5] Rafiezadeh Shahi, K., Ghamisi, P., Rasti, B., Jackisch, R., Scheunders, P., and Gloaguen, R. (2020). Data Fusion Using a Multi-Sensor Sparse-Based Clustering Algorithm. Remote Sensing, 12(23), 4007.
[6] Rafiezadeh Shahi, K., Rasti, B., Ghamisi, P., Scheunders, P., and Gloaguen, R. When is the right time to apply denoising. In 2021 IEEE Geoscience and Remote Sensing Symposium, IEEE.

Physical Presentation

I would not feel comfortable to present in front of an audience and prefer a video (call) presentation.

Primary authors: Mr RAFIEZADEH SHAHI, Kasra (Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Freiberg 09599, Germany.); Prof. GHAMISI, Pedram (Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Freiberg 09599, Germany.); Dr RASTI, Behnood (Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Freiberg 09599, Germany.); Prof. SCHEUNDERS, Paul (Imec-Visionlab, department of Physics, University of Antwerp, 2000 Antwerp, Belgium); GLOAGUEN, Richard (Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Freiberg 09599, Germany.)

Presenter: Mr RAFIEZADEH SHAHI, Kasra (Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Freiberg 09599, Germany.)

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