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Factor models for multivariate imaging

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Abstract

Multivariate or spectral imaging aims at collecting multi-dimensional measurements at several locations generally arranged over a regular 2-dimensional spatial grid. Each image pixel is thus characterized by a vector (sometimes referred to as a spectrum) of several hundreds of components. This collection of measurements allows the scene of interest to be characterized in terms of spatial distributions of the physico-chemical elements. This kind of imaging is intensively used in various application fields, including remote sensing for Earth observation and planetology (multispectral and hyperspectral imaging), astronomy and astrophysics (e.g., MUSE and JWST), spectro-microscopy (EELS, cathodoluminescence, Raman spectroscopy) and medical imaging (dynamic positron emission tomography, magnetic resonance spectroscopic imaging). Analyzing and processing such multivariate images generally require an explicit modeling of the redundancy inherent to the data, often by conducting a factor or subspace modeling.

This talk will survey and compare the most common factor models (e.g., PCA, ICA, MCR, NMF), their specificities and their underlying hypotheses. Then, it will show how factor modeling helps to solve various kinds of inverse problems, such as spectral mixture analysis, denoising, inpainting or multi-resolution image fusion. To illustrate the concepts, recent results will be presented coming from various applicative fields, including Earth observation, EELS microscopy and functional medical imaging.

Joint work with my colleagues Thomas Oberlin, Cédric Févotte, Nathalie Brun, Clovis Tauber and Olivier Berné and my former Ph.D. students Yoann Altmann, Qi Wei, Etienne Monier, Yanna Cavalcanti and Claire Guilloteau.

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