# Thesis Defense

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**10h00**
**INP-ENSEEIHT, Salle des thèses**


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# Modeling spatial and temporal variabilities in hyperspectral image unmixing

*Jury:*

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*Abstract:* Acquired in hundreds of contiguous spectral bands, hyperspectral (HS) images have received an increasing interest due to the significant spectral information they convey about the materials present in a given scene.

However, the limited spatial resolution of hyperspectral sensors implies that the observations are mixtures of multiple signatures corresponding to distinct materials. Hyperspectral unmixing is aimed at identifying the reference spectral signatures composing the data — referred to as endmembers — and their relative proportion in each pixel according to a predefined mixture model. In this context, a given material is commonly assumed to be represented by a single spectral signature.

This assumption shows a first limitation, since endmembers may vary locally within a single image, or from an image to another due to varying acquisition conditions, such as declivity and possibly complex interactions between the incident light and the observed materials. Unless properly accounted for, spectral variability can have a significant impact on the shape and the amplitude of the acquired signatures, thus inducing possibly significant estimation errors during the unmixing process.

A second limitation results from the significant size of HS data, which may preclude the use of batch estimation procedures commonly used in the literature, i.e., techniques exploiting all the available data at once. Such computational considerations notably become prominent to characterize endmember variability in multi-temporal HS (MTHS) images, i.e., sequences of HS images acquired over the same area at different time instants.

The main objective of this thesis consists in introducing new models and unmixing procedures to account for spatial and temporal endmember variability. Endmember variability is addressed by considering an explicit variability model based on the total least square problem, and extended to account for time-varying signatures.

The variability is first estimated using an unsupervised deterministic optimization procedure based on the Alternating Direction Method of Multipliers (ADMM). Given the sensitivity of this approach to abrupt spectral variations, a robust model formulated within a Bayesian framework is introduced. This formulation enables smooth spectral variations to be described in terms of spectral variability, and abrupt changes in terms of outliers.



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Finally, the computational restrictions induced by the size of the data is tackled by an online estimation algorithm. This work further investigates an asynchronous distributed estimation procedure to estimate the parameters of the proposed models.