# How to properly analyze hyperspectral images?

## > Context / customer need

Hyperspectral imaging has applications in many fields, including agriculture, environment, medicine and industry. This so-called "chemical" imaging makes it possible to characterize the chemical composition of products at each point of an image, thanks to the near-infrared spectrum measured for each pixel. It can thus be used to classify objects according to their composition, or to quantify compounds present on the surface and show their spatial distribution.

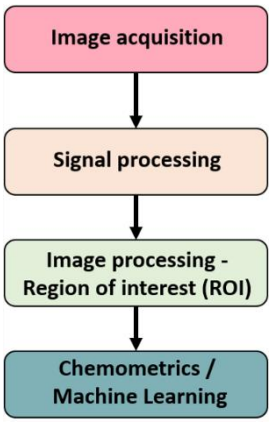
In order to optimize the hyperspectral image analysis, it is essential to follow an adapted methodology, by applying the good practices of image acquisition, signal processing, image processing, and also Chemometrics / Machine learning methods applicable to hyperspectral images.

This study was carried out in collaboration with INRAE (UMR ITAP, Team COMIC) and IFV (IFV Occitanie - Languedoc Roussillon) as part of the VINIoT project, co-funded by the Interreg SUDOE program. In this frame, INRAE wanted to answer its issue of **hyperspectral image analysis for predicting the maturity of grape bunches in the vineyard**. The project aimed at providing SMEs in the wine sector with a tool for monitoring their plantations in real time, remotely and at different levels of precision (grapes, plants, plots and vineyards).

## > Hyperspectral image analysis methodology

**Hyperspectral Imaging** (HSI) is an analysis technique that combines the principles of conventional imaging and vibrational spectroscopy. It provides both spatial and spectral information related to the chemical composition of the sample being analyzed.

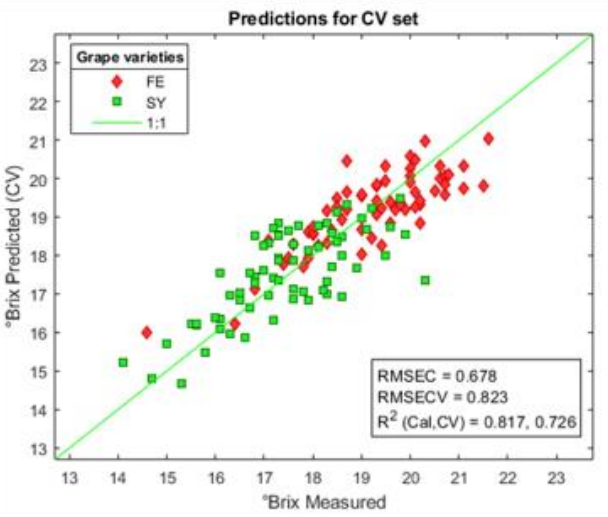
To properly analyze the hyperspectral data, it is essential to follow a rigorous methodology starting with the image acquisition and ending with processing the database by applying Chemometrics and Machine Learning methods. These different steps (see opposite) can be applied for building quantification and classification / discrimination models.



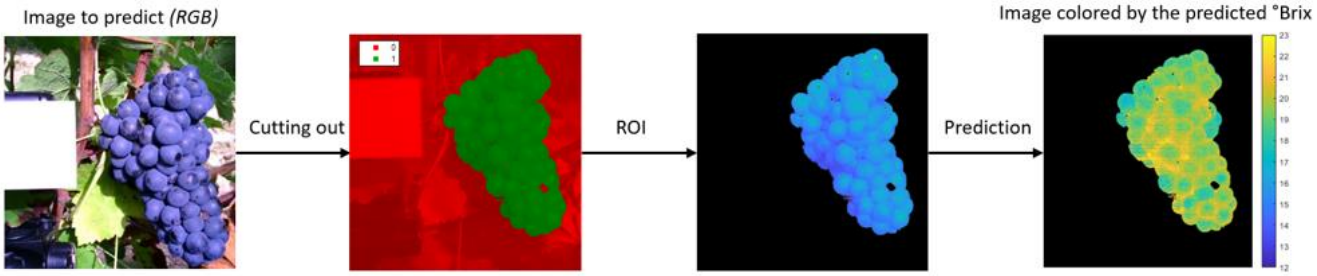
## > Ondalys application

In the frame of the Interreg project VINIoT, INRAE (UMR ITAP, COMIC team) and IFV (IFV Occitanie – Languedoc Roussillon), hyperspectral images had been obtained with the SPECIM IQ (SPECIM – Konica Minolta) portable visible – near-infrared hyperspectral camera. The database included hyperspectral images of 2 red grape varieties (Fer Servadou and Syrah), measured on 4 maturity dates. The parameter to be predicted is the sugar content expressed in °Brix.

The processing methodology was applied according to the flowchart presented previously. The first step in image processing was to explore the images in the database to understand the data. This step was necessary in particular, to determine the strategy for the 2nd step, i.e. the extraction of the region of interest (ROI). Finally, the last step consisted in developing and then applying a SVM-R (Support Vector Machines - Regression) model to all the images.




The results obtained by predicting the sugar content (°Brix) using a SVM-R model after a SNV (Standard Normal Variate) preprocessing are encouraging.




## > Conclusion

In the case of the VINIoT project, the combination of hyperspectral imaging and chemometrics proved to be a promising solution for assessing grape maturity at plot level. The PCA-based identification strategy and the use of MIA_Toolbox® proved effective in extracting the region of interest. The optimized SVM-R model demonstrated its ability to predict sugar levels despite the complexity of vineyard imaging.

## > Publications / Communications

*BOYER J., 2023. Comment bien analyser les données hyperspectrales – Ondalys Webinar, in partnership with SPECIM – Clapiers, France.*

For more scientific details, **ask-us the complete scientific study**.