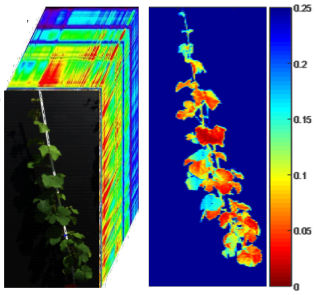
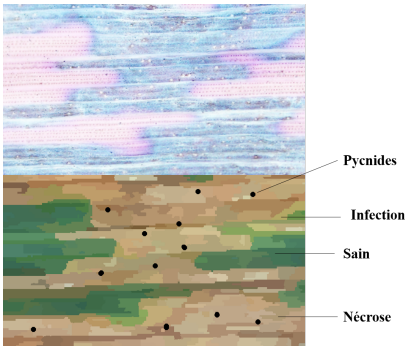
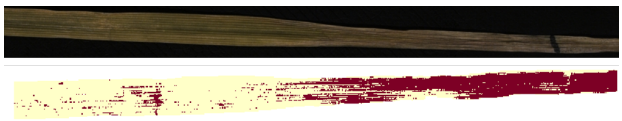
New tools for hyperspectral imaging: agro-environmental applications

Objectives of M2 interniship (M1 cæsura):
Parametric modelling in the space of covariance matrices, application to unsupervised segmentation of hyperspectral images.

Key-words: Hyperspectral, unsupervised segmentation, clustering, Bayesian statistics, Riemannian manifold,







Place :	UMR Itap, Inrae Montpellier
Main supervisor :	Florent Abdelghafour (Itap)
Collaboration :	Lionel Bombrun (UMR IMS Bordeaux, Bordeaux Sciences Agro)
Duration:	6 months from 01/02/2023

Description of the host laboratory:

The mix research unit, UMR Itap (INRAE), is a laboratory based in Montpellier (south France), which is dedicated to developing new methods and tools for tomorrow's agriculture (lien. Within this unit, the team COMiC (optical sensors for complex media) is developing optical based measurement systems associated with signal processing methods to characterise objects and media involved in key agricultural or environmental processes. The research conducted in the team are mainly based on spectrometry technologies in the UV, visible and near infrared domains and **hyperspectral imaging**.
COMiC has a long experience in analysing heterogeneous and multivariate data, in particular with the tools of chemometrics. The team is invested both in the development of new processing methods for spectral data and to innovating agro-environmental applications.//

Objectives:

The purpose of the internship is to explore new methods for the processing of hyperspectral images, especially for the evaluation of foliage material in the context of phenotyping and phytopathology. These new methods are based on covariance matrix type features, described by mixture models. It consists in exploiting jointly the spatial and spectral features of this type of data to perform unsupervised segmentation. To do so, the project has three thematics:

- (i) Developing spectro-spatial features as covariance matrices
- (ii) Model these features in the particular space of covariance matrices
- (iii) Algorithmic implementation for the characterisation of plant material

Activities:
The master student will have a literature corpus, technical notes and a group of scripts dedicated to (i) and (ii). These notions will have first to be assimilated with the help of the supervisors. Then different practical problems will be proposed regarding the time monitoring of fungal diseases (*e.g.* wheat's septoriosis, tomato's early blights) and the assessment of water stress (Sunflower, grapevine). Theoretical basis of this work rely mostly on parametric modelling and Bayesian statistics in the particular space of covariance matrices. Data acquisition and experiment design in growth chambers can also be included.

Profile:

- MSc, Ms.Eng and equivalents
- signal and image processing
- applied statistics
- programming and scientific computation (Python, Matlab, R)
- willing to assimilate theoretical notions
- interested in agriculture and environment

Compensation:
Legal rate according to current legislation (about 550 €/month)

Location and contacts:
Internship will take place in Montpellier (361 Rue Jean-François Breton, 34196 Montpellier)
Application (CV+ML) to be sent to Florent Abdelghafour (florent.abdelghafour-at-inrae.fr)