MACHINE LEARNING METHODS FOR SUGAR QUANTIFICATION IN GRAPES BASED ON NEAR-INFRARED HYPERSPECTRAL IMAGING

Julien BOYER[1], Jordane POULAIN[1], Dr Sylvie ROUSSEL[1], Nicolas SAURIN[2], Maxime RYCKWAERT[3], Ryad BENDOULA[3], Carole FEILHES[4] and Eric SERRANO[4]

[1]Ondalys, Clapiers, FRANCE - sroussel@ondalys.fr - [2]ITAP, Univ Montpellier, INRAE, Institut Agro, Montpellier, France - [3]UE Pech Rouge, Univ Montpellier, INRAE, Gruissan, France - [4]IFV Sud-Ouest, V'innopôle, Peyrole, France

1. Context

- **Objective :** grape bunch maturity prediction directly in vineyards
- **Database** from VINIoT project
  - 131 hyperspectral images
  - 2 red grape varieties (Fer Servadou N. and Syrah N.)
- **HSI Instrument :** SPECIM IQ (SPECIM - Konica Minolta)

2. Why using Hyperspectral Imaging[1] for quantification?

- Better representativity of the sample
- Knowledge about spatial distribution
- Hand-held instruments for easy use in the field

Constraints

- Lower signal to noise ratio compared to a classical spectrometer
- Reference value on the whole sample (No local reference value on each pixel)
- Measurements directly in the field

➔ high heterogeneity (weather, shadows, non-uniform background)

Solutions

- Average of pixels

➔ higher signal to noise ratio, representativity of the whole grape

- Spectral preprocessing
- Segmentation of the Region Of Interest (ROI) to remove background

3. Methodology & Results

- Segmentation:
  - Choice of some heterogenous images + manual selection of grapes
  - Raw normalization to attenuate the effect of non-uniform lightning
  - Soft Independent Modeling of Class Analogy (SIMCA[2]) ➔ $D = \sqrt{T2^2_{reduced} + Q^2_{reduced}}$
  - Segmentation on Image D with Particle Size Analysis (MIA_Toolbox® – Eigenvector Research Inc.)
- Average of the Region Of Interest (ROI) for each image
- Regression model: comparison of PLSR[3] and SVMR[4]
  - ➔ SVMR is significantly better at a risk of 5% (bootstrap testing)
- Application on the whole image to visualize spatial distribution

Segmentation

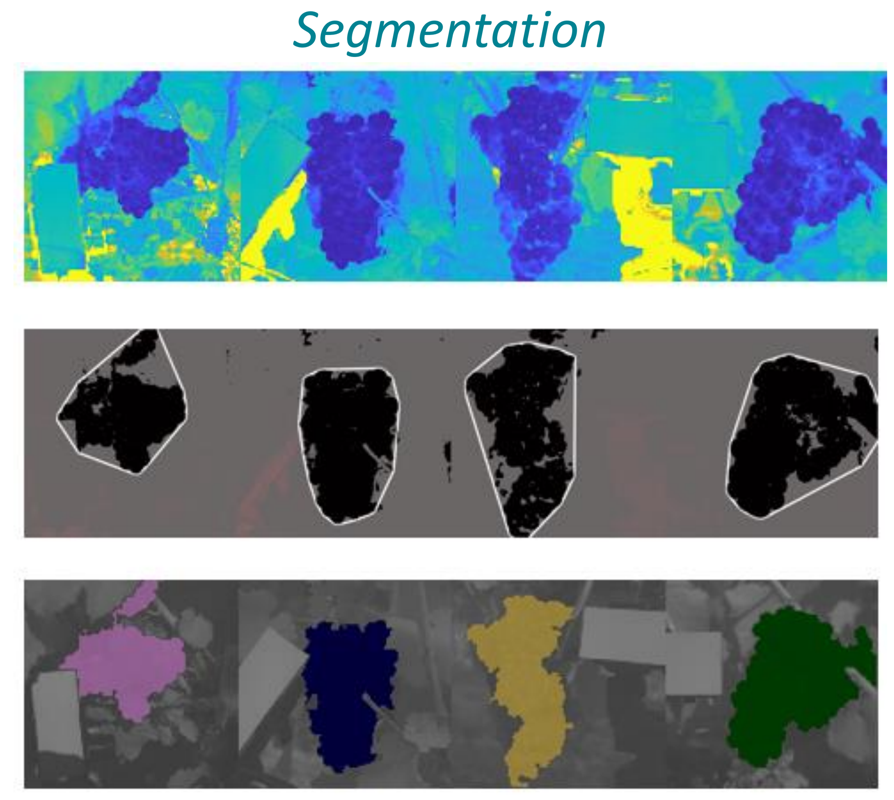


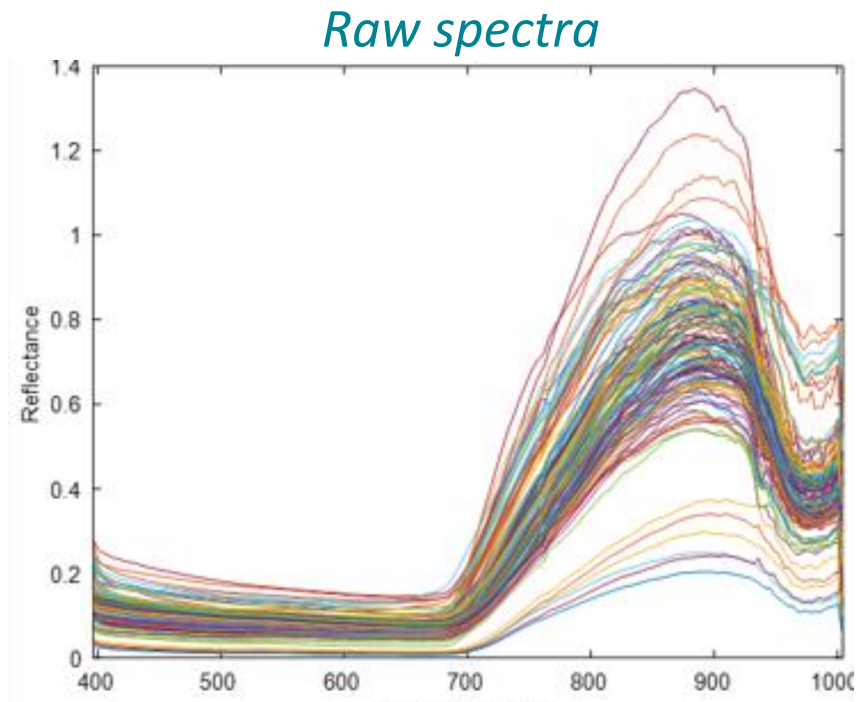
Image D

Thresholding

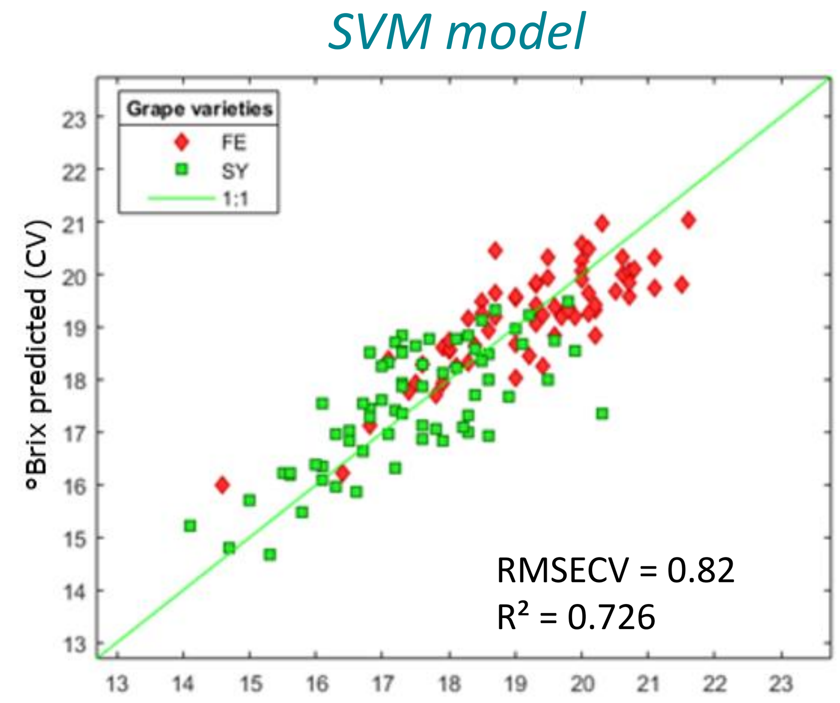
Final segmentation

MIA Toolbox® (Eigenvector Research Inc.)

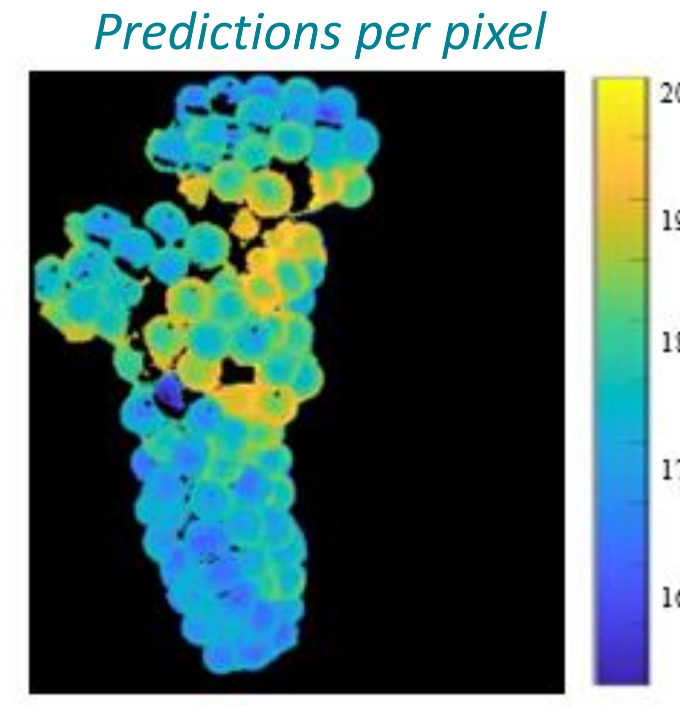
Raw spectra



SVM model



Predictions per pixel



Conclusions

- **Good prediction model performances** despite direct measurements in vineyards
- **Spatial distribution of sugar content** in grape bunches

ACKNOWLEDGMENTS

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www.ondalys.fr
contact@ondalys.fr