>>> **Feature Extraction**
>>> **GRSS Summer School**

Name: Mathieu Fauvel (UMR Dynafor)
Date: *[2017-04-26 Wed 10:30]–[2017-04-26 Wed 12:00]*

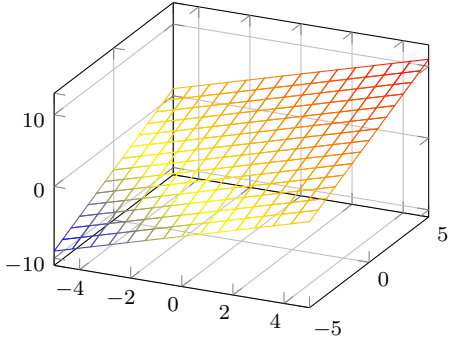
⋆ Curse of dimensionality: it is not possible to get enough data to cover all the observation space.

High dimensional saces are mostly empty !

- ⋆ Curse of dimensionality: it is not possible to get enough data to cover all the observation space.

High dimensional saces are mostly empty !

- ⋆ Multivariate data live in a lower dimensional space



- Feature extraction is important in remote sensing because:
  - It reduces the size of the data,
  - It limits the spatial and spectral redundancy,
  - It permits visualization of the data,
  - It mitigates the *curse of dimensionality*.
- Extraction techniques:
  - Spectral
    - Physically based method,
    - Statistical methods.
  - Spatial:
    - Linear filters,
    - Non linear techniques (Mathematical Morphology)

- Spectral indices are a linear/non-linear combination of two (or more) spectral bands.
- They provides information as a *single number* about:
  - Plant structure,
  - Biochemistry,
  - Humidity,
  - Stress.
- Four main types [TLH11]:

Name	Formulae
Difference vegetation index	$R_{\lambda_1} - R_{\lambda_2}$
Ratio vegetation index	$\frac{R_{\lambda_1}}{R_{\lambda_2}}$
Normalized difference vegetation index	$\frac{R_{\lambda_1} - R_{\lambda_2}}{R_{\lambda_1} + R_{\lambda_2}}$
Soil-adjusted vegetation index	$(1+L) \times \frac{R_{\lambda_1} - R_{\lambda_2}}{R_{\lambda_1} - R_{\lambda_2} + L}$

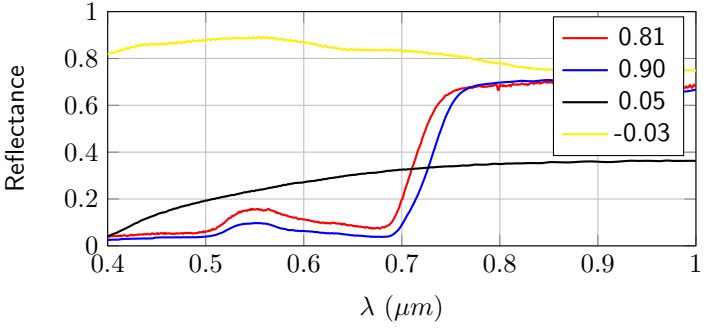
- *The three last indexes are invariant to a multiplicative factor*

Index database : `http://www.indexdatabase.de/`

Name	Formulae (λ nm)
Normalized Difference Vnegetation index	$\frac{R_{\lambda_{800}} - R_{\lambda_{670}}}{R_{\lambda_{800}} + R_{\lambda_{670}}}$
Modified Soil-Adjusted Vegetation Index	$\frac{1}{2}\left[2R_{\lambda_{800}} + 1 - \sqrt{(2R_{\lambda_{800}} + 1)^2 - 8(R_{\lambda_{800}} - R_{\lambda_{670}})}\right]$
Modified Chlorophyll Absorption Ratio Index	$[(R_{\lambda_{700}} - R_{\lambda_{670}}) - 0.2(R_{\lambda_{700}} - R_{\lambda_{550}})] \times \frac{R_{\lambda_{700}}}{R_{\lambda_{670}}}$
Normalized Difference Water Index	$\frac{R_{\lambda_{858}} - R_{\lambda_{1240}}}{R_{\lambda_{858}} + R_{\lambda_{1240}}}$
Datt Reflectance Index	$\frac{R_{\lambda_{816}} - R_{\lambda_{2218}}}{R_{\lambda_{816}} + R_{\lambda_{2218}}}$
Normalized Difference Redness Index	$\frac{R_{\lambda_{540}} - R_{\lambda_{700}}}{R_{\lambda_{540}} + R_{\lambda_{700}}}$
Soil Brightness Index	$0.406R_{\lambda 550} + 0.600R_{\lambda 650} + 0.645R_{\lambda 750} + 0.243R_{\lambda 950}$

$$\text{NDVI} = \frac{R_{\lambda_{800}} - R_{\lambda_{670}}}{R_{\lambda_{800}} + R_{\lambda_{670}}}$$

- $-1 \leq \text{NVDI} \leq 1$
- NDVI < 0: surfaces other thatn plant cover
- NDVI ≈ 0: bare soil
- NDVI ≥ 0.1: vegetation cover (higher values correspond to more dense covers)

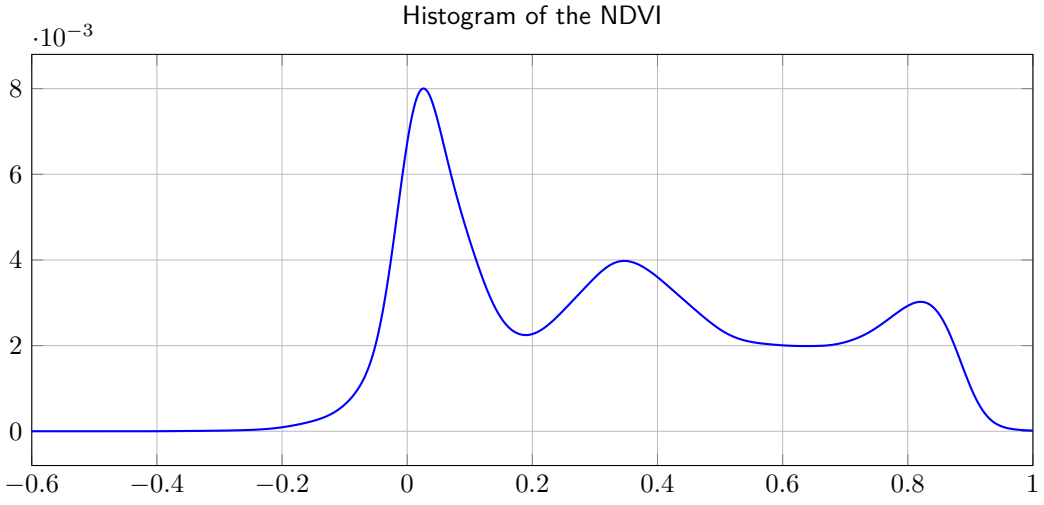


- ⋆ Peri-urban area
- ⋆ Rosis-3 sensor
- ⋆ 103 Spectral bands (400nm-900nm)
- ⋆ 1.5 meter per pixel spatial resolution
- ⋆ 610 $\times$ 340 pixels

- ⋆ OTB is a C++ library for remote sensing images processing.
- ⋆ It is free, open-source and available for most OS (window, apple, linux)
- ⋆ OTB-Applications are set of tools appropriated for big/large images
- ⋆ They are avalaible from QGIS, Python and Bash
- ⋆ To compute the NDVI

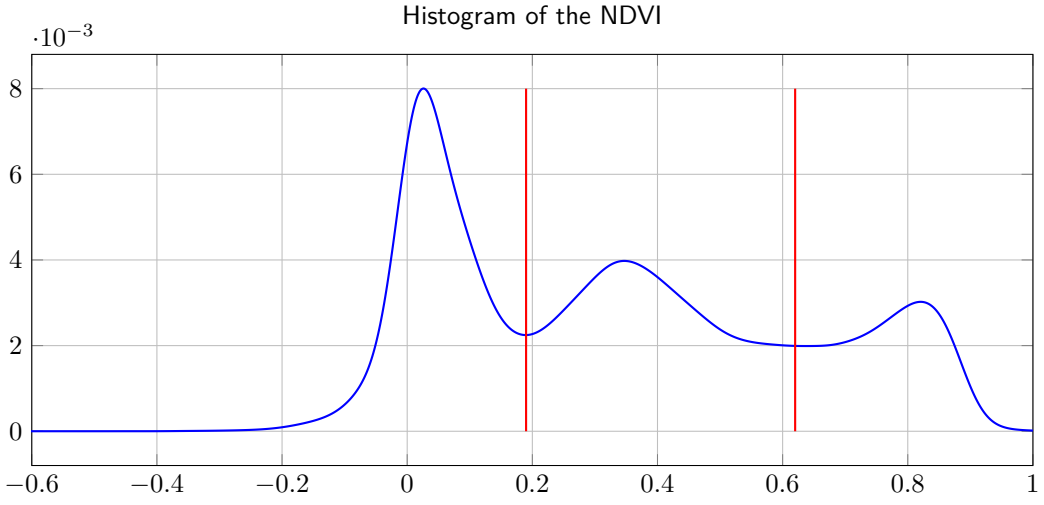
```
# Computation of the NDVI
otbcli_BandMath -il ../Data/university.tif -out ../Data/university_ndvi.tif \
-exp "(im1b83-im1b56)/(im1b83+im1b56)"

# Computation of the SBI
otbcli_BandMath -il ../Data/university.tif -out ../Data/university_sbi.tif \
-exp "0.406*im1b31 + 0.6*im1b52 + 0.645*im1b73"
```

>>> Where is the vegetation 1/2 ?



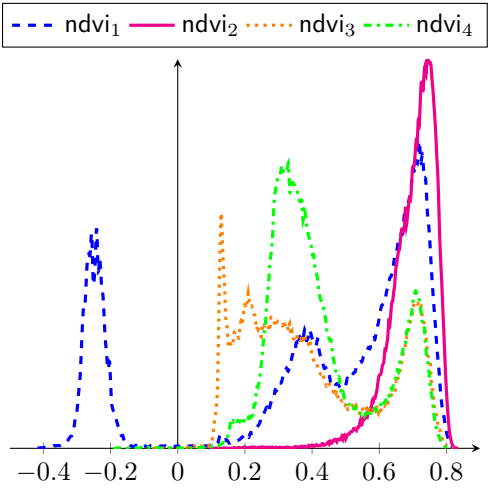

```
# Segmentation of the NDVI in three classes
otbcli_BandMath -il ../Data/university_ndvi.tif -out ../Data/university_ndvi_segmented.tif \
-exp "(im1b1<0.19?1:(im1b1<0.62?2:3))"
```

>>> Where is the vegetation 1/2 ?




```
# Segmentation of the NDVI in three classes
otbcli_BandMath -il ../Data/university_ndvi.tif -out ../Data/university_ndvi_segmented.tif \
-exp "(im1b1<0.19?1:(im1b1<0.62?2:3))"
```

Image



NDVI Histogram

From the histogram, which one does correspond to the NDVI of the image ?