POLARIMETRY EXERCISE IN PYTHON: SHIP DETECTION WITH QUAD POL AND DUAL POL DATA (ALOS PALSAR, RADARSAT-2 AND TERRASAR-X)

This exercise uses data from different bands and sensors, both quad pol and dual pol, to perform polarimetric analysis, do classification and detect ships.

List of datasets:

Sensor		Acquisition date	Image ID	Area
TerraSAR-X (X-Band)	Stripmap Polarisation: HH+ VV	2014-01-28 2014-03-02 2014-03-13 2014-04-15 2014-09-05	1483504 1483506 1483508 1483512 1623765	Buenos Aires
Radarsat-2 (C-Band)	Polarisation: HH+VV+HV+VH	2018-08-31 2017-09-22 2017-09-22	662586 588510 588510	Buenos Aires Puerto Madryn Puerto Madryn
ALOS PALSAR (L-Band)	Polarisation: HH+VV+HV+VH	2010-12-15 2011-04-06	ALPSRP260536120-L1.1 ALPSRP276866490-L1.1	Strait of Magellan Buenos Aires

Prior to this exercise, ensure you download and install (in the order listed below):

- SNAP (latest version)
- Anaconda: select installer for Python version 3.7 (the python version must not be 2.7, and should be higher than 3.2): https://www.anaconda.com/download/
- Install the Spectral package (http://www.spectralpython.net/installation.html), which is needed to open images in ENVI format. As part of the installation of this package you will need to:
    - Open the Anaconda prompt (command line)
    - Enter the commands shown in the Annex below (e.g. pip install spectral)

We will first import the data in SNAP, to save them in ENVI format. This will enable us to use them as an input for the second part, which is done in python.

In the python part, the python script called “Tutorial_CONAE_180927_quadpol.py” allows you to process the ALOS PALSAR and Radarsat-2 datasets listed above. You will see this script contains some sections called “QUIZ”, which are meant for you to fill in the correct solution. We will start by opening this script and you can spend some time thinking about how to complete the QUIZ parts. Then, the script called “Tutorial_CONAE_180927_quadpol_solutions.py” gathers the correct responses.

For dual pol data (like our TerraSAR-X dataset), the steps are similar. You can find them detailed in the python script called “Tutorial_CONAE_180927_dualpol_solutions.py”. You will see it differs from the quad pol script because the sections with subscript 3 have been removed.

1. Calibrate and save data in ENVI format using SNAP
   1.1. Open SNAP: Import / SAR Sensors / ALOS PALSAR CEOS if you are working with the ALOS PALSAR datasets.
   1.2. It is a good practice to radiometrically calibrate the data before exporting them: Radar / Radiometric / Calibrate. Select "Save as complex output" in the Processing Parameters tab.
   1.3. Export the calibrated output in ENVI format: Export / ENVI.
   Explore the folder where the ENVI images are. They are paired as a header "hdr" and data "img". In there, "i "stands for real part and "q" for imaginary part.

2. Load and process the images in python
   2.1. Spyder is the interface (the editor) to write and run Python commands.
   Right click on the "Tutorial_CONAE_180927_quadpol.py " file, Open With and select Spyder. In some cases you may be able to double click on the .py file to open the script in Spyder directly, or you may need to start Spyder and then, from the Open icon, open the script. In Windows you will find Spyder in the Start Menu in the folder Anaconda.

   2.2. Adapt the paths to the script location and to the datasets:
   - Lines 18 and 40: replace this path with the path to the folder where your python script is saved.
   - Line 49: enter the path to the folder where your dataset in ENVI format contains the data files.

   Note: Use double slashes in your paths. In a windows computer use double back slashes ("\\"), and in a linux computer use double forward slashes ("//").

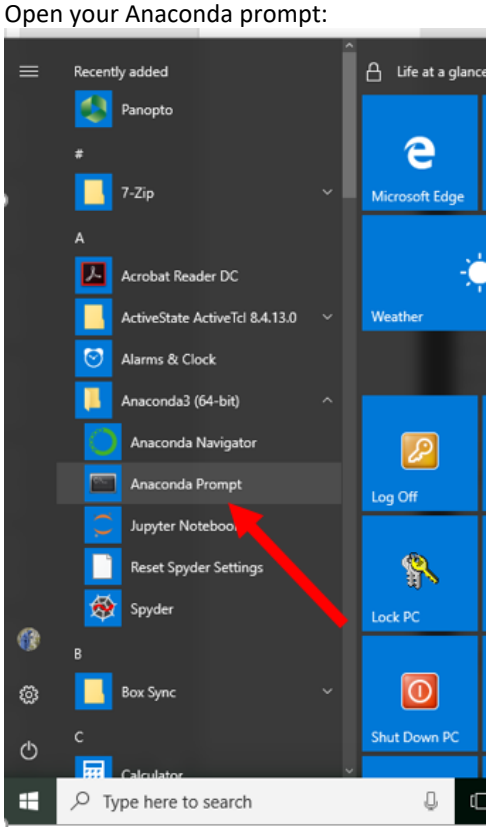
   2.3. Follow the comments on the script to load and process the data. The script covers the following steps:
   - Export image in ENVI format
   - Read ENVI images in Python
   - Data visualisation,
   - Making covariance matrices,
   - Applying the Cloude-Pottier decomposition
   - Ship detector (optional).

   2.4. Once loaded you can check the data are there by looking at "Variable explorer" (bottom right of your window)

   Extra information:
   - If you want to run the full script, click on the green Play button, or put the cursor on the script and press F5.
   - The code is separated in cells, which are units that can run separately. When the process reaches a particular cell, it is highlighted in light yellow.
   - To run a cell of the script press the symbol beside the green button or go with the cursor in the cell and press Ctrl + Enter.
   - To run some highlighted text in the script, highlight the text with the mouse and press F9.
   - The text in grey that is following an # is annotation (comment to the reader, not read by the machine).
   - To have graphics display as an extra window (which you may find easier), Tools / Preferences/ iPython console / Graphics / Backend: Automatic

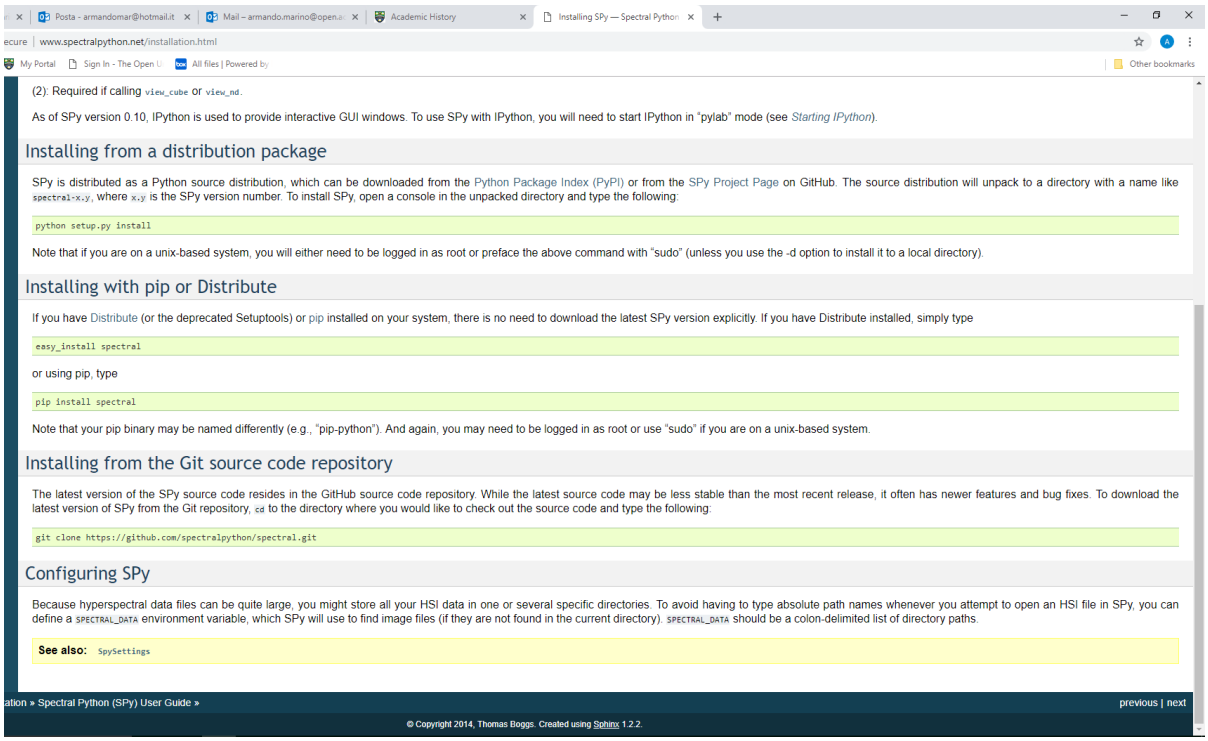
Annex – Commands for the installation of the Spectral package:

Open your Anaconda prompt:



The commands that appear in the screenshot below are (in order):

- python setup.py install
- easy_install spectral
- pip install spectral
- git clone https://github.com/spectralpython/spectral.git



(2): Required if calling `view_cube` or `view_nd`.

As of SPy version 0.10, IPython is used to provide interactive GUI windows. To use SPy with IPython, you will need to start IPython in "pylab" mode (see *Starting IPython*).

Installing from a distribution package

SPy is distributed as a Python source distribution, which can be downloaded from the Python Package Index (PyPI) or from the SPy Project Page on GitHub. The source distribution will unpack to a directory with a name like `spectral-x.y`, where `x.y` is the SPy version number. To install SPy, open a console in the unpacked directory and type the following:

```
python setup.py install
```

Note that if you are on a unix-based system, you will either need to be logged in as root or preface the above command with "sudo" (unless you use the -d option to install it to a local directory).

Installing with pip or Distribute

If you have Distribute (or the deprecated Setuptools) or pip installed on your system, there is no need to download the latest SPy version explicitly. If you have Distribute installed, simply type

```
easy_install spectral
```

or using pip, type

```
pip install spectral
```

Note that your pip binary may be named differently (e.g., "pip-python"). And again, you may need to be logged in as root or use "sudo" if you are on a unix-based system.

Installing from the Git source code repository

The latest version of the SPy source code resides in the GitHub source code repository. While the latest source code may be less stable than the most recent release, it often has newer features and bug fixes. To download the latest version of SPy from the Git repository, `cd` to the directory where you would like to check out the source code and type the following:

```
git clone https://github.com/spectralpython/spectral.git
```

Configuring SPy

Because hyperspectral data files can be quite large, you might store all your HSI data in one or several specific directories. To avoid having to type absolute path names whenever you attempt to open an HSI file in SPy, you can define a `SPECTRAL_DATA` environment variable, which SPy will use to find image files (if they are not found in the current directory). `SPECTRAL_DATA` should be a colon-delimited list of directory paths.

See also: `SpySettings`

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