

## Exercise 1: Introduction to image manipulation using Python

### Introduction

In this exercise, we will manipulate and analyze Sentinel-2 images using Python libraries. Please use the Jupyter Notebook provided to complete this exercise.

### Info

All parts in the code that require your input for completion are marked with the flag “#TODO”.

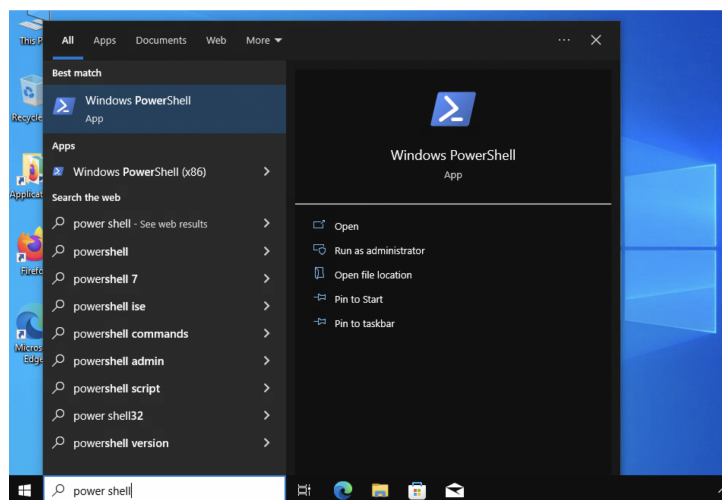
### Tasks

#### 1 Setup

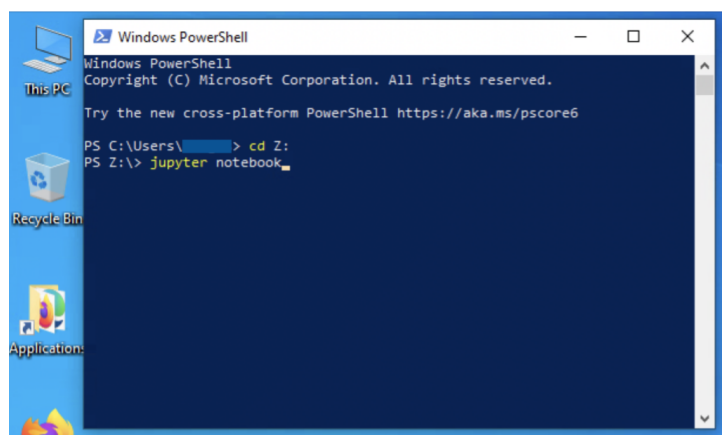
Follow the steps below to open the Jupyter Notebook of the exercise.

##### On the classroom computers

- 1.1 Download all the files for Exercise 1 available on Moodle, in your drive Z: if you are using the computers in the classroom.
- 1.2 Open PowerShell. This is a terminal where you can execute commands.



- 1.3 In the terminal, type `cd Z:` and press Enter to move to the drive Z:, and then type `jupyter notebook` and press Enter again to open Jupyter.



- 1.4 In Jupyter open the file `ex1.ipynb` by clicking on it.

**On your own computer** If you are working with your own computer, we recommend that you use the package manager `conda`. It enables you to create separate environments where all libraries needed for a specific project are installed.

- 1.1 Install Anaconda (Miniconda recommended) following these instructions .
- 1.2 Read this tutorial, if you are not familiar with `conda` environments.
- 1.3 Download all the files of the Exercise 1 available on Moodle, and move them to the directory where you will be working.
- 1.4 Open a terminal window in your chosen working directory.
- 1.5 Run the following commands with the environment name of your choice:

```
conda create -n name-of-env      # creates new env named name-of-env
conda activate name-of-env      # activate environment in terminal
conda install jupyter           # install jupyter + notebook
jupyter notebook                # start server + kernel inside name-of-env
```

Alternatively, you can open the Jupyter Notebook in VSCode.

- 1.6 A new tab should have appeared in your browser. In this tab, look for `ex1.ipynb` and open it.
- 1.7 Next time you want to open this notebook, you will simply need to use the following commands, in the correct location.

```
conda activate name-of-env      # activate environment in terminal
jupyter notebook                # start server + kernel inside name-of-env
```

## 2 Read images

Read the Sentinel-2 images using the function `imread` of the `skimage` library. You will find four image files when uncompressing the provided zip file (band2: blue, band3: green, band4: red, and band8: near infrared).

## 3 Save multi-band images as TIF files, and visualize them

- 3.1 Use the function `save_multiband_image` (provided in the Jupyter Notebook) to save, in tif files, the following images:
  - Natural color image
  - False color composite image
    - Near infrared → Red
    - Red → Green
    - Green → Blue
- 3.2 Read the saved images, normalize them using the function `get_normalized_image`, and use the function `imshow` of the `matplotlib` library to visualize the two saved images.

**Q** What changes significantly and what remains similar when comparing the false color composite image to the natural color image?

## 4 Crop images using bounding boxes

- 4.1 Use the function `crop_and_save_image` to crop the natural color image, and the false color composite image, using the following bounding boxes (pixel coordinates):
  - Region 1 → `y_min: 2500, x_min: 3090, y_max: 2590, x_max: 3180`
  - Region 2 → `y_min: 920, x_min: 1830, y_max: 1120, x_max: 2030`
- 4.2 Visualize the natural color image, and false color composite image of Region 1.

**Q** Some objects of different categories have similar colors in the natural color image. Which objects are similar in the natural color image but very different in the false color composite image?

4.3 Visualize the natural color image, and false color composite image of Region 2.

Q In general, with which colors are shown the roads, crops, and trees, in the false color composite image?

4.4 Now analyze the size of the cropped regions.

Q What is the shape of the numpy arrays of the two cropped regions?

Q The spatial resolution of the images is 10m. What is the area in square meters covered by each of the two cropped regions?