Exercise 1

The image **drone_blurr.tif** shown in Figure 1 turned out a bit blurry. Use one or several of the sharpening technques you have learned and see if you can make the image sharper. It is ok to transform the image to an 8-bit image and work only on this.
Describe the technique(s) you use and show the results.

Figure 1: Blurred image of solar panels with drone

Exercise 2

In this exercise you will work with two images taken with a thermal camera (infrared wavelengths). When monitoring solar panels we often take thermal images to detect defects and errors. The defects and errors will be warmer than the surroundings and therefore have high intensity in thermal images. There are two types of different defects that these images illustrate.
The first is an error on a whole string like shown in Figure 2A, the second is module defects showing up as individual points in the image as shown in Figure 2B.

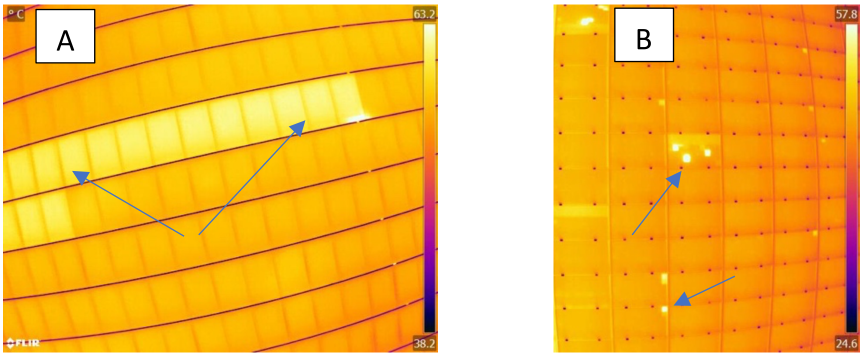

Figure 2: A) string fault with a bright line; B) module fault with individual spots

These two images are called **string.jpeg** and **module.jpeg** that you will download and import into python.

The task is the following:
Imagine that you work on a solar panel farm and you take such thermal images of all the modules at regular intervals to detect faults. Describe and show with these two examples images how you may distinguish these two faults from each other using the techniques you have learned in INF250.
Write down the different techniques you suggest to use and show examples on how you have carried them out. Include images to illustrate your steps.

Tip: plot histograms, split channels, try out thresholding (also in ImageJ for a quick test)

Exercise 3

In this task you will look at another image of a solar panel. The image you downloaded called **UVfluor.tif** shows a fluorescence effect and has a rather low contrast. In the image we look for dark areas that are cracks in the solar panel. From the image **UVfluor.tif** we want to obtain images like the ones in Figure 3 in order to detect cracks in the solar panels. Describe how you obtain these and include the scripts you used.

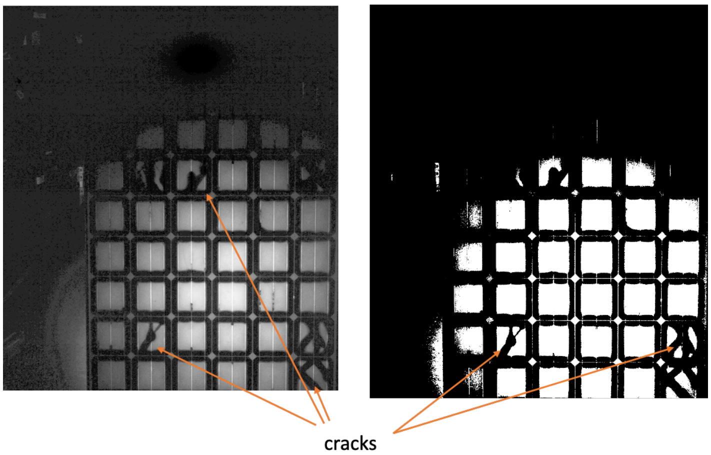

Figure 3: Left: high contrast image of cracks in solar panel. Right: Binary image with the cracks.

Exercise 4

In this exercise you will study a hyperspectral image airborne image (**hyperspectral_vnir.bsq and hyperspectral_vnir.hdr**) of solar panels in the visible and near infrared wavelengths (these are the same wavelengths as we had in lecture). A combination of three of the bands is shown in Figure 4.
Import the image to Python using the script handed out from the lectures.
If the image is too large for you to work on you may crop it as shown in the script.

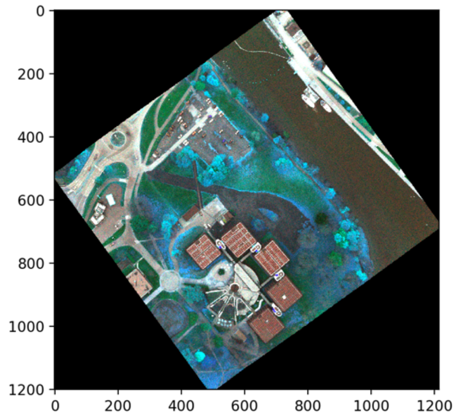

Figure 4: Three bands (10,48,70) combined of the hyperspectral image.

The task is as follows:

1) Locate three wavebands in the red, green and blue wavelength region and display them together to simulate an RGB image.
2) Display a spectrum from the following materials in the image: grass, solar panels, asphalt and water
3) For each of the materials, compute a mean spectrum of 20x20 pixels. Observe the difference
4) Compute an NDVI image as shown on the script from the lecture (NDVI = (Red-NIR)/(Red+NIR))
5) Compute a PCA and display the first 3 score images together with the loading plots. What do you see ? Can you identify the solar panels in any of the components ?
6) Compute a k-means clustering and show the results
7) Carry out a gaussian maximum likelihood classification with the selected classes. Suggestions for classes can be:
   1 – grass
   2 – asphalt
   3 – water
   4 – solar panel
   5 - the darker road in front of the solar panels
   Feel fre to experiment with classes.
   What do you think about the results ?