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EasyPCC_V2 - How to use

Version 1.0

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This package includes :

- 1) MainFileGUI.py
- 2) FunctionForSegmentation.py
- 3) FunctionToCreateTrainingData.py
- 4) FunctionToSelectROI.py
- 5) how_to_use_eng.pdf

This tutorial has been written using Windows 10 with a 64-bit Operating System, x64-based processor

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1. Anaconda Installation and Configuration

1.1 Install Anaconda

Go to the address : <https://www.anaconda.com/download/>

Click on 'Download' for python 3.6 version

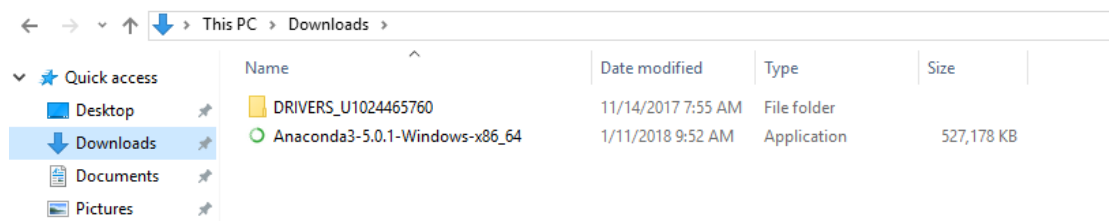
Python 3.6 version *

↓ Download

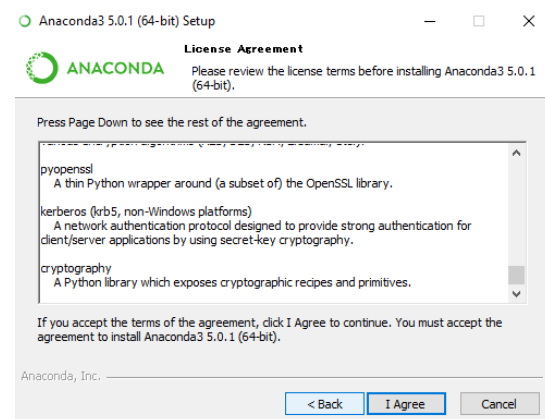
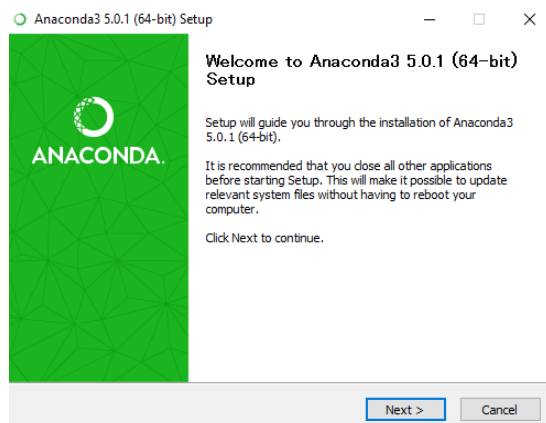
[64-Bit Graphical Installer \(569 MB\)](#) ?

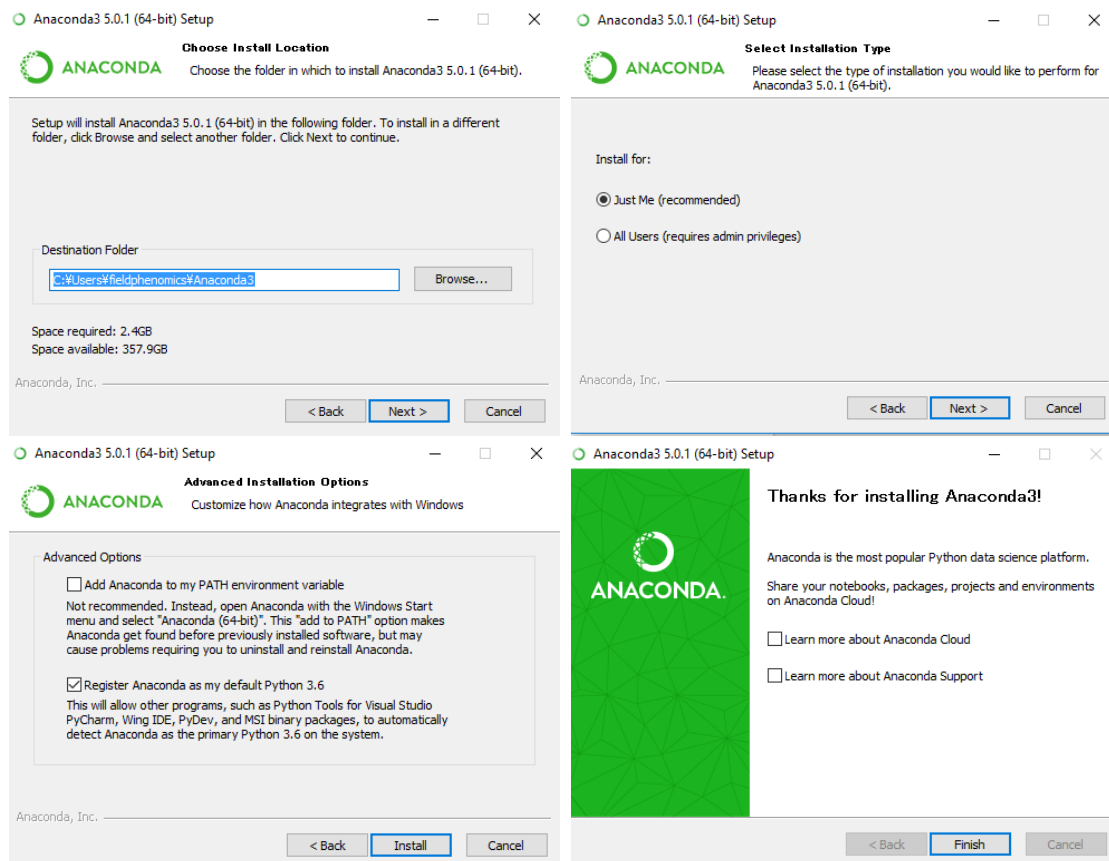
[64-Bit Command-Line Installer \(491 MB\)](#) ?

Go to the 'Downloads' directory and open the installer: Anaconda3-5.01-Windows-x86_64

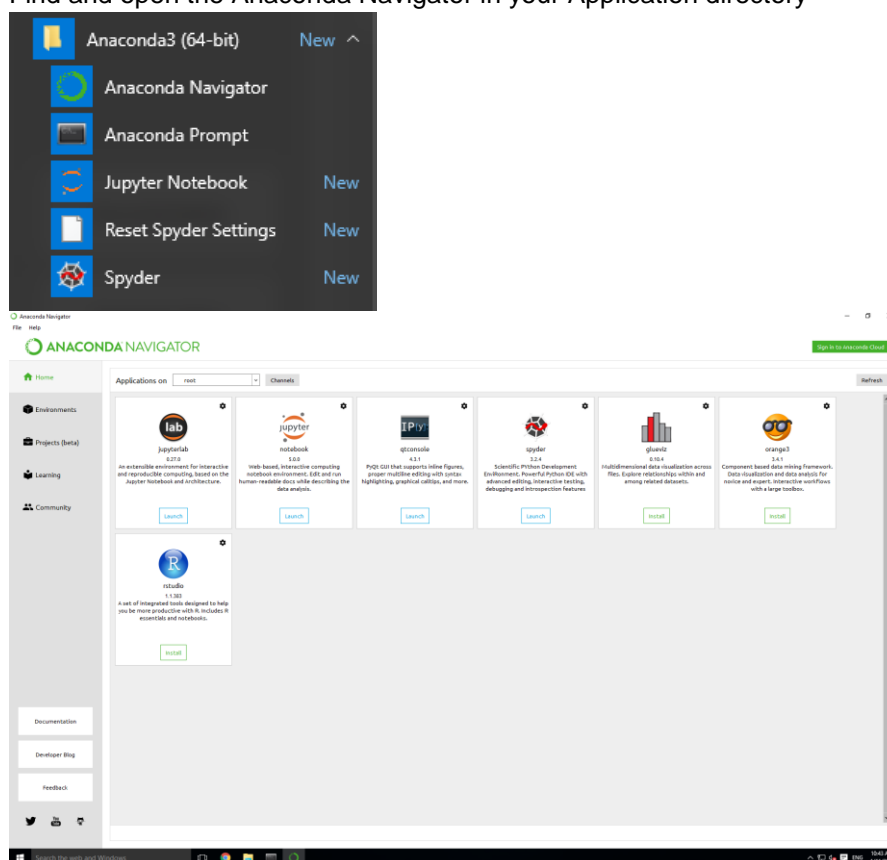


Follow the steps of the Setup





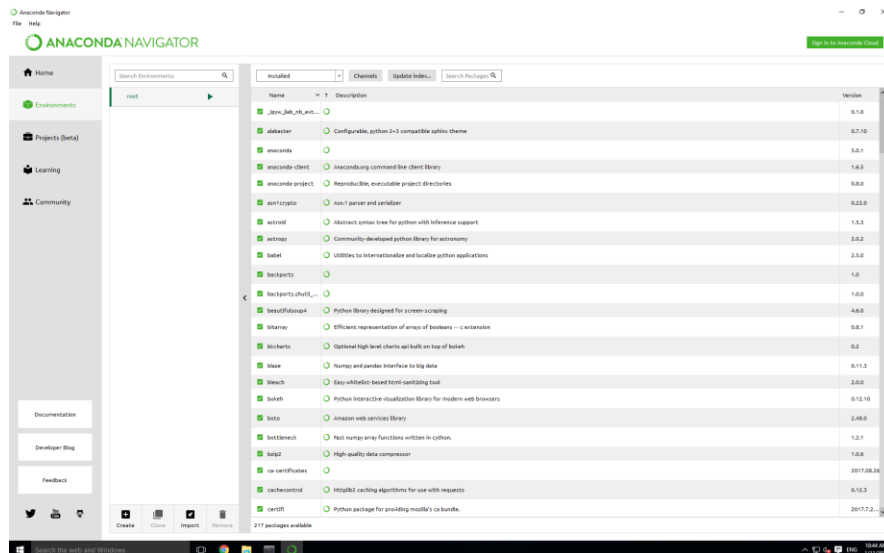
Find and open the Anaconda Navigator in your Application directory



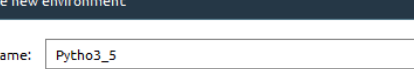
1.2 Set up the environment with python 3.5

The default environment in Anaconda called 'root' uses python 3.6 but we need python 3.5 to be able to use openCV. The easiest way is to create a new environment in which python 3.5 will be installed.

Go to 'Environment' (Left grey column, under 'Home')



Click on . This window appears :



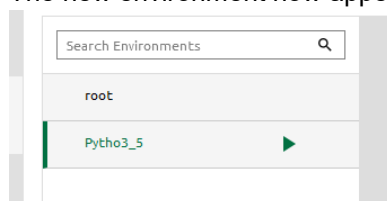
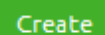
Create new environment X

Name:

Location: C:\Users\fieldphenomics\Anaconda3\envs\Pytho3_5

Packages: ☒ Python 3.5
☐ R

Choose a name for the new environment, select python 3.5 and click on The new environment now appear under 'root'.



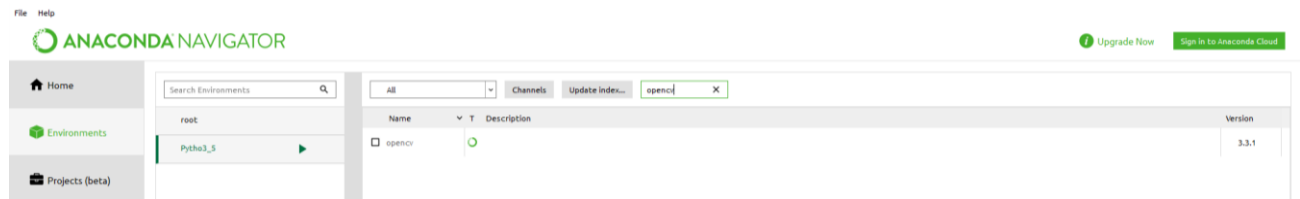
1.3 Install the packages necessary to run the scripts

The scripts require the user to install several packages :

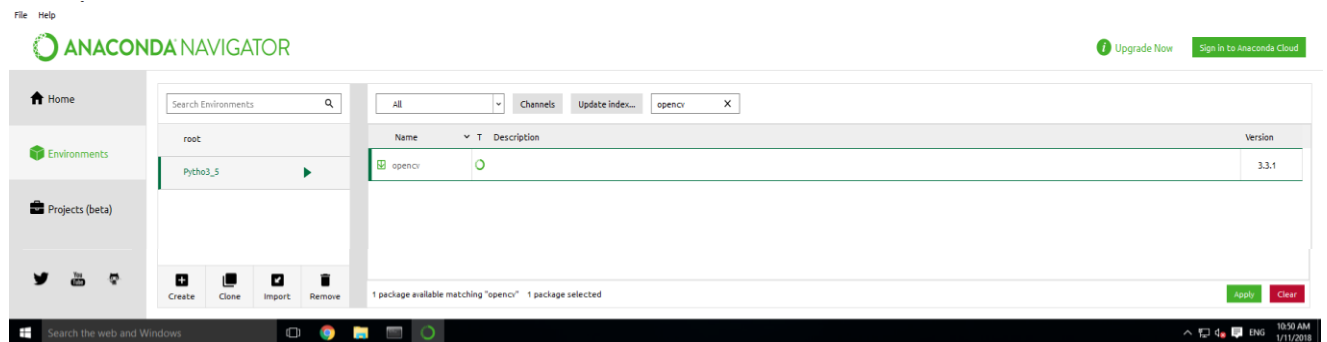
- openCV 3
- PyQt 5
- scikit-image
- scikit-learn

1.3.1 OpenCV3

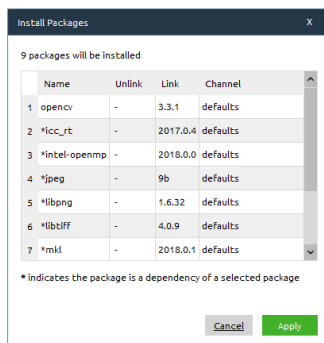
Look for the name of the package in the search bar and select 'All' in the menu.



Select opencv and click on  at the bottom right corner

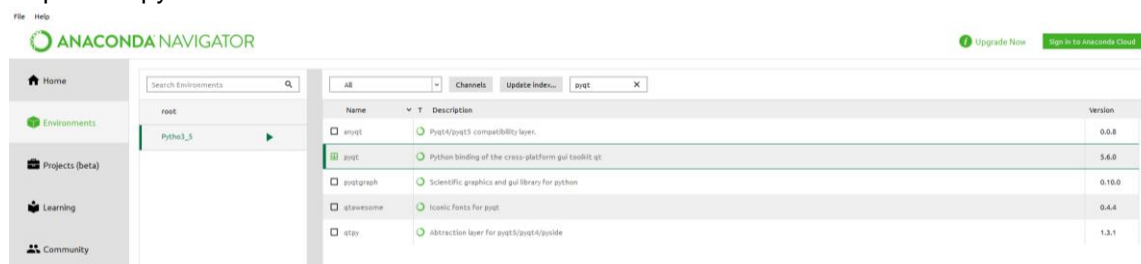


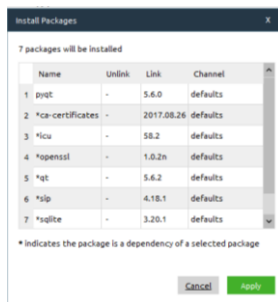
Click on  again.



1.3.2 PyQt 5

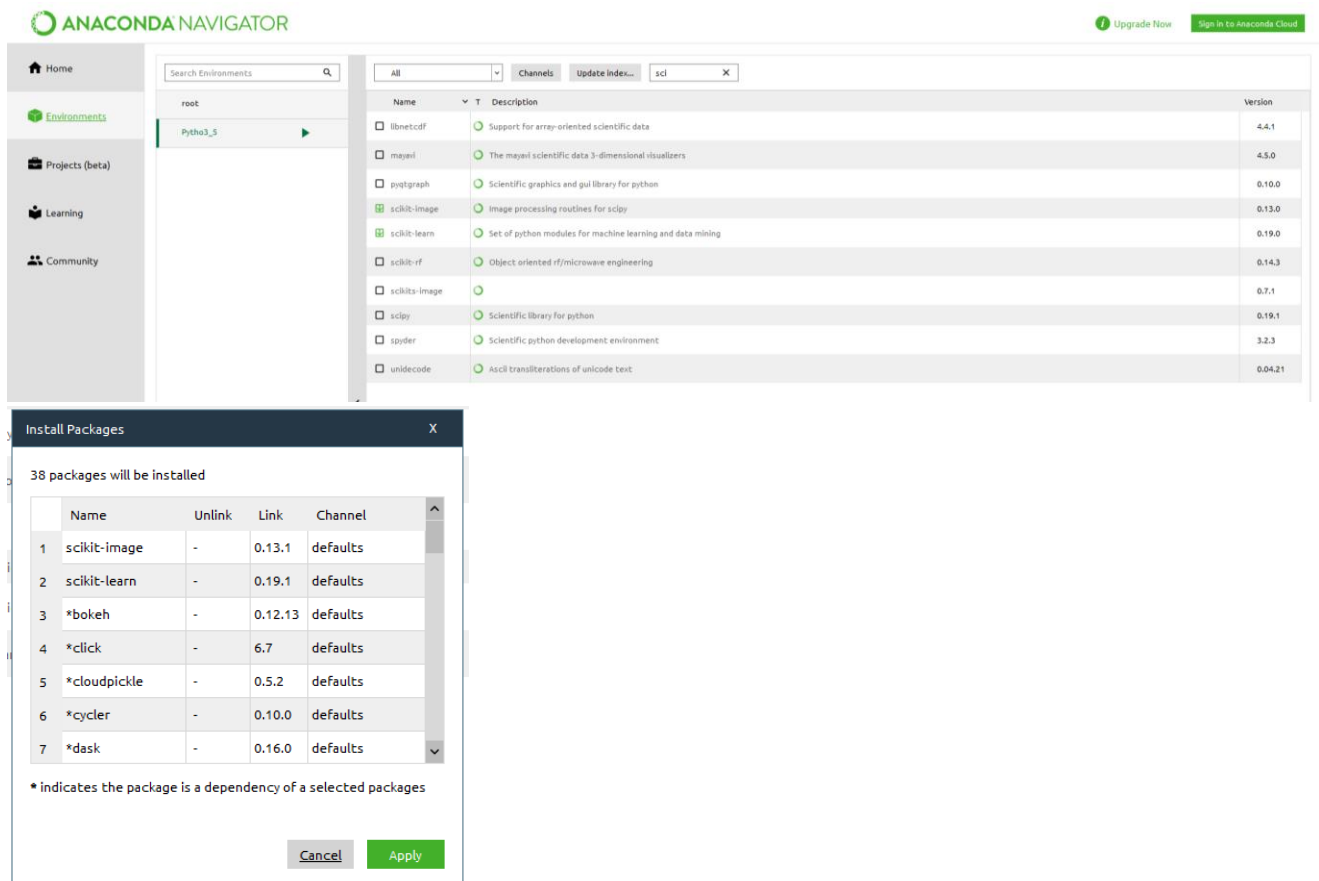
Repeat for PyQt5






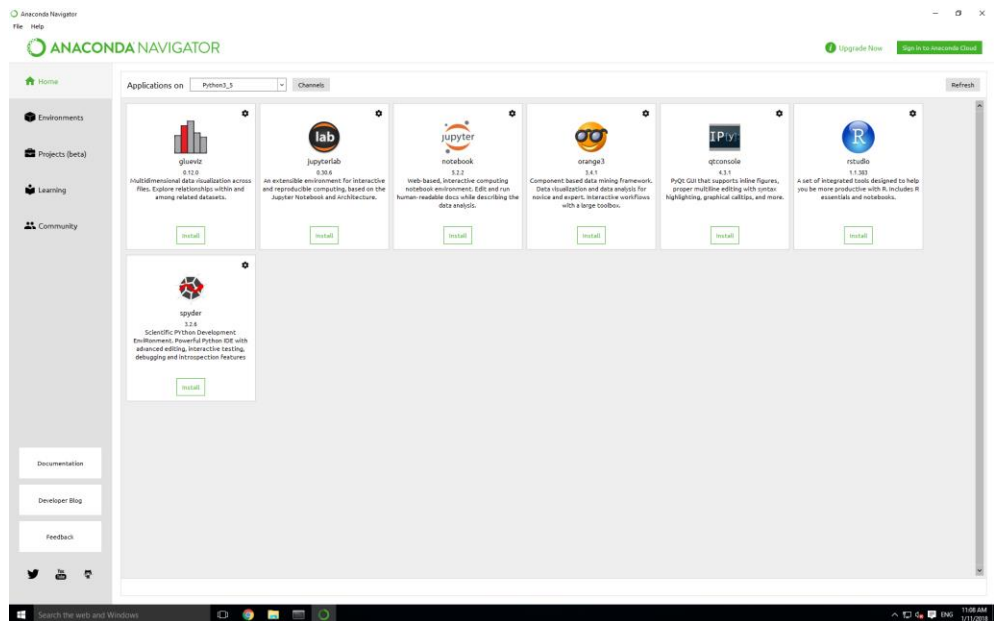
1.3.3 scikit

Repeat for scikit-image and scikit-learn. You can download the two at the same time.

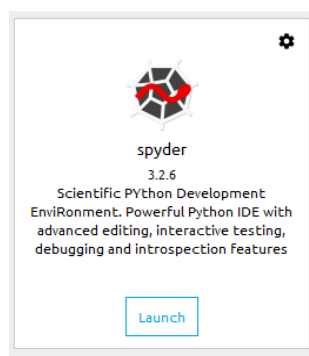



1.4 Install Spyder

Go back to the Home page  Home and select the new environment in the menu 'Applications on ...'



Click on  under Spyder  3.2.6 .

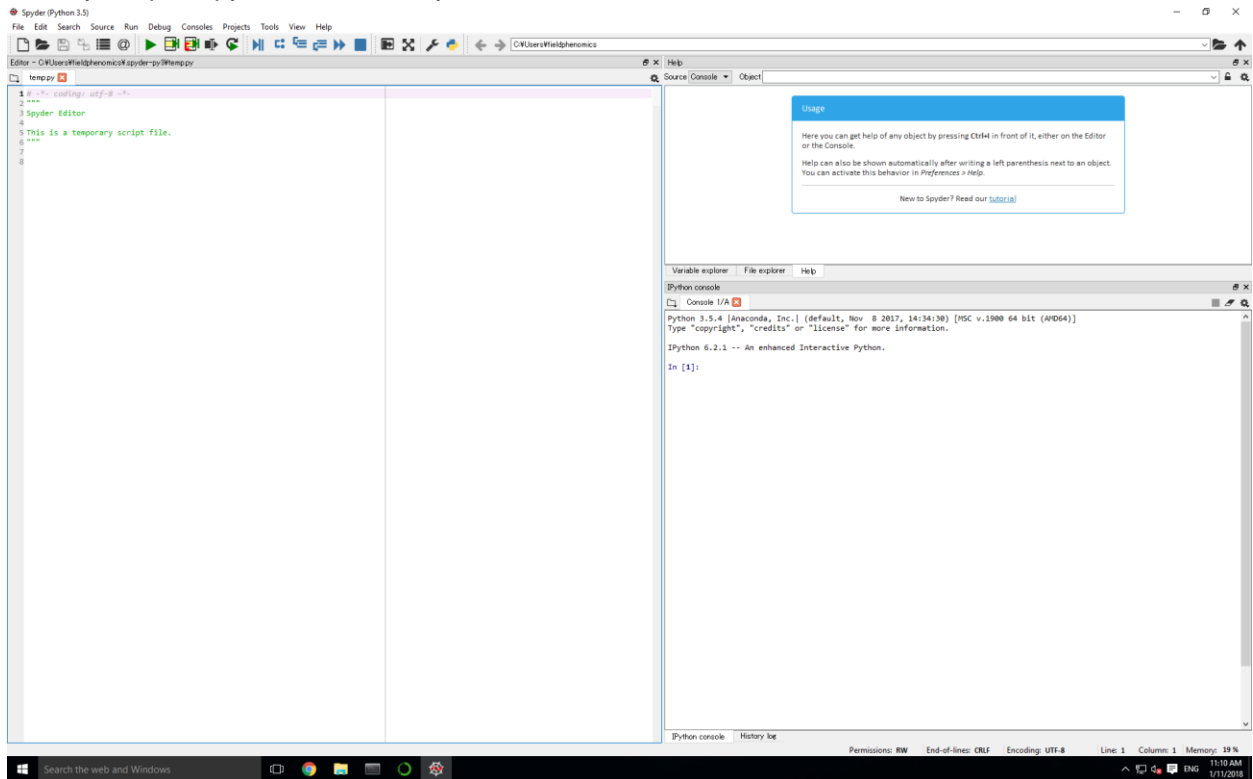


Launch Spyder by clicking on 

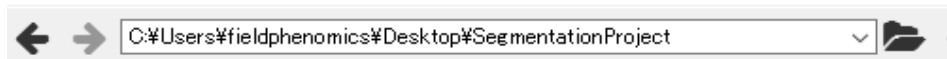
2 Set up Spyder

2.1 Set the source directory

When you open spyder, this is what you can see :



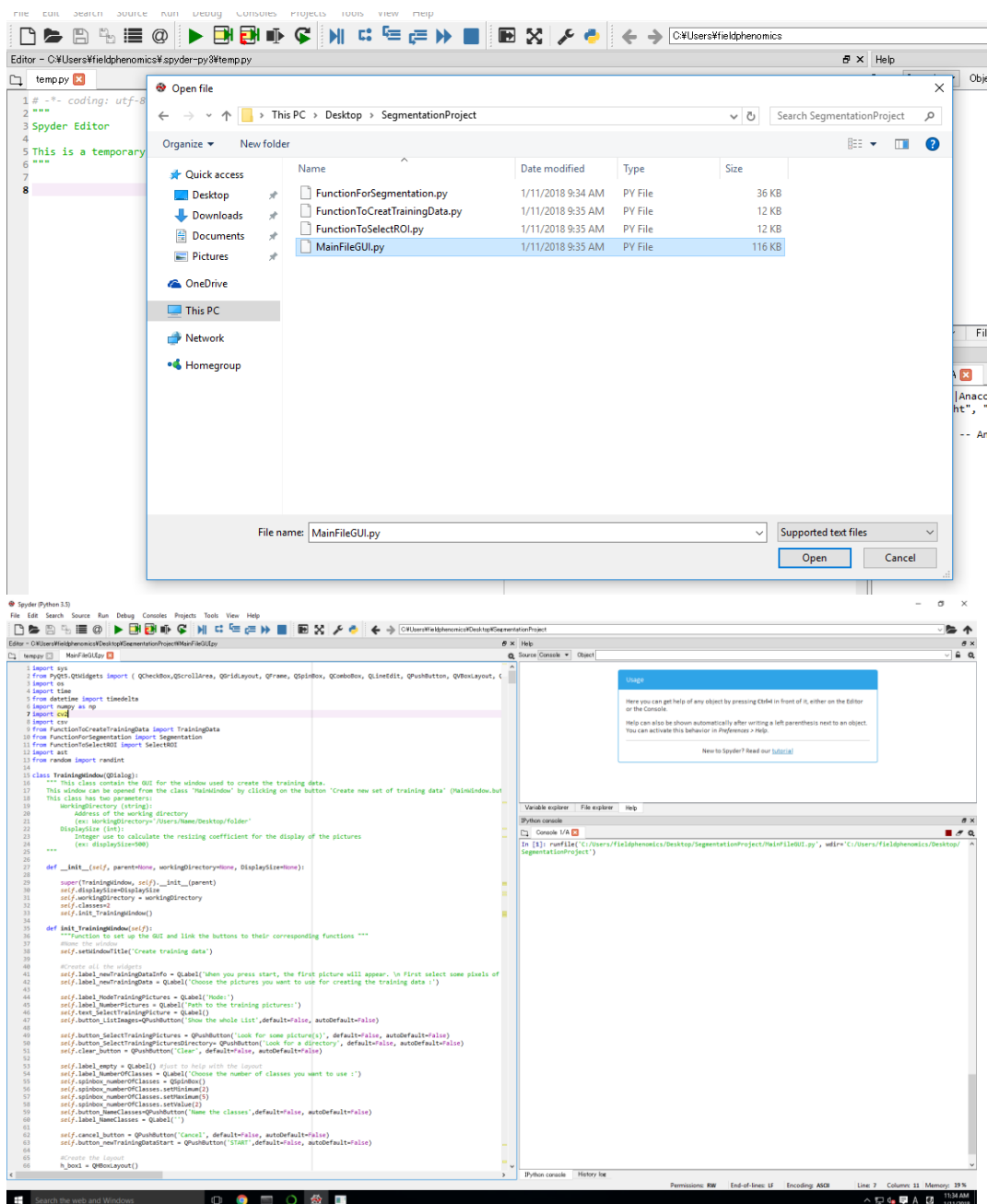
To change the source directory, click on the icon at the top right corner and chose the directory 'SegmentationProject'.



2.2 Open the Main file



Click on the icon on the top left corner and choose MainFileGUI.py in the directory 'SegmentationProject'.



NB : No need to open the other files

2.3 Read the Main file

To execute the main file, click on



3 Use the Graphical User Interface (GUI)

When the MainFileGUI.py is executed, this window is opened.
This Main window is organized by line, each line being a step.

The screenshot shows the MainFileGUI.py window with the following sections:

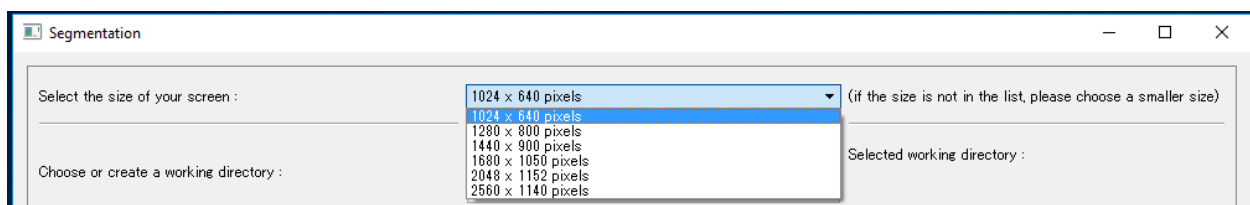
- Select the size of your screen:** A dropdown menu showing "1024 x 640 pixels" with a note "(if the size is not in the list, please choose a smaller size)".
- Choose or create a working directory:** Two buttons: "Create a new directory" and "Choose a directory".
- Choose or create a training Data set:** Two buttons: "Create a new set of training data" and "Use a training data file".
- Choose the pictures to be processed:** Two buttons: "Select one or several picture(s)" and "Select a whole Directory".
- Choose the Region(s) Of Interest (ROI):** Three buttons: "Select one or several ROI", "Use the whole picture(s)", and "Use coordinates from a file".
- Choose the machine learning model:** A dropdown menu showing "Classification and Regression Tree (Sklearn)".
- Size filter for the noise reduction:** A text input field showing "100".
- Choose the outputs:** A section with checkboxes for "Information file (surface, coverage + shape analysis)", "Non filtered mask", "Reconstructed image", and "Black and White mask".
- Choose the class of interest:** Two checkboxes: "Class_1" (checked) and "Class_2".
- Blob filter:** Two checkboxes: "Only keep the biggest blob and do shape analysis" (checked) and "Keep all the blobs".
- Selected working directory:** A text input field.
- Training data set path:** A text input field.
- Number of classes:** A text input field.
- Mode:** A text input field.
- Path to the test picture(s):** A text input field.
- Region(s) Of Interest (ROI):** A text input field.
- Whole pictures:** A text input field.
- Execute:** A large button at the bottom right.

3.1 Select the size of your screen

Selecting the size of the screen will define the dimension of the window where the image will be display for the selection of the ROI and of the training data.

WARNING : Do not choose a screen size that is bigger than your actual screen or the window for the image display will be resized and it will interfere with the pixel selection.

On the other hand, there is no problem if you choose a smaller screen size, the dimension of the image display will just be smaller.



3.2 Choose or create a working directory

The working directory is the directory where all the training data, ROI coordinates and outputs will be saved.

(NB: It is different from the source directory. Please do not choose 'SegmentationProject' as the working directory)

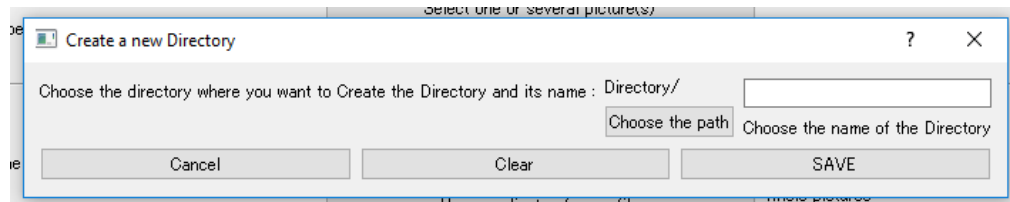
There is 2 possibilities :

- Create a new directory
- or use an already existing working directory

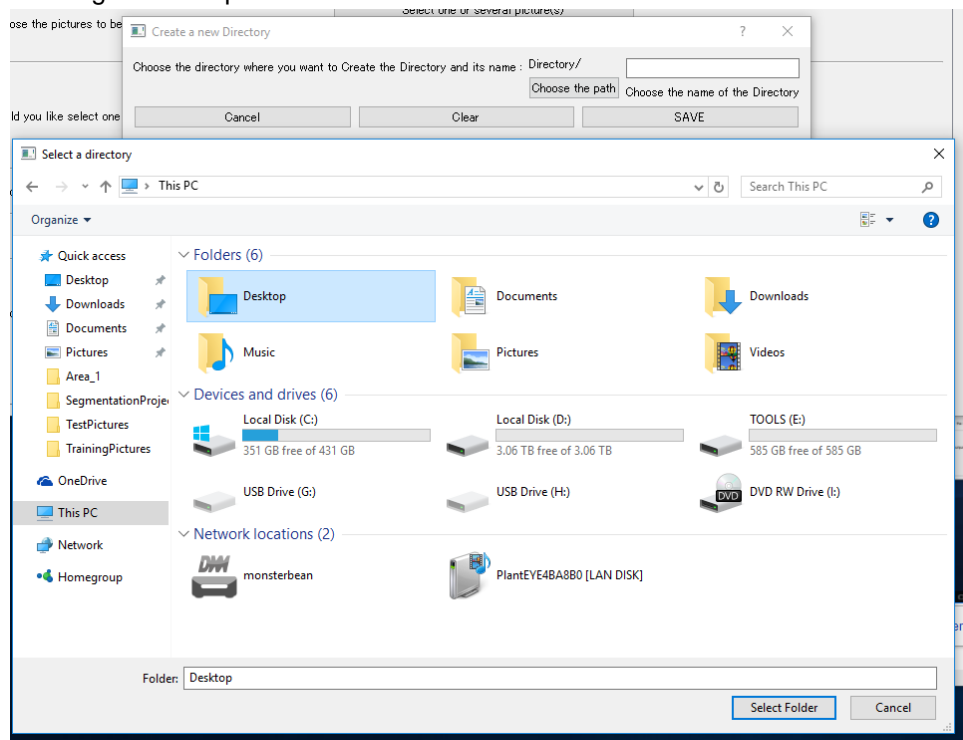
Choose or create a working directory :	<input type="button" value="Create a new directory"/>	Selected working directory :
	<input type="button" value="Choose a directory"/>	

3.2.1 Create a new directory

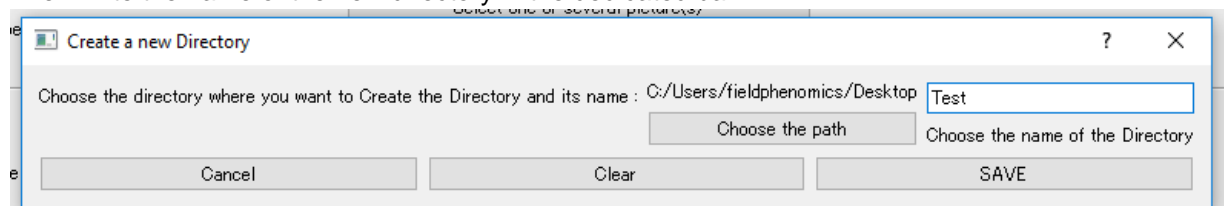
Click on and a new window will open :



Choose the path of the new directory by clicking on .
A dialog window opens:



Then write the name of the new directory in the dedicated bar :




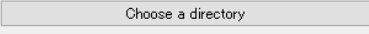
Click on

3.2.2 Use an already existing working directory

Click on  and select a directory from your computer.

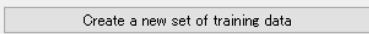
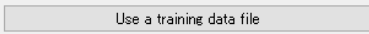
3.2.3 Result

In both case, the address of the selected directory will be display in the main Window in the right column


Choose or create a working directory :		Selected working directory :
		C:/Users/fieldphenomics/Desktop/Test

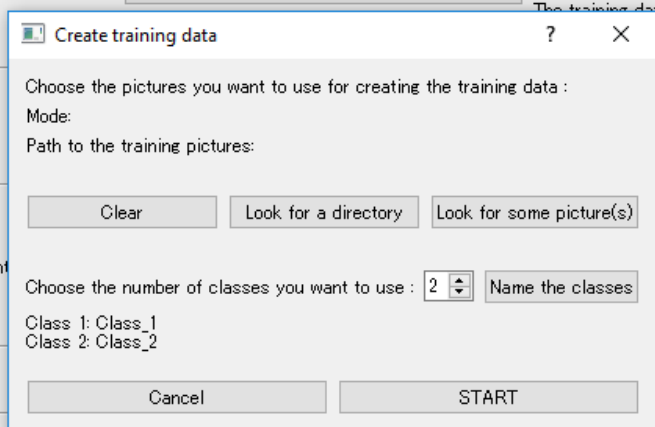
3.3 Choose or create a training data set

The training data set consist in in a csv file containing color data (RGB, HSV and Lab values for each pixels) on selected pixels attributed to a certain class. You can create a new set or reuse one that is already saved.

Choose or create a training Data set :		Training data set path :
		Number of classes :

3.2.1 Create a new training data set

By clicking on  the training window opens:



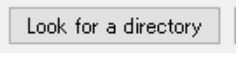
The dialog box titled "Create training data" contains the following elements:

- Text: "Choose the pictures you want to use for creating the training data :"
- Text: "Mode:"
- Text: "Path to the training pictures:"
- Buttons: "Clear", "Look for a directory", "Look for some picture(s)"
- Text: "Choose the number of classes you want to use : 2" (with a spinner box)
- Text: "Name the classes" (with a text input field)
- Text: "Class 1: Class_1", "Class 2: Class_2"
- Buttons: "Cancel", "START"


3.2.1.1 Choose the training pictures

The first step is to choose the picture you would like to use to create the training data set. You can

choose to select the pictures one by one by clicking on  or choose a directory

containing all the pictures by clicking on 

Once you have selected the pictures or the directory, the addresses will be displayed as shown here :

Choose the pictures you want to use for creating the training data :
Mode: Directory
Path to the directory: (6 pictures)
C:/Users/fieldphenomics/Desktop/TestPictures


To review the list of pictures, click on

Show the whole List

3.2.1.2 Choose the number of classes and name them

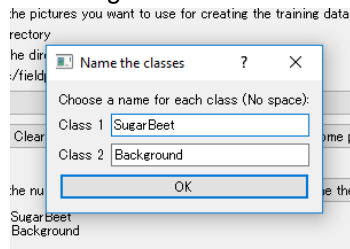
To choose the number of classes you would like to use, use the spin box :

You can choose between 2 and 5 classes.

To change the name of the classes click on

Name the classes

:



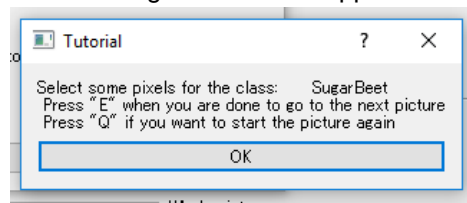
write the names and click on 'OK' to save.

3.2.1.3 Select pixels for each class

To start the pixel selection click on

START

This message window will appear :



This window informs you of the commands ('E' for the next picture and 'Q' to go back) and of which class is first (In this example, the first class is 'SugarBeet')

Press OK to start.

The picture will be displayed in another window. The size of this window will depend of the screen size that you have selected in the main window.

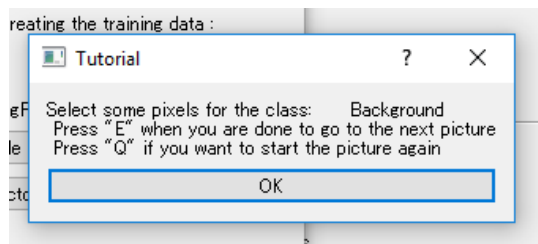
Draw a few lines on the picture according to the class.

It is recommended to select pixels from a maximum of different shades from the same class. It is also a good idea to use cropped pictures to make the selection easier.

WARNING: Do not change the size of the window ! It will impact the coordinates of the selected pixels.

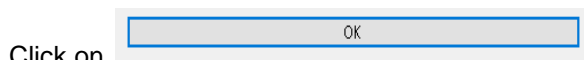
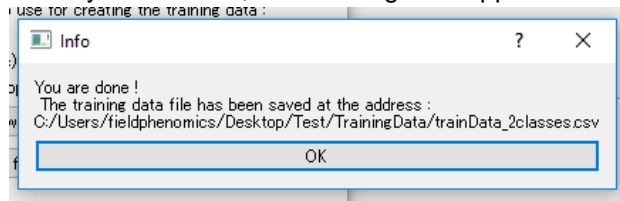


When all the pictures have been labeled with the first class, this message will appear :



Do the same for the next class and the ones after if you have chosen more than two classes.

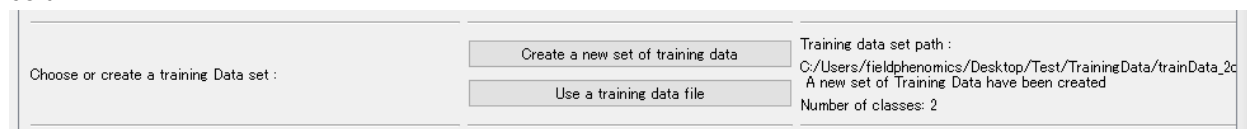
When you are done, this message will appear :



Click on to save the data and go back to the main window.

3.2.1.4 Result

In the main window, the address of the csv file and the number of class will be displayed in the right column :

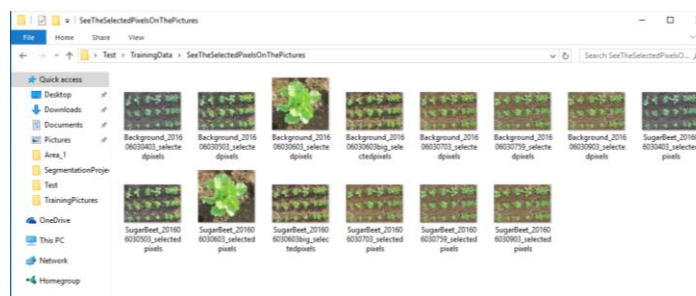


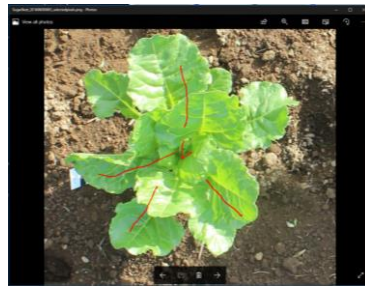
You can see in your working directory that a new folder has been created called 'TrainingData'. In this folder You will find :

- 1 csv file compiling all the training data.

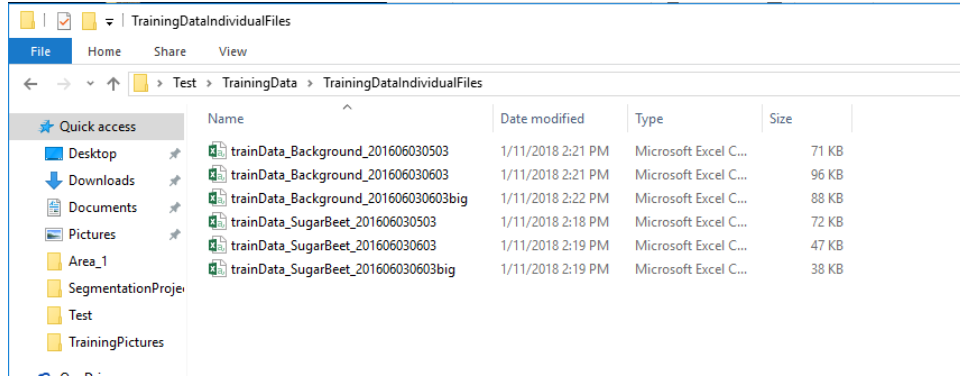
Class	Image	x	y	B	G	R	H	S	V	L	a	b
Background	201606021155 copy	487	311	28	34	33	35	45	34	33	125	132
Background	201606021155 copy	488	311	26	31	30	36	41	31	29	127	131
Background	201606021155 copy	488	312	25	32	29	43	56	32	29	127	132
SugarBeet	IMG_0086 copy	1479	2762	130	167	93	75	113	167	161	96	140
SugarBeet	IMG_0086 copy	1479	2771	133	156	88	80	111	156	152	101	133
SugarBeet	IMG_0086 copy	1480	2771	124	152	86	77	111	152	148	100	136
SugarBeet	IMG_0086 copy	1480	2772	119	150	83	76	114	150	146	99	138

- one folder called 'SeeTheSelectedPixelsOnThePictures' containing reminders of the selected pixels for each picture and class.



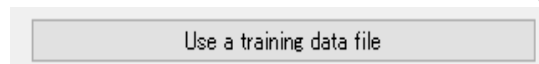


- one folder called 'TrainingDataIndividualFiles' containing individual training data files : one file per picture and per class.

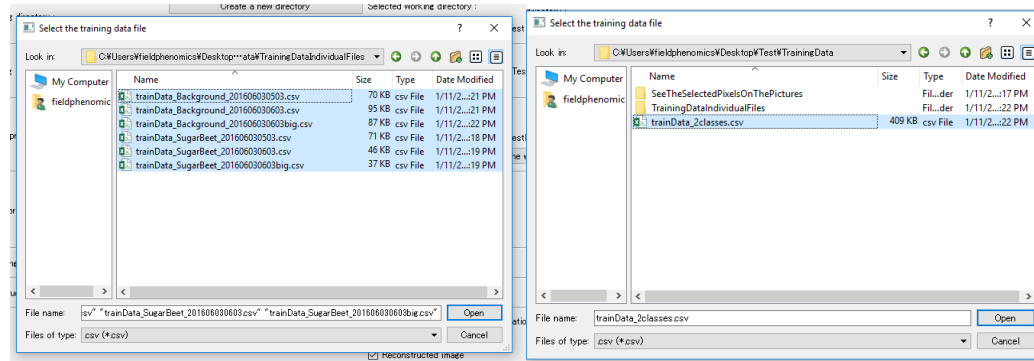


3.2.2 Use an already existing training data set

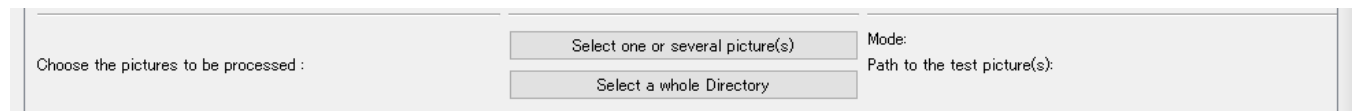
You can choose to use one or several training data files already created by clicking on




If you select more than one file, the files will be merged in a new file and save in the working directory.



3.3 Choose the picture(s) to test



3.2.1 Select one several picture(s)

Click on  to select one or several pictures.

3.2.2 Select a whole directory

Click on  to select all the pictures of a directory.

3.2.3 Result

The addresses will be displayed in the right column of the main window.

Choose the pictures to be processed :

Select one or several picture(s)

Select a whole Directory

Show the whole List

Mode: Directory
Path to the directory: (6 pictures)
C:/Users/fieldphenomics/Desktop/TestPictures

To see the complete liste click on

3.4 Choose one or several Region of Interest (ROI)

Three possibilities : use the whole pictures, use the coordinates from a file or select new regions of interest.

Would you like select one or several Region(s) Of Interest (ROI) ?

Select one or several ROI

Use the whole picture(s)

Use coordinates from a file

Region(s) Of Interest (ROI):

Whole pictures

3.4.1 Select one several ROI

To select new ROI, click on

. The ROI window will open :

Select one or several Regions of interest (ROI)

Select the Region(s) of Interest and choose if you want to save the cropped pictures.
Note : saving the cropped pictures might take a lot of space and time if you are using big and/or many pictures

Select the area(s) Use the center Choose random rectangle

Coordinates of the selected region(s) :



Clear Name/View the areas

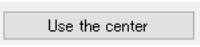
☐ Save the cropped pictures ☒ Use the rectangle(s) as a mask

Cancel OK

Three modes are available the select the ROI :

3.4.1.1 Use the center of the image as ROI

By clicking on , the coordinates of a rectangle in the center of the image whose area equal 50% of the total area are calculates and a spinbox appears 

You can change the percentage of the image with this spinbox. Press  again to calculate the new coordinates.

Select one or several Regions of interest (ROI)

Select the Region(s) of Interest and choose if you want to save the cropped pictures.
Note : saving the cropped pictures might take a lot of space and time if you are using big and/or many pictures

Pourcentage of the image : 70

Select the area(s) Use the center Choose random rectangle


Coordinates of the selected region : (1 region)
[[777, 518, 4406, 2937]]

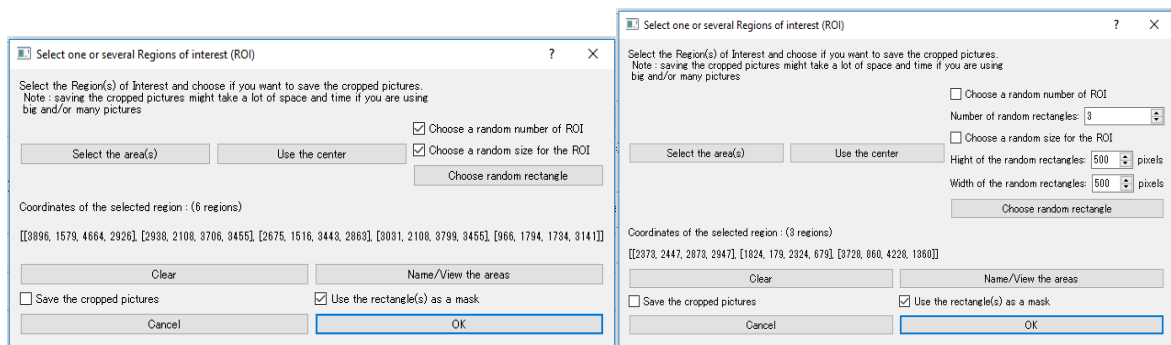
Clear Name/View the areas

☐ Save the cropped pictures ☒ Use the rectangle(s) as a mask

Cancel OK

3.4.1.2 Use some random rectangle as ROI

By clicking on  the coordinates of a random number of rectangle (max 20) with random dimensions (all the rectangle have the same dimensions) are calculated and two checkbox appear. :

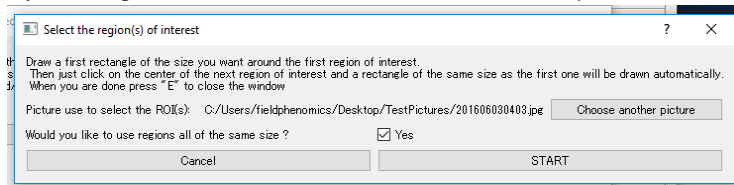


If you uncheck these checkboxes, you will be able to choose the number and dimensions of the random rectangles.

The rectangle CAN overlap each other.

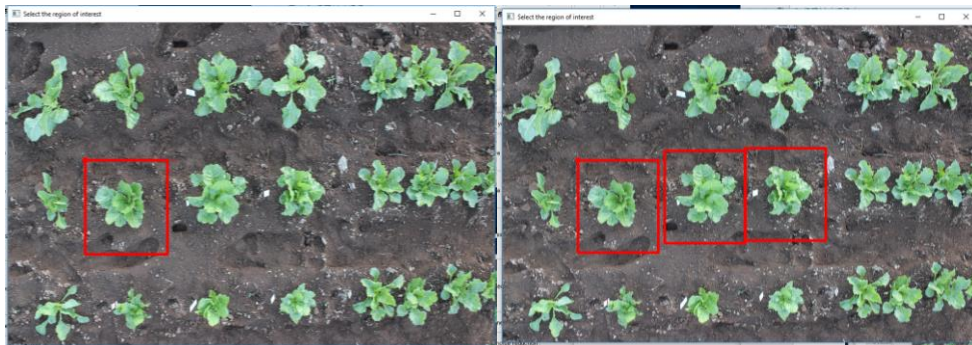
3.4.1.3 Select the ROI manually

By clicking on **Select the area(s)**, a new window opens :



You can choose which picture to use to draw the ROI and if you want all the rectangles of the same size. Press 'START' to open the picture:

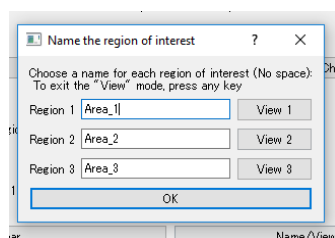
If you have checked the checkbox to have same size rectangle, draw the first rectangle and then click in the middle of the next ROI.



3.4.1.4 Name and review the ROI

You can name and review the ROI by clicking on

Name/View the areas

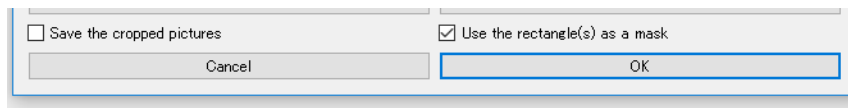


Click view to review the area

Click on 'OK' to save the new names

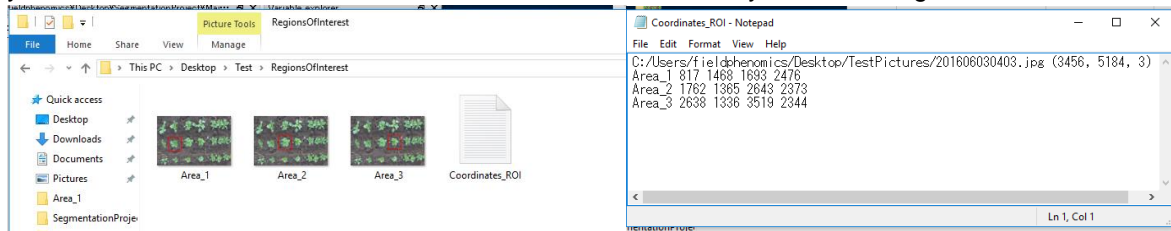
3.4.1.5 Save the ROI

When saving the ROI you can decide to save the cropped pictures or not. If you save the cropped pictures, the pictures will be cropped according to the ROI and save in the working directory. (This is not recommended as it will take time and memory if the photo set is big.)

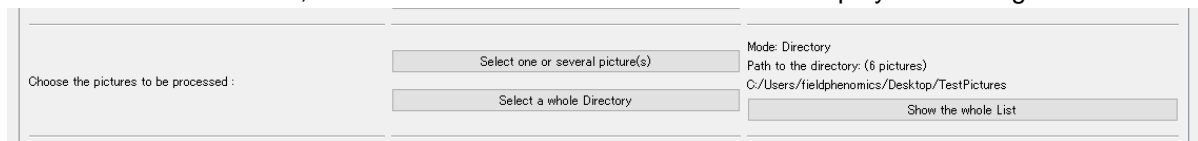


Click on 'OK' to save the ROI.

If you go to the working directory, a new folder called 'RegionsOfInterest' will have been created. Inside you can find reminders of the ROI and the coordinates file that you can use again.

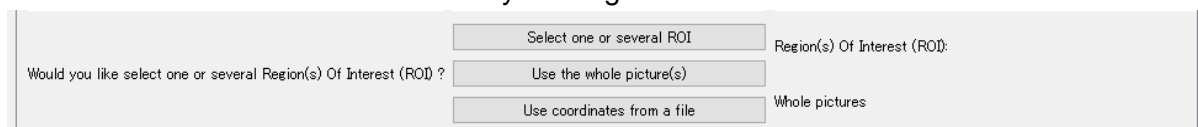
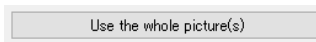


Back in the main window, the address of the coordinates file will be displayed in the right column.



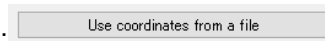
3.4.2 Use the whole picture

You can also choose not to use ROI by clicking on



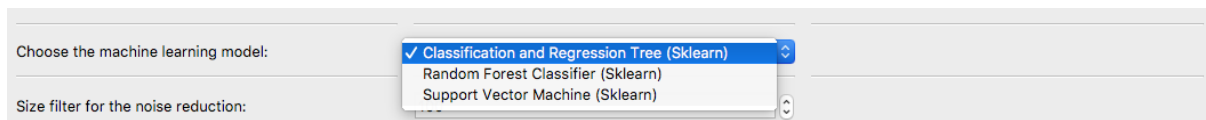
3.4.3 Use coordinates from a file

You can use a coordinates file already created by clicking on :



3.5 Choose the machine learning model

To choose the machine learning model, use the combo box.



3.6 Choose the size filter for the noise reduction

The size filter will be used to reduce the noise by erasing all regions whose surface is less than the size filter.

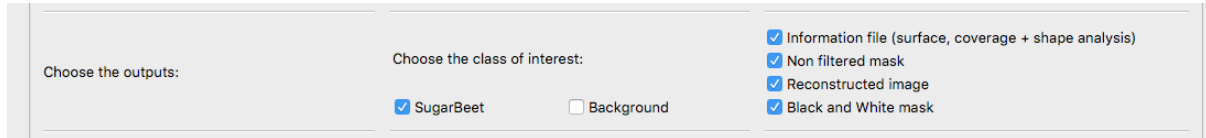


3.7 Choose the outputs and execute the program

This line will be different depending of the number of classes

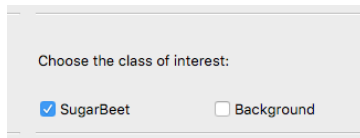
3.7.1 Two classes

This is what the last line of the main window will look like if you are using 2 classes :



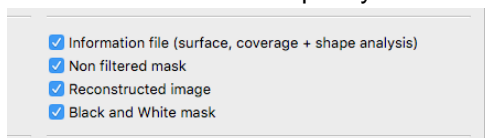
3.7.1.1 Choose the class of interest

The class of interest is the class that will be analysed for the surface and morphology, usually the plant.



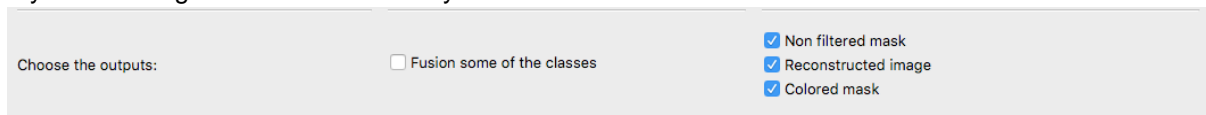
3.7.1.2 Choose the outputs

You can select which outputs you would like to save. See part 4 to understand the outputs.



3.7.2 More than two classes

If you are using more than 2 classes you will see :

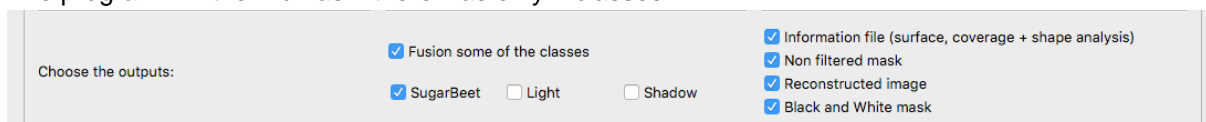


3.7.2.1 Fusion of classes

If you want to analyse only one of the classes and use the other as background or if you want to fusion several classes and use the other as background, check the checkbox 'Fusion some of the classes'

The list of the classes will appear. Check the class or classes of interest.

The program will then run as if there was only 2 classes.



The fusion of classes can be useful if a class has very different colors and if the machine learning isn't working well.

3.7.2.2 Choose the outputs

If you have not fusion any classes, the output will be different and no information file will be created as it can only be created for one class of interest.

☒ Non filtered mask
☒ Reconstructed image
☒ Colored mask

See part 4 to understand the outputs.

3.8 Region filter

This line will only appear if you are using 2 classes or fusion of classes.

Region filter:

☒ Only keep the biggest region and do shape analysis
☐ Keep all the regions

A region (also known as blob) refers here to a group a pixels belonging to the same class.

If you choose only to keep the biggest region, all the smaller ones will be erased and considered as belonging to the background/second class. They will not be counted in the surface measuring. This option is useful if there is only one plant per ROI for example. Do not use this option for canopy coverage measurement.

3.9 Execute

The program will start running when you click on

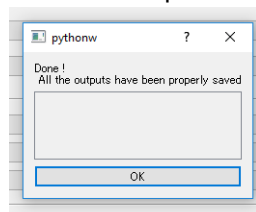
Execute

You can follow the progress of the program in the spyder :

```
In [1]: runfile('C:/Users/fieldphenomics/Desktop/Segmen
fieldphenomics/Desktop/SegmentationProject')
201606030403 Area_1 Done!
201606030403 Area_2 Done!
201606030403 Area_3 Done!
Running time for 1 image = 0:00:00.672000
Total running time estimation = 0:00:04.032000
201606030503 Area_1 Done!
201606030503 Area_2 Done!
201606030503 Area_3 Done!
201606030603 Area_1 Done!
201606030603 Area_2 Done!
201606030603 Area_3 Done!
201606030703 Area_1 Done!
201606030703 Area_2 Done!
201606030703 Area_3 Done!
201606030759 Area_1 Done!
201606030759 Area_2 Done!
201606030759 Area_3 Done!
201606030903 Area_1 Done!
201606030903 Area_2 Done!
201606030903 Area_3 Done!
```

After the first picture has been processed, a running time estimation is calculated and printed.

When all the pictures have been processed, this window will open:



If you are using ROI and one of the picture is not the right size, it won't be processed and its address will be displayed in the empty rectangle.

3.10 Optional time filter in the code

There is an extra filter available but it is not accessible via the GUI.

In the FunctionForSegmentation.py file, line 177 to line 181, you have the possibility to use the name of the pictures to apply a time filter ONLY if the name of the picture refers to the time when the picture was taken under the format YYYYMMDDHHMM (ex: 201606021155.jpg was taken on the 2nd of june 2016 at 11:55).

This is the lines :

```
178      #      hour=float(ImageName[8:10])
179          hour=float(10)
180          if 8<hour<16:
```

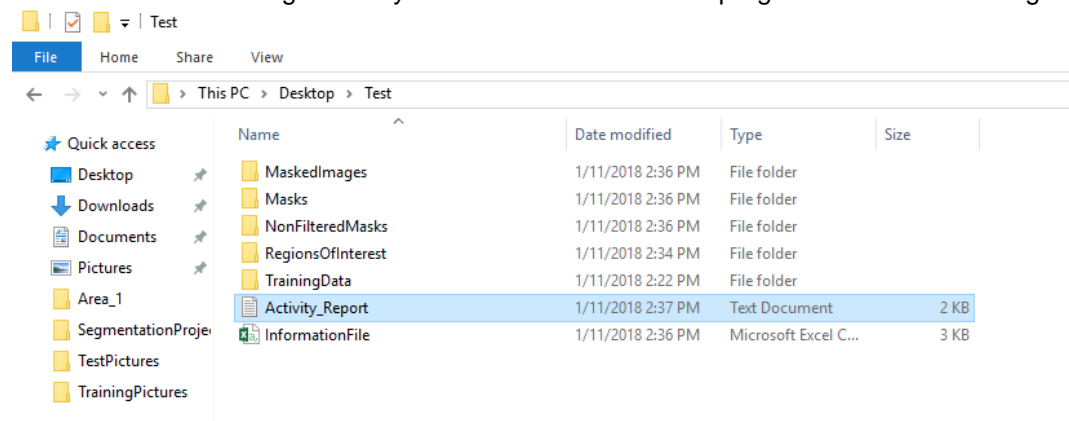
To use it, uncomment line 178 (erase the '#') , comment line 179 (add a '#' at the start of the line) and change the numbers line 180 as your convenience.

In the case $8 < \text{hour} < 16$, the program will only process the pictures taken between 8:00 and 16:00.

4 Outputs

4.1 For two classes or more than two classes with fusion

This is what the working directory should look like when the program is finished running :



4.1.1 Activity report

The activity report is a text file containing all the parameter and running time of the last run.

```
Activity_Report - Notepad
File Edit Format View Help
Activity report:
Working directory: C:/Users/fieldphenomics/Desktop/Test
Training data: ['C:/Users/fieldphenomics/Desktop/Test/TrainingData/trainData_2classes.csv']
Number of classes : 2
Classes name: ['SugarBeet', 'Background']
Fusion of classes: N
Classe(s) of interest: ['SugarBeet']
Number of pictures tested: 8
Size of the pictures: (3456, 5184, 3)
Model: Classification and Regression Tree (Sklearn)
Number of regions of interest:3
Regions of interest coordinates: [[817, 1468, 1693, 2476], [1762, 1365, 2643, 2373], [2638, 1336, 3519, 2344]]
Region names: ['Area_1', 'Area_2', 'Area_3']
Size of the regions of interest: (1008, 876)
Noise reduction: 100
Mask saved: Y
Reconstructed image saved: Y
Information file saved: Y
Reference picture used for choosing the region of interest: C:/Users/fieldphenomics/Desktop/TestPictures/201606030403.jpg
Total Running time: 0:00:04.594000
Mean running time for each pictures: 0.7031666666666666sec
Mean time to create the test data: 0.022944444444444448sec
Mean time to apply the model: 0.035444444444444445sec
Mean time to save the outputs: 0.06922222222222224sec
Pictures which have not been processed because of their size: []
Pictures List: ['C:/Users/fieldphenomics/Desktop/TestPictures/201606030403.jpg', 'C:/Users/fieldphenomics/Desktop/TestPictures/201606030503.jpg', 'C:/Users/fieldphenomics/Desktop/TestPictures/201606030603.jpg', 'C:/Users/fieldphenomics/Desktop/TestPictures/201606030703.jpg', 'C:/Users/fieldphenomics/Desktop/TestPictures/201606030803.jpg', 'C:/Users/fieldphenomics/Desktop/TestPictures/201606030903.jpg', 'C:/Users/fieldphenomics/Desktop/TestPictures/201606031003.jpg', 'C:/Users/fieldphenomics/Desktop/TestPictures/201606031103.jpg']
Ln 1, Col 1
```

4.1.2 Non filtered masks

The non filtered mask is the mask before being processed.

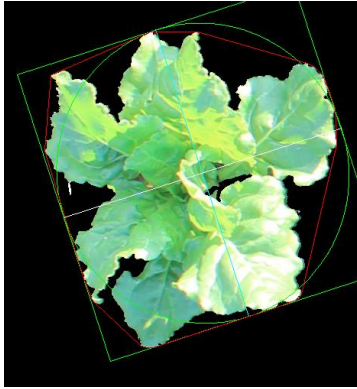


4.1.3 Masked Images

The masked images show a black background and the class of interest

4.1.3.1 You have use the region filter

Some morphological information will be displayed on the mask: the convex hull in red, the bounding rectangle and ellipse in green and the main axes in blue and white



4.1.3.2 You have not use the region filter (keep all the regions)

No morphological information.



4.1.4 Masks

The mask is a black and white image with the class of interest in white.

The filtering process for two classes uses one or two filter method :

- first a morphological filter to remove the small objects using the size filter chosen in the main window
- Second, only if you choose to keep only the biggest region, a blob detection to only keep the biggest blob. **WARNING**: This filtering process is only working if all the part of interest touches each other ! only one blob is kept.



4.1.5 Information file

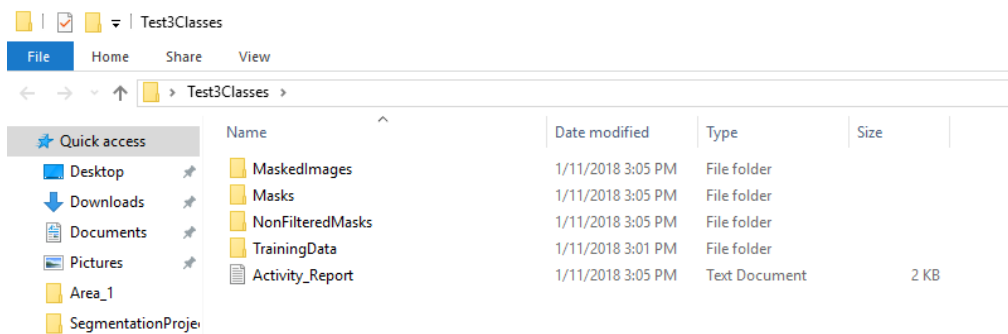
The information file is a csv file containing data on the class of interest : surface and coverage

If you have chosen the region filter, some shape analysis data will be added to the file : aspect ratio, extent, solidity, equivalent diameter, length of the axes. **WARNING** : These informations are valid only if the plants are not touching each other and if there is only one plant per ROI.

Area/Plant	Image Name	Surface	Coverage	Aspect Ra	Extent	Solidity	Equivalent D	Main axis	Secondary axis
Area_1	201606030403	181340.5	0.205367	1.040385	0.644606	0.8332	480.510037	550.775269	505.6396484
Area_2	201606030403	251379	0.283069	1.060465	0.569788	0.775798	565.743479	648.899353	616.0116577
Area_3	201606030403	172829	0.194617	0.939781	0.612391	0.795013	469.097769	529.135559	522.8734131
Area_1	201606030503	183250.5	0.20753	1.081511	0.669697	0.843551	483.033936	552.256165	488.8479004
Area_2	201606030503	253382	0.285325	1.063467	0.570935	0.777099	567.992942	649.187012	616.4970703
Area_3	201606030503	178967.5	0.201529	0.95082	0.624498	0.811633	477.355736	530.338745	529.5901489
Area_1	201606030603	183337.5	0.207628	1.088757	0.655095	0.827651	483.148585	560.882263	492.9660034
Area_2	201606030603	253223	0.285146	1.04908	0.567805	0.777534	567.814703	654.142517	615.6532593
Area_3	201606030603	182064.5	0.205017	0.968921	0.628004	0.809622	481.468297	535.549072	535.3615112
Area_1	201606030703	191871	0.217292	1.118547	0.627122	0.820809	494.264853	551.407837	546.3096924
Area_2	201606030703	263528	0.29675	1.034848	0.584604	0.788052	579.253201	668.598328	624.835022
Area_3	201606030703	182779.5	0.205822	0.960073	0.627076	0.808292	482.412777	543.037109	532.4161377
Area_1	201606030759	194705	0.220502	1.168279	0.623519	0.827124	497.901703	554.758667	544.927002
Area_2	201606030759	273439.5	0.307911	1.032934	0.593247	0.799547	590.045748	675.351685	634.4667969
Area_3	201606030759	188650	0.212432	0.972826	0.636419	0.812399	490.098602	550.483398	533.7971191
Area_1	201606030903	196844	0.222924	1.169557	0.634836	0.823179	500.629169	558.485107	551.1532593
Area_2	201606030903	276220.5	0.311042	1.038748	0.59061	0.797097	593.03867	679.574524	641.0932228
Area_3	201606030903	187881	0.211566	0.98	0.63377	0.805872	489.09868	547.266479	539.1610718

4.2 More than two classes without fusion

This is what the working directory should look like when the program is finished running :
Note that there is no information file



(There is no 'RegionOfInterest' folder either because for this example, an already created coordinates file was used)

4.2.1 Activity report

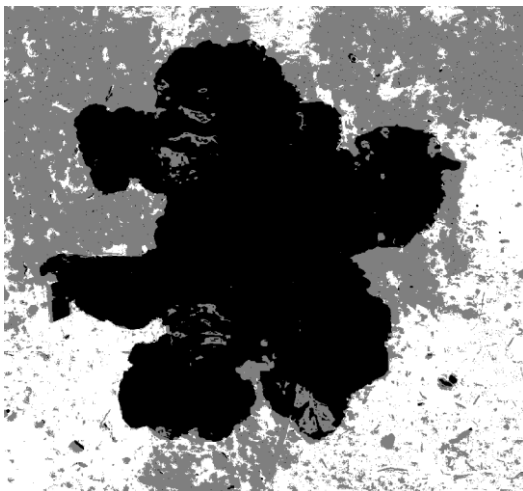
Same as 4.1.1

4.2.2 Masked Images

The masked image is the original image with a color filter corresponding to the classes(see 4.2.4 Masks)

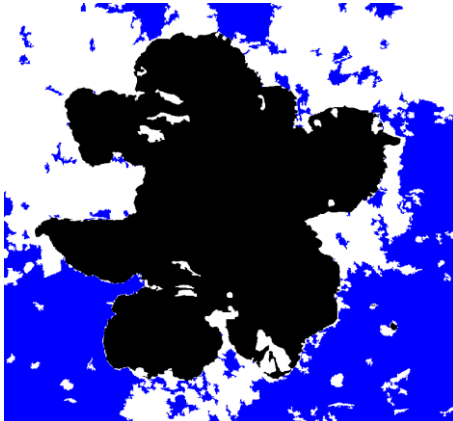


4.2.3 Non filtered masks



4.2.4 Masks

When there is more than 2 classes, only the first morphological noise reduction filter is used.



5. Frequent problem

When using the GUI, the kernel often dies and need to be restarted. This is done automatically and this message should be displayed :

```
In [3]: runfile('/Users/Laure/Desktop/SegmentationProject/MainFileGUI.py', wdir='/Users/Laure/Desktop/SegmentationProject')  
Kernel died, restarting
```

Sometime, you will need to reopen the consol. Close the current console and open a new one.

These problems happen when the file MainFileGUI.py is run twice in a row. (the first time usually works fine)

It does not influence the results.