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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

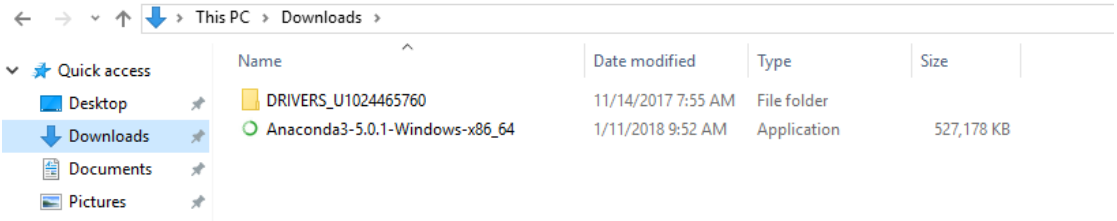
Table of content :

1. Anaconda Installation and Configuration

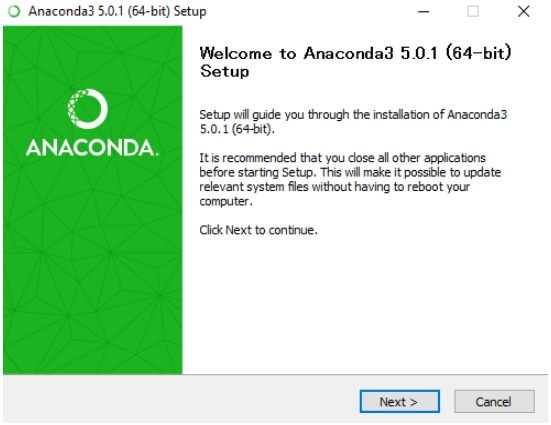
1.1 Install Anaconda

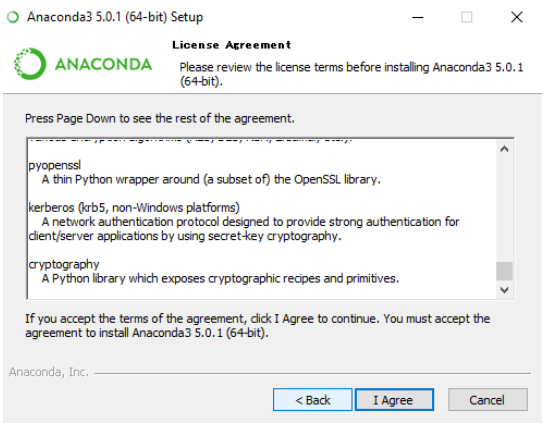
Go to the address : https://www.anaconda.com/download/
Click on ‘Download’ for python 3.6 version

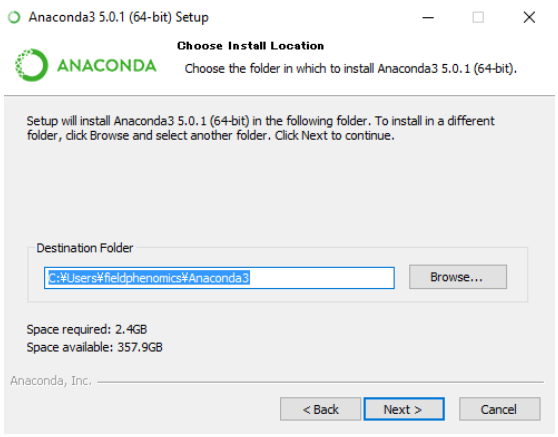
Go to the ‘Downloads’ directory and open the installer: Anaconda3-5.01-Windows-x86_64

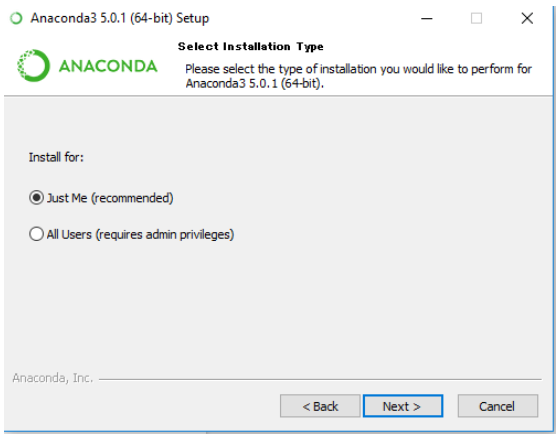


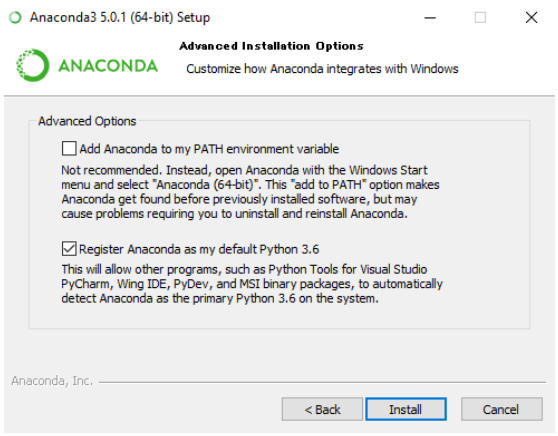
Follow the steps of the Setup

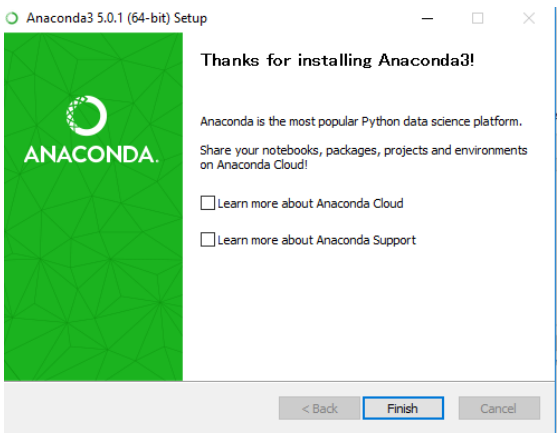




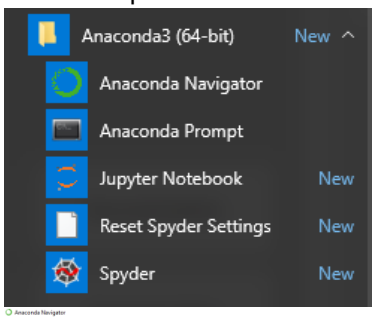


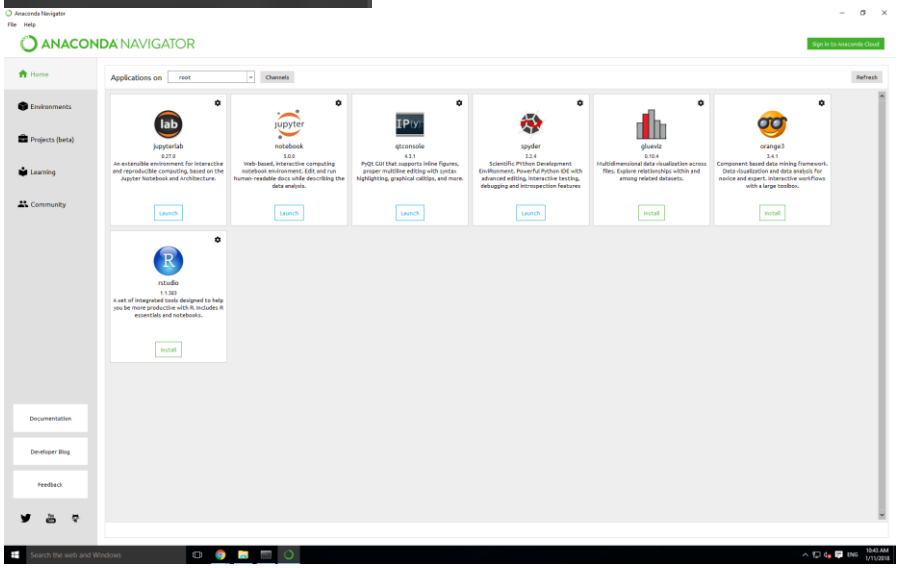






Find and open the Anaconda Navigator in your Application directory

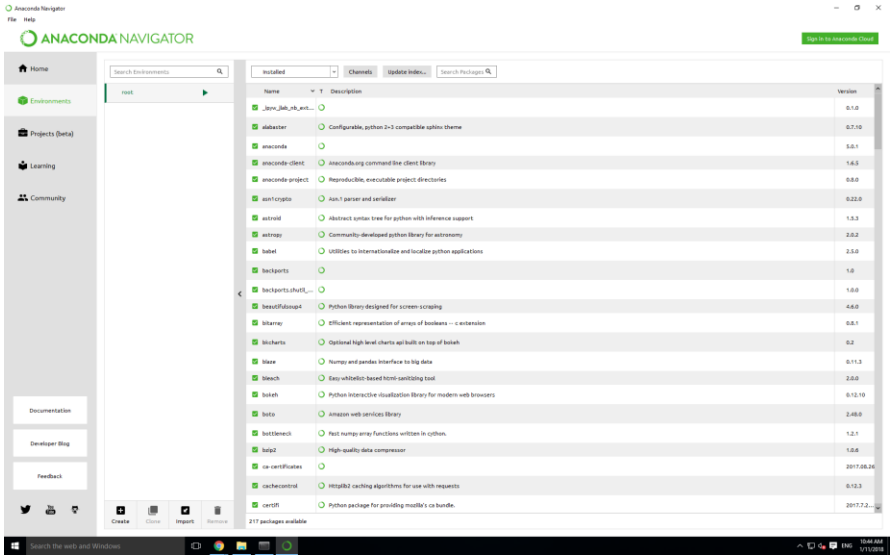




1.2 Set up the environment with python 3.5

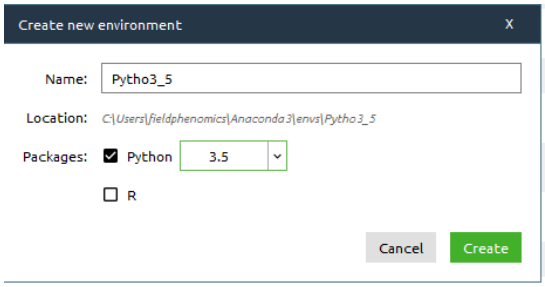
The default environment in Anaconda called ‘root’ uses python 3.6 but we need python 3.5 to be able to use openCV. The easiest way is to create a new environment in which python 3.5 will be installed.

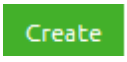
Go to ‘Environment’ (Left grey column, under ‘Home’)



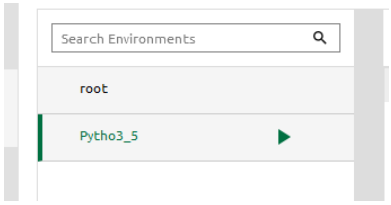
Click on 

. This window appears :



Choose a name for the new environment, select python 3.5 and click on 

The new environment now appear under ‘root’.

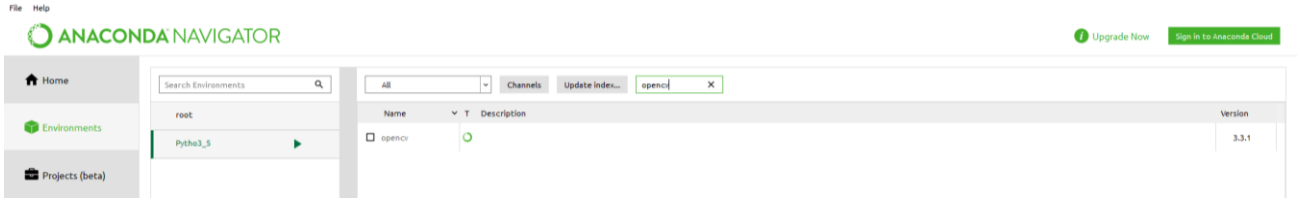


1.3 Install the packages necessary to run the scripts

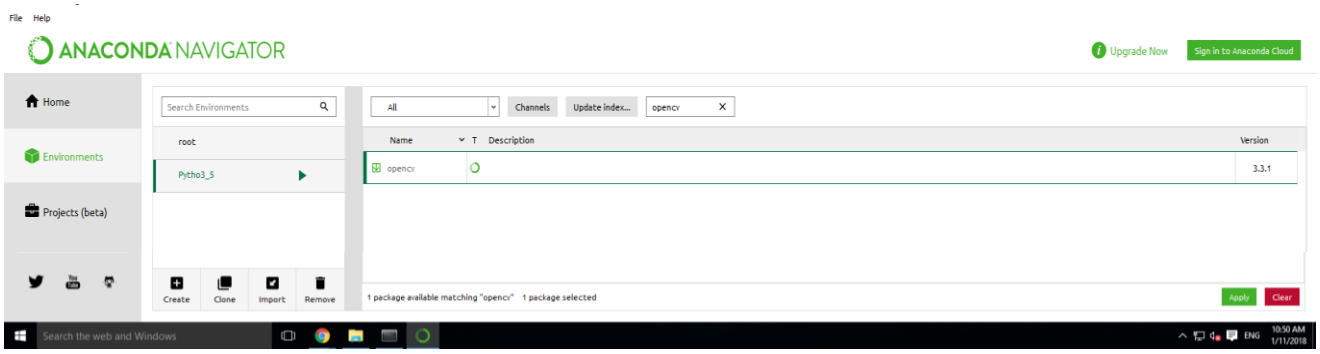
The scripts require the user to install several packages :
- openCV 3
- pyQt 5
- scikit-image
- scikit-learn

1.3.1 OpenCV3

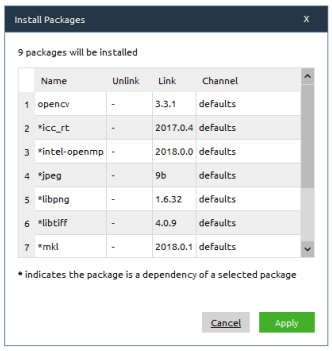
Look for the name of the package in the search bar and select ‘All’ in the menu.



Select opencv and click on  at the bottom right corner

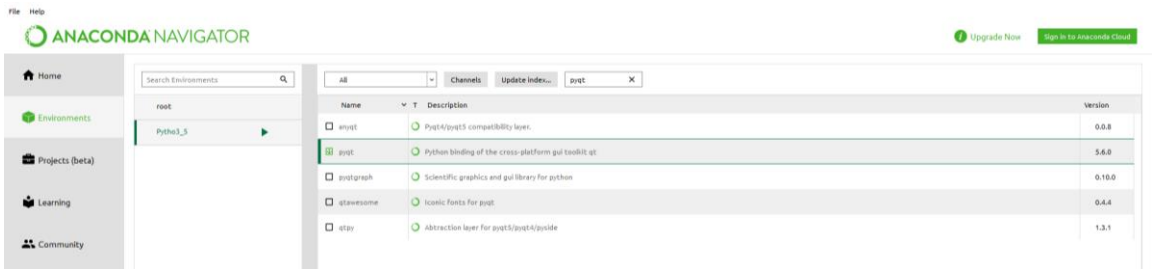


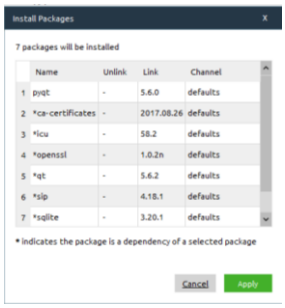
Click on  again.



1.3.2 pyQt 5

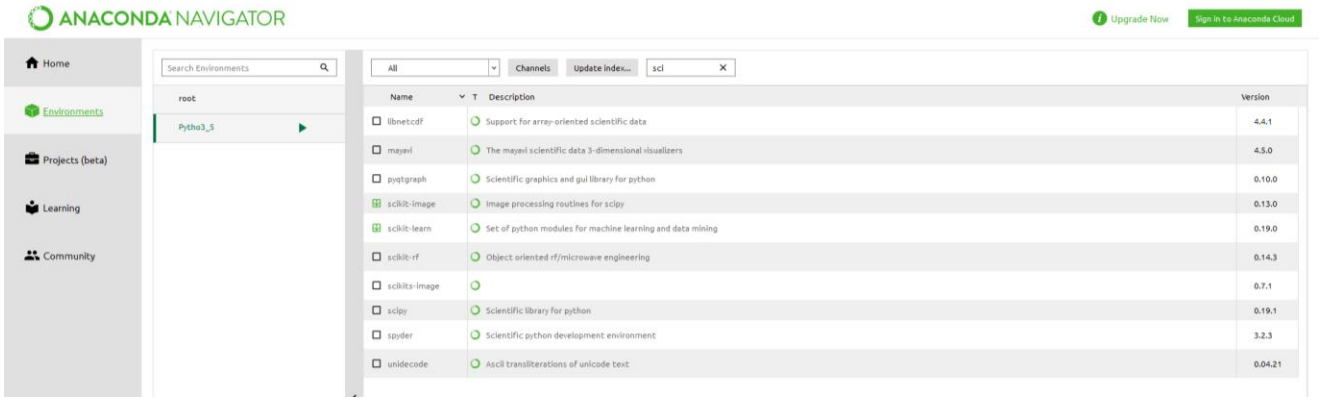
Repeat for pyQt5

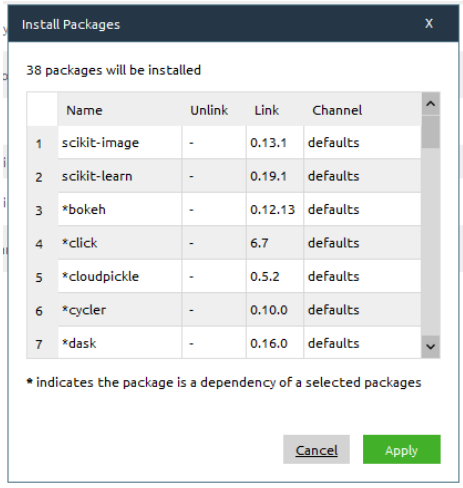




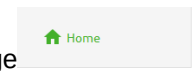
1.3.3 scikit

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

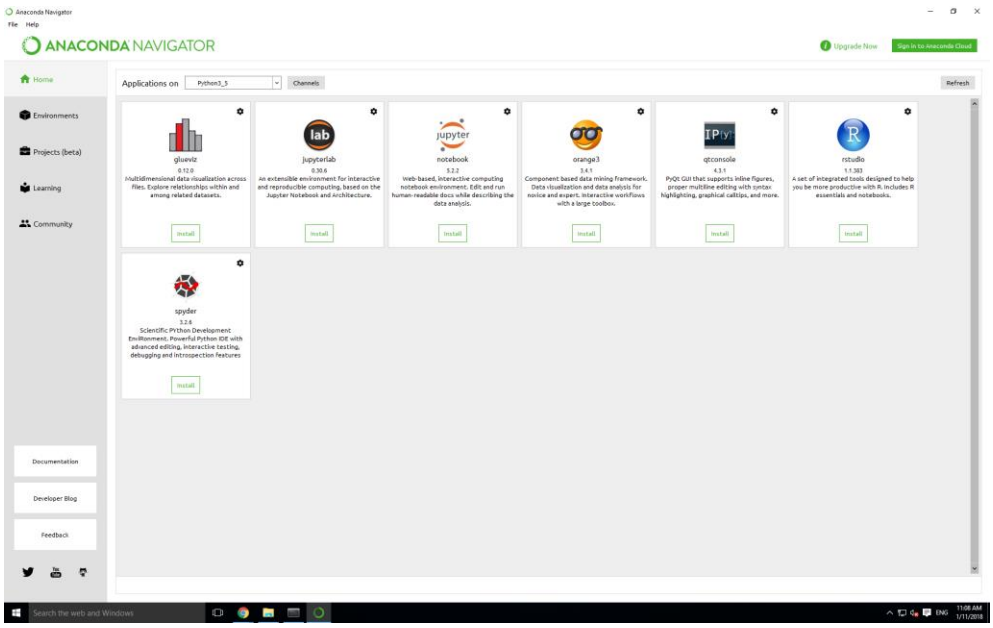




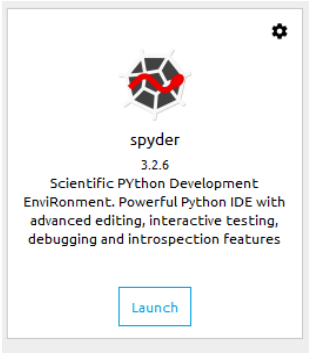
1.4 Install Spyder

Go back to the Home page 

and select the new environment in the menu ‘Applications on …’



Click on Install under Spyder spyder 3.2.6 .

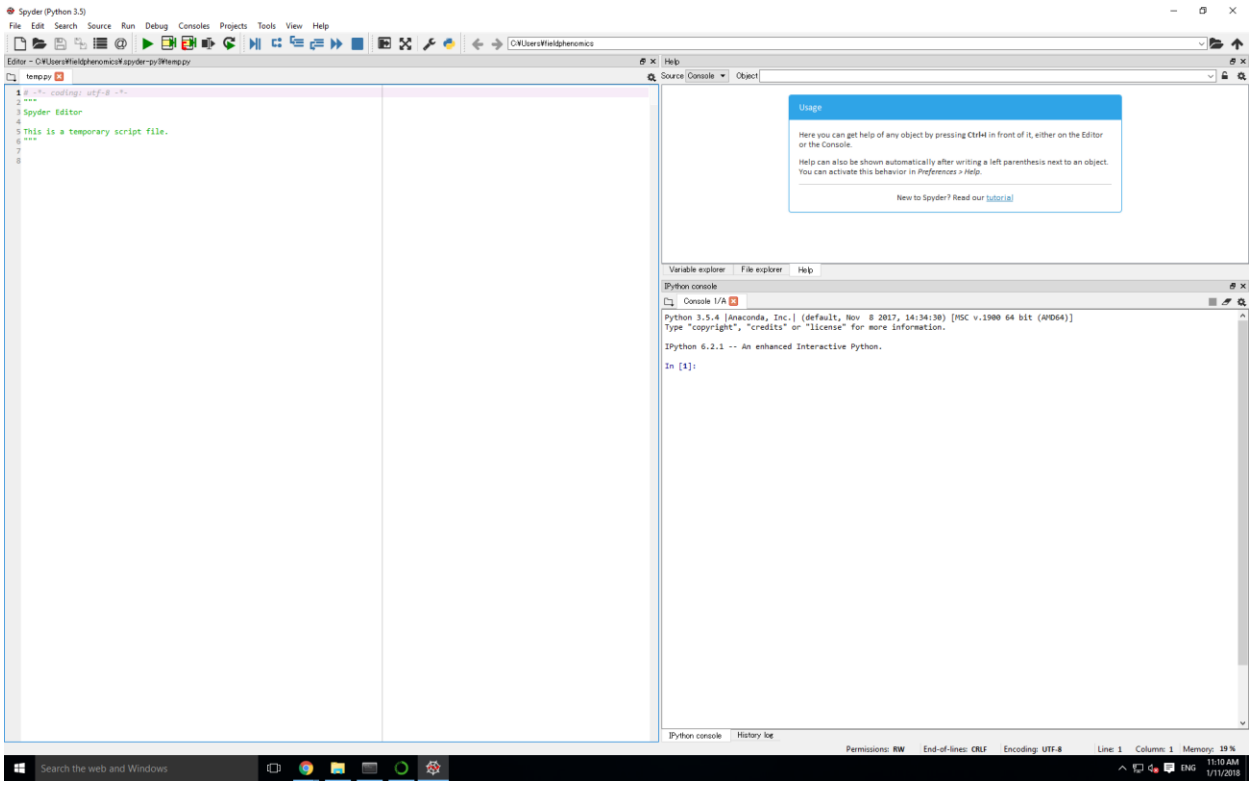


Lauch Spyder by clicking on Launch

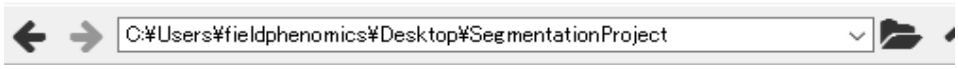
2 Set up Spyder

2.1 Set the source directory

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

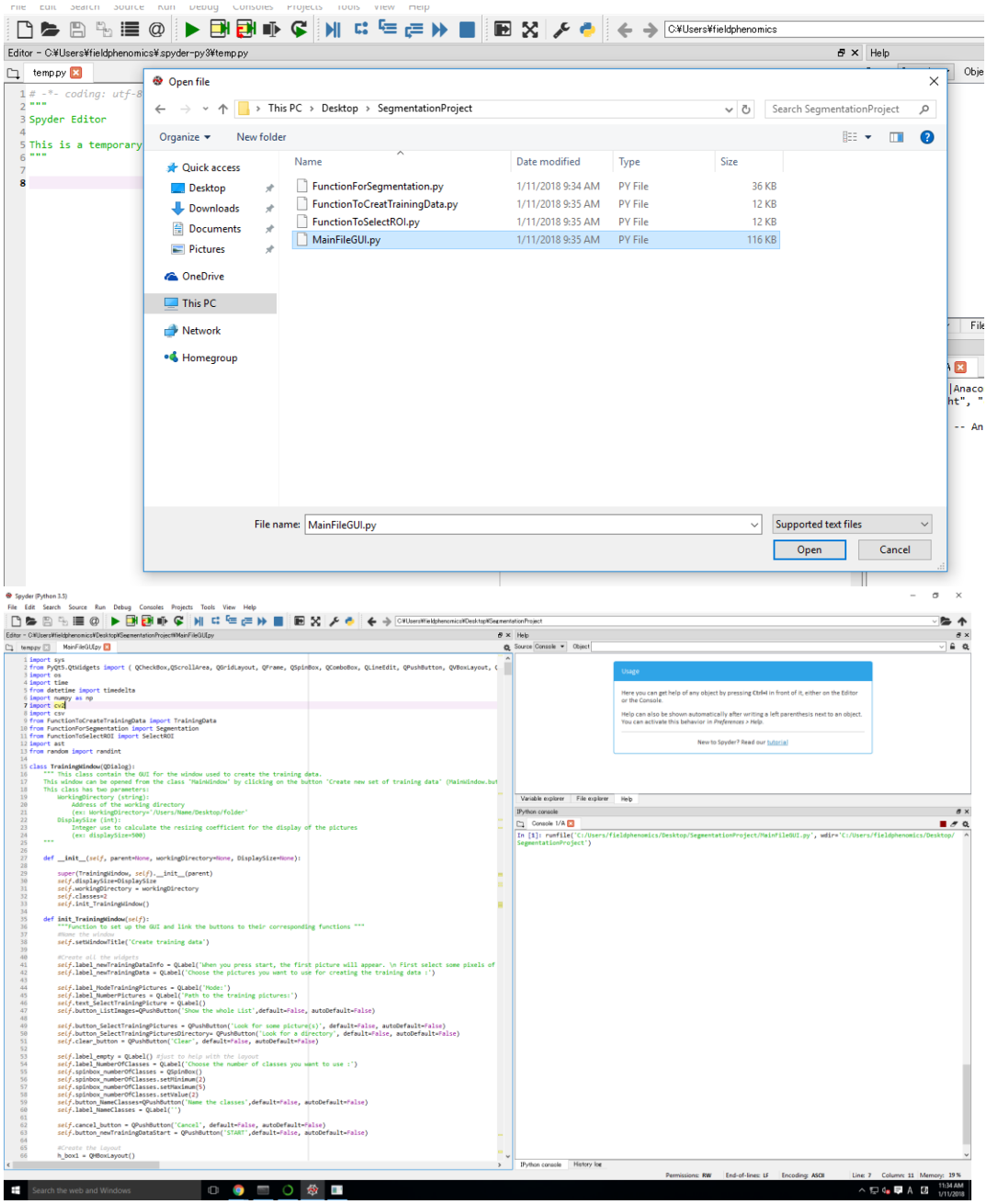


To change the source directory, click on the icon  at the top right corner and chose the directory ‘SegmentationProject’.



2.2 Open the Main file

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



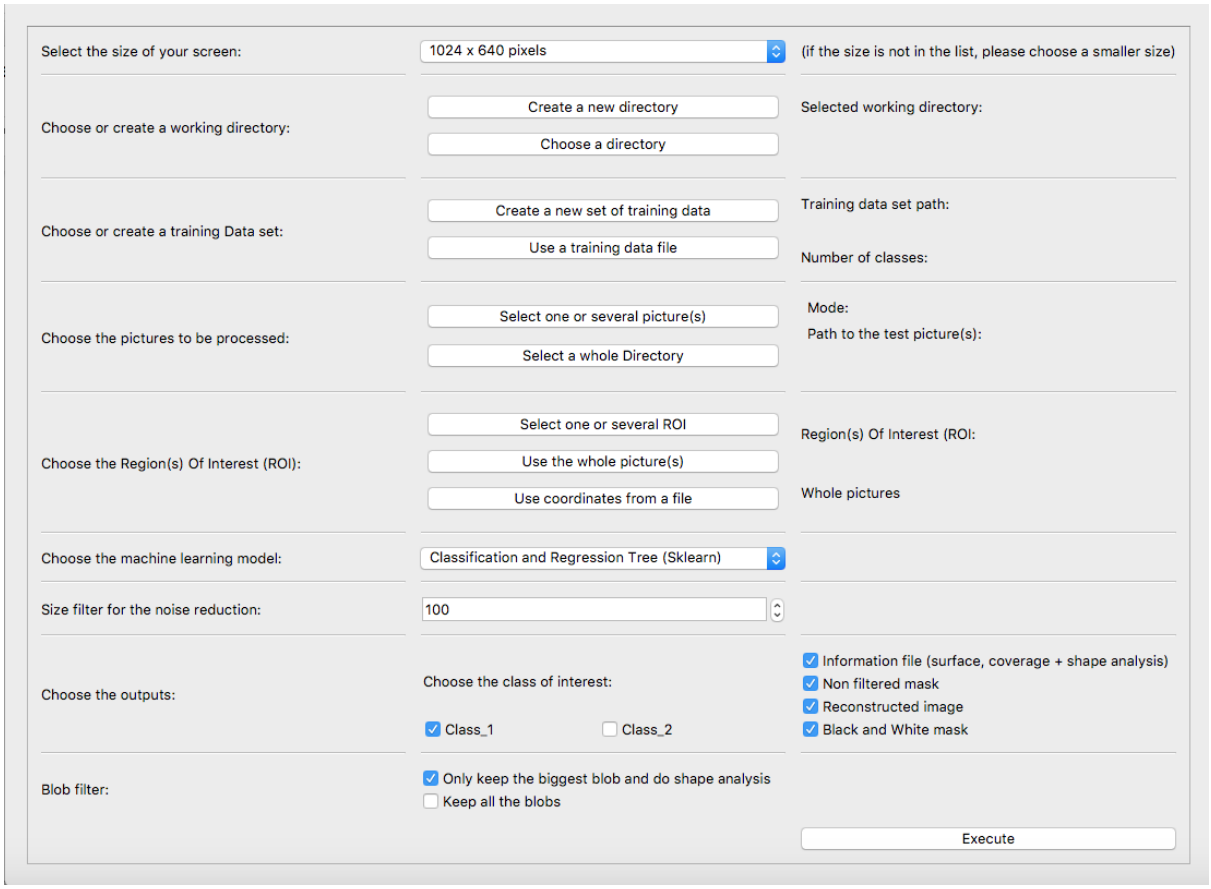
NB : No need to open the other files

2.3 Read the Main file

To execute the main file, click on  .

3 Use the Graphical User Interface (GUI)

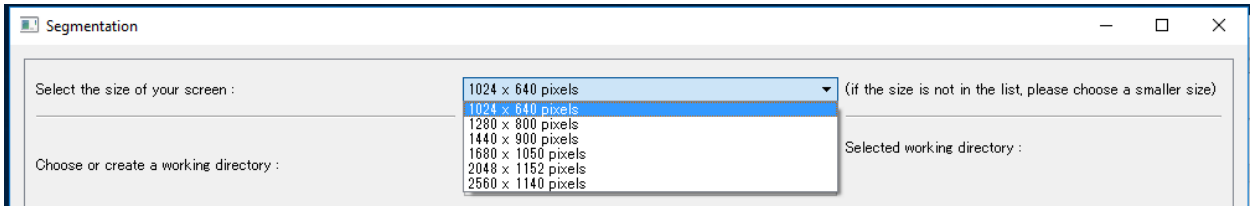
When the MainFileGUI.py is exectuted, this window is opened.
This Main window is organized by line, each line being a step.



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.

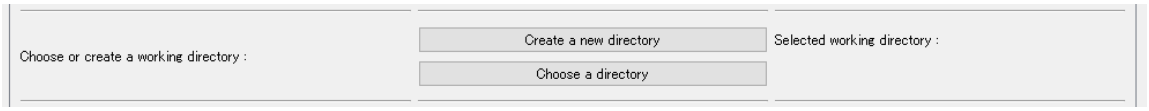


3.2 Choose or create a working directory

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

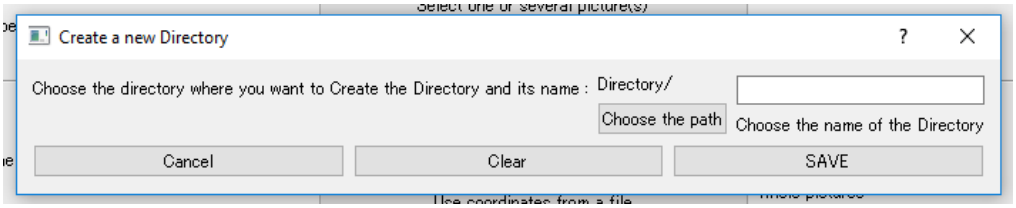
(NB: It is different from the source directory. Please do not choose ‘SegmentationProject’ as the working directory)
There is 2 possibilities :

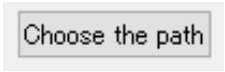
- Create a new directory
- or use an already existing working directory



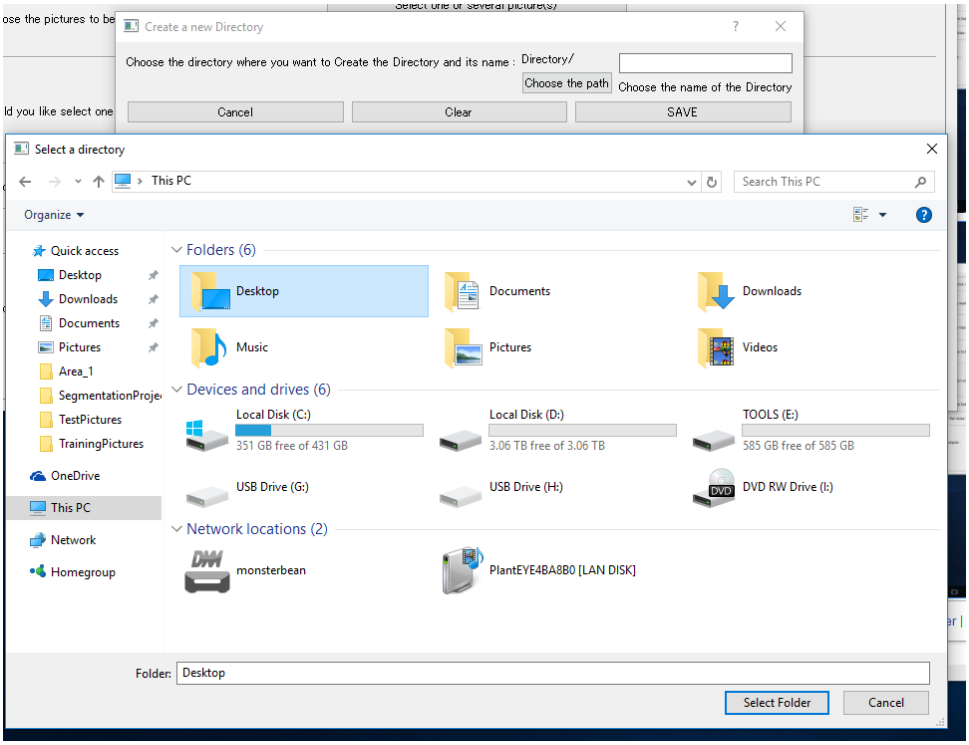
3.2.1 Create a new directory

Click on  and a new window will open :

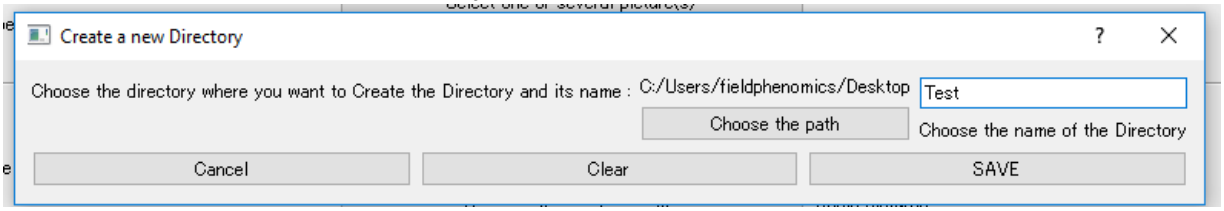


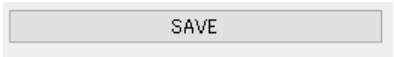
Choose the path of the new directory by clicking on  .

A dialog window opens:



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



Click on 

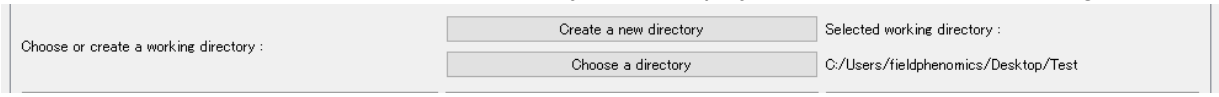
3.2.2 Use an already existing working directory

Click on 

and select a directory from your computer.

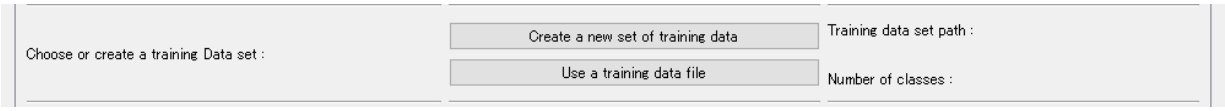
3.2.3 Result

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

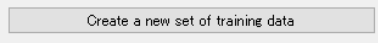


3.3 Choose or create a training data set

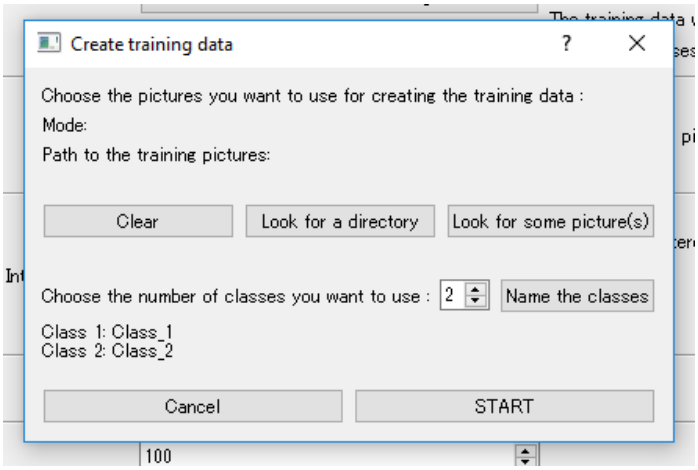
The training data set consist in in a csv file containing color data (RGB, HSV and Lab values for each pixels) on selected pixels attributed to a certain class. You can create a new set or reuse one that is already saved.



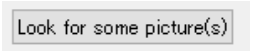
3.2.1 Create a new training data set

By clicking on 

the training window opens:



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 

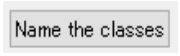
Once you have selected the pictures or the directory, the adresses will be displayed as shown here :

To review the list of pictures, click on 

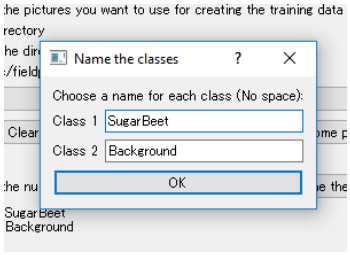
3.2.1.2 Choose the number of classes and name them

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 

:

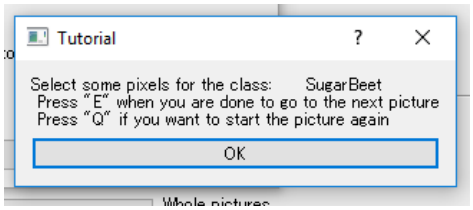


write the names and click on ‘OK’ to save.

3.2.1.3 Select pixels for each class

To start the pixel selection click on 

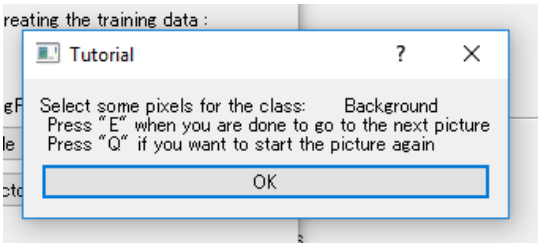
.
This message window will appear :



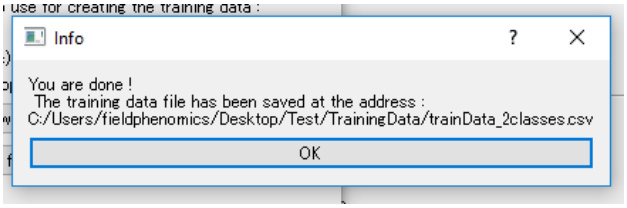
This window informs you of the commands (‘E’ for the next picture and ‘Q’ to go back) and of wich class is first (In this example, the first class is ‘SugarBeet’)
Press OK to start.
The picture will be displayed in another window. The size of this window will depend of the screen size that you have selected 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 :

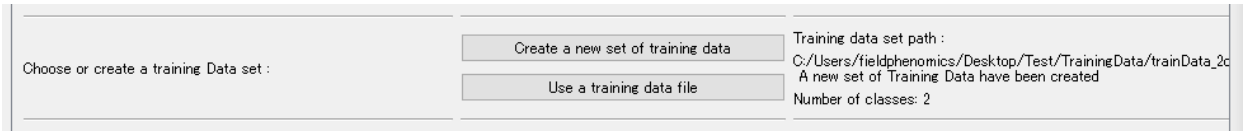


Click on 

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 :

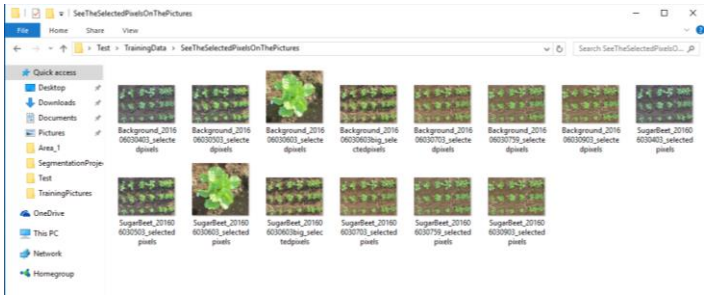


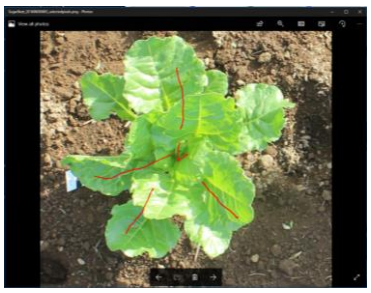
You can see in your working directory that a new folder has been created called 'TrainingData'. In this folder You will find :

- 1 csv file compiling all the training data.

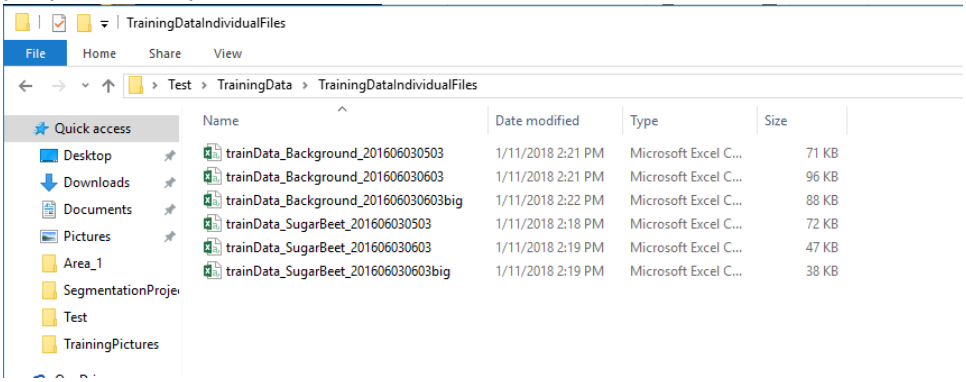
Class	Image	x	y	B	G	R	H	S	V	L	a	b
Background	201606021155 copy	487	311	28	34	33	35	45	34	33	125	132
Background	201606021155 copy	488	311	26	31	30	36	41	31	29	127	131
Background	201606021155 copy	488	312	25	32	29	43	56	32	29	127	132
SugarBeet	IMG_0086 copy	1479	2762	130	167	93	75	113	167	161	96	140
SugarBeet	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.



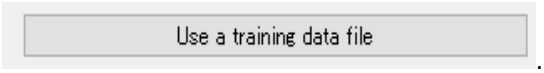


- one folder called ‘TrainingDataIndividualFiles’ containing individual training data files : one file per picture and per class.



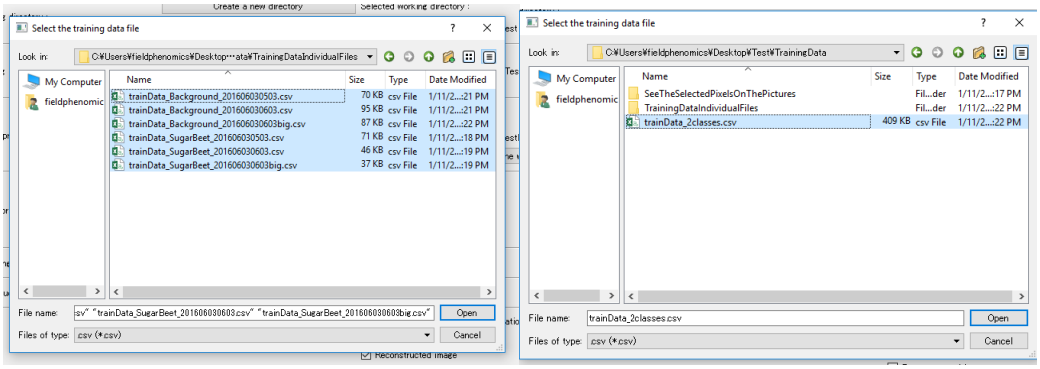
3.2.2 Use an already existing training data set

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

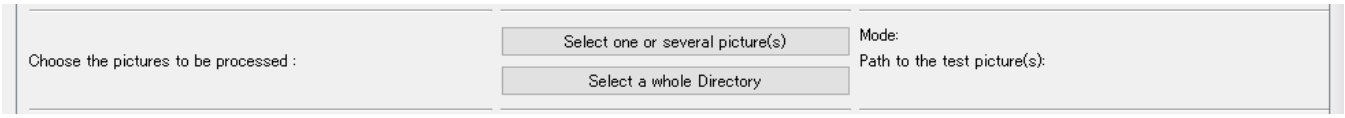


.

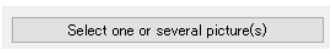
If you select more than one file, the files will be merged in a new file and save in the working directory.



3.3 Choose the picture(s) to test

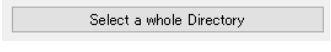


3.2.1 Select one several picture(s)

Click on 

to select one or several pictures.

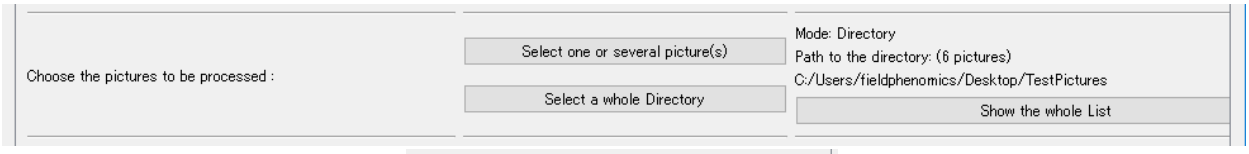
3.2.2 Select a whole directory

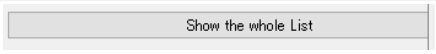
Click on 

to select all the pictures of a directory.

3.2.3 Result

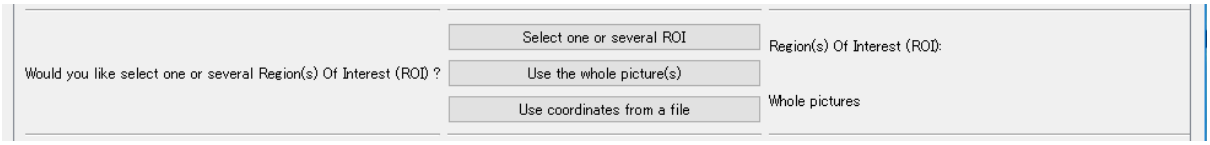
The addresses will be displayed in the right column of the main window.



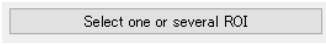
To see the complete liste click on 

3.4 Choose one or several Region of Interest (ROI)

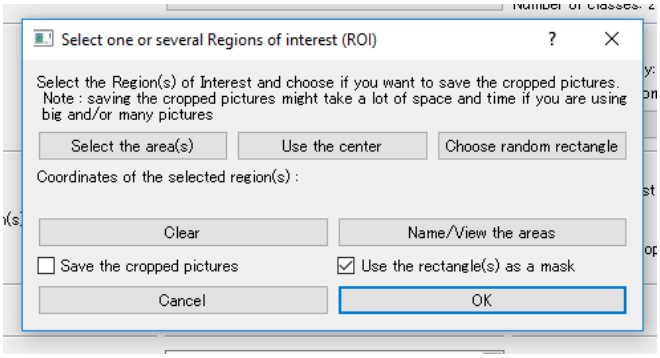
Three possibilities : use the whole pictures, use the coordinates from a file or select new regions of interest.



3.4.1 Select one several ROI

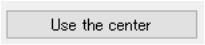
To select new ROI, click on 

. The ROI window will open :

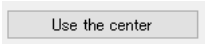


Three modes are available the select the ROI :

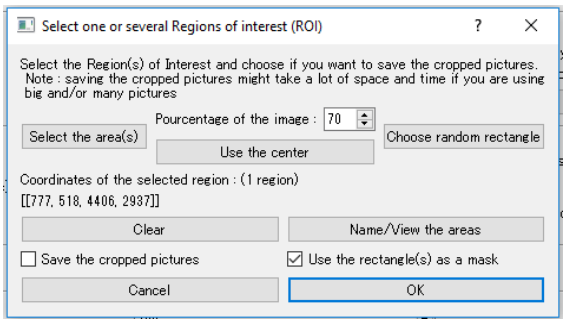
3.4.1.1 Use the center of the image as ROI

By clicking on 

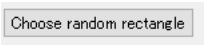
, the coordinates of a rectangle in the center of the image whose area equal 50% of the total area are calculates and a spinbox appears 

You can change the percentage of the image with this spinbox. Press 

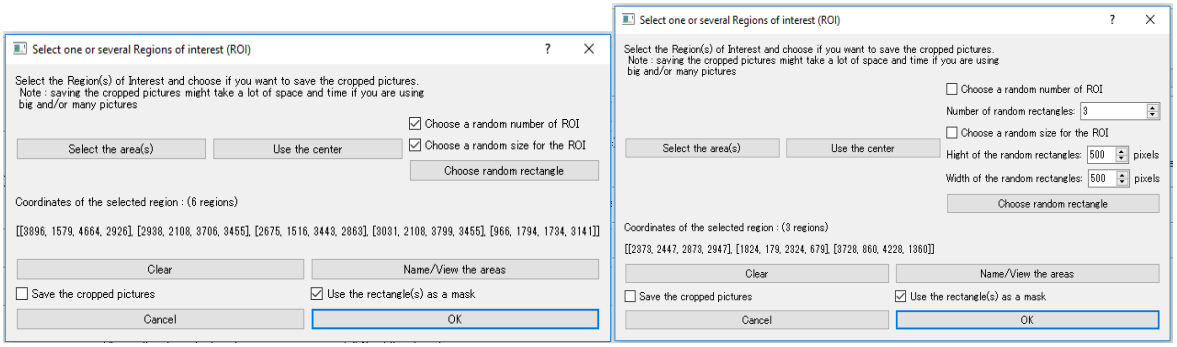
again to calculate the new coordinates.



3.4.1.2 Use some random rectangle as ROI

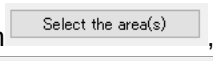
By clicking on 

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. :

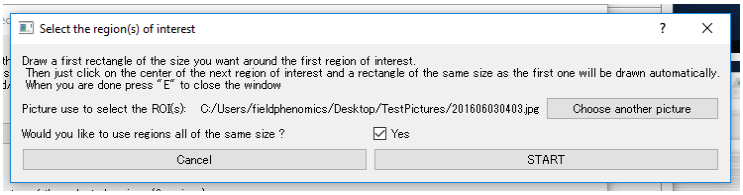


If you uncheck these checkboxes, you will be able to choose the number and dimensions of the random rectangles.
The rectangle CAN overlap each other.

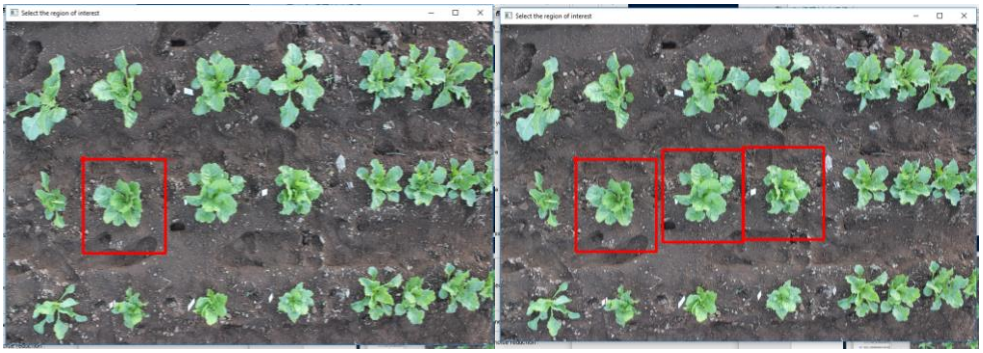
3.4.1.3 Select the ROI manually

By clicking on 

, a new window opens :

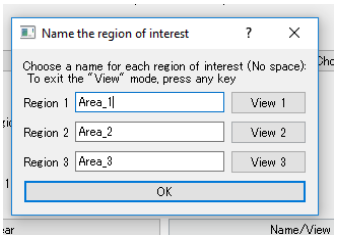


You can choose which picture to use to draw the ROI and if you want all the rectangles of the same size.
Press 'START' to open the picture:
If you have checked the checkbox to have same size rectangle, draw the first rectangle and then click in the middle of the next ROI.



3.4.1.4 Name and review the ROI

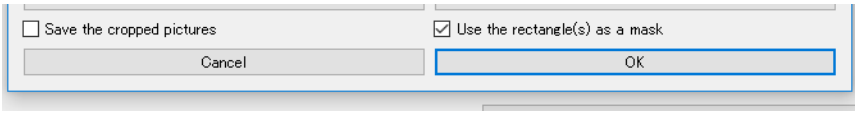
You can name and review the ROI by clicking on 



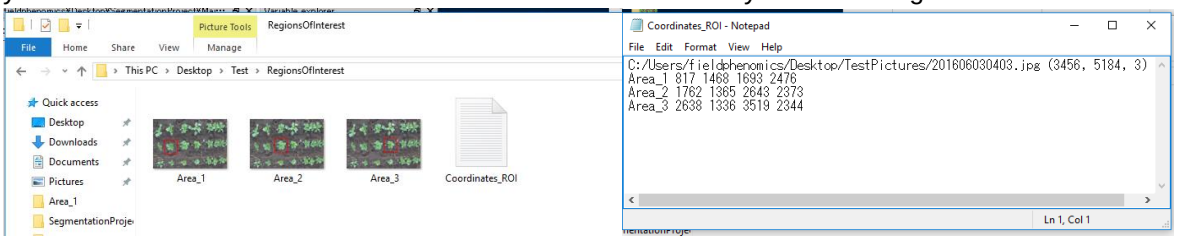
Click view to review the area
Click on 'OK' to save the new names

3.4.1.5 Save the ROI

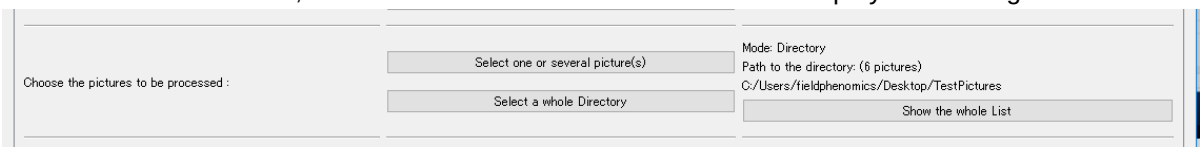
When saving the ROI you can decide to save the cropped pictures or not. If you save the cropped pictures, the pictures will be cropped according to the ROI and save in the working directory. (This is not recommended as it will take time and memory if the photo set is big.



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.

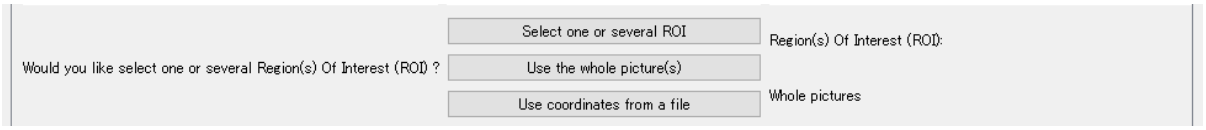


Back in the main window, the address of the coordinates file will be displayed in the right column.



3.4.2 Use the whole picture

You can also choose not to use ROI by clicking on 

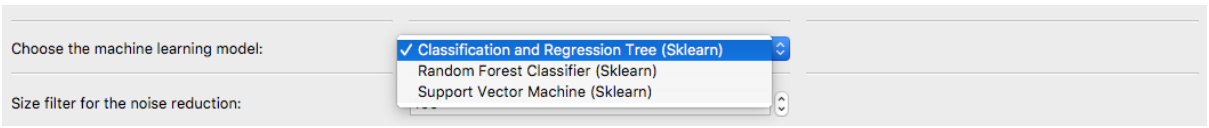


3.4.3 Use coordinates from a file

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

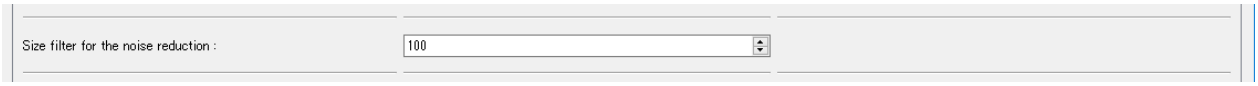
3.5 Choose the machine learning model

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.

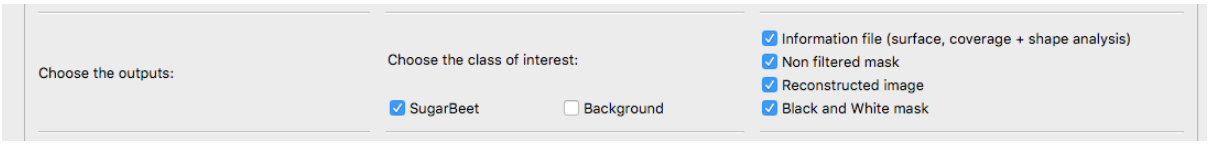


3.7 Choose the outputs and execute the program

This line will be different depending of the number of classes

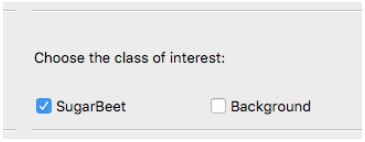
3.7.1 Two classes

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



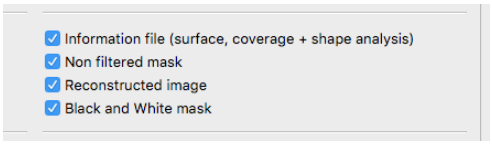
3.7.1.1 Choose the class of interest

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



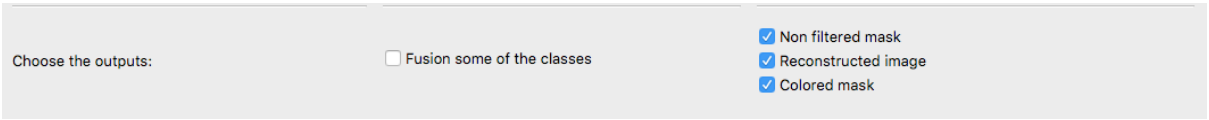
3.7.1.2 Choose the outputs

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



3.7.2 More than two classes

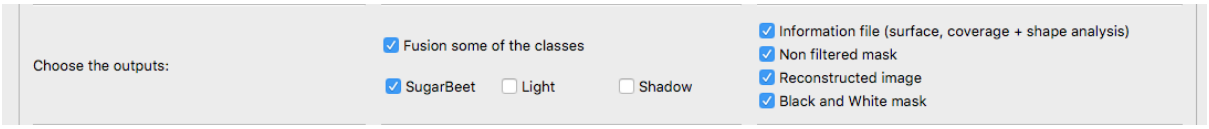
If you are using more than 2 classes you will see :



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.

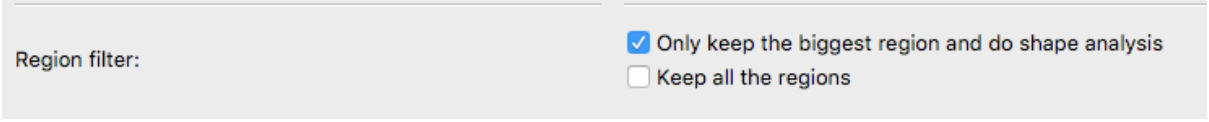
3.7.2.2 Choose the outputs

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.

See part 4 to understand the outputs.

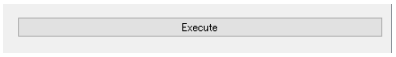
3.8 Region filter

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



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

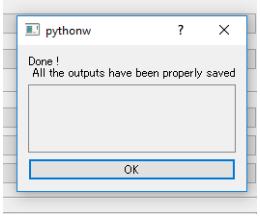
The program will start running when you click on 

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 :

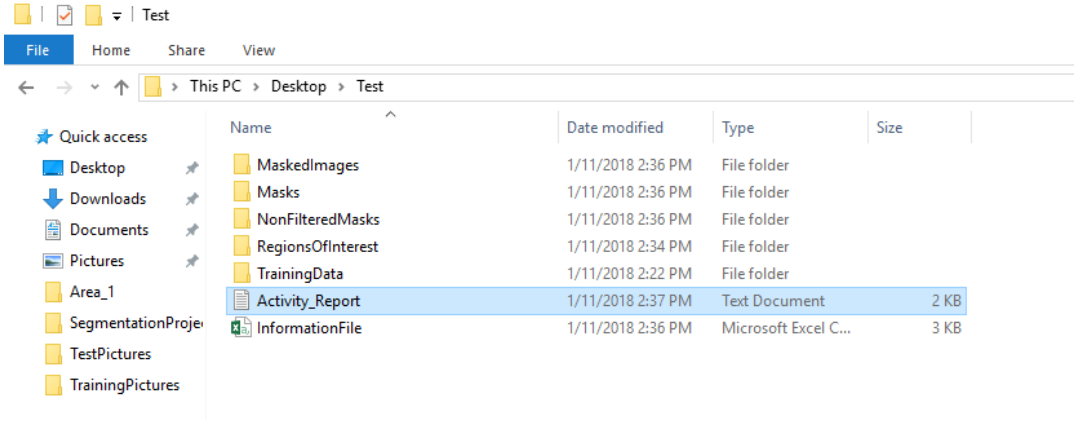
```
178         #           hour=float(ImageName[8:10])
179                     hour=float(10)
180                     if 8<hour<16:
```

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<hour<16, the program will only process the pictures taken between 8:00 and 16:00.

4 Outputs

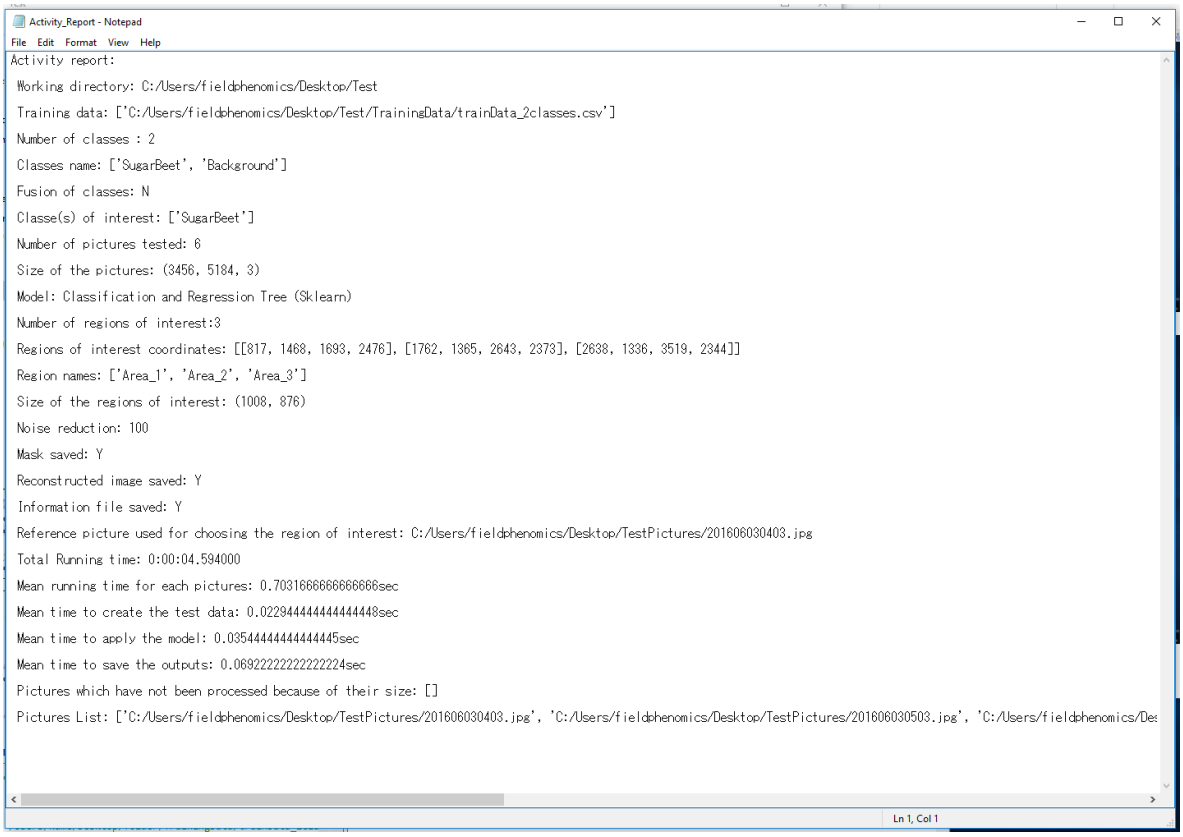
4.1 For two classes or more than two classes with fusion

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.



4.1.2 Non filtered masks

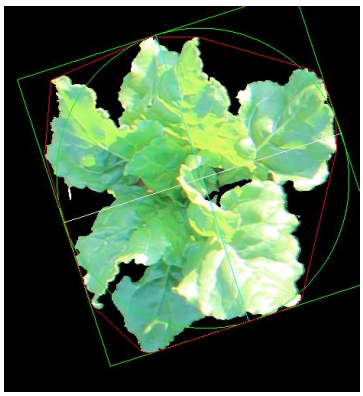
The non filtered mask is the mask before being processed.

4.1.3 Masked Images

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

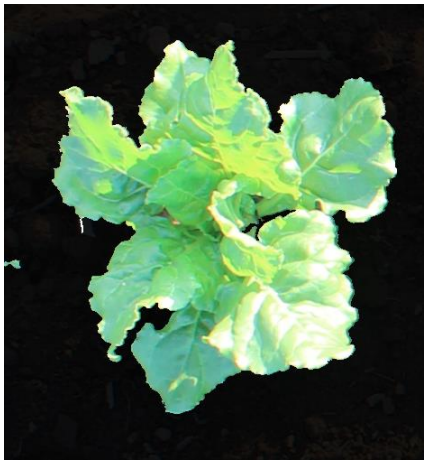
4.1.3.1 You have use the region filter

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

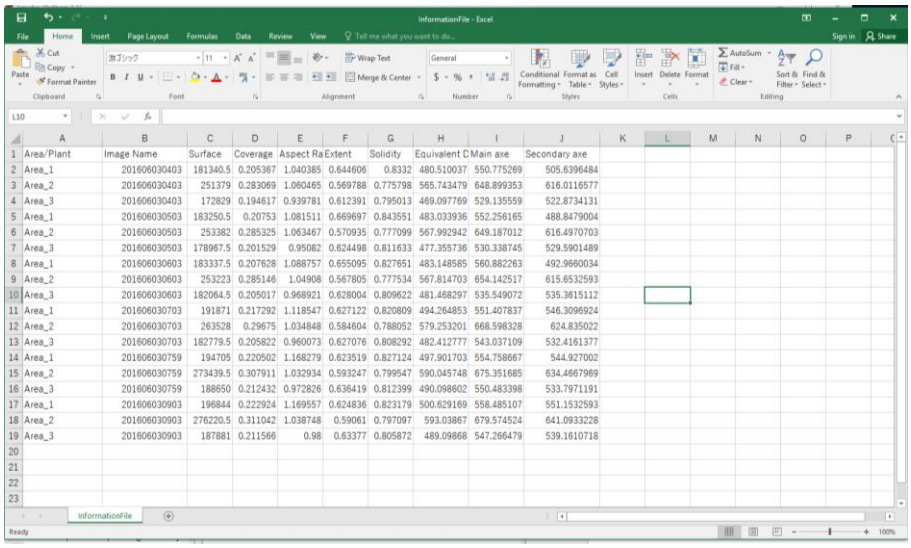
The mask is a black and white image with the class of interest in white.
The filtering process for two classes uses one or two filter method :

- 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

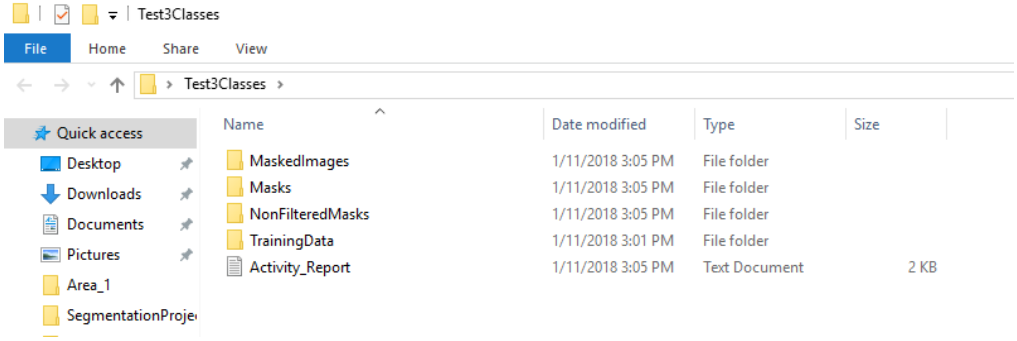
If you have chosen the region filter, some shape analysis data will be added to the file : aspect ratio, extent, solidity, equivalent diameter, length of the axes. WARNING : These informations are valid only if the plants are not touching each other and if there is only one plant per ROI.



	A	B	C	D	E	F	G	H	I	J
1	Area/Plant	Image Name	Surface	Coverage	Aspect Ra	Extent	Solidity	Equivalent D	Main axe	Secondary axe
2	Area_1	201606030403	181340.5	0.205367	1.040385	0.644606	0.8332	480.510037	550.775269	505.6396484
3	Area_2	201606030403	251379	0.283069	1.060465	0.569788	0.775798	565.743479	648.899353	616.0116577
4	Area_3	201606030403	172829	0.194617	0.939781	0.612391	0.795013	469.097769	529.135559	522.8734131
5	Area_1	201606030503	183250.5	0.20753	1.081511	0.669697	0.843551	483.033936	552.256165	488.8479004
6	Area_2	201606030503	253382	0.285325	1.063467	0.570935	0.777099	567.992942	649.187012	616.4970703
7	Area_3	201606030503	178967.5	0.201529	0.95082	0.624498	0.811633	477.355736	530.338745	529.5901489
8	Area_1	201606030603	183337.5	0.207628	1.088757	0.655095	0.827651	483.148585	560.882263	492.9660034
9	Area_2	201606030603	253223	0.285146	1.04908	0.567805	0.777534	567.814703	654.142517	615.6532593
10	Area_3	201606030603	182064.5	0.205017	0.968921	0.628004	0.809622	481.468297	535.549072	535.3615112
11	Area_1	201606030703	191871	0.217292	1.118547	0.627122	0.820809	494.264853	551.407837	546.3096924
12	Area_2	201606030703	263528	0.29675	1.034848	0.584604	0.788052	579.253201	668.598328	624.835022
13	Area_3	201606030703	182779.5	0.205822	0.960073	0.627076	0.808292	482.412777	543.037109	532.4161377
14	Area_1	201606030759	194705	0.220502	1.168279	0.623519	0.827124	497.901703	554.758667	544.927002
15	Area_2	201606030759	273439.5	0.307911	1.032934	0.593247	0.799547	590.045748	675.351685	634.4667969
16	Area_3	201606030759	188650	0.212432	0.972826	0.636419	0.812399	490.098602	550.483398	533.7971191
17	Area_1	201606030903	196844	0.222924	1.169557	0.624836	0.823179	500.629169	558.485107	551.1532593
18	Area_2	201606030903	276220.5	0.311042	1.038748	0.59061	0.797097	593.03867	679.574524	641.0933228
19	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)

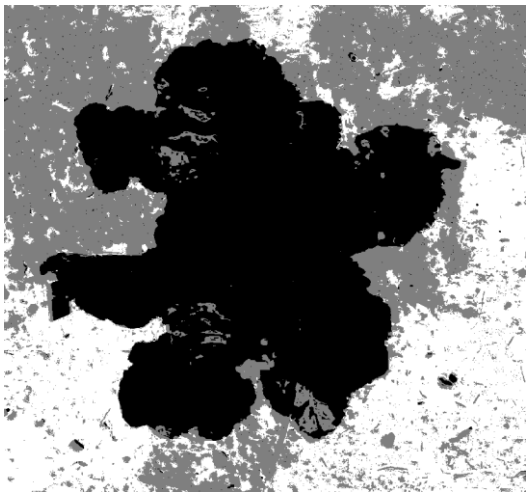
4.2.1 Activity report

Same as 4.1.1

4.2.2 Masked Images

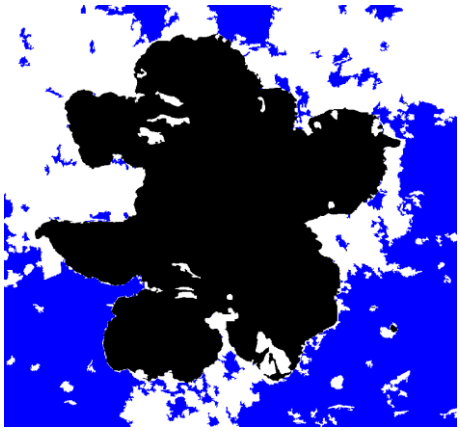
The masked image is the original image with a color filter corresponding to the classes(see 4.2.4 Masks)

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.