EcoTransLearn R-package

Version 1.0-1

USER MANUAL

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IFREMER
LABORATOIRE ENVIRONNEMENT RESSOURCES
CENTRE MANCHE MER DU NORD

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INTRODUCTION

In recent years, Deep Learning (DL) has been increasingly used in many fields, in particular in image recognition, due to its ability to solve problems where traditional machine learning algorithms fail. However, building an appropriate DL model from scratch especially in the context of ecological studies, such as monitoring marine ecosystems, is a difficult task due to the dynamic nature and morphological variability of living organisms, as well as the high cost in terms of time, human resources, and skills required to label a large number of training images. To overcome this problem, Transfer Learning (TL) can be used to improve a classifier by transferring information learnt from many domains thanks to a very large training set composed of various images, to another domain with a smaller amount of training data. To compensate the lack of "easy-to-use" software optimized for ecological studies, we propose the *EcoTransLearn* R-package, which allows greater automation in classification of images acquired with various devices, thanks to different TL methods pre-trained on the generic ImageNet dataset.

INSTALLATION AND EXECUTION

R-package installation

The version **1.0-0** of the *EcoTransLearn* package needs a recent version of R (version **4.0.x** or upper). It can be directly downloaded on GitHub at: *https://github.com/IFREMER-LERBL/EcoTransLearn* (see '*Releases'* page to download the .tar file.)

By double-clicking on the R icon on the desktop, or by selecting R in the start menu, a window appears on the screen: this is the R console. This allows to control R directly by command lines. It also allows to display the main results and messages of the different actions performed with *EcoTransLearn*.

The R-packages needed by *EcoTransLearn* (*colorRamps* **2.3**, *ggplot2* **3.3.5**, *grid* **4.0.5**, *jpeg* **0.1-9**, *mapplots* **1.5.1**, *maps* **3.4.0**, *randomForest* **4.6-14**, *reticulate* **1.23**, *SDMTools* **1.1-221.2**, *shapefiles* **0.7**, *stringr* **1.4.0**, *svDialogs* **1.0.3**, *svMisc* **1.2.3**, *tcltk2* **1.2-11**, *tiff* **0.1-10**, *zooimage* **5.5.2** *or upper versions*) can be installed directly from the R console, by typing:

```
install.packages(c("colorRamps",
                   "ggplot2",
                   "grid",
                   "jpeg",
                   "mapplots",
                   "maps",
                   "randomForest",
                   "reticulate",
                   "SDMTools",
                   "shapefiles",
                   "stringr",
                   "svDialogs",
                   "svMisc",
                   "tcltk2",
                   "tiff",
                   "zooimage"))
```

Then choose a mirror (default: 0-cloud) to start download and installation.

Python installation

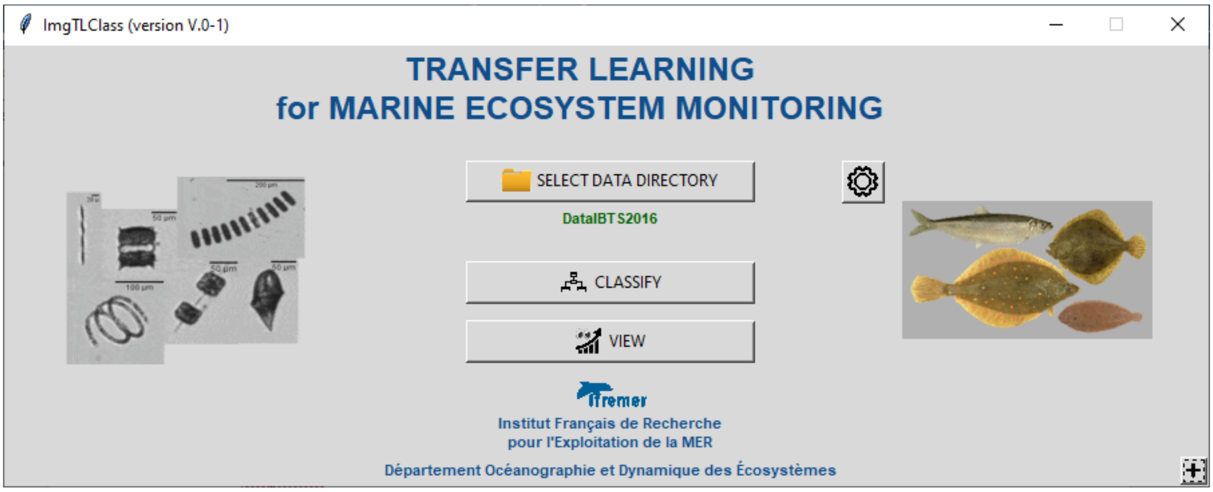
Anaconda is a scientific distribution of Python, which allows to use several applications (such as Spyder, Jupyter Notebook, …) and to manage different libraries. It can be downloaded on the website: https://docs.anaconda.com/anaconda/navigator/install/. The *EcoTransLearn* package needs the version **3.7** (or upper) of Python.

Once the distribution installed, the Python libraries needed by *EcoTransLearn* (*matplotlib* **3.3.4**, *numpy* **1.19.2**, *pandas* **1.1.5**, *sklearn* **0.24.2**, *tensorflow* **2.2.0** or upper versions) can be installed directly by opening an Anaconda Prompt, and by entering the commands:

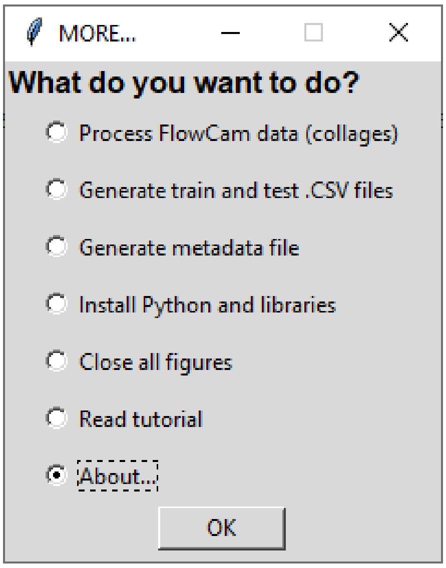
```
conda install matplotlib
conda install numpy
conda install pandas
conda install sklearn
conda install tensorflow
```

Launching the Graphical User Interface

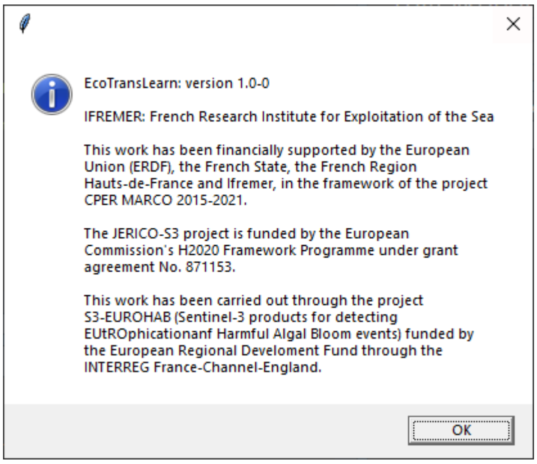
Once the installation of the packages is finished, it is possible to make sure that the previous steps run smoothly by checking that the installed version is **1.0-0**. To do this, first type in the R console `library(EcoTransLearn)`, to load the package, then `EcoTransLearn()`, to launch the Graphical User Interface (GUI):


ImgTLClass (version V.0-1)
TRANSFER LEARNING
for MARINE ECOSYSTEM MONITORING
SELECT DATA DIRECTORY
DataIBTS2016
CLASSIFY
VIEW
Ifremer
Institut Français de Recherche
pour l'Exploitation de la MER
Département Océanographie et Dynamique des Écosystèmes
+

Click on the **+** button (bottom right). A new window appears:



By selecting **About...**, a dialog box appears and informs the user of the *EcoTransLearn* version.



EcoTransLearn: version 1.0-0

IFREMER: French Research Institute for Exploitation of the Sea

This work has been financially supported by the European Union (ERDF), the French State, the French Region Hauts-de-France and Ifremer, in the framework of the project CPER MARCO 2015-2021.

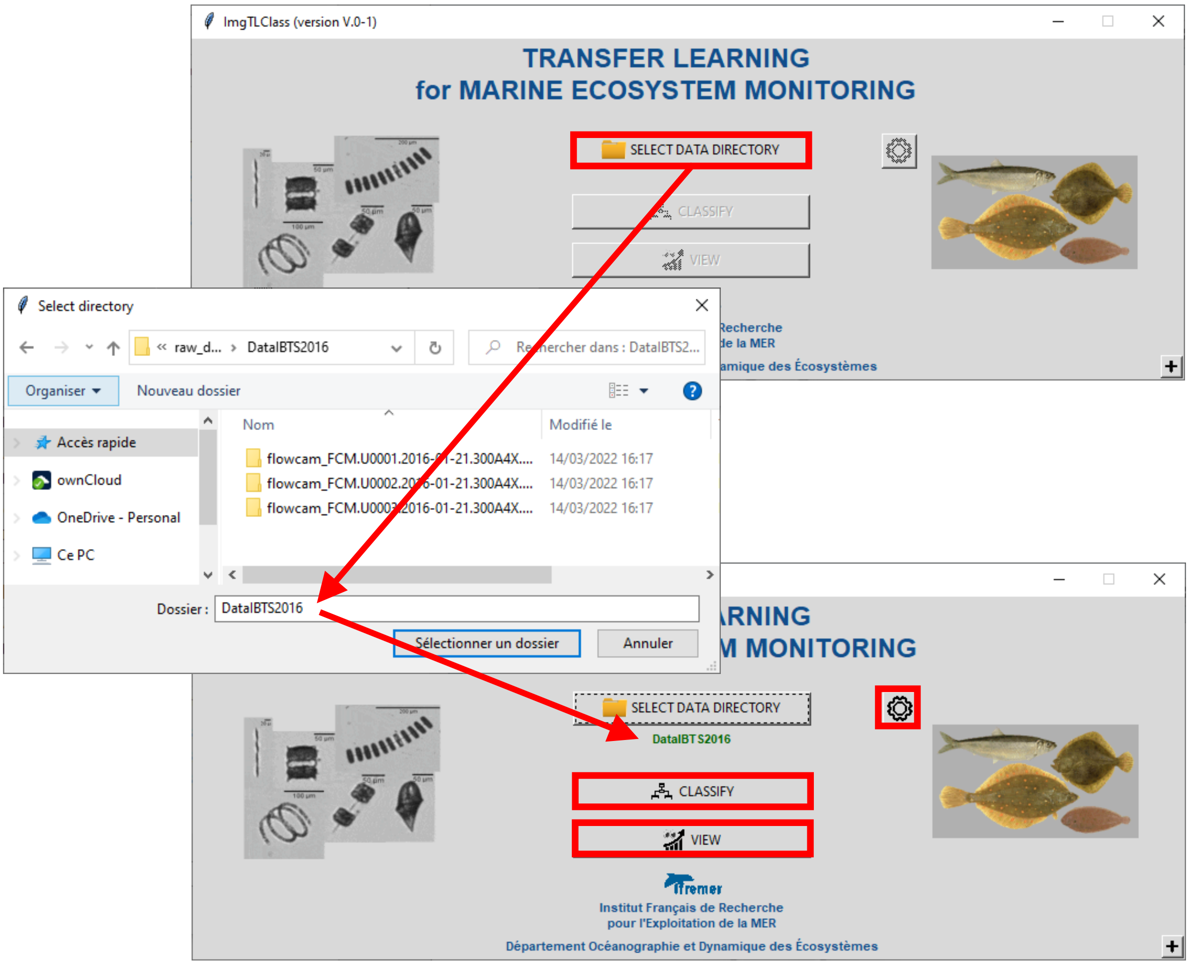
The JERICO-S3 project is funded by the European Commission's H2020 Framework Programme under grant agreement No. 871153.

This work has been carried out through the project S3-EUROHAB (Sentinel-3 products for detecting EUtROphicationanf Harmful Algal Bloom events) funded by the European Regional Develoment Fund through the INTERREG France-Channel-England.

USE OF THE GRAPHICAL USER INTERFACE

For routine use of *EcoTransLearn*, an ergonomic Graphical User Interface is available.

DATA SELECTION button



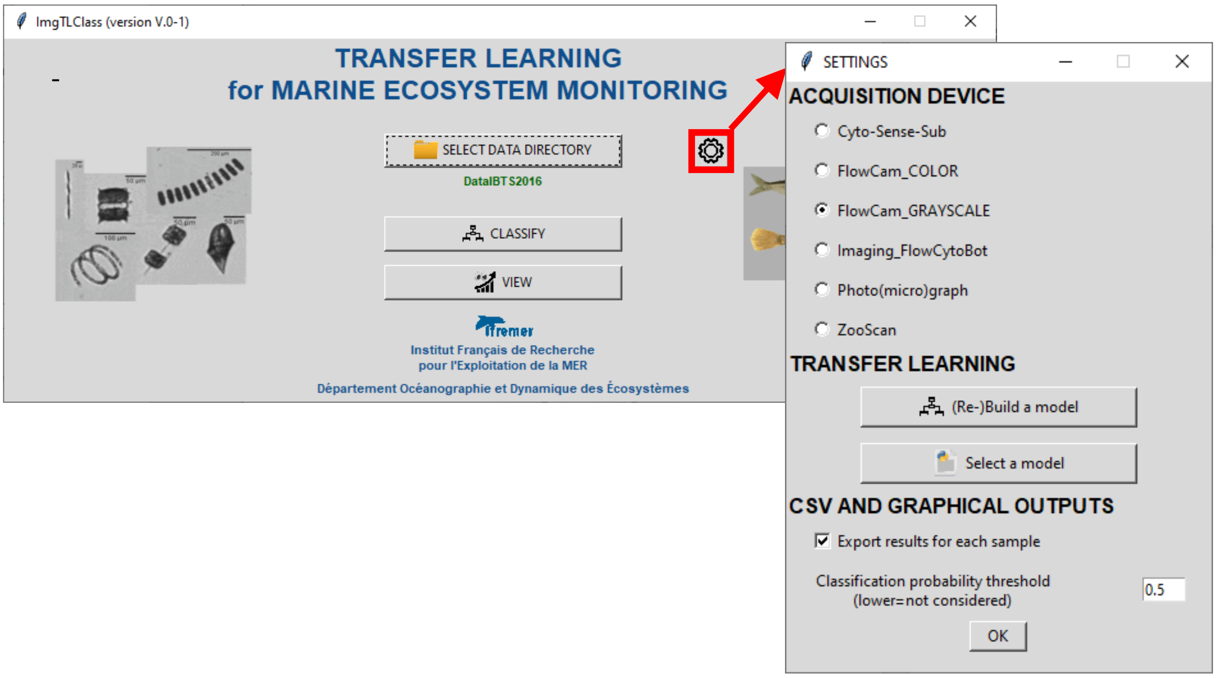
Nom	Modifié le
flowcam_FCM.U0001.2016-01-21.300A4X....	14/03/2022 16:17
flowcam_FCM.U0002.2016-01-21.300A4X....	14/03/2022 16:17
flowcam_FCM.U0003.2016-01-21.300A4X....	14/03/2022 16:17

Dossier : DataIBTS2016

Click on the **SELECT DATA DIRECTORY** button, select the directory containing the images to classify, then validate by clicking on **OK**: the name of the selected directory is displayed below the selection button, and the **SETTINGS**, **CLASSIFY** and **VIEW** buttons become active.

SETTINGS button

After selection of the input data, the settings window is automatically displayed (without clicking on the **SETTINGS** button). However, it is possible to redisplay this window at any time by clicking on this button.


ImgTLClass (version V.0-1)
TRANSFER LEARNING
for MARINE ECOSYSTEM MONITORING
SELECT DATA DIRECTORY
DataIBTS2016
CLASSIFY
VIEW
Ifremer
Institut Français de Recherche
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Département Océanographie et Dynamique des Écosystèmes
SETTINGS

ACQUISITION DEVICE

○ Cyto-Sense-Sub
○ FlowCam_COLOR
● FlowCam_GRAYSCALE
○ Imaging_FlowCytoBot
○ Photo(micro)graph
○ ZooScan

TRANSFER LEARNING

(Re-)Build a model

Select a model

CSV AND GRAPHICAL OUTPUTS

☑ Export results for each sample

Classification probability threshold (lower=not considered) 0.5

OK

❖ ACQUISITION parameters

Choose the kind of instrument used for image acquisition.

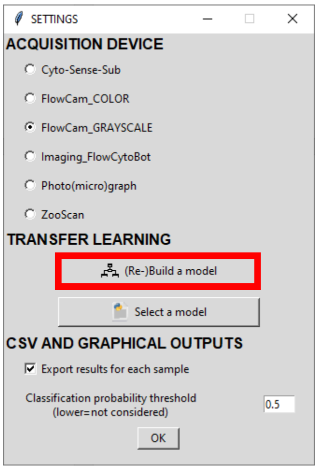
<u>Note</u>: for the FlowCam_COLOR and the FlowCam_GRAYSCALE, it is possible to directly output the raw data from the instruments (collages). The package allows to directly create the vignettes (1 image per particle) from the collages and the lst file.

❖ CLASSIFICATION parameters

▪ (Re-)Build a model

This button allows to build (or rebuild) a classification model by Transfer Learning using a data set including a training set (directory must be named **train**) for learning, and a test set (directory must be named **test**) for validation and evaluation.

All unsorted images are bulked into these directories. Two CSV files (named 'train.csv' and 'test.csv') allows listing the group of each image (see **Generate train and test .CSV files** section).



ACQUISITION DEVICE

○ Cyto-Sense-Sub
○ FlowCam_COLOR
● FlowCam_GRAYSCALE
○ Imaging_FlowCytoBot
○ Photo(micro)graph
○ ZooScan

TRANSFER LEARNING

(Re-)Build a model

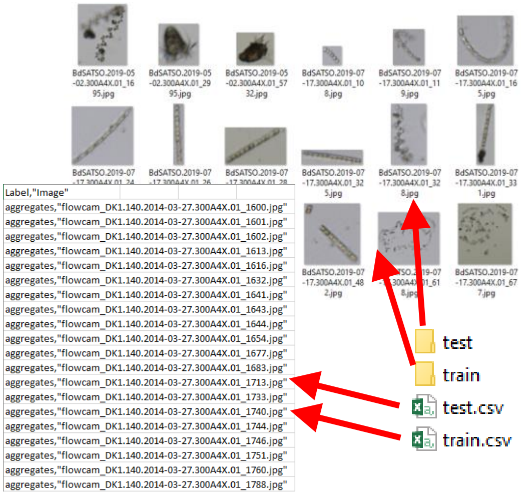
Select a model

CSV AND GRAPHICAL OUTPUTS

☑ Export results for each sample

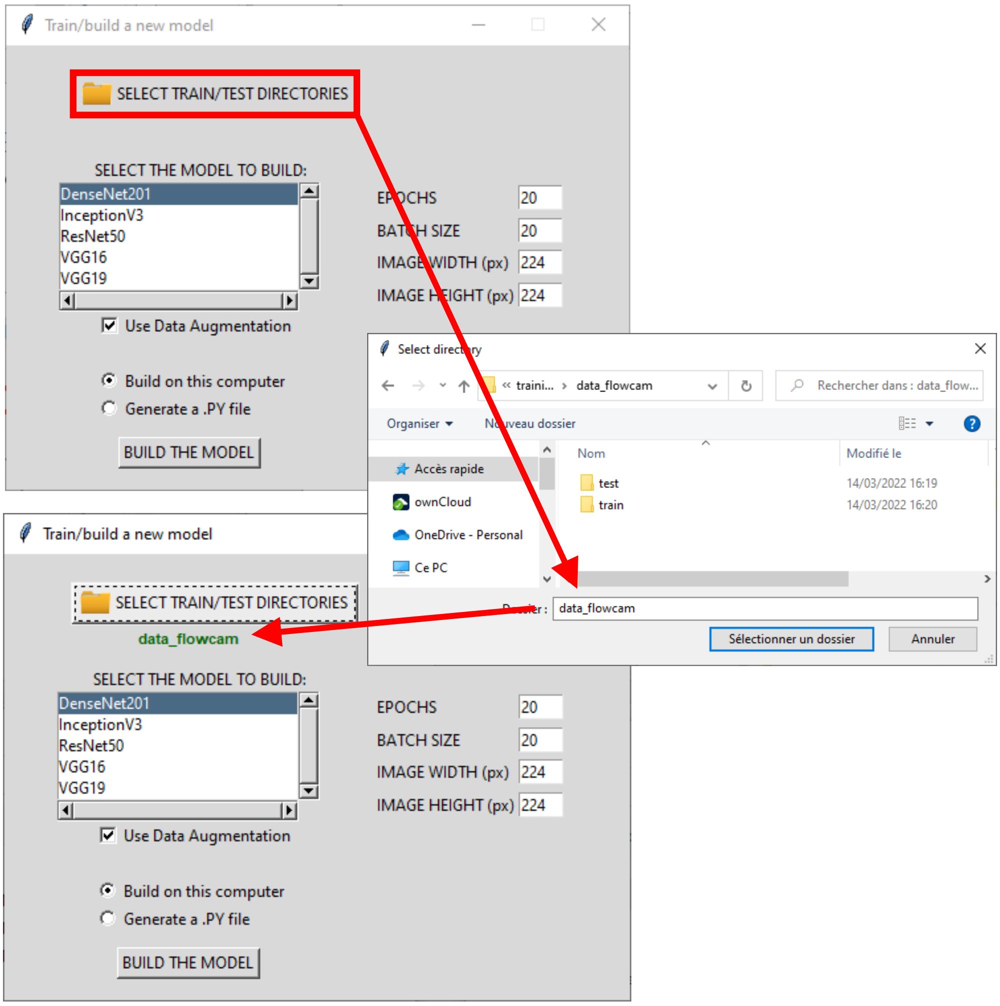
Classification probability threshold (lower=not considered) 0.5

OK



```
Label,"Image"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1600.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1601.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1602.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1613.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1616.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1632.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1641.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1643.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1644.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1654.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1677.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1683.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1713.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1733.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1740.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1744.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1746.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1751.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1760.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1788.jpg"
```

By clicking on this button, a new window appears.



EPOCHS 20
BATCH SIZE 20
IMAGE WIDTH (px) 224
IMAGE HEIGHT (px) 224

☑ Use Data Augmentation

● Build on this computer
○ Generate a .PY file

Nom	Modifié le
test	14/03/2022 16:19
train	14/03/2022 16:20

Dossier : data_flowcam

Click on the **SELECT TRAIN/TEST DIRECTORIES** button, select the directory containing the two sub-folders **train** and **test**, then confirm by clicking **OK**: the name of the selected directory is then displayed below the selection button

It is then possible to select different Convolutional Neural Network (CNN) architectures in the **SELECT THE MODEL TO BUILD** list, among:

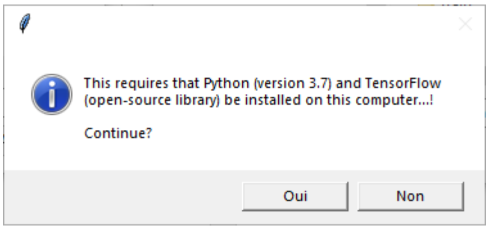
- DenseNet201
- InceptionV3
- ResNet50
- VGG16
- VGG19

and adjust parameters related to images and training step, by setting values for **EPOCH** (default=20), **BATCH SIZE** (default=20), **IMAGE WIDTH** (default=224) and **IMAGE WEIGHT** (default=224), but also choose the possibility of using the technique of data augmentation (**Use Data Augmentation**). In the case of a training set with few images, this option is used to automatically generate additional images from the original images in the training set, by applying geometric transformations such as rotations (by default, rotation_range=45) and horizontal and vertical flips (by default, horizontal_flip=True and vertical_flip=True).

The last step is to choose the material on which to build and adapt the classification model. Depending on the selected option, and after clicking on the **BUILD THE MODEL** button:

- **Build on this computer**

  A dialog box appears:



This requires that Python (version 3.7) and TensorFlow (open-source library) be installed on this computer...!

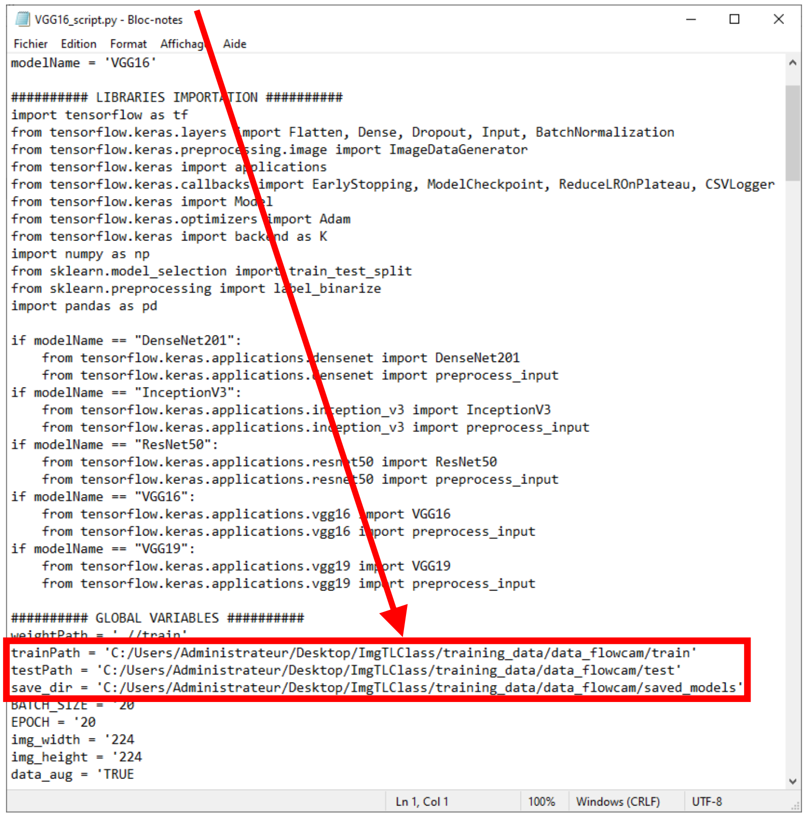
Continue?

  Warning: the training duration can be long (several hours) depending on the number of images in the training set and according to the parameters defined in the previous step.

- **Generate a .PY file**

  A script is automatically created, and can be run on other hardware (dedicated computer, calculation server, etc.).

  *Warning: three variables must be modified according to the data location ('**trainPath**', '**testPath**' and '**save_dir**').*



VGG16_script.py - Bloc-notes
Fichier Edition Format Affichage Aide

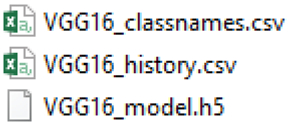
```
modelName = 'VGG16'

########## LIBRARIES IMPORTATION ##########
import tensorflow as tf
from tensorflow.keras.layers import Flatten, Dense, Dropout, Input, BatchNormalization
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras import applications
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoint, ReduceLROnPlateau, CSVLogger
from tensorflow.keras import Model
from tensorflow.keras.optimizers import Adam
from tensorflow.keras import backend as K
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import label_binarize
import pandas as pd

if modelName == "DenseNet201":
    from tensorflow.keras.applications.densenet import DenseNet201
    from tensorflow.keras.applications.densenet import preprocess_input
if modelName == "InceptionV3":
    from tensorflow.keras.applications.inception_v3 import InceptionV3
    from tensorflow.keras.applications.inception_v3 import preprocess_input
if modelName == "ResNet50":
    from tensorflow.keras.applications.resnet50 import ResNet50
    from tensorflow.keras.applications.resnet50 import preprocess_input
if modelName == "VGG16":
    from tensorflow.keras.applications.vgg16 import VGG16
    from tensorflow.keras.applications.vgg16 import preprocess_input
if modelName == "VGG19":
    from tensorflow.keras.applications.vgg19 import VGG19
    from tensorflow.keras.applications.vgg19 import preprocess_input

########## GLOBAL VARIABLES ##########
weightPath = './/train'
trainPath = 'C:/Users/Administrateur/Desktop/ImgTLClass/training_data/data_flowcam/train'
testPath = 'C:/Users/Administrateur/Desktop/ImgTLClass/training_data/data_flowcam/test'
save_dir = 'C:/Users/Administrateur/Desktop/ImgTLClass/training_data/data_flowcam/saved_models'
BATCH_SIZE = '20
EPOCH = '20
img_width = '224
img_height = '224
data_aug = 'TRUE
```

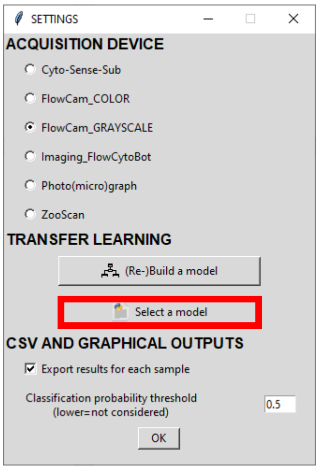
At the end of the execution of the script, a new folder is created at the root of the training/test set. In this directory (named '***saved_model***'), a ZIP file is saved and contains all the information necessary for the classification of a new set of images.



VGG16_classnames.csv
VGG16_history.csv
VGG16_model.h5

modelName_classNames.csv contains the class names in the training set.
modelName_history.csv contains the evaluation scores of the built model.
modelName_model.h5 is the model built with Python.

- **Select a model**



SETTINGS

ACQUISITION DEVICE

○ Cyto-Sense-Sub
○ FlowCam_COLOR
● FlowCam_GRAYSCALE
○ Imaging_FlowCytoBot
○ Photo(micro)graph
○ ZooScan

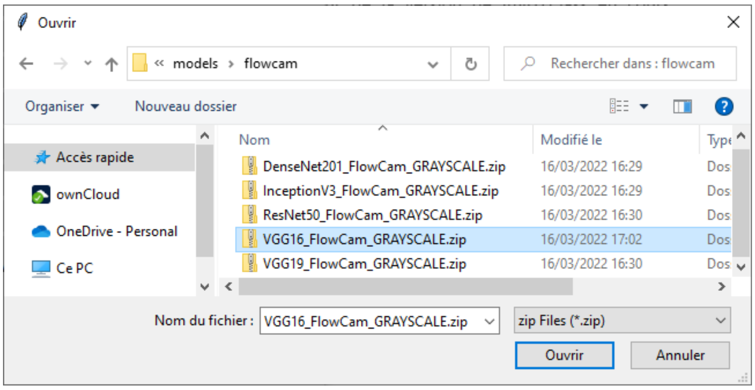
TRANSFER LEARNING

CSV AND GRAPHICAL OUTPUTS

☑ Export results for each sample

Classification probability threshold (lower=not considered): 0.5

This button allows to choose a model for the automated classification of the images contained in the directory selected during the first step (see section “Selection of input data”).



Ouvrir

« models › flowcam

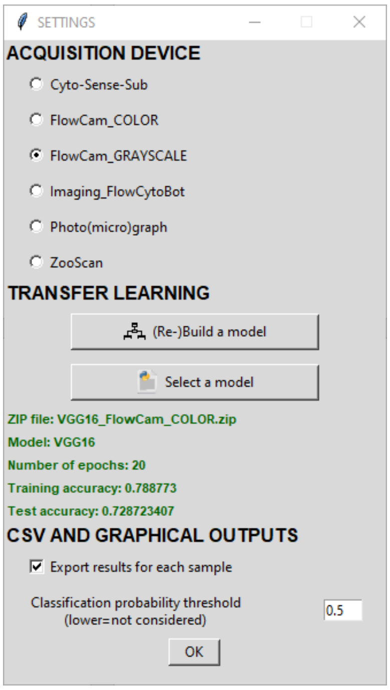
Rechercher dans : flowcam

Nom	Modifié le	Type
DenseNet201_FlowCam_GRAYSCALE.zip	16/03/2022 16:29	Dos
InceptionV3_FlowCam_GRAYSCALE.zip	16/03/2022 16:29	Dos
ResNet50_FlowCam_GRAYSCALE.zip	16/03/2022 16:30	Dos
VGG16_FlowCam_GRAYSCALE.zip	16/03/2022 17:02	Dos
VGG19_FlowCam_GRAYSCALE.zip	16/03/2022 16:30	Dos

Nom du fichier : VGG16_FlowCam_GRAYSCALE.zip

zip Files (*.zip)

Select the ZIP file generated during the previous step, then validate by clicking on **Open**: information on the model performance (calculated during the training and validation steps) is then displayed below the selection button, as well as **Accuracy** (≈ percentage of correctly classified data) and **Loss** (≈ distance between actual data and predicted data) curves, confusion matrix, etc.



SETTINGS

ACQUISITION DEVICE

○ Cyto-Sense-Sub
○ FlowCam_COLOR
● FlowCam_GRAYSCALE
○ Imaging_FlowCytoBot
○ Photo(micro)graph
○ ZooScan

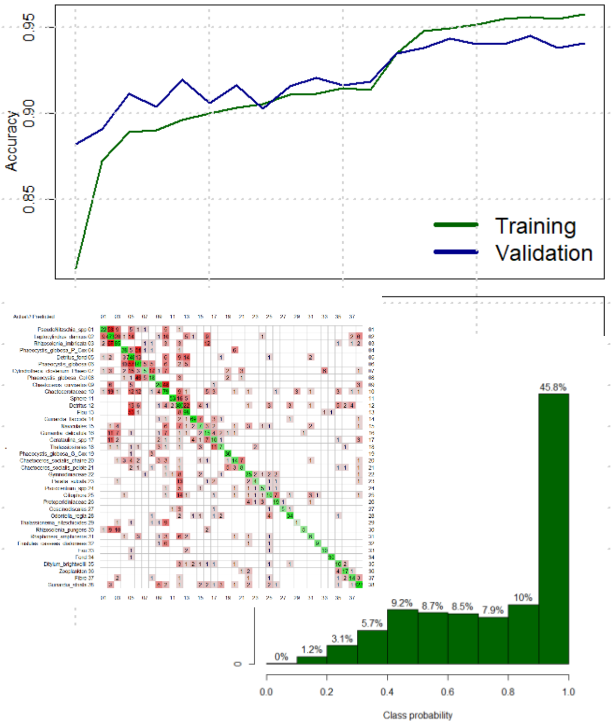
TRANSFER LEARNING

ZIP file: VGG16_FlowCam_COLOR.zip
Model: VGG16
Number of epochs: 20
Training accuracy: 0.788773
Test accuracy: 0.728723407

CSV AND GRAPHICAL OUTPUTS

☑ Export results for each sample

Classification probability threshold (lower=not considered): 0.5



The proposed graphical tools provide an overall view of recognition performance of the model through:

- the distribution of class probabilities, in order to have an overview of the degree of confidence for each identification ;
- the accuracy and loss curves computed during the training phase (by cross-validation), as well as on a validation dataset, as the epochs progress (the epoch is a hyperparameter that defines the number times that the training algorithm will work through the entire training dataset) ;
- the confusion matrix which is a square contingency table opposing the actual identification to the predicted ones (on the diagonal : correctly identified, off-diagonal: erroneous predictions), and which allows to define the groups presenting the most important confusions in order to be able to optimize the training set (by merging or separating groups, adding images, etc.).

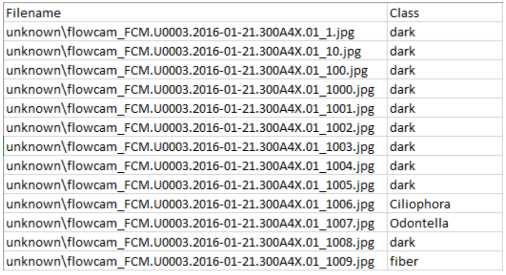
❖ OUTPUTS parameters

▪ Export results for each sample

This option allows to export the results for each sub-folder of the directory selected during the first step (see section "Selection of input data").

For each processed sample, three CSV files can be generated:

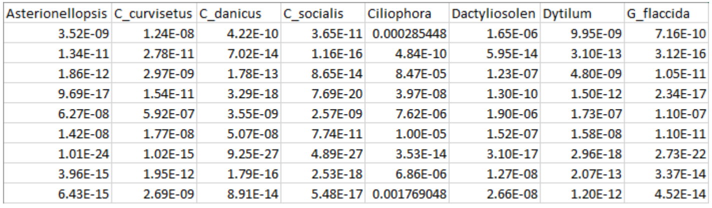
sampleName_CLASSIF.csv



Filename	Class
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_10.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_100.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1000.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1001.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1002.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1003.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1004.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1005.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1006.jpg	Ciliophora
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1007.jpg	Odontella
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1008.jpg	dark
unknown\flowcam_FCM.U0003.2016-01-21.300A4X.01_1009.jpg	fiber

with Filename: the name of the image file
Class: the predicted class of the image

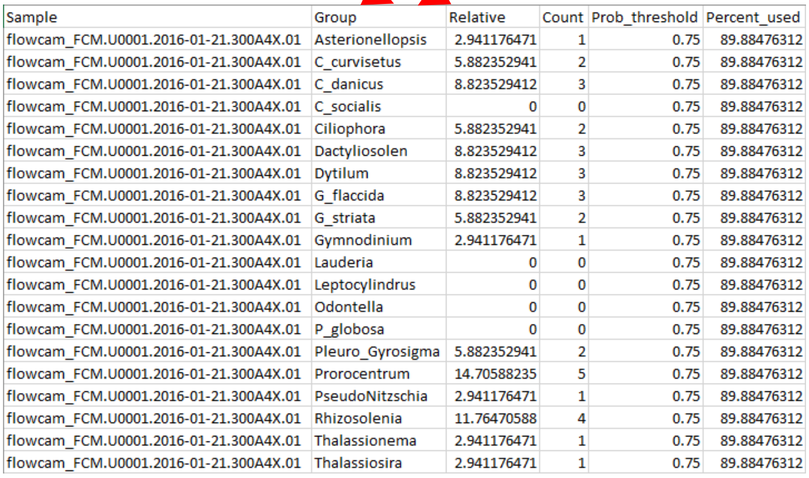
sampleName_PRED.csv



Asterionellopsis	C_curvisetus	C_danicus	C_socialis	Ciliophora	Dactyliosolen	Dytilum	G_flaccida
3.52E-09	1.24E-08	4.22E-10	3.65E-11	0.000285448	1.65E-06	9.95E-09	7.16E-10
1.34E-11	2.78E-11	7.02E-14	1.16E-16	4.84E-10	5.95E-14	3.10E-13	3.12E-16
1.86E-12	2.97E-09	1.78E-13	8.65E-14	8.47E-05	1.23E-07	4.80E-09	1.05E-11
9.69E-17	1.54E-11	3.29E-18	7.69E-20	3.97E-08	1.30E-10	1.50E-12	2.34E-17
6.27E-08	5.92E-07	3.55E-09	2.57E-09	7.62E-06	1.90E-06	1.73E-07	1.10E-07
1.42E-08	1.77E-08	5.07E-08	7.74E-11	1.00E-05	1.52E-07	1.58E-08	1.10E-11
1.01E-24	1.02E-15	9.25E-27	4.89E-27	3.53E-14	3.10E-17	2.96E-18	2.73E-22
3.96E-15	1.95E-12	1.79E-16	2.53E-18	6.86E-06	1.27E-08	2.07E-13	3.37E-14
6.43E-15	2.69E-09	8.91E-14	5.48E-17	0.001769048	2.66E-08	1.20E-12	4.52E-14

This file contains the class probabilities for each image file and group.

sampleName.csv



Sample	Group	Relative	Count	Prob_threshold	Percent_used
flowcam_FCM.U0001.2016-01-21.300A4X.01	Asterionellopsis	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	C_curvisetus	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	C_danicus	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	C_socialis	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Ciliophora	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Dactyliosolen	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Dytilum	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	G_flaccida	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	G_striata	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Gymnodinium	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Lauderia	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Leptocylindrus	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Odontella	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	P_globosa	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Pleuro_Gyrosigma	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Prorocentrum	14.70588235	5	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	PseudoNitzschia	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Rhizosolenia	11.76470588	4	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Thalassionema	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Thalassiosira	2.941176471	1	0.75	89.88476312

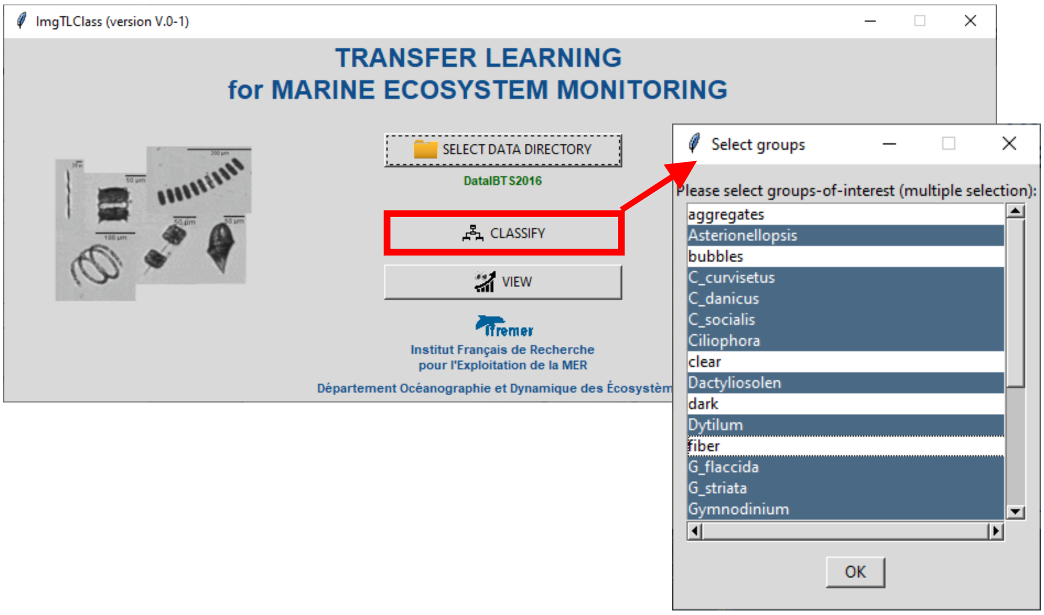
with Sample: the name of the sample
Group: list of all groups in the training set
Relative: relative abundance (in %) of each group
Count: absolute abundance of each group
Prob_threshold: threshold for class probability (see next section)
Percent_used: percentage of images with class probability upper than threshold

- **Classification probability threshold**

  The threshold value defined at this step allows to take into account only the images having a probability of “good” classification greater than this threshold. To take into account all the images, this value must be set to 0.

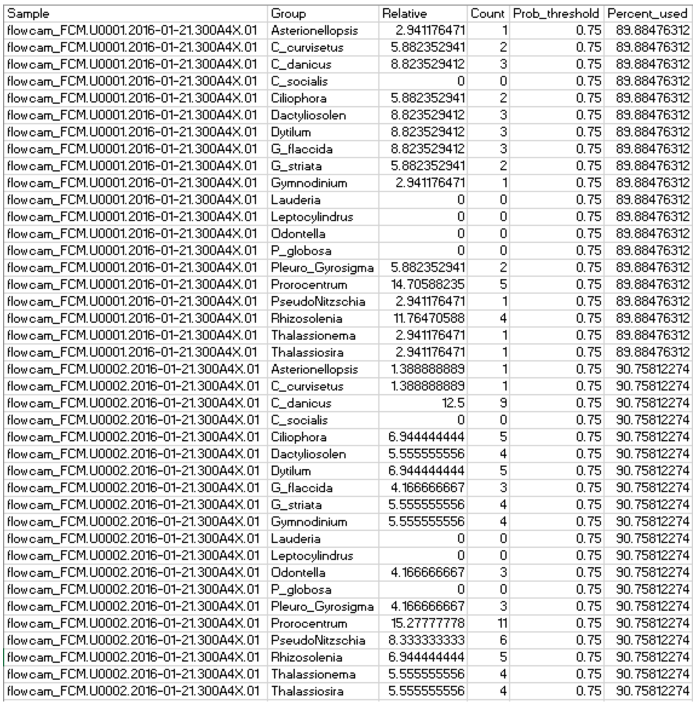
CLASSIFY button

To classify new images, click on the **CLASSIFY** button. A new window appears for group selection.


ImgTLClass (version V.0-1)
TRANSFER LEARNING
for MARINE ECOSYSTEM MONITORING
SELECT DATA DIRECTORY
DataIBTS2016
CLASSIFY
VIEW
Ifremer
Institut Français de Recherche
pour l'Exploitation de la MER
Département Océanographie et Dynamique des Écosystèm
Select groups
OK

Please select groups-of-interest (multiple selection):

aggregates
Asterionellopsis
bubbles
C_curvisetus
C_danicus
C_socialis
Ciliophora
clear
Dactyliosolen
dark
Dytilum
fiber
G_flaccida
G_striata
Gymnodinium

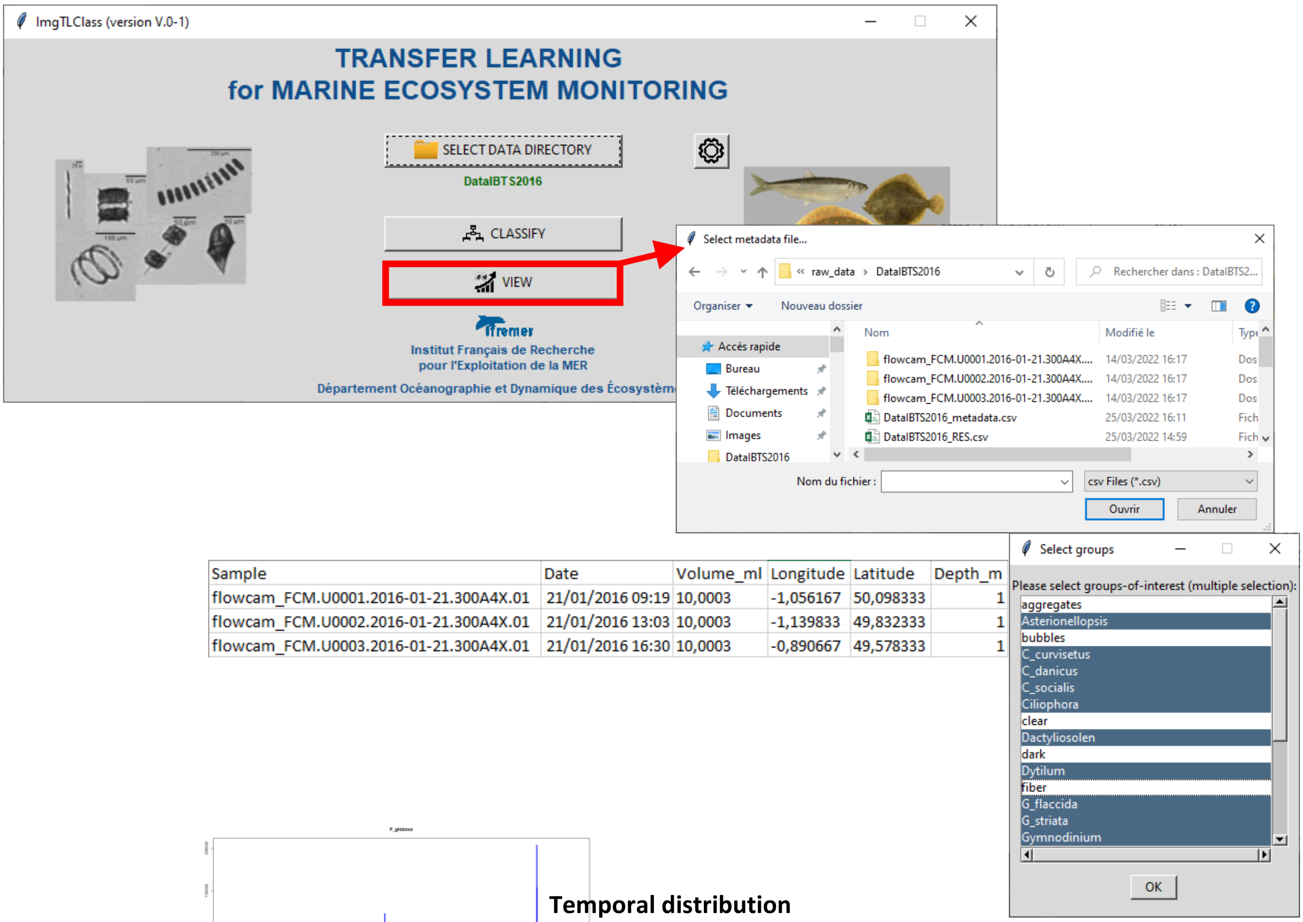


Sample	Group	Relative	Count	Prob_threshold	Percent_used
flowcam_FCM.U0001.2016-01-21.300A4X.01	Asterionellopsis	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	C_curvisetus	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	C_danicus	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	C_socialis	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Ciliophora	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Dactyliosolen	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Dytilum	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	G_flaccida	8.823529412	3	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	G_striata	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Gymnodinium	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Lauderia	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Leptocylindrus	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Odontella	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	P_globosa	0	0	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Pleuro_Gyrosigma	5.882352941	2	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Prorocentrum	14.70588235	5	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	PseudoNitzschia	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Rhizosolenia	11.76470588	4	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Thalassionema	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0001.2016-01-21.300A4X.01	Thalassiosira	2.941176471	1	0.75	89.88476312
flowcam_FCM.U0002.2016-01-21.300A4X.01	Asterionellopsis	1.388888889	1	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	C_curvisetus	1.388888889	1	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	C_danicus	12.5	9	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	C_socialis	0	0	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Ciliophora	6.944444444	5	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Dactyliosolen	5.555555556	4	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Dytilum	6.944444444	5	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	G_flaccida	4.166666667	3	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	G_striata	5.555555556	4	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Gymnodinium	5.555555556	4	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Lauderia	0	0	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Leptocylindrus	0	0	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Odontella	4.166666667	3	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	P_globosa	0	0	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Pleuro_Gyrosigma	4.166666667	3	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Prorocentrum	15.27777778	11	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	PseudoNitzschia	8.333333333	6	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Rhizosolenia	6.944444444	5	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Thalassionema	5.555555556	4	0.75	90.75812274
flowcam_FCM.U0002.2016-01-21.300A4X.01	Thalassiosira	5.555555556	4	0.75	90.75812274

with
Sample: the name of the sample
Group: list of all groups in the training set
Relative: relative abundance (in %) of each group
Count: absolute abundance of each group
Prob_threshold: threshold for class probability (see next section)
Percent_used: percentage of images with class probability upper than threshold

VIEW button

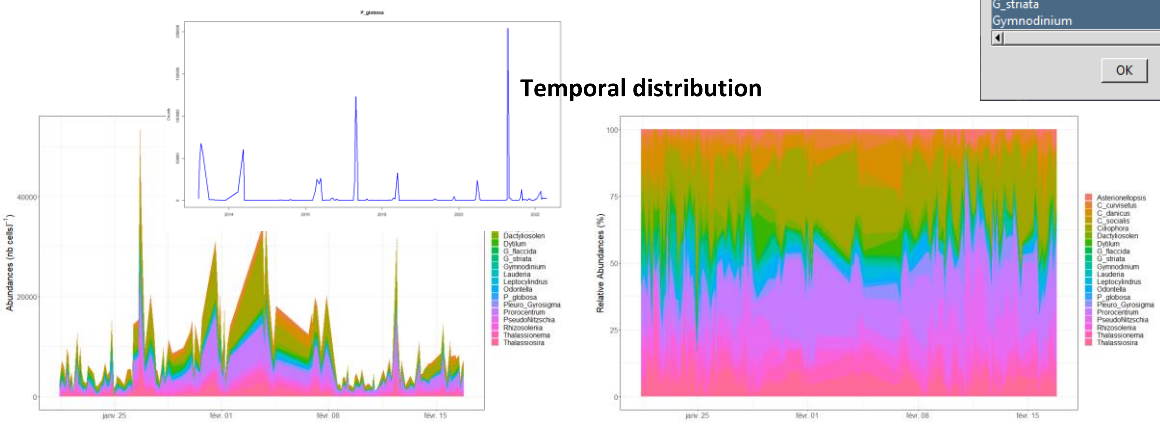
By clicking on this button, a new window appears for group selection.



Sample	Date	Volume_ml	Longitude	Latitude	Depth_m
flowcam_FCM.U0001.2016-01-21.300A4X.01	21/01/2016 09:19	10,0003	-1,056167	50,098333	1
flowcam_FCM.U0002.2016-01-21.300A4X.01	21/01/2016 13:03	10,0003	-1,139833	49,832333	1
flowcam_FCM.U0003.2016-01-21.300A4X.01	21/01/2016 16:30	10,0003	-0,890667	49,578333	1

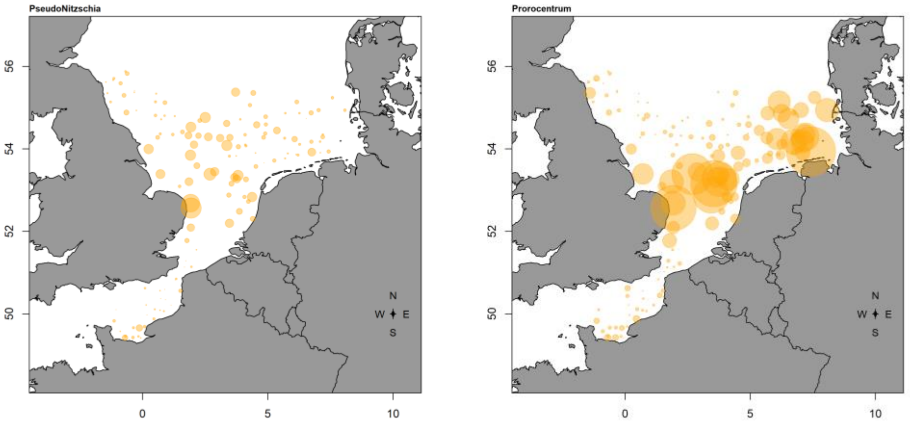
Please select groups-of-interest (multiple selection):

- aggregates
- Asterionellopsis
- bubbles
- C_curvisetus
- C_danicus
- C_socialis
- Ciliophora
- clear
- Dactyliosolen
- dark
- Dytilum
- fiber
- G_flaccida
- G_striata
- Gymnodinium



Temporal distribution

Spatial distribution

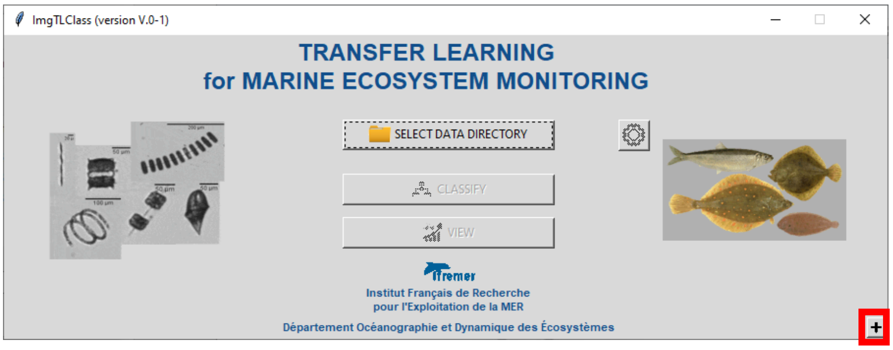


Thanks to the selection of a CSV file containing metadata on the samples (GPS coordinates, sampling date, imaged volume, ...), it can be possible to obtain differents graphical outputs for temporal and spatial distribution.

For temporal distribution, the absolute and relative counts are computed from the results file ('sampleName.csv', see 'OUTPUTS parameters' section), then plotted on graphs (a global graph with all groups, and individual graphs for each selected group). Concerning the spatial distribution, a mapping tool is proposed. Abundances of each selected group is projected on the map, thanks to the GRPS coordinates provided in the metadata file (the diameter of the circles is depending on the obtained counts).

MORE... (+) button

To help the user in the different data formatting steps for image analysis, several options are available. To view the list of these additional tools, click on the **+** button (**MORE**..., located at the bottom right of the main window).



ImgTLClass (version V.0-1)

TRANSFER LEARNING
for MARINE ECOSYSTEM MONITORING

SELECT DATA DIRECTORY
CLASSIFY
VIEW
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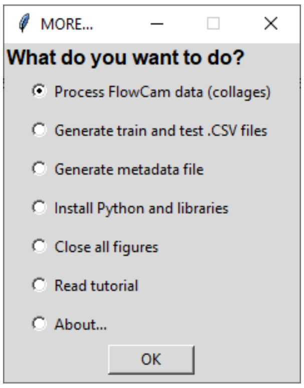
pour l'Exploitation de la MER
Département Océanographie et Dynamique des Écosystèmes
+

- **Process FlowCam data (collages)**

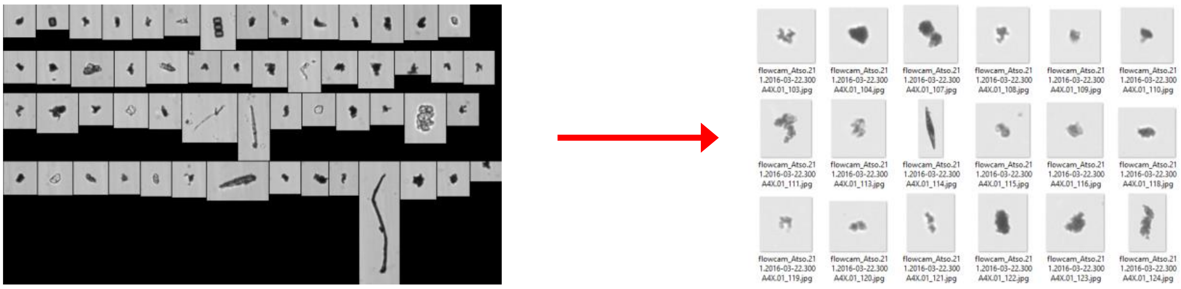


MORE...

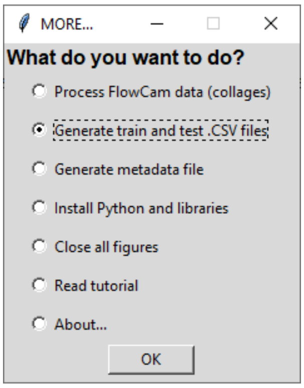
What do you want to do?

- ● Process FlowCam data (collages)
- ○ Generate train and test .CSV files
- ○ Generate metadata file
- ○ Install Python and libraries
- ○ Close all figures
- ○ Read tutorial
- ○ About...

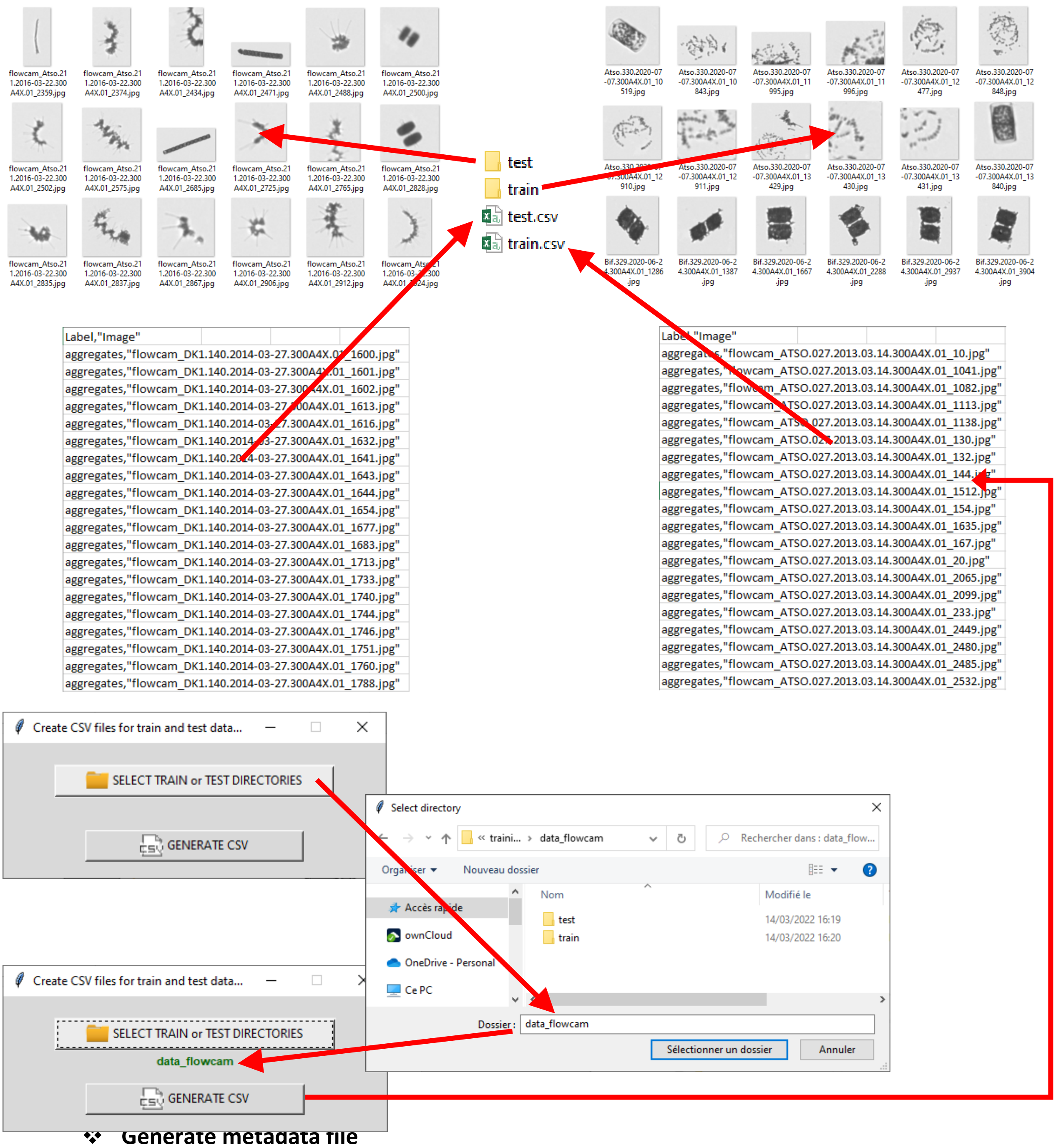
Raw data from the FlowCam is often presented as collages (one file with multiple images). It is then possible to cut and save vignettes (one image file per particle) from these collages. To do this, choose **Process FlowCam data (collages)**.


flowcam_Atso.21 1.2016-03-22.300 A4X.01_103.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_104.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_107.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_108.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_109.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_110.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_111.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_113.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_114.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_115.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_116.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_118.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_119.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_120.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_121.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_122.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_123.jpg
flowcam_Atso.21 1.2016-03-22.300 A4X.01_124.jpg

❖ Generate train and test .CSV files



The images for training and test sets can be sorted into different subfolders (corresponding to groups). However, *Ecotranslearn* works with unique directories for **train** and **test**, in which images are put in bulk. To find out which group each image belongs to, a CSV file must be created. This is possible by selecting this option.



flowcam_Atso.211.2016-03-22.300A4X.01_2359.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2374.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2434.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2471.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2488.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2500.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2502.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2575.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2685.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2725.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2765.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2828.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2835.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2837.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2867.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2906.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2912.jpg
flowcam_Atso.211.2016-03-22.300A4X.01_2924.jpg
test
train
test.csv
train.csv
Atso.330.2020-07-07.300A4X.01_10519.jpg
Atso.330.2020-07-07.300A4X.01_10843.jpg
Atso.330.2020-07-07.300A4X.01_11995.jpg
Atso.330.2020-07-07.300A4X.01_11996.jpg
Atso.330.2020-07-07.300A4X.01_12477.jpg
Atso.330.2020-07-07.300A4X.01_12848.jpg
Atso.330.2020-07-07.300A4X.01_12910.jpg
Atso.330.2020-07-07.300A4X.01_12911.jpg
Atso.330.2020-07-07.300A4X.01_13429.jpg
Atso.330.2020-07-07.300A4X.01_13430.jpg
Atso.330.2020-07-07.300A4X.01_13431.jpg
Atso.330.2020-07-07.300A4X.01_13840.jpg
Bif.329.2020-06-24.300A4X.01_1286.jpg
Bif.329.2020-06-24.300A4X.01_1387.jpg
Bif.329.2020-06-24.300A4X.01_1667.jpg
Bif.329.2020-06-24.300A4X.01_2288.jpg
Bif.329.2020-06-24.300A4X.01_2937.jpg
Bif.329.2020-06-24.300A4X.01_3904.jpg

```
Label,"Image"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1600.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1601.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1602.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1613.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1616.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1632.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1641.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1643.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1644.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1654.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1677.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1683.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1713.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1733.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1740.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1744.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1746.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1751.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1760.jpg"
aggregates,"flowcam_DK1.140.2014-03-27.300A4X.01_1788.jpg"
```

```
Label,"Image"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_10.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_1041.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_1082.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_1113.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_1138.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_130.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_132.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_144.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_1512.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_154.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_1635.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_167.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_20.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_2065.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_2099.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_233.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_2449.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_2480.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_2485.jpg"
aggregates,"flowcam_ATSO.027.2013.03.14.300A4X.01_2532.jpg"
```

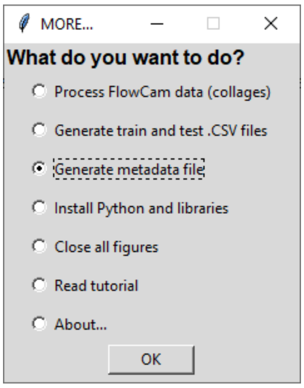
Create CSV files for train and test data...
SELECT TRAIN or TEST DIRECTORIES
GENERATE CSV
Select directory
« traini... › data_flowcam
Rechercher dans : data_flow...
Organiser ▾
Nouveau dossier
Accès rapide
ownCloud
OneDrive - Personal
Ce PC
Nom
Modifié le

Nom	Modifié le
test	14/03/2022 16:19
train	14/03/2022 16:20

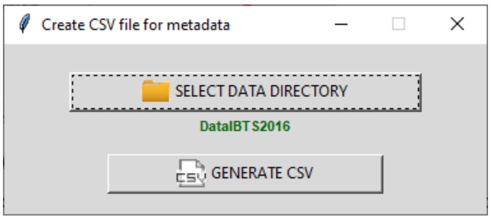
Dossier : data_flowcam

Sélectionner un dossier
Annuler
Create CSV files for train and test data...
SELECT TRAIN or TEST DIRECTORIES
data_flowcam
GENERATE CSV

❖ Generate metadata file



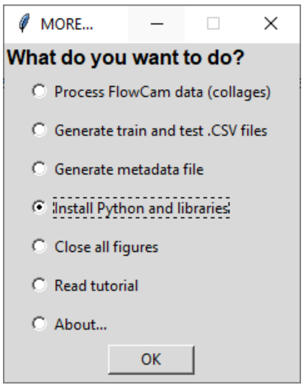
For the visualisation of classification results, a metadata file is required. This CSV file contains information on each sample, such as Date, Volume, GPS coordinates, and other metadata. A template can be generated thanks to this option.



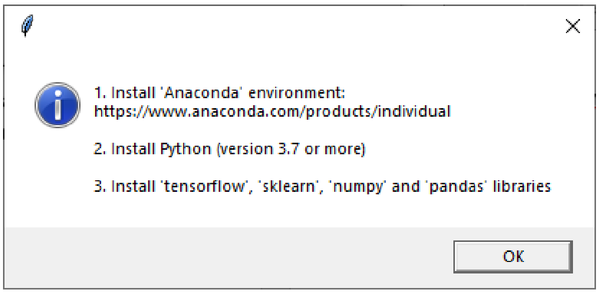
Sample	Date	Volume_ml	Longitude	Latitude	Depth_m
R1.2021-03-04.300A4X.01	2021-03-04 16:58:14	2,9994	NA	NA	1
R1.2021-03-17.300A4X.01	2021-03-17 14:55:44	5,0002	NA	NA	1
R1.2021-03-25.300A4X.02	2021-03-25 14:31:37	2,7657	NA	NA	1

with Sample: the sample name
Date: the date of sampling (format: YYYY-mm-dd HH:MM:SS)
Volume_ml: imaged volume (ml)
Longitude: sample longitude (ex: -1,056167)
Latitude: sample latitude (ex: 50,098333)
Depth: sampling depth (m)

❖ Python and libraries requirements



This option allows having information on Python installation and the required libraries.

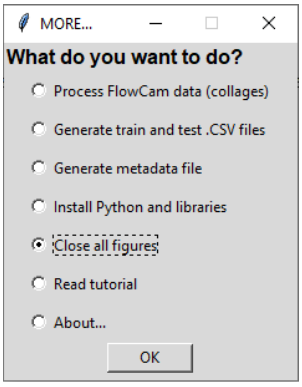


1. Install 'Anaconda' environment:
https://www.anaconda.com/products/individual

2. Install Python (version 3.7 or more)

3. Install 'tensorflow', 'sklearn', 'numpy' and 'pandas' libraries

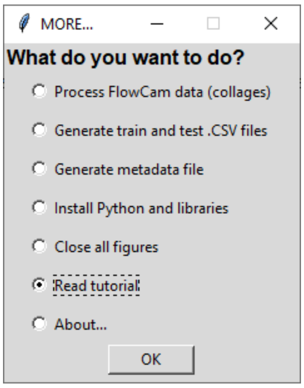
❖ Close all figures



This option allows closing all figures.

❖ Read tutorial

A user manual is available (PDF file).

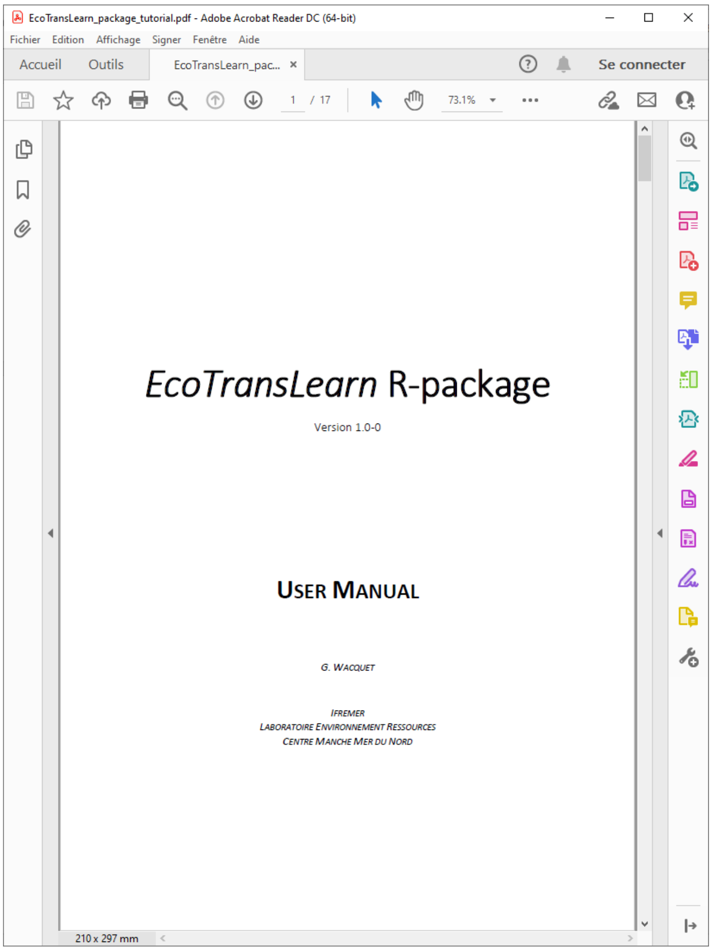


MORE...

What do you want to do?

○ Process FlowCam data (collages)
○ Generate train and test .CSV files
○ Generate metadata file
○ Install Python and libraries
○ Close all figures
● Read tutorial
○ About...

OK



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210 x 297 mm

EcoTransLearn R-package

Version 1.0-0

USER MANUAL

G. WACQUET

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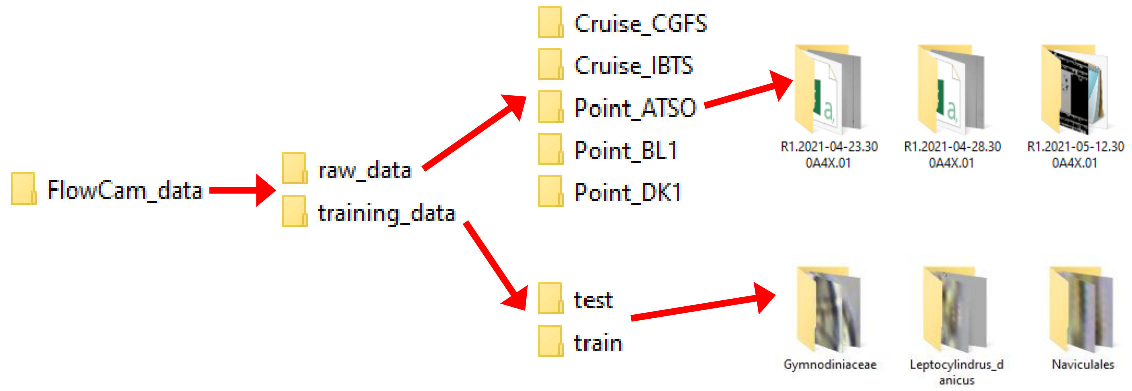
Recommended folder tree



For each acquisition device, it is recommended to create a dedicated folder, containing two sub-folders: one for the raw data to be processed (‘***raw_data***’), and one for the training data (‘***training_data***’).
‘***raw_data***’ should contain all samples with images to classify, or samples with collages files (for the FlowCam device).
‘***training_data***’ should contain a 'train' folder and a 'test' folder, where the images will be sorted into different subdirectories (which will be bulked up using the **Generate train and test .CSV files** option).