```
gpu_info = !nvidia-smi
gpu_info = '\n'.join(gpu_info)
if gpu_info.find('failed') >= 0:
  print('Not connected to a GPU')
else:
  print(gpu_info)
```

```
/bin/bash: nvidia-smi: command not found
time: 143 ms (started: 2022-02-15 07:17:05 +00:00)
```

Libraries

```
!pip install ipython-autotime
%load_ext autotime
```

```
Requirement already satisfied: ipython-autotime in /usr/local/lib/python3.7/dist-
Requirement already satisfied: ipython in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: decorator in /usr/local/lib/python3.7/dist-package
Requirement already satisfied: prompt-toolkit<2.0.0,>=1.0.4 in /usr/local/lib/pyt
Requirement already satisfied: setuptools>=18.5 in /usr/local/lib/python3.7/dist-
Requirement already satisfied: pexpect in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: traitlets>=4.2 in /usr/local/lib/python3.7/dist-pa
Requirement already satisfied: pickleshare in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: simplegeneric>0.8 in /usr/local/lib/python3.7/dist
Requirement already satisfied: pygments in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: six>=1.9.0 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: ptyprocess>=0.5 in /usr/local/lib/python3.7/dist-p
The autotime extension is already loaded. To reload it, use:
  %reload_ext autotime
time: 3.45 s (started: 2022-02-15 07:17:07 +00:00)
```

```
# Load the TensorBoard notebook extension
%load_ext tensorboard
```

```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
time: 1.59 ms (started: 2022-02-15 07:17:11 +00:00)
```

```
!pip install --quiet optuna
```

```
time: 3.65 s (started: 2022-02-15 07:17:11 +00:00)
```

```
import os
import pandas as pd
import numpy as np
import time
import datetime
import itertools
import glob
import re
from tqdm import tqdm
import gc

import matplotlib.pyplot as plt
import seaborn as sns
import matplotlib.style as style
style.use('fivethirtyeight')

from skimage import io
from PIL import Image
import cv2
import collections
from skimage import filters
from skimage import util
from sklearn.preprocessing import MinMaxScaler
from sklearn.cluster import KMeans
from mpl_toolkits.mplot3d import Axes3D
from sklearn.cluster import MeanShift, estimate_bandwidth
from skimage.transform import resize

from sklearn.model_selection import train_test_split


from __future__ import print_function
from ipywidgets import interact, interactive, fixed, interact_manual, IntSlider
from ipywidgets import BoundedIntText,FloatSlider
import ipywidgets as widgets
from sklearn.cluster import MiniBatchKMeans
import numpy as np
from skimage.exposure import histogram
from skimage import img_as_float
from skimage.segmentation import watershed
from skimage.segmentation import mark_boundaries
from sklearn.cluster import spectral_clustering
import sklearn.feature_extraction
from skimage.color import rgb2gray
from skimage.filters import sobel
```

```
time: 28 ms (started: 2022-02-15 07:17:14 +00:00)
```

Variables

Paths

```
root_dir ='/content/drive/MyDrive/@Projet datascientest/'
raw_data_dir = root_dir + 'RAW DATA/'
DL_dir = root_dir + 'DEEP LEARNING/'
```

```

# export dir with time satmp
timestamp = datetime.datetime.now().strftime('%y%m%d_%HH%M')
export_dir = DL_dir + timestamp + '/'
os.makedirs(export_dir)
print(str(export_dir))
```

```
/content/drive/MyDrive/@Projet datascientest/DEEP LEARNING/220215_07H17/
time: 14.2 ms (started: 2022-02-15 07:17:14 +00:00)
```

Other

```
# seed
random_seed = 42

#ZIP file with images
raw_data_folder = 'RAW DATA.zip'
raw_data_folder = 'RAW DATA FOR DEBUG.zip' # pour aller plus vite sur unzip 1400 im
# df with file_path
csv_file_paths = 'image_and_json_data_DEBUG.csv' if raw_data_folder == 'RAW DATA FO


# resolution des images apres redimmensionnement (/!\ inversé par rapport à scikit)
resol = (240, 320) # (240, 320), [(24 , 32),(48 , 64),(72 , 96)]
# number of class to keep
family_number = 7 # 7 pour comparaison Xgboost (acc = 0.32) & random 1/7 = 0.14
number_of_images = 1000  # None to get all images
add_FRUIT360_images = False #add a class with 6000 images of 131 classes of fruit i


# DEBUG
debug = False
one_image_per_class_only = False  # HARD DEBUG TO SEE if CNN learn
# epochs
number_of_images = 1000 if debug else number_of_images
family_number = 3 if debug else family_number

```

```
time: 10.2 ms (started: 2022-02-15 07:17:14 +00:00)
```

Load & filter data

Unzip images

```
# unzipping the file into the VM disk is SO much faster than reading each file indi
# cf https://stackoverflow.com/questions/59120853/google-colab-is-so-slow-while-rea
main_path = "/content/"  + raw_data_folder.replace('.zip','')
if os.path.exists(main_path)== False :
  if csv_file_paths == 'image_and_json_data_DEBUG.csv':
    !unzip '/content/drive/MyDrive/@Projet datascientest/RAW DATA FOR DEBUG.zip' -d
  elif csv_file_paths == 'image_and_json_data.csv':
    !unzip '/content/drive/MyDrive/@Projet datascientest/RAW DATA.zip' -d "/content
else:
  print('ZIP already extracted')
```

```
ZIP already extracted
time: 6.92 ms (started: 2022-02-15 07:17:14 +00:00)
```

```
#FRUIT360 dataset pour créer un dataset sans champigons
main_path = "/content/FRUIT360"
if os.path.exists(main_path)== False :
  if add_FRUIT360_images:
    !unzip '/content/drive/MyDrive/@Projet datascientest/FRUIT360.zip' -d "/content
```

```
time: 2.97 ms (started: 2022-02-15 07:17:14 +00:00)
```

File_path df

```
# df with path & target
df_paths = pd.read_csv(root_dir + csv_file_paths)
print('{} rows in the file'.format(len(df_paths)))
df_paths .head()
```

```
1480 rows in the file
```

	Unnamed: 0	file_name	file_path	resolution	file_year	image_id	forma
0	1381	6746.jpg	C:/Users/thibe/Google Drive/@Projet datascient...	(320, 240)	2007	6746	jp
1	338	507.jpg	C:/Users/thibe/Google Drive/@Projet datascient...	(320, 240)	2006	507	jp
2	1875	4009.jpg	C:/Users/thibe/Google Drive/@Projet datascient...	(320, 240)	2007	4009	jp
3	4632	8992.jpg	C:/Users/thibe/Google Drive/@Projet datascient...	(320, 240)	2007	8992	jp
4	137	855.jpg	C:/Users/thibe/Google Drive/@Projet datascient...	(320, 240)	2006	855	jp

```
time: 118 ms (started: 2022-02-15 07:17:14 +00:00)
```

```
# FRUIT360
if add_FRUIT360_images:
  # Trouver tous les chemins vers les fichiers qui finissent par .jpg
  liste = glob.glob('/content/FRUIT360/*/*.jpg')
  # Remplacer les \\ par /
  liste = list(map(lambda x : [x, x.split('/')[2]], liste))
  # Créer un DataFrame pandas
  df_FRUIT360  = pd.DataFrame(liste, columns=['drive_file_path', 'gbif_info.family'
  display(df_FRUIT360.head())
```

```
time: 6.33 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# adjust paths for drive
# SPECIFIC DRIVE lo laod image from content
df_paths['drive_file_path'] =df_paths['file_path'].apply(lambda x: x.replace('C:/Us
                                              '/content')).apply(lambda x: x.replac
                                              '/content')) # pas propre, remplacer
df_paths['drive_file_path'] =df_paths['drive_file_path'].apply(lambda x: x.replace(
df_paths['drive_file_path']
```

```
0       /content/RAW DATA FOR DEBUG/Training/Agaricace...
1       /content/RAW DATA FOR DEBUG/Training/Psathyrel...
2       /content/RAW DATA FOR DEBUG/Training/Boletacea...
3       /content/RAW DATA FOR DEBUG/Training/Suillacea...
4       /content/RAW DATA FOR DEBUG/Training/Amanitace...
                              ...
1475    /content/RAW DATA FOR DEBUG/Testing/Stropharia...
1476    /content/RAW DATA FOR DEBUG/Testing/Boletaceae...
1477    /content/RAW DATA FOR DEBUG/Testing/Suillaceae...
1478    /content/RAW DATA FOR DEBUG/Testing/Russulacea...
1479    /content/RAW DATA FOR DEBUG/Testing/Russulacea...
Name: drive_file_path, Length: 1480, dtype: objecttime: 14.8 ms (started: 2022-02
```

```
#select only 320,240 images with family info
df_paths = df_paths[df_paths['resolution']=='(320, 240)']
```

```
time: 8.92 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# drop na
df_paths = df_paths[df_paths['gbif_info.family'].notna()]
```

```
time: 5.76 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# keep conf level over 90
df_paths = df_paths.loc[df_paths['gbif_info.confidence']>90]
```

```
time: 5.45 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# keep only most common class
top_class = df_paths['gbif_info.class'].value_counts().index[0]
df_paths = df_paths[df_paths['gbif_info.class'] == top_class]
df_paths['gbif_info.class'].value_counts()
```

```
Agaricomycetes    1480
Name: gbif_info.class, dtype: int64time: 12.3 ms (started: 2022-02-15 07:17:15 +6
```

```
# Check number of classes
pd.DataFrame(df_paths.groupby(['gbif_info.family'], as_index=False).size())
```

	gbif_info.family	size
0	Agaricaceae	224
1	Amanitaceae	194
2	Boletaceae	138
3	Cortinariaceae	99
4	Inocybaceae	82
5	Psathyrellaceae	100
6	Russulaceae	226
7	Strophariaceae	153
8	Suillaceae	97
9	Tricholomataceae	167

```
time: 17.7 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# keep only top families
top_fam = df_paths['gbif_info.family'].value_counts().index[:family_number].values
df_paths = df_paths[df_paths['gbif_info.family'].isin(top_fam)]
```

```
time: 6.58 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# reduce number or images if needed
if number_of_images != None and not one_image_per_class_only:
  df_paths,_ = train_test_split(df_paths,train_size=number_of_images,stratify=df_pa
  print('{} rows in the file'.format(len(df_paths)))
```

```
1000 rows in the file
time: 11.1 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
summary = df_paths.copy() #copy for later
# summary.info()
```

```
time: 2.94 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# subset col of interest + label encoding
df = df_paths[['drive_file_path','gbif_info.family']].copy()
df['label'] = df['gbif_info.family'].replace(df['gbif_info.family'].unique(), [*ran

df.head()
```

	drive_file_path	gbif_info.family	label
40	/content/RAW DATA FOR DEBUG/Training/Russulace...	Russulaceae	0
337	/content/RAW DATA FOR DEBUG/Training/Boletacea...	Boletaceae	1
202	/content/RAW DATA FOR DEBUG/Training/Russulace...	Russulaceae	0
1191	/content/RAW DATA FOR DEBUG/Testing/Psathyrell...	Psathyrellaceae	2
230	/content/RAW DATA FOR DEBUG/Training/Strophari...	Strophariaceae	3

```
# concat with FRUIT360
if add_FRUIT360_images:
  df_FRUIT360['label'] = df['label'].max() + 1
  df = pd.concat([df,df_FRUIT360]).reset_index(drop=True)
```

```
time: 2.72 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# compute number of classes
print('number of rows = {}'.format(len(df['label'])))
dict_label_df = pd.DataFrame(df.groupby(['label','gbif_info.family'], as_index=Fals
classes_count = len(dict_label_df)
dict_label_df
```

```
number of rows = 1000
```

	label	gbif_info.family	size
0	0	Russulaceae	188
1	1	Boletaceae	115
2	2	Psathyrellaceae	83
3	3	Strophariaceae	127
4	4	Amanitaceae	162
5	5	Tricholomataceae	139
6	6	Agaricaceae	186

```
time: 23.9 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# CREATE DICT LABELS
dict_label = dict(dict_label_df[['label','gbif_info.family']].values)
dict_label
```

```
{'0': 'Russulaceae',
 '1': 'Boletaceae',
 '2': 'Psathyrellaceae',
 '3': 'Strophariaceae',
 '4': 'Amanitaceae',
 '5': 'Tricholomataceae',
 '6': 'Agaricaceae'}time: 7.84 ms (started: 2022-02-15 07:17:15 +00:00)
```

Train/test split

```
#train/test
# Train/test
df_train, df_test= train_test_split(df, train_size=0.8, stratify =df['label'], rand
# train / val
df_train_, df_val_= train_test_split(df_train, train_size=0.8, stratify =df_train['
print(df_train_.shape,df_val_.shape,df_test.shape)
```

```
(640, 3) (160, 3) (200, 3)
time: 16.4 ms (started: 2022-02-15 07:17:15 +00:00)
```

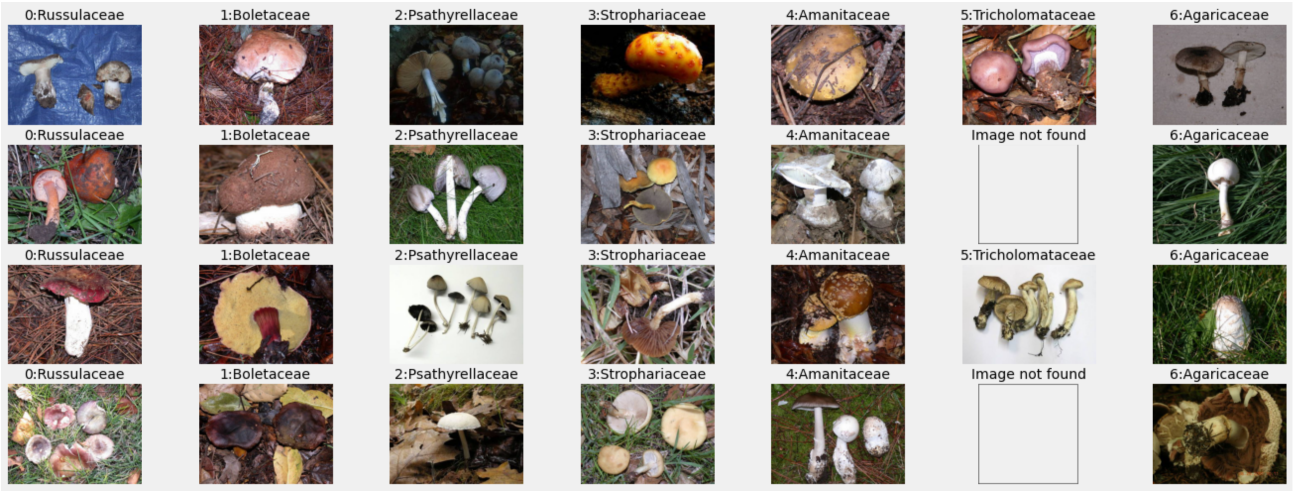
Plot few images

```
# first od each cat to check train/test
im_to_plot = df_train.groupby('label').head(1)
# plot
fig = plt.figure(figsize=(3*family_number,2))
j = 1
for idx in im_to_plot.index:
  col_number = family_number
  row_number = 1
  ax = plt.subplot(row_number,col_number,j)
  im = io.imread(im_to_plot.loc[idx,'drive_file_path'])
  plt.imshow(im)
  label = str(im_to_plot.loc[idx,'label']) + ':' + dict_label[str(im_to_plot.loc[id
  plt.title(label,size = 14)
  plt.axis('off')
  j +=1
fig.savefig(export_dir + str(resol) + '_first image of each family.jpeg' );
```

```
time: 555 ms (started: 2022-02-15 07:17:15 +00:00)
```

```
# Plot random images de X_train (im_per_class per class)
im_per_class = 5
#generate df with n image per class train set
dfs_ = []
for n in range(im_per_class-1):
  df_ = df_train.groupby('label').apply(lambda x: x.sample(1))
  df_ = df_.droplevel(level=0)
  dfs_.append(df_)
im_to_plot = pd.concat(dfs_)
```

```
# plot
fig = plt.figure(figsize=(3*family_number,2*im_per_class))
j = 1
for idx in im_to_plot.index:
  try:
    col_number = family_number
    row_number = im_per_class
    ax = plt.subplot(row_number,col_number,j)
    im = io.imread(im_to_plot.loc[idx,'drive_file_path'])
    plt.imshow(im)
    label = str(im_to_plot.loc[idx,'label']) + ':' + dict_label[str(im_to_plot.loc[
    plt.title(label,size = 14)
    plt.axis('off')
  except:
    im = io.imread('https://upload.wikimedia.org/wikipedia/commons/thumb/1/1f/Blank
    plt.imshow(im)
    label = 'Image not found'
    plt.title(label,size = 14)
    plt.axis('off')
  j +=1
fig.savefig(export_dir + str(resol) + '_family examples.jpeg' );
```



```
time: 3.03 s (started: 2022-02-15 07:17:15 +00:00)
```

Segmentation

- https://stackoverflow.com/questions/46392904/scikit-mean-shift-algorithm-returns-black-picture
- https://medium.com/@muhammetbolat/image-segmentation-using-k-means-clustering-algorithm-and-mean-shift-clustering-algorithm-fb6ebe4cb761

Kmeans

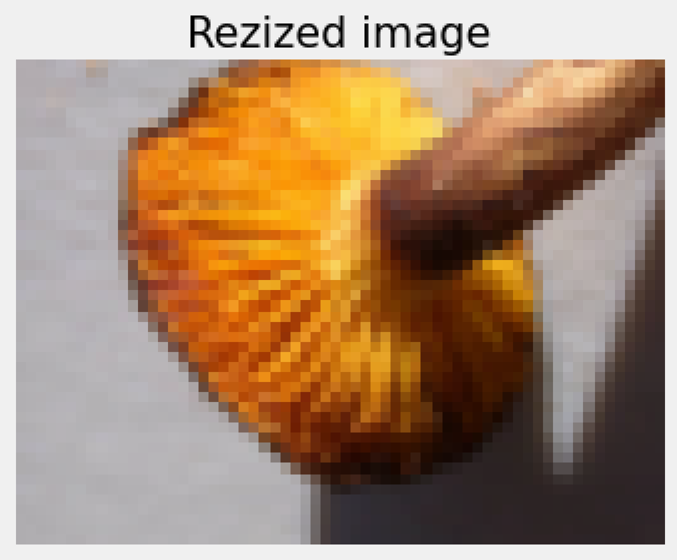
- https://analyticsindiamag.com/beginners-guide-to-image-compression-using-k-means-clustering/#:~:text=Beginners%20Guide%20to%20Image%20Compression%20using%20K%2DMeans%20Clustering,-By%20Himanshu%20Sharma&text=Image%20compression%20is%20reducing%20the,low%20quality%20takes%20less%20memory.

```
# define image
i = 5 #5
resize_factor = 5 #5
image_path = df_train.iloc[i]['drive_file_path']
```

```
time: 3.11 ms (started: 2022-02-15 07:17:18 +00:00)
```

```
#Loading original image
originImg = io.imread(image_path)# ploat original image
imageName = image_path
image = plt.imread(imageName)
image = resize(image,(int(image.shape[0]/resize_factor), int(image.shape[1]/resize_
plt.figure(dpi=75)
plt.title('Rezized image')
plt.axis('off')
plt.imshow(image)
```

```
<matplotlib.image.AxesImage at 0x7f6cf678f890>
```



```
time: 126 ms (started: 2022-02-15 07:17:18 +00:00)
```

```
# dfs from images
index = pd.MultiIndex.from_product(
    (*map(range, image.shape[:2]), ('r', 'g', 'b')),
    names=('row', 'col', None))
df_5_feat = pd.Series(image.flatten(), index=index)
df_5_feat = df_5_feat.unstack()
df_5_feat = df_5_feat.reset_index().reindex(columns=['col','row',   'r','g','b'])
df_3_feat = df_5_feat[['r','g','b']]
```

```
time: 18.5 ms (started: 2022-02-15 07:17:19 +00:00)
```

```
#normalisation
scaler_3d = MinMaxScaler(feature_range = (0,1))
nd_3_feat = scaler_3d.fit_transform(df_3_feat)

scaler_5d = MinMaxScaler(feature_range = (0,1))
nd_5_feat = scaler_5d.fit_transform(df_5_feat)
```

```
time: 15.7 ms (started: 2022-02-15 07:17:19 +00:00)
```

```
# find K
total_inertias_1 = [KMeans(n_clusters=i).fit(nd_3_feat).inertia_ for i in range(1,
total_inertias_2 = [KMeans(n_clusters=i).fit(nd_5_feat).inertia_ for i in range(1,
import matplotlib.pyplot as plt
fig, (ax1, ax2) = plt.subplots(1, 2, sharex='col', sharey='row', figsize=(30,10))
ax1.plot(range(1, 20), total_inertias_1, c='black')
ax1.set(xlabel='Total Inertias', ylabel='Number of Clusters', title='RGB Pixels wit
ax2.plot(range(1, 20), total_inertias_2, c='black')
ax2.set(xlabel='Total Inertias', title='RGB Pixels with locations');
```

RGB Pixels without locations
RGB Pixels with locations
Number of Clusters
1400
1200
1000
800
600
400

```python
# final fit
km_3_feat = KMeans(n_clusters=3).fit(nd_3_feat) #3 for im 5
km_5_feat = KMeans(n_clusters=7).fit(nd_5_feat) #7 for im 5
```

```
time: 2.62 s (started: 2022-02-15 07:20:50 +00:00)
```

```python
#Using K value to create clusters
km_colors_3_feat = km_3_feat.cluster_centers_[km_3_feat.predict(nd_3_feat)]
km_colors_5_feat = km_5_feat.cluster_centers_[km_5_feat.predict(nd_5_feat)]
# Reshaping the image according to the clusters
k_img_3_feat = np.reshape(km_colors_3_feat, (image.shape))
k_img_5_feat = np.reshape(km_colors_5_feat[:,2:5], (image.shape))

#Plotting the compressed and original image
fig, (ax1,ax2,ax3) = plt.subplots(1, 3,figsize=(20,5))
# fig.suptitle('K-means Image Compressor', fontsize=20)
ax1.set_title('Original', fontsize=17)
ax1.set_xticks([])
ax1.set_yticks([])
ax1.imshow(image)
ax2.set_title('Pixels w/o their location ({} colors, kMeans)'.format(len(km_3_feat.
ax2.set_xticks([])
ax2.set_yticks([])
ax2.imshow(k_img_3_feat)
ax3.set_title('Pixels w/ their location ({} colors, kMeans)'.format(len(km_3_feat.c
ax3.set_xticks([])
ax3.set_yticks([])
ax3.imshow(k_img_5_feat)
plt.scatter(scaler_5d.inverse_transform(km_5_feat.cluster_centers_)[:, 0], scaler_5
plt.subplots_adjust(top=0.85)
plt.show()
```

Original
Pixels w/o their location (3 colors, kMeans)
Pixels w/ their location (3 colors, kMeans)

Interactive widget k selector

- from https://analyticsindiamag.com/beginners-guide-to-image-compression-using-k-means-clustering/#:~:text=Beginners%20Guide%20to%20Image%20Compression%20using%20K%2DMeans%20Clustering,-By%20Himanshu%20Sharma&text=Image%20compression%20is%20reducing%20the,low%20quality%20takes%20less%20memory.

```
@interact
#defining compression function
def compression(
                i = BoundedIntText(min=1, max=len(df_train),step=1,value=45,  conti
                                         description='image number',layout=dict(wid
                resize_factor = IntSlider(min=1, max=10,step=1,value=5,  continuous_
                                         description='resize factor',layout=dict(wi
                k_3_feat=IntSlider(min=1, max=30,step=1,value=2,  continuous_update
                                         layout=dict(width='50%')),
                k_5_feat=IntSlider(min=1, max=30,step=1,value=5,  continuous_update
                                         layout=dict(width='50%'))
                ):
    # define image
    # i = 5 #5
    # resize_factor = 5 #5
    image_path = df_train.iloc[i]['drive_file_path']
    # load image
    image = plt.imread(image_path)
    image = resize(image,(int(image.shape[0]/resize_factor), int(image.shape[1]/res
    # dfs from images
    index = pd.MultiIndex.from_product(
        (*map(range, image.shape[:2]), ('r', 'g', 'b')),
        names=('row', 'col', None))
    df_5_feat = pd.Series(image.flatten(), index=index)
    df_5_feat = df_5_feat.unstack()
    df_5_feat = df_5_feat.reset_index().reindex(columns=['col','row',   'r','g','b'
    df_3_feat = df_5_feat[['r','g','b']]
    #normalisation
    scaler_3d = MinMaxScaler(feature_range = (0,1))
    nd_3_feat = scaler_3d.fit_transform(df_3_feat)
    scaler_5d = MinMaxScaler(feature_range = (0,1))
    nd_5_feat = scaler_5d.fit_transform(df_5_feat)
    #Using K value to create clusters
    km_3_feat = MiniBatchKMeans(k_3_feat).fit(nd_3_feat)
    km_colors_3_feat = km_3_feat.cluster_centers_[km_3_feat.predict(nd_3_feat)]
    km_5_feat = MiniBatchKMeans(k_5_feat).fit(nd_5_feat)
    km_colors_5_feat = km_5_feat.cluster_centers_[km_5_feat.predict(nd_5_feat)]
```

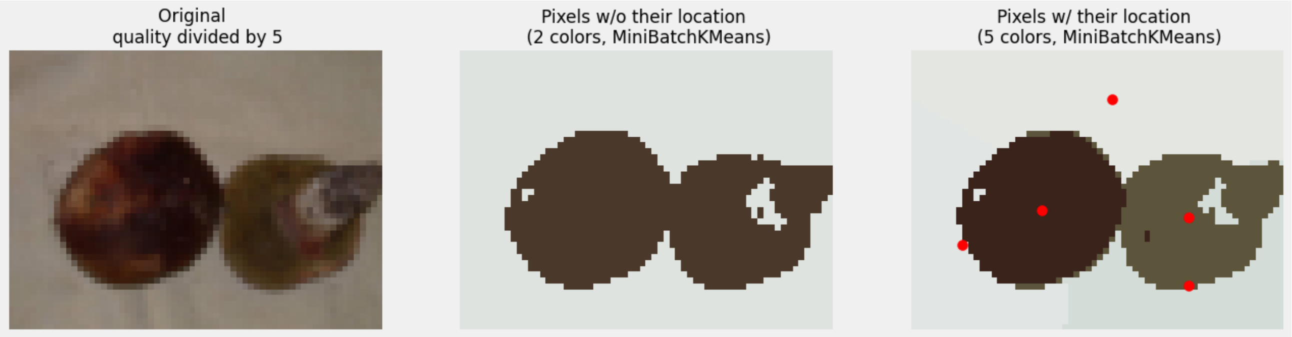
```
# Reshaping the image according to the clusters
k_img_3_feat = np.reshape(km_colors_3_feat, (image.shape))
k_img_5_feat = np.reshape(km_colors_5_feat[:,2:5], (image.shape))
#Plotting the compressed and original image
plt.clf()
fig1, (ax1, ax2,ax3) = plt.subplots(1, 3,figsize=(20,10))
ax1.set_title('Original \n quality divided by {}'.format(resize_factor), fontsi
ax1.set_xticks([])
ax1.set_yticks([])
ax1.imshow(image)
ax2.set_title('Pixels w/o their location \n ({} colors, MiniBatchKMeans)'.forma
ax2.set_xticks([])
ax2.set_yticks([])
ax2.imshow(k_img_3_feat)
ax3.set_title('Pixels w/ their location \n ({} colors, MiniBatchKMeans)'.format
ax3.set_xticks([])
ax3.set_yticks([])
ax3.imshow(k_img_5_feat)
plt.scatter(scaler_5d.inverse_transform(km_5_feat.cluster_centers_)[:, 0], scal
plt.subplots_adjust(top=0.85)
display(fig1);
# plt.close()
# find K
plt.clf()
total_inertias_1 = [MiniBatchKMeans(n_clusters=i).fit(nd_3_feat).inertia_ for i
total_inertias_2 = [MiniBatchKMeans(n_clusters=i).fit(nd_5_feat).inertia_ for i
fig2, (ax1, ax2) = plt.subplots(1, 2, sharex='col', sharey='row',figsize=(20,5)
ax1.plot(range(1, 20), total_inertias_1, c='black')
ax1.set(xlabel='Total Inertias', ylabel='Number of Clusters', title='RGB Pixels
ax1.axvline(x= k_3_feat,c='r')
ax2.plot(range(1, 20), total_inertias_2, c='black')
ax2.set(xlabel='Total Inertias', title='RGB Pixels with locations')
ax2.axvline(x= k_5_feat,c='r')
plt.show();
```

image num… □

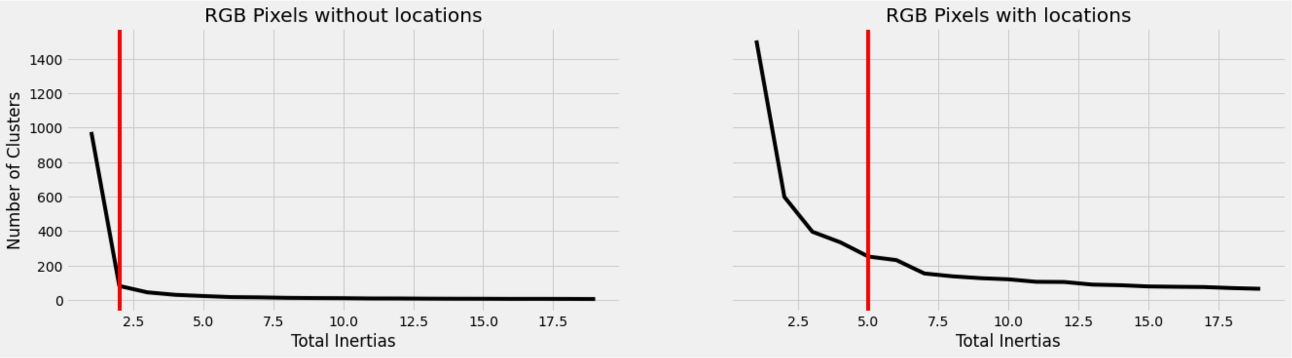
resize factor ○ 5

k_3_feat ○ 2

k_5_feat ○ 5


Original
quality divided by 5
Pixels w/o their location
(2 colors, MiniBatchKMeans)
Pixels w/ their location
(5 colors, MiniBatchKMeans)

```
<Figure size 432x288 with 0 Axes>
<Figure size 1440x720 with 0 Axes>
```



Mean shift

- https://medium.com/@muhammetbolat/image-segmentation-using-k-means-clustering-algorithm-and-mean-shift-clustering-algorithm-fb6ebe4cb761

```
@interact
#defining compression function
def meanshift_compression(
                i = BoundedIntText(min=1, max=len(df_train),step=1,value=45,  conti
                                          description='image number',layout=dict(wid
                resize_factor = IntSlider(min=1, max=10,step=1,value=5,  continuous
                                          description='resize factor',layout=dict(wi
                bandwidth_3_feat=FloatSlider(min=0.01, max=1,step=0.01,value=0.2,
                                          layout=dict(width='50%')),
                bandwidth_5_feat=FloatSlider(min=0.01, max=1,step=0.01,value=0.3,
                                          layout=dict(width='50%'))

                ):
  # define image
  # i = 5 #5
  # resize_factor = 5 #5
  image_path = df_train.iloc[i]['drive_file_path']
  # load image
```

```
image = plt.imread(image_path)
image = resize(image,(int(image.shape[0]/resize_factor), int(image.shape[1]/resiz
# dfs from images
index = pd.MultiIndex.from_product(
    (*map(range, image.shape[:2]), ('r', 'g', 'b')),
    names=('row', 'col', None))
df_5_feat = pd.Series(image.flatten(), index=index)
df_5_feat = df_5_feat.unstack()
df_5_feat = df_5_feat.reset_index().reindex(columns=['col','row',   'r','g','b'])
df_3_feat = df_5_feat[['r','g','b']]
#normalisation
scaler_3d = MinMaxScaler(feature_range = (0,1))
nd_3_feat = scaler_3d.fit_transform(df_3_feat)
scaler_5d = MinMaxScaler(feature_range = (0,1))
nd_5_feat = scaler_5d.fit_transform(df_5_feat)
# mean shift fit
sug_bandwidth_3_feat = round(estimate_bandwidth(nd_3_feat, quantile=.1, n_jobs=-1
sug_bandwidth_5_feat = round(estimate_bandwidth(nd_5_feat, quantile=.1, n_jobs=-1
print('suggested settings using estimate_bandwidth fonction = {} / {}'.format(sug
ms_3_feat = MeanShift(bandwidth = bandwidth_3_feat, n_jobs=-1, bin_seeding=True,
ms_5_feat = MeanShift(bandwidth = bandwidth_5_feat , n_jobs=-1, bin_seeding=True,
#Using N clusters value to create clusters
ms_colors_3_feat = ms_3_feat.cluster_centers_[ms_3_feat.predict(nd_3_feat)]
ms_colors_5_feat = ms_5_feat .cluster_centers_[ms_5_feat .predict(nd_5_feat)]
# Reshaping the image according to the clusters
ms_img_3_feat = np.reshape(ms_colors_3_feat, (image.shape))
ms_img_5_feat = np.reshape(ms_colors_5_feat[:,2:5], (image.shape))
#Plotting the compressed and original image
plt.clf()
fig1, (ax1, ax2,ax3) = plt.subplots(1, 3,figsize=(20,10))
ax1.set_title('Original \n quality divided by {}'.format(resize_factor), fontsize
ax1.set_xticks([])
ax1.set_yticks([])
ax1.imshow(image)
ax2.set_title('Pixels w/o their location \n ({} colors, MeanShift)'.format(len(ms
ax2.set_xticks([])
ax2.set_yticks([])
ax2.imshow(ms_img_3_feat)
ax3.set_title('Pixels w/ their location \n ({} colors, MeanShift)'.format(len(ms_
ax3.set_xticks([])
ax3.set_yticks([])
ax3.imshow(ms_img_5_feat)
plt.scatter(scaler_5d.inverse_transform(ms_5_feat.cluster_centers_)[:, 0], scaler
plt.subplots_adjust(top=0.85)
plt.show();
```

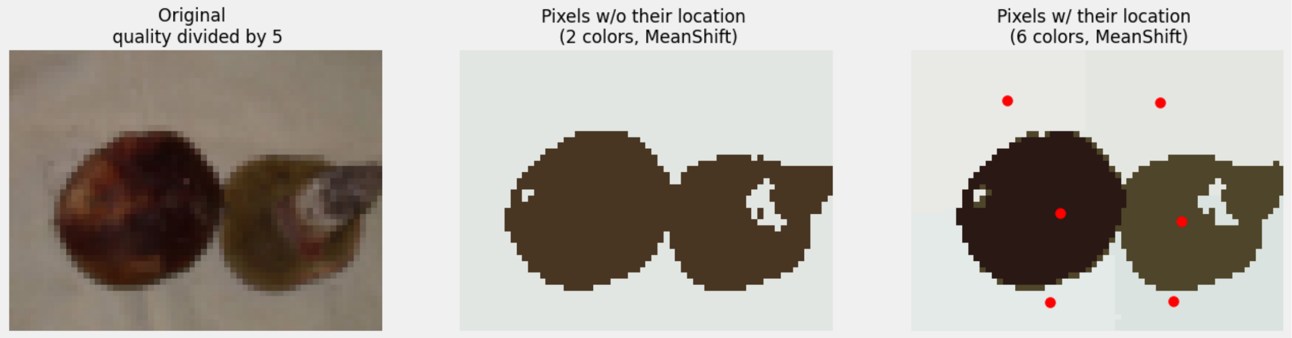
image num… □

resize factor ○ 5

bandwidth_… 0.20

bandwidth_… 0.30

```
suggested settings using estimate_bandwidth fonction = 0.09 / 0.31
<Figure size 432x288 with 0 Axes>
```



```
time: 4.05 s (started: 2022-02-15 07:21:03 +00:00)
```

Spectral_clustering

- https://scikit-learn.org/stable/auto_examples/cluster/plot_coin_segmentation.html#sphx-glr-auto-examples-cluster-plot-coin-segmentation-py

```
i = 45 #5
resize_factor = 5 #5
image_path = df_train.iloc[i]['drive_file_path']
# load image
image = io.imread(image_path)
image = rgb2gray(image)
image = resize(image, (int(image.shape[0]/resize_factor), int(image.shape[1]/resize_
```

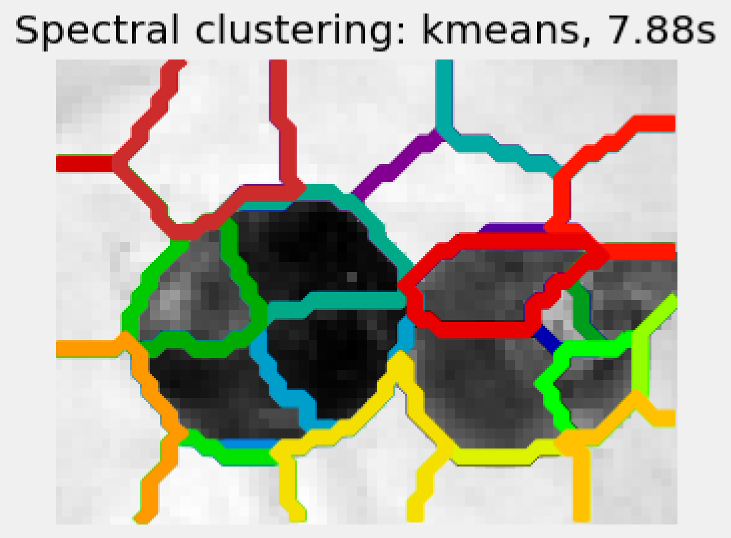
```
time: 17.2 ms (started: 2022-02-15 07:21:08 +00:00)
```

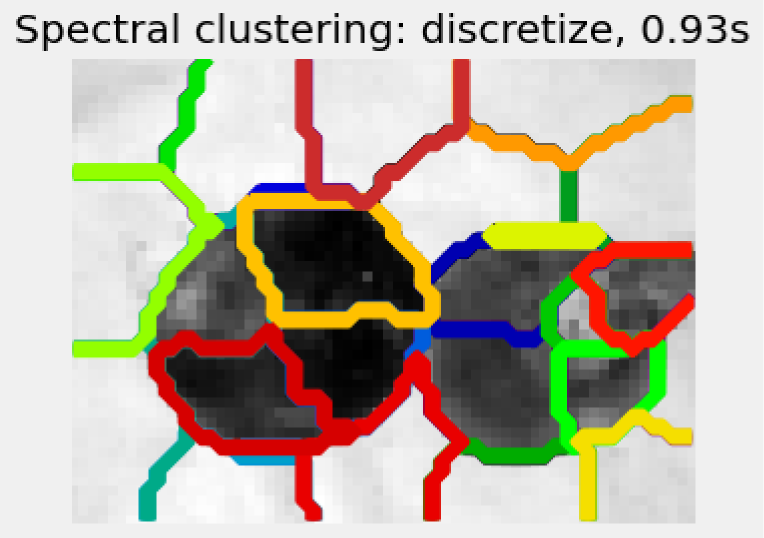
```
graph = sklearn.feature_extraction.image.img_to_graph(image)

# Take a decreasing function of the gradient: an exponential
# The smaller beta is, the more independent the segmentation is of the
# actual image. For beta=1, the segmentation is close to a voronoi
beta = 10
eps = 1e-6
graph.data = np.exp(-beta * graph.data / graph.data.std()) + eps

# Apply spectral clustering (this step goes much faster if you have pyamg
# installed)
N_REGIONS = 25
```

```
time: 8.88 ms (started: 2022-02-15 07:21:08 +00:00)
```

```
for assign_labels in ("kmeans", "discretize"):
    t0 = time.time()
    labels = spectral_clustering(
        graph, n_clusters=N_REGIONS, assign_labels=assign_labels, random_state=42
    )
    t1 = time.time()
    labels = labels.reshape(image.shape)

    plt.figure(figsize=(5, 5))
    plt.imshow(image, cmap=plt.cm.gray)
    for l in range(N_REGIONS):
        plt.contour(labels == l, colors=[plt.cm.nipy_spectral(l / float(N_REGIONS))
    plt.xticks(())
    plt.yticks(())
    title = "Spectral clustering: %s, %.2fs" % (assign_labels, (t1 - t0))
    print(title)
    plt.title(title)
plt.show()
```

```
Spectral clustering: kmeans, 7.88s
Spectral clustering: discretize, 0.93s
```



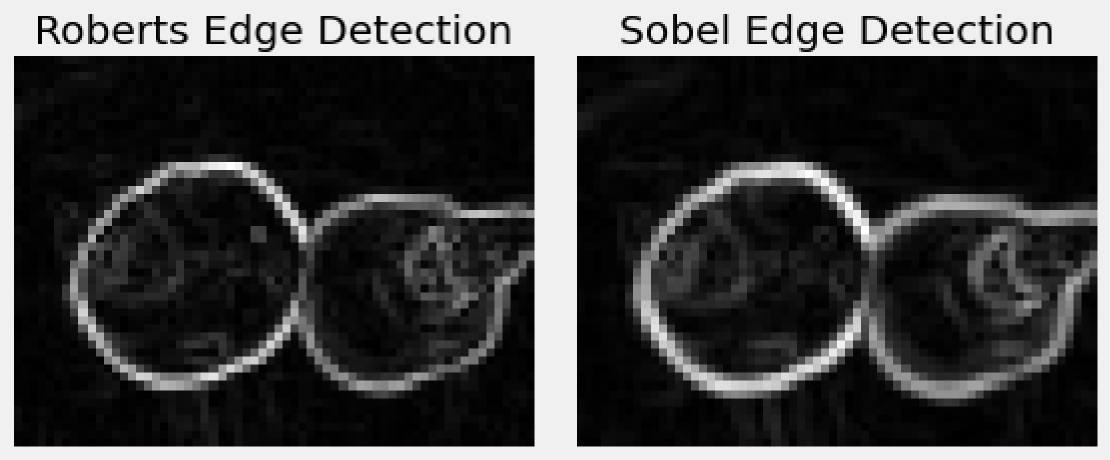


```
time: 9.73 s (started: 2022-02-15 07:21:08 +00:00)
```

Edge detection

- https://scikit-

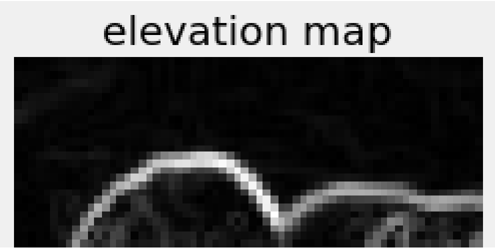
```
#
i = 45 #5
resize_factor = 5 #5
image_path = df_train.iloc[i]['drive_file_path']
# load image
image = io.imread(image_path)
image = rgb2gray(image)
image = resize(image, (int(image.shape[0]/resize_factor), int(image.shape[1]/resize
edge_roberts = filters.roberts(image)
edge_sobel = filters.sobel(image)

fig, axes = plt.subplots(ncols=2, sharex=True, sharey=True,
                         figsize=(8, 4))

axes[0].imshow(edge_roberts, cmap=plt.cm.gray)
axes[0].set_title('Roberts Edge Detection')

axes[1].imshow(edge_sobel, cmap=plt.cm.gray)
axes[1].set_title('Sobel Edge Detection')

for ax in axes:
    ax.axis('off')

plt.tight_layout()
plt.show()
```



```
time: 173 ms (started: 2022-02-15 07:21:18 +00:00)
```

```
elevation_map = sobel(image)
fig, ax = plt.subplots(figsize=(4, 3))
ax.imshow(elevation_map, cmap=plt.cm.gray)
ax.set_title('elevation map')
ax.axis('off')
```

```
(-0.5, 63.5, 47.5, -0.5)
```



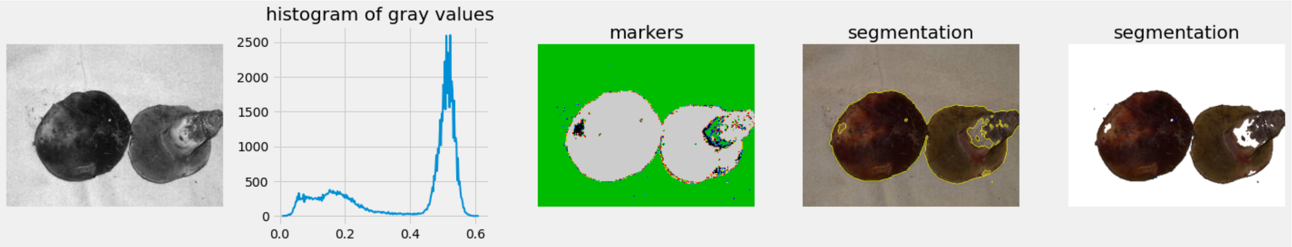
```
@interact
#defining compression function
def meanshift_compression(
                img_idx = BoundedIntText(min=1, max=len(df_train),step=1,value=45,
                                         description='image number',layout=dict(wid
                resize_factor = IntSlider(min=1, max=10,step=1,value=1,  continuous
                                         description='resize factor',layout=dict(wi
                object_thresh =FloatSlider(min=0.01, max=1,step=0.01,value=0.4,  co
                                         layout=dict(width='50%')),
                background_thresh =FloatSlider(min=0.01, max=1,step=0.01,value=0.3,
                                         layout=dict(width='50%'))

                ):
  # LOAD IMAGE
  image_path = df_train.iloc[img_idx]['drive_file_path']
  image = plt.imread(image_path)
  image_resized = resize(image, (int(image.shape[0]/resize_factor), int(image.shape
  image_gray = rgb2gray(image_resized)
  image_gray = img_as_float(image_gray)
  # Find markers
  hist, hist_centers = histogram(image_gray )
  markers = np.zeros_like(image_gray )
  markers[image_gray  > object_thresh] = 1
  markers[image_gray  < background_thresh] = 2
  # Segmentation
  gradient = sobel(image_gray )
  segments_watershed = watershed(gradient, markers=markers)
  # object extraction
  # create mask with same dimensions as image
  mask = np.zeros_like(image_resized)
  segments_watershed[segments_watershed==2] = 0
  mask_2D = np.invert(segments_watershed.astype(bool))
  # copy your image_mask to all dimensions (i.e. colors) of your image
  for j in range(3):
      mask[:,:,j] = mask_2D.copy()
  # apply the mask to your image
  masked_image = image_resized*mask
  masked_image[masked_image==0] = 1
  # plot
  fig, axes = plt.subplots(1, 5, figsize=(20, 4))
  axes[0].imshow(image_gray, cmap=plt.cm.gray)
  axes[0].axis('off')
  axes[1].plot(hist_centers, hist, lw=2)
  axes[1].set_title('histogram of gray values')
  axes[2].imshow(markers, cmap=plt.cm.nipy_spectral)
  axes[2].set_title('markers')
  axes[2].axis('off')
  axes[3].imshow(mark_boundaries(image_resized, segments_watershed))
  axes[3].set_title('segmentation')
  axes[3].axis('off')
  axes[4].imshow(masked_image)
  axes[4].set_title('segmentation')
  axes[4].axis('off')
  plt.tight_layout()
```

image num… ▯

resize factor ○ 1

object_thresh 0.40

background… 0.30



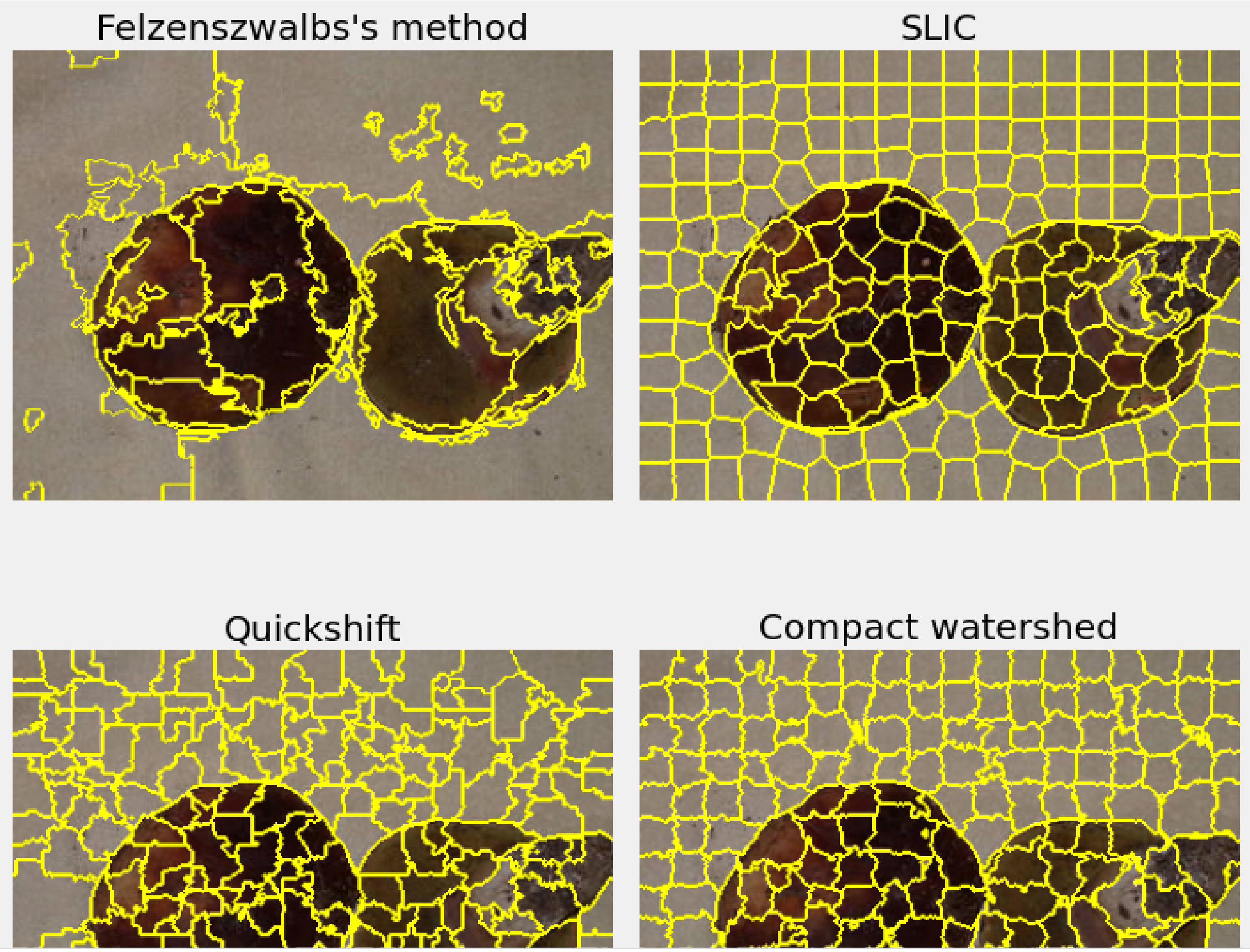
```
time: 666 ms (started: 2022-02-15 07:21:18 +00:00)
```

Other

```
# scikit image cf https://scikit-image.org/docs/dev/auto_examples/segmentation/plot
import matplotlib.pyplot as plt
import numpy as np

from skimage.data import astronaut
from skimage.color import rgb2gray
from skimage.filters import sobel
from skimage.segmentation import felzenszwalb, slic, quickshift, watershed
from skimage.segmentation import mark_boundaries
from skimage.util import img_as_float

image_path = df_train.iloc[45]['drive_file_path']
image = plt.imread(image_path)
img = img_as_float(image)

segments_fz = felzenszwalb(img, scale=100, sigma=0.5, min_size=50)
segments_slic = slic(img, n_segments=250, compactness=10, sigma=1,
                     start_label=1)
```

```
segments_quick = quickshift(img, kernel_size=3, max_dist=6, ratio=0.5)
gradient = sobel(rgb2gray(img))
segments_watershed = watershed(gradient, markers=250, compactness=0.001)

print(f'Felzenszwalb number of segments: {len(np.unique(segments_fz))}')
print(f'SLIC number of segments: {len(np.unique(segments_slic))}')
print(f'Quickshift number of segments: {len(np.unique(segments_quick))}')

fig, ax = plt.subplots(2, 2, figsize=(10, 10), sharex=True, sharey=True)

ax[0, 0].imshow(mark_boundaries(img, segments_fz))
ax[0, 0].set_title("Felzenszwalbs's method")
ax[0, 1].imshow(mark_boundaries(img, segments_slic))
ax[0, 1].set_title('SLIC')
ax[1, 0].imshow(mark_boundaries(img, segments_quick))
ax[1, 0].set_title('Quickshift')
ax[1, 1].imshow(mark_boundaries(img, segments_watershed))
ax[1, 1].set_title('Compact watershed')

for a in ax.ravel():
    a.set_axis_off()

plt.tight_layout()
plt.show()
```

```
Felzenszwalb number of segments: 77
SLIC number of segments: 219
Quickshift number of segments: 226
```



Felzenszwalbs's method

SLIC

Quickshift

Compact watershed

✓ 3 s terminée à 08:21