Image processing with `scikit-image`

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Surface, Glass and Interfaces, CNRS/Saint-Gobain

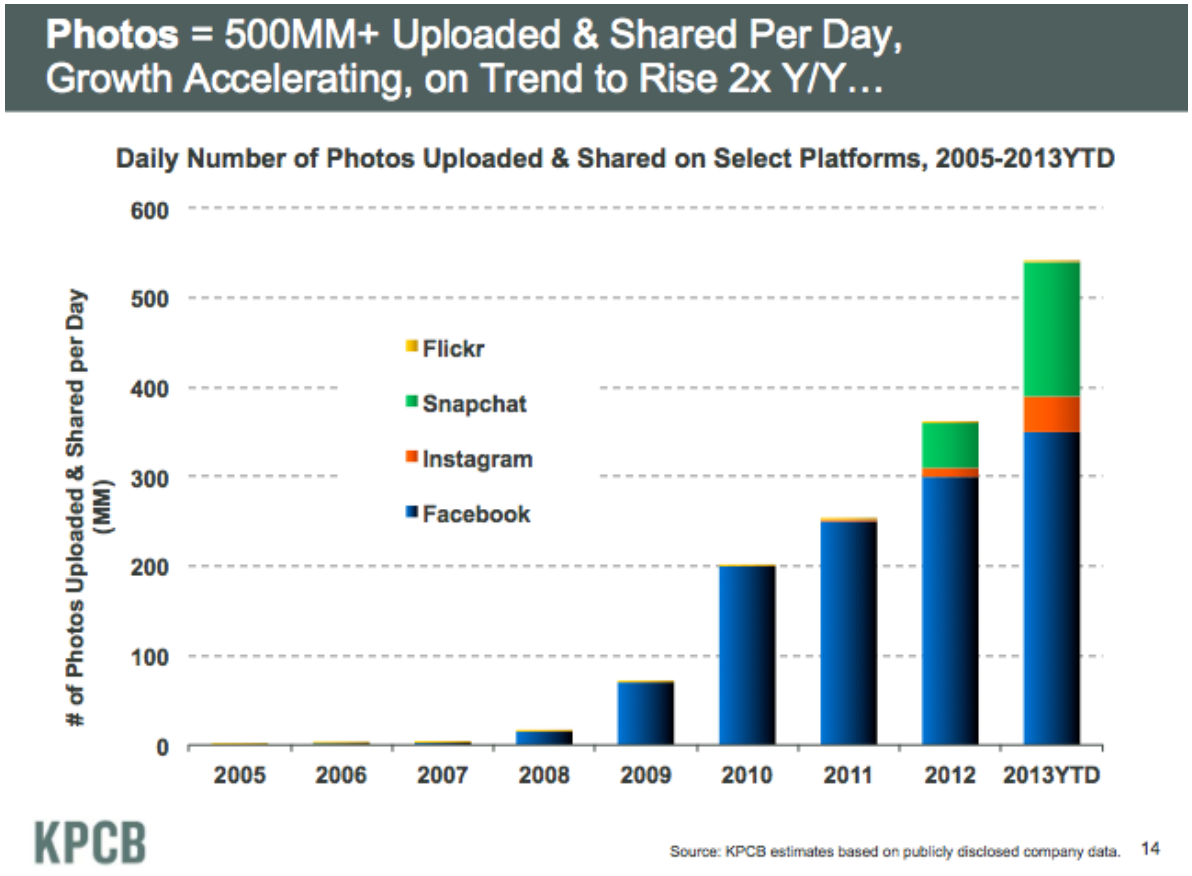
@EGouillart

scikit-image
image processing in python

The revolution of images

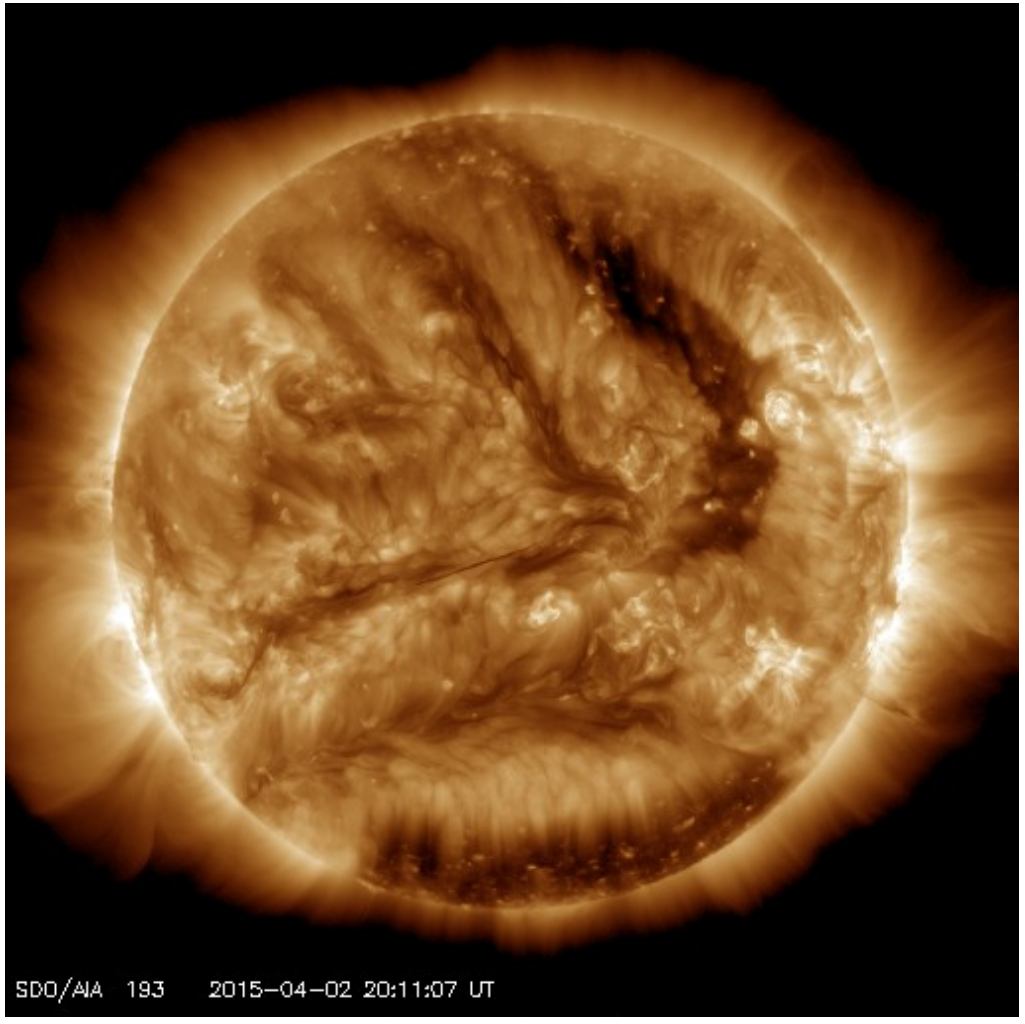
The revolution of images

A flood of images



several 10^8 images uploaded on Facebook each day

A flood of images



hundreds of terabytes of scientific data for scientific experiment

http://sdo.gsfc.nasa.gov/

A flood of images

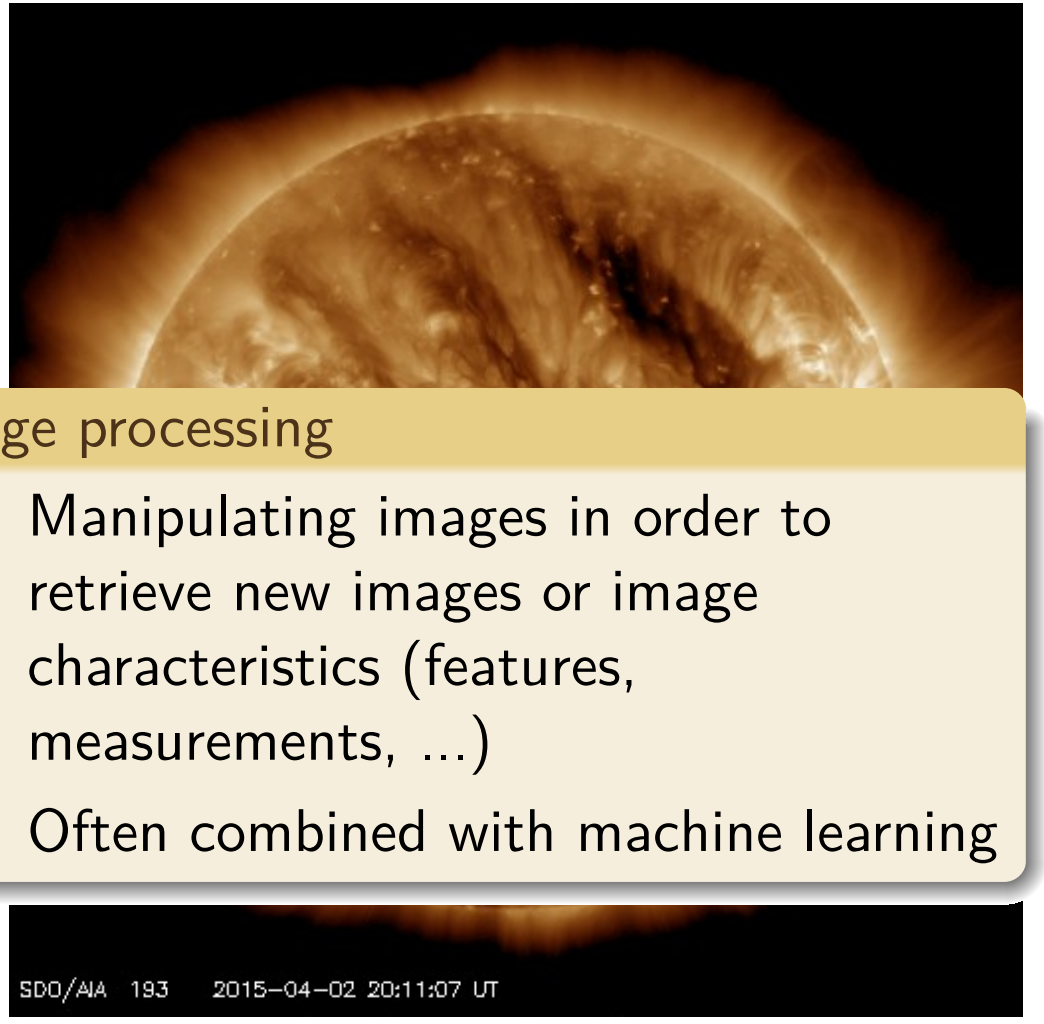


Image processing

- Manipulating images in order to retrieve new images or image characteristics (features, measurements, ...)
- Often combined with machine learning

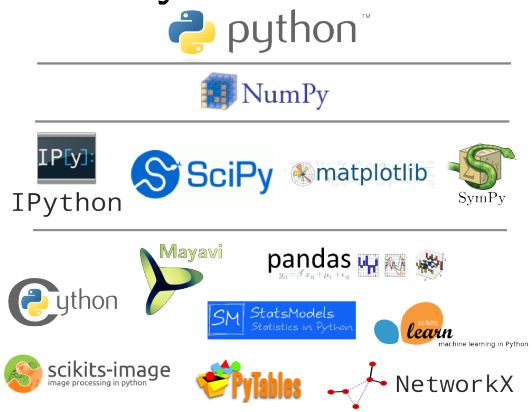
hundreds of terabytes of scientific data for scientific experiment

http://sdo.gsfc.nasa.gov/

Why use scikit-image?

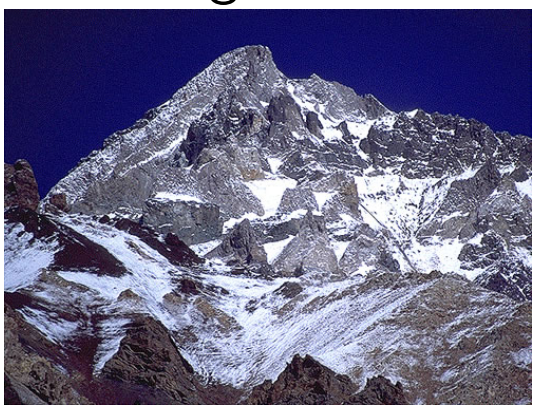
Lots of excellent tools available: OpenCV (computer vision), ImageJ (GUI-based software), ITK, ...

- Native NumPy compatibility

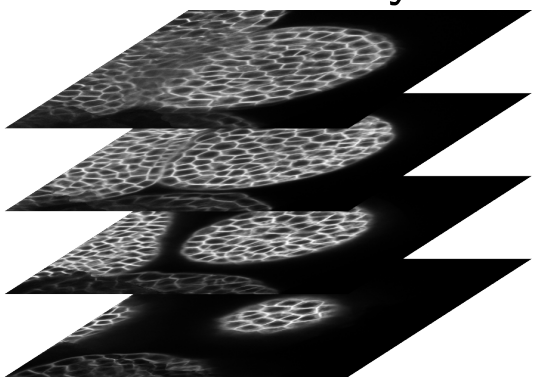


- Variety of features

- Gentle learning curve



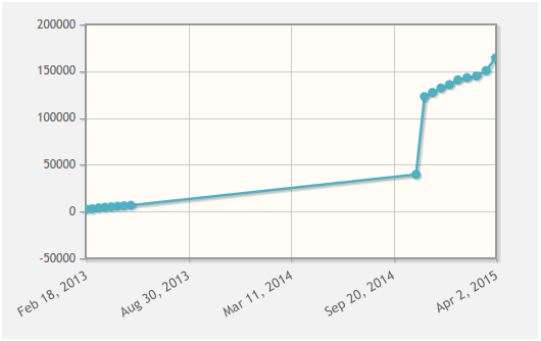
- Versatile - 3D-friendly



Datasheet

Package statistics

- `http://scikit-image.org/`
- Release 0.11 (1 - 2 release per year)
- Available in most Scientific Python Distributions: Canopy, Anaconda, ...
- Packaged on Ubuntu/Debian
- Among 1000 best ranked packages on PyPi



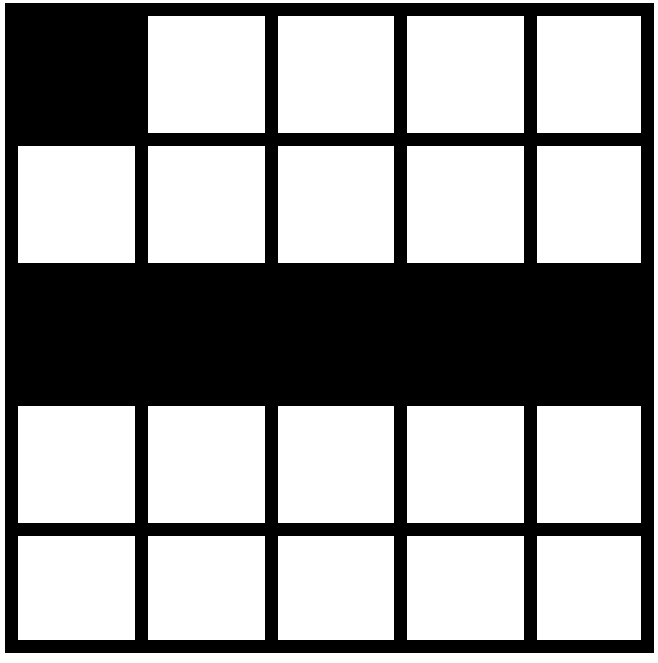
Development model

- Mature algorithms
- Only `Python` + `Cython` code for easier maintainability
- Thorough code review by others: readability, PEP8, efficiency, ...
- Core team of $5 - 10$ persons (close to applications)

Manipulating images as numerical (numpy) arrays

- Pixels are arrays elements

```
import numpy as np
image = np.ones((5, 5))
image[0, 0] = 0
image[2, :] = 0
```



Manipulating images as numerical (numpy) arrays

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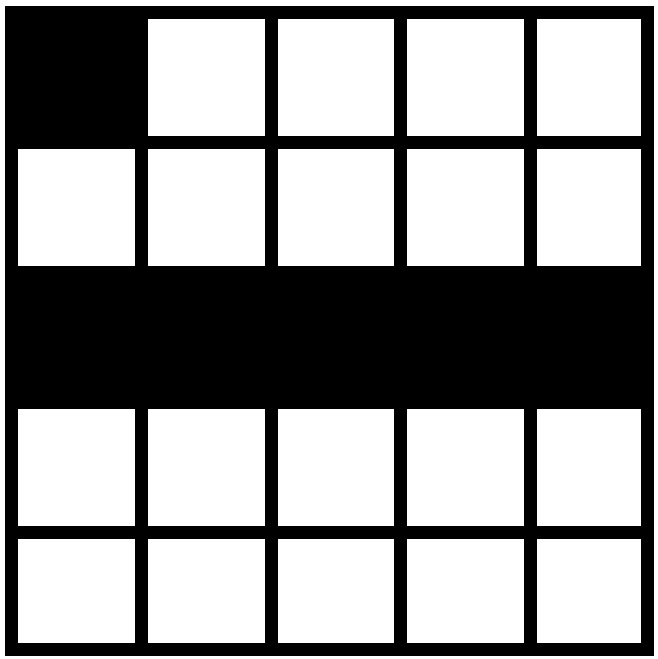

```
>>> coffee.shape
(400, 600, 3)
>>> red_channel =
coffee[..., 0]
>>> image_3d =
np.ones((100, 100, 100))
```

NumPy-native: images as NumPy arrays

- NumPy arrays as arguments and outputs

```
>>> from skimage import io, filters
>>> camera_array = io.imread('camera_image.png')
>>> type(camera_array)
<type 'numpy.ndarray'>
>>> camera_array.dtype
dtype('uint8')
>>> filtered_array = filters.gaussian_filter(
    camera_array, sigma=5)
>>> type(filtered_array)
<type 'numpy.ndarray'>
>>> import matplotlib.pyplot as plt
>>> plt.imshow(filtered_array, cmap='gray')
```

An API relying mostly on functions

```
skimage.filters.gaussian_filter(image, sigma, output=
    None, mode='nearest', cval=0, multichannel=None)

Multi-dimensional Gaussian filter

Parameters
----------

image : array-like
    input image (grayscale or color) to filter.
sigma : scalar or sequence of scalars
    standard deviation for Gaussian kernel. The
        standard
    deviations of the Gaussian filter are given for
        each axis as a
    sequence, or as a single number, in which case it
        is equal for
    all axes.
output : array, optional
    The ``output`` parameter passes an array in which
        to store the
    filter output.
```

Getting started: finding documentation

scikit-image
image processing in python

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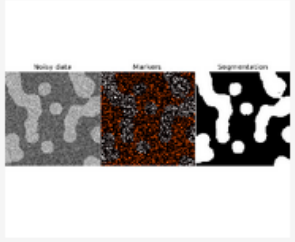
Image processing in Python

scikit-image is a collection of algorithms for image processing. It is available free of charge and free of restriction. We pride ourselves on high-quality, peer-reviewed code, written by an active community of volunteers.

Download



Stable
0.10.1 - June 2014
Download

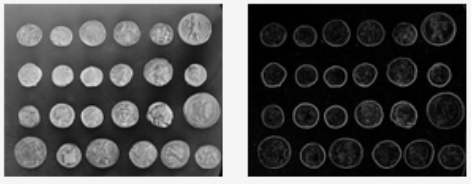
Development
pre-0.11
Download

Getting Started

Filtering an image with `scikit-image` is easy! For more examples, please visit our gallery.

```
from skimage import data, io, filter

image = data.coins() # or any NumPy arr
ay!
edges = filter.sobel(image)
io.imshow(edges)
io.show()
```



+1 307 Star 522

Links
- Issue tracker
- Mailing list
- Test results

Related Projects
- OpenCV
- Scikit-learn
- Mahotas
- SimpleCV
- Ilastik

If you find this project useful, please cite: [BiBTeX]

Stéfan van der Walt, Johannes L. Schönberger, Juan Nunez-Iglesias, François Boulogne, Joshua D. Warner, Neil Yager, Emmanuelle Gouillart, Tony Yu and the scikit-image contributors. **scikit-image: Image processing in Python**. PeerJ 2:e453 (2014) http://dx.doi.org/10.7717/peerj.453

Gallery of examples

scikit-image
image processing in python

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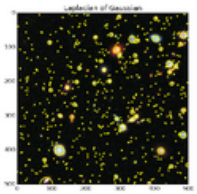
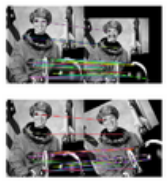
General examples

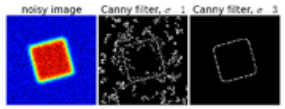
General-purpose and introductory examples for the scikit.



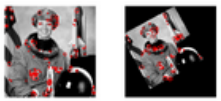
Blob Detection



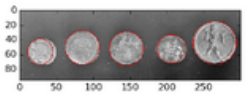
BRIEF binary descriptor



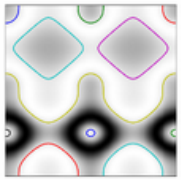
Canny edge detector



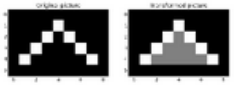
CENSURE feature detector



Circular and Elliptical Hough Transforms



Contour finding



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skimage 0.8.0
skimage 0.7.0
skimage 0.6
skimage 0.5
skimage 0.4
skimage 0.3

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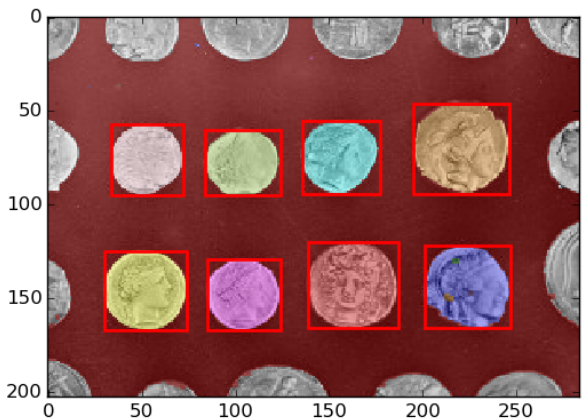
Label image regions

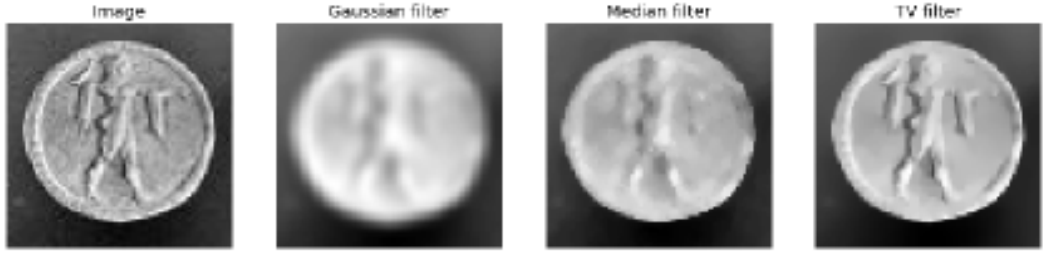
This example shows how to segment an image with image labelling. The following steps are applied:

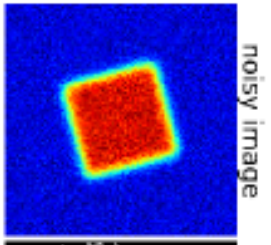
1. Thresholding with automatic Otsu method
2. Close small holes with binary closing
3. Remove artifacts touching image border
4. Measure image regions to filter small objects

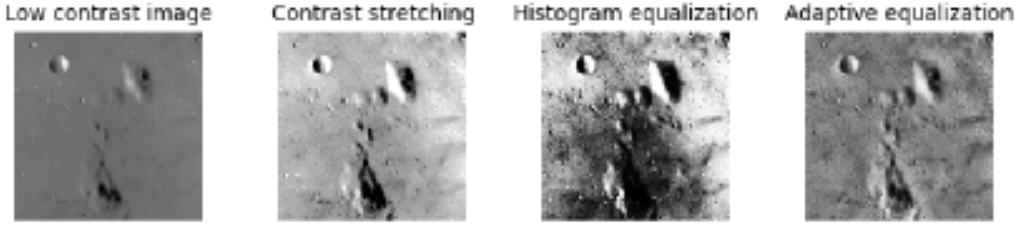


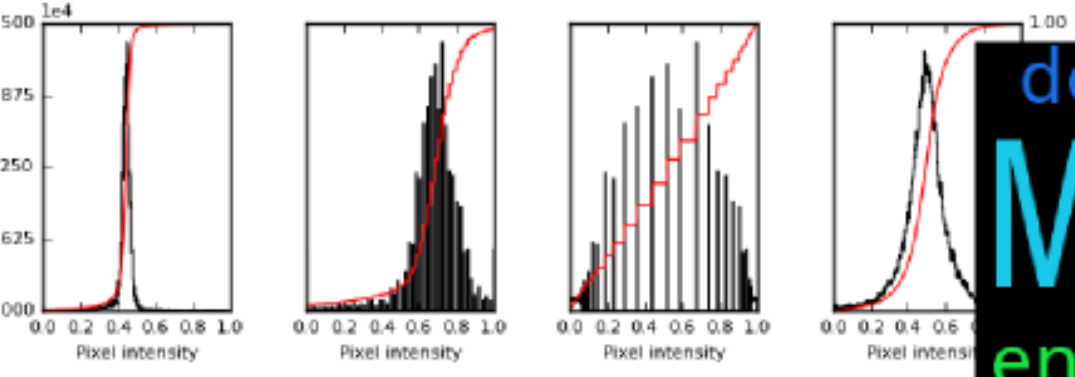

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches

from skimage import data
from skimage.filter import threshold_otsu
from skimage.segmentation import clear_border
from skimage.morphology import label, closing, square
from skimage.measure import regionprops
from skimage.color import label2rgb


image = data.coins()[50:-50, 50:-50]

# apply threshold
thresh = threshold_otsu(image)
bw = closing(image > thresh, square(3))

# remove artifacts connected to image border
cleared = bw.copy()
clear_border(cleared)

# label image regions
label_image = label(cleared)
borders = np.logical_xor(bw, cleared)
label_image[borders] = -1
image_label_overlay = label2rgb(label_image, image=image)

fig, ax = plt.subplots(ncols=1, nrows=1, figsize=(6, 6))
ax.imshow(image_label_overlay)

for region in regionprops(label_image):

    # skip small images
    if region.area < 100:
        continue

    # draw rectangle around segmented coins
    minr, minc, maxr, maxc = region.bbox
    rect = mpatches.Rectangle((minc, minr), maxc - minc, maxr - minr,
                              fill=False, edgecolor='red', linewidth=2)
    ax.add_patch(rect)

plt.show()
```

Filtering: transforming image data



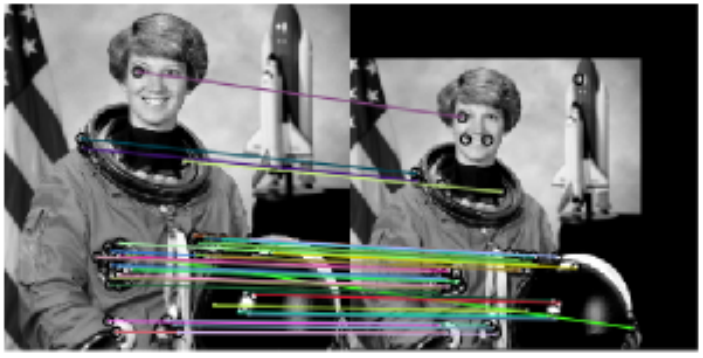


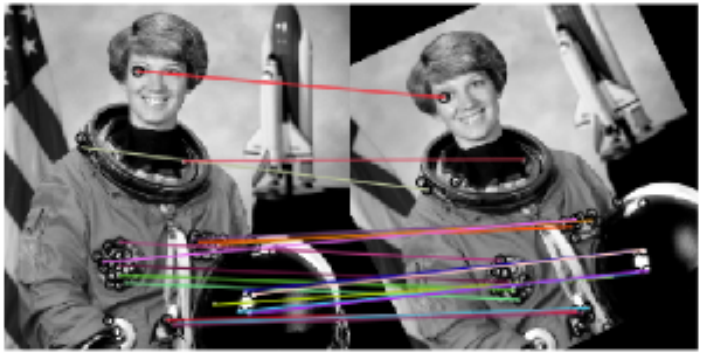


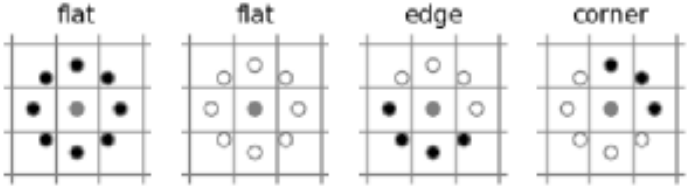


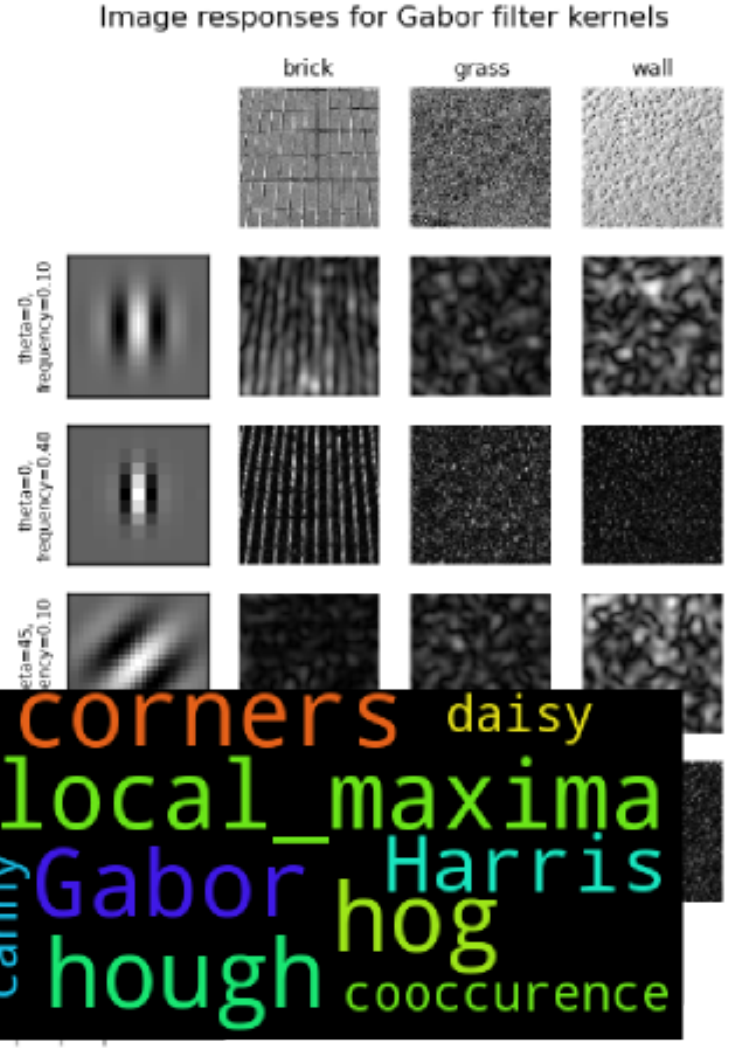
`skimage.filter`, `skimage.exposure`, `skimage.restoration`

Extracting features









`skimage.feature`, `skimage.filter`

Feature extraction followed by classification

Combining `scikit-image` and `scikit-learn`

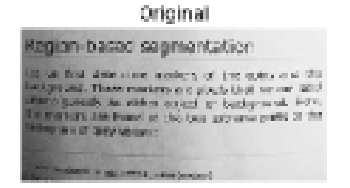
- Extract features (`skimage.feature`)
  - Pixels intensity values (R, G, B)
  - Local gradients
  - More advanced descriptors: HOGs, Gabor, ...
- Train classifier with known regions
  - here, random forest classifier
- Classify pixels

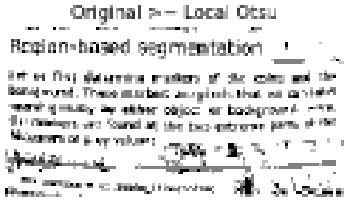
Geometrical transformations

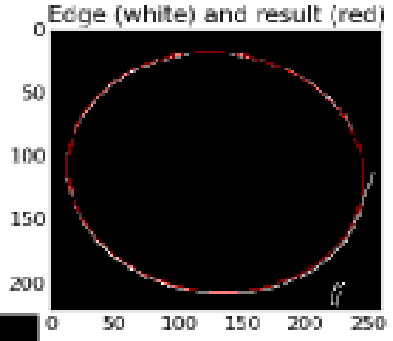
`skimage.transform`

scale, zoom, rotate, swirl, warp, ...

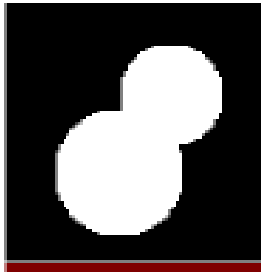
Segmentation: labelling regions

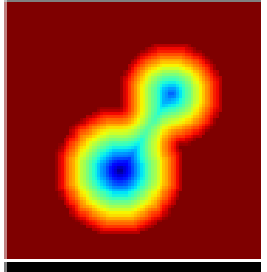


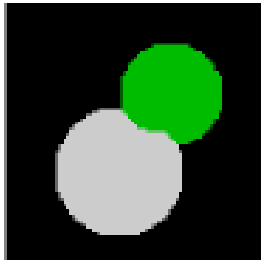




watershed
superpixel
thresholding
otsu
randomwalker





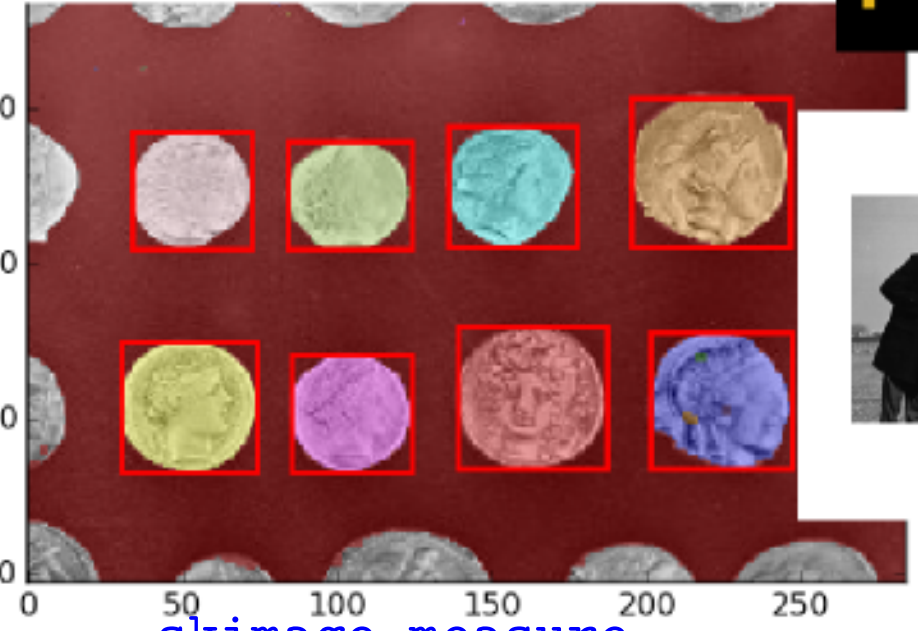


Felzenszwalbs's method

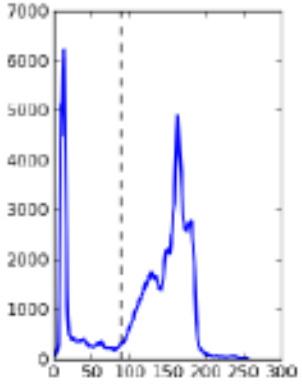
skimage.segmentation

Measures on images

size label
measure
histogram
regionprops

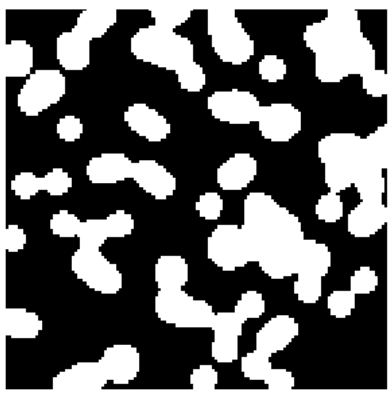


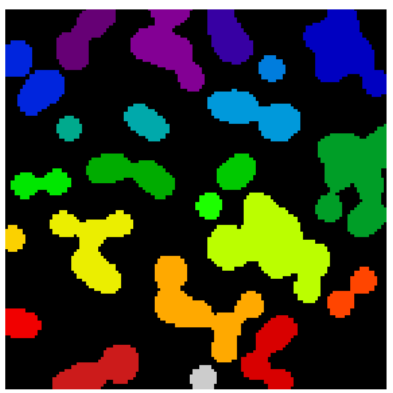
skimage.measure

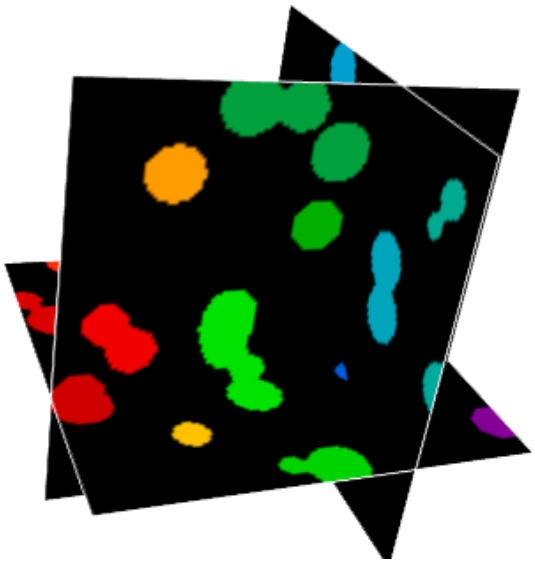


Versatile use for 2D, 2D-RGB, 3D...

```
>>> from skimage import measure
>>> labels_2d = measure.label(image_2d)
>>> labels_3d = measure.label(image_3d)
```







Try it out! `http://scikit-image.org/`

scikit-image
image processing in python

Feedback welcome

`github.com/scikit-image/scikit-image`

Please cite the paper ☺

scikit-image: image processing in Python

Stéfan van der Walt[1], Johannes L. Schönberger[2], Juan Nunez-Iglesias[3], François Boulogne[4], Joshua D. Warner[5], Neil Yager[6], Emmanuelle Gouillart[7], Tony Yu[8], the scikit-image contributors

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