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# **pyregion Documentation**

*Release 2.1.dev336*

**Jae-Joon Lee**

**Jul 02, 2018**



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**Release**

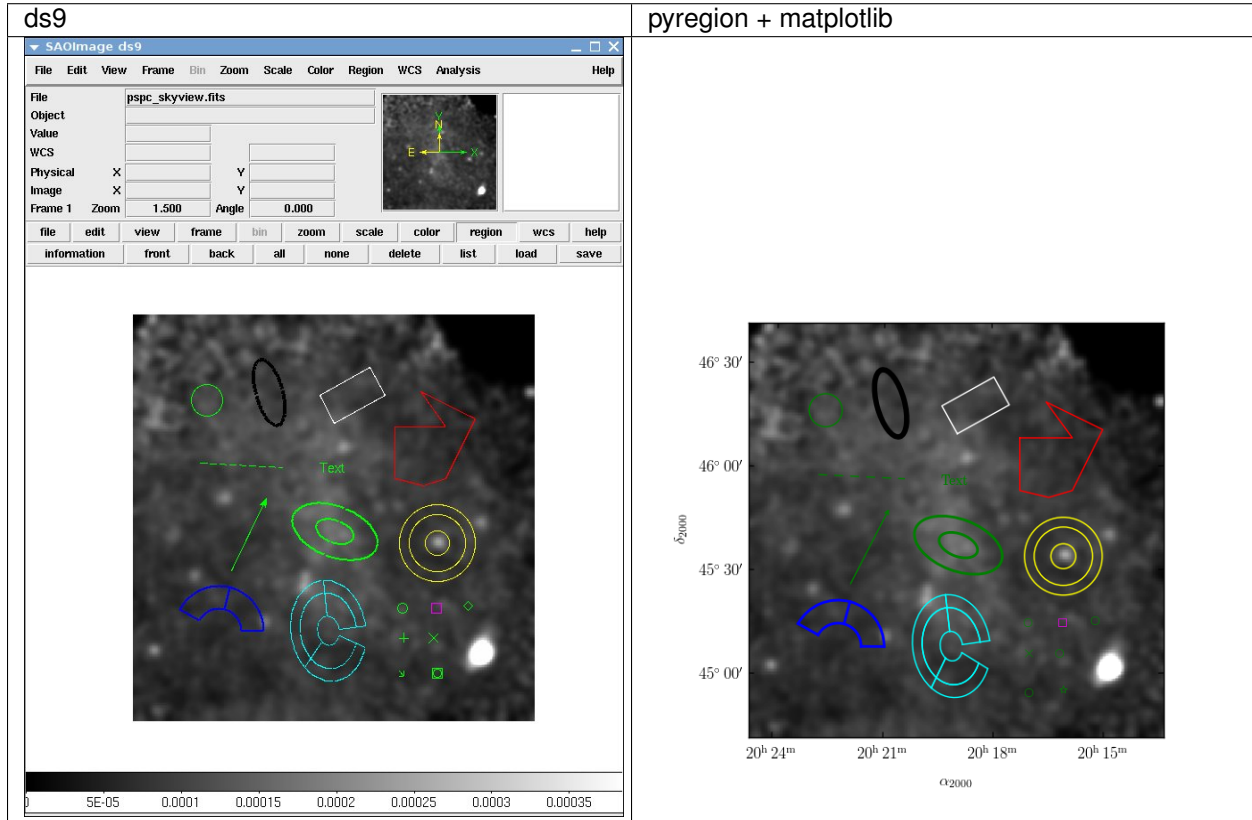
2.1.dev336

**Date**

Jul 02, 2018

pyregion is a python module to parse ds9 region files. It also supports ciao region files.

**Note:** See also the in-development regions package at <https://github.com/astropy/regions> a new astronomy package for regions based on Astropy.





**Part I**

**Documentation**





### 1.1 Stable version

Installing the latest stable version is possible either using pip or conda.

#### 1.1.1 Using pip

To install pyregion with pip from PyPI simply run:

```
pip install --no-deps pyregion
```

---

**Note:** The `--no-deps` flag is optional, but highly recommended if you already have Numpy installed, since otherwise pip will sometimes try to “help” you by upgrading your Numpy installation, which may not always be desired.

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#### 1.1.2 Using conda

To install regions with Anaconda from the conda-forge channel on [anaconda.org](https://anaconda.org) simply run:

```
conda install -c conda-forge pyregion
```

#### 1.1.3 Testing installation

To check if your install is OK, run the tests:

```
python -c 'import pyregion; pyregion.test()'
```

## 1.2 Development version

Install the latest development version from <https://github.com/astropy/pyregion> :

```
git clone https://github.com/astropy/pyregion
cd pyregion
python setup.py install
python setup.py test
python setup.py build_docs
```

## 1.3 Dependencies

Python 2.7 and 3.4+ are supported.

pyregion has the following required dependencies:

- [Astropy](#) version 1.0 or later (which requires Numpy)
- **pyarsing version 2.0 or later for parsing the DS9 region files**
  - [Homepage](#)
  - [PyPI page](#)

pyregion has the following optional dependencies for plotting:

- [matplotlib](#)

If you are using Astropy version 1.3 or later, then you have `astropy.visualization.wcsaxes`. For older versions of Astropy, you have to install the separate package: [wcsaxes](#)

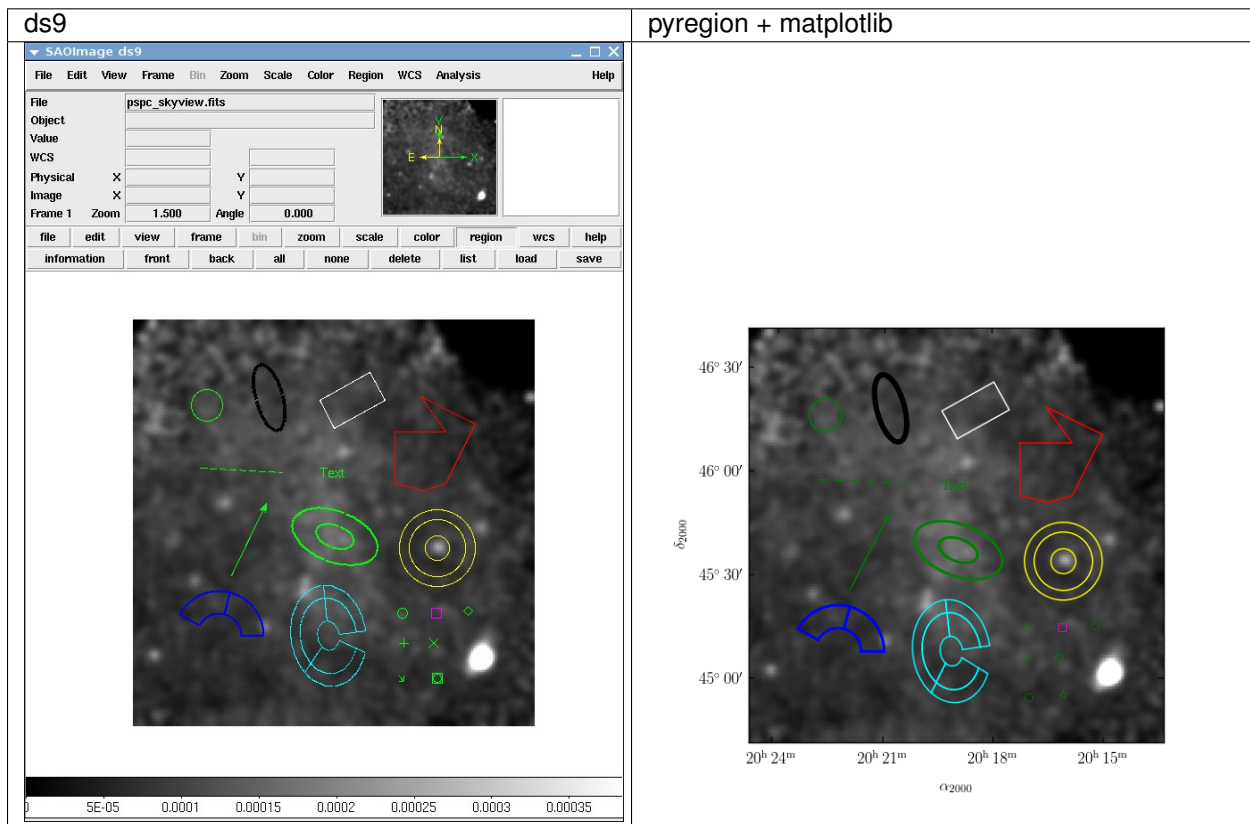
To work with the development version, you'll need Cython and a C compiler, because the code to generate masks from regions is written in Cython.

## CHAPTER 2

### Getting started

pyregion is a python module to parse ds9 region files. It also supports ciao region files.

Please note that the main emphasis of the package is to read in the regions files generated by ds9 itself. It reads most of the region files created by ds9. However, it may fail to read some of the user-created (or created by other programs) region files, even if they can be successfully read by ds9. Ruler, Compass and Projection types are ignored.



- *Read Region Files*
- *Draw Regions with Matplotlib*
- *Use Regions for Spatial Filtering*

## 2.1 Read Region Files

`pyregion.open` takes the region name as an argument and returns a `ShapeList` object, which is basically a list of Shape objects (`ShapeList` is a sub-class of the Python built-in list class).

```
import pyregion
region_name = "ds9.reg"
r = pyregion.open(region_name)
```

You may use `pyregion.parse` if you have a string that defines a region

```
region = 'fk5;circle(290.96388,14.019167,843.31194)''
r = pyregion.parse(region)
```

The shape object is a python representation of each region definition. For example,:

```
import pyregion

region_string = """
# Region file format: DS9 version 4.1
# Filename: test01.fits
global color=green dashlist=8 3 width=1 font="helvetica 10 normal" select=1 highlite=1 dash=0 fixed=0
edit=1 move=1 delete=1 include=1 source=1
fk5
circle(11:24:24.230,-59:15:02.20,18.5108") # color=cyan background
box(11:24:39.213,-59:16:53.91,42.804",23.616",19.0384) # width=4
"""

r = pyregion.parse(region_string)
```

And you have:

```
>>> print r[0]
Shape : circle ( HMS(11:24:24.230),DMS(-59:15:02.20),Ang(18.5108") )
>>> print r[1]
Shape : box ( HMS(11:24:39.213),DMS(-59:16:53.91),Ang(42.804"),Ang(23.616"),Number(19.0384) )
```

The shape object has the following attributes,

- `name` : name of the shape. e.g., circle, box, etc..

```
>>> print r[0].name
circle
```

- `coord_format` : coordinate format. e.g., "fk5", "image", "physical", etc. . .

```
>>> print r[0].coord_format
fk5
```

- `coord_list` : list of coordinates in `coord_format`. The coordinate value for sky coordinates is degree.

```
>>> print r[0].coord_list
[171.10095833333332, -59.250611111111112, 0.005141888888888886]
```

- `comment` : comment string associated with the shape (can be None)

```
>>> print r[0].comment
color=cyan background
```

- `attr` : attributes of the shape. This includes global attributes defined by the global command and local attributes defined in the comment. The first item is a list of key-only attributes without associated values (e.g., background..) and the second item is a dictionary of attributes of key-value pairs.

```
>>> print r[0].attr[0]
['background']
>>> print r[0].attr[1]
{'color': 'cyan',
 'dash': '0 ',
 'dashlist': '8 3 ',
 'delete': '1 ',
 'edit': '1 ',
 'fixed': '0 ',
 'font': '"helvetica 10 normal"',
 'highlite': '1 ',
 'include': '1 ',
 'move': '1 ',
 'select': '1 ',
 'source': '1',
 'width': '1 '}
```

Some attributes like “tag” allow multiple items, but this is not currently supported (the last definition overrides any previous ones).

The `pyregion.ShapeList` class have a few methods that could be useful. `ShapeList.as_imagecoord` returns a new `ShapeList` instance with the coordinates converted to the image coordinate system. It requires an `astropy.io.fits.Header` instance.

```
from astropy.io import fits
f = fits.open("t1.fits")
r2 = pyregion.parse(region_string).as_imagecoord(f[0].header)
```

The return value is a new `ShapeList` instance, but the coordinate is converted to image coordinates.

```
>>> print r2[0].coord_format
image

>>> print r2[0].coord_list
[482.27721401429852, 472.76641383805912, 18.811792596807045]
```

`ShapeList.as_imagecoord` will use the subset of the header defining a celestial coordinate system, ignoring any velocity or channel components.

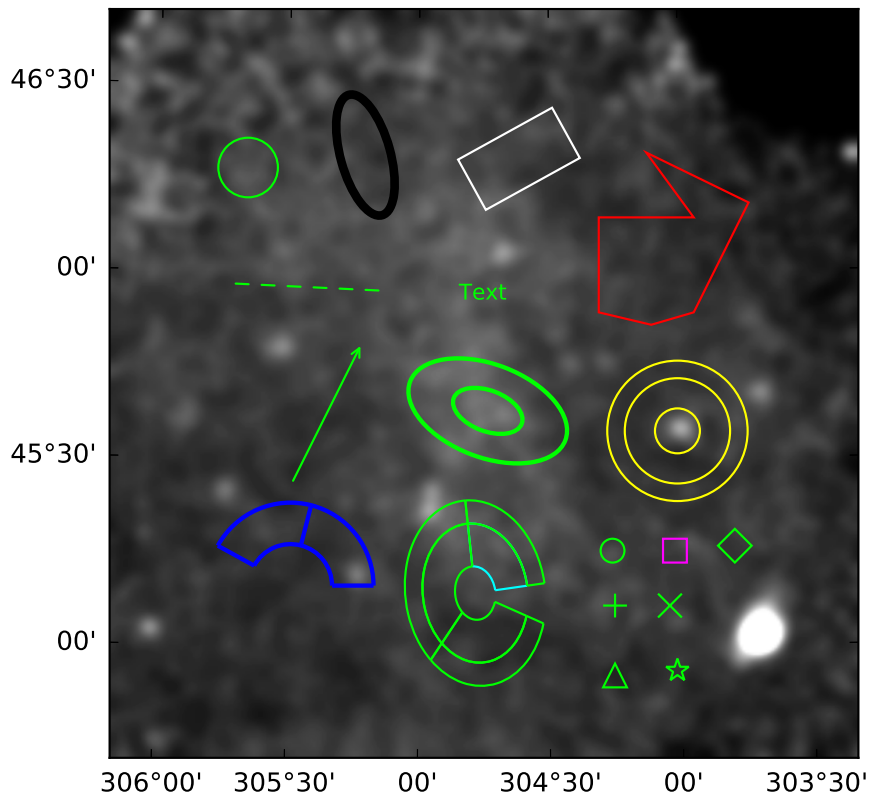
## 2.2 Draw Regions with Matplotlib

pyregion can help you draw ds9 regions with matplotlib. `ShapeList.get_mpl_patches_texts` returns a list of `matplotlib.artist.Artist` objects

```
r2 = pyregion.parse(region_string).as_imagecoord(f[0].header)
patch_list, artist_list = r2.get_mpl_patches_texts()
```

The first item is a list of `matplotlib.patches.Patch`, and the second one is other kinds of artists (usually `Text`). It is your responsibility to add these to the axes.

```
# ax is a mpl Axes object
for p in patch_list:
    ax.add_patch(p)
for t in artist_list:
    ax.add_artist(t)
```



The (optional) argument of the `get_mpl_patches_texts` method is a callable object that takes the shape object as an argument and returns a dictionary object that will be used as a keyword arguments (e.g., colors and line width) for creating the mpl artists. By default, it uses `pyregion.mpl_helper.properties_func_default`, which tries to respect the ds9 attributes. However, the colors (and other attributes) of some complex shapes are not correctly handled as shown in above example, and you need to manually adjust the associated attributes of patches.

```

import matplotlib.pyplot as plt
import matplotlib.cm as cm
from astropy.io import fits
import pyregion

# read in the image
xray_name = "pspc_skyview.fits"
f_xray = fits.open(xray_name)

try:
    from astropy.wcs import WCS
    from astropy.visualization.wcsaxes import WCSAxes

    wcs = WCS(f_xray[0].header)
    fig = plt.figure()
    ax = WCSAxes(fig, [0.1, 0.1, 0.8, 0.8], wcs=wcs)
    fig.add_axes(ax)
except ImportError:
    ax = plt.subplot(111)

ax.imshow(f_xray[0].data, cmap=cm.gray, vmin=0., vmax=0.00038, origin="lower")

reg_name = "test.reg"
r = pyregion.open(reg_name).as_imagecoord(header=f_xray[0].header)

from pyregion.mpl_helper import properties_func_default

# Use custom function for patch attribute
def fixed_color(shape, saved_attrs):
    attr_list, attr_dict = saved_attrs
    attr_dict["color"] = "red"
    kwargs = properties_func_default(shape, (attr_list, attr_dict))

    return kwargs

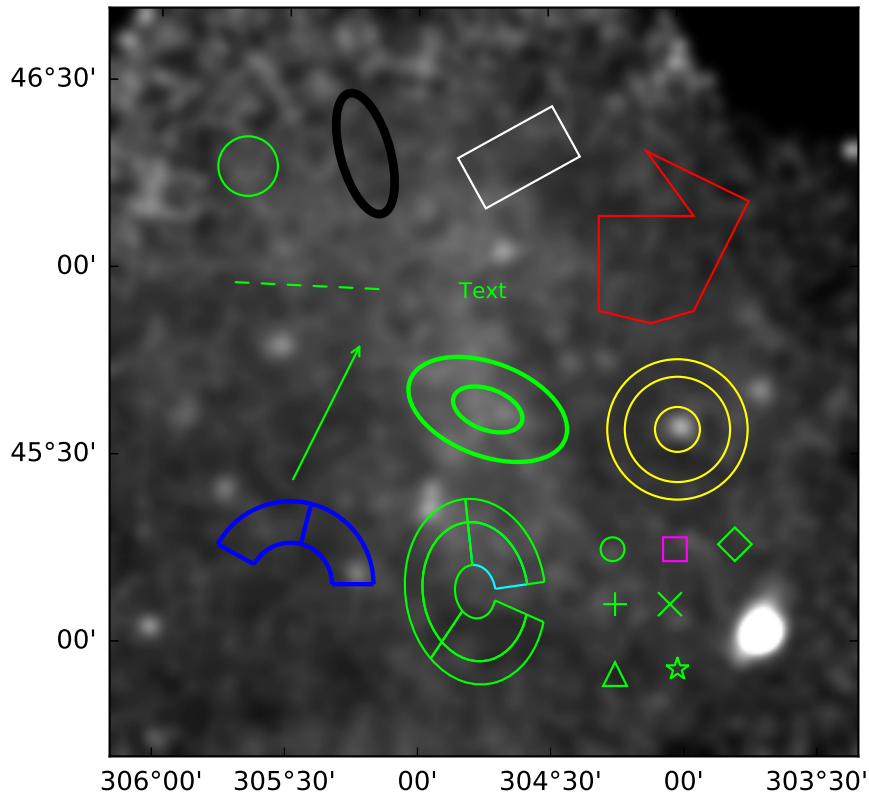
# select region shape with tag=="Group 1"
r1 = pyregion.ShapeList([rr for rr in r if rr.attr[1].get("tag") == "Group 1"])
patch_list1, artist_list1 = r1.get_mpl_patches_texts(fixed_color)

r2 = pyregion.ShapeList([rr for rr in r if rr.attr[1].get("tag") != "Group 1"])
patch_list2, artist_list2 = r2.get_mpl_patches_texts()

for p in patch_list1 + patch_list2:
    ax.add_patch(p)
for t in artist_list1 + artist_list2:
    ax.add_artist(t)

plt.show()

```



## 2.3 Use Regions for Spatial Filtering

pyregion includes some basic spatial filter support.

The `ShapeList.get_filter` method returns the filter from the parsed region.

The filter is meant to be used in the image coordinate, thus you need to convert the region to the image coordinate before calling `get_filter`.

```
r2 = pyregion.parse(region_string).as_imagecoord(f[0].header)
myfilter = r2.get_filter()
myfilter.inside1(50, 30)
```

The returned filter has a `mask` method that creates a 2d mask. You can create the mask directly from the `ShapeList` object.

```
r2 = pyregion.parse(region_string)
mymask = r2.get_mask(hdu=f[0])
```

It will creates an mask in the shape of the given hdu image (the mask will be created after transforming the region to the image coordinate if necessary).



```

import matplotlib.pyplot as plt
import pyregion

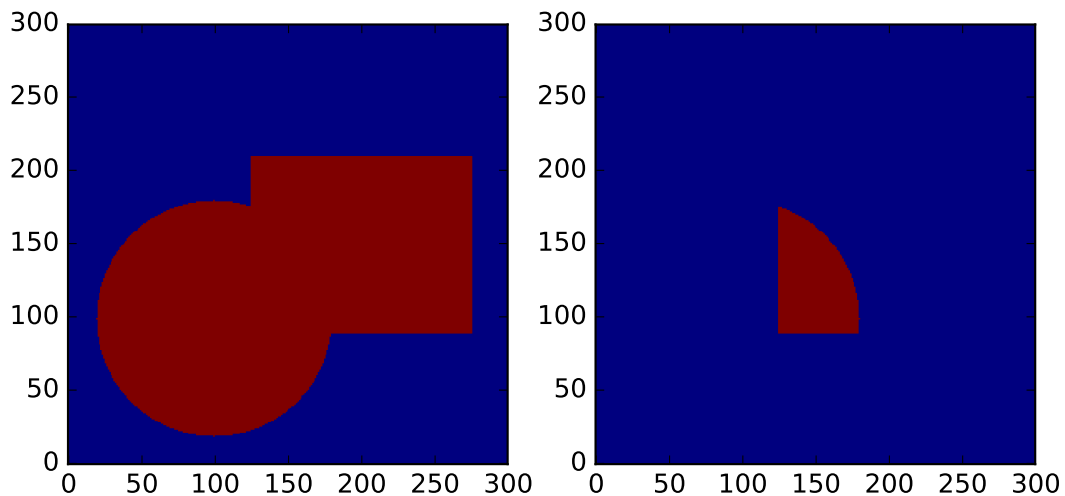
region = """
image
circle(100, 100, 80)
box(200, 150, 150, 120, 0)
"""

r = pyregion.parse(region)
mask_1or2 = r.get_mask(shape=(300, 300))

myfilter = r.get_filter()
mask_1and2 = (myfilter[0] & myfilter[1]).mask((300, 300))

plt.subplot(121).imshow(mask_1or2, origin="lower", interpolation="nearest")
plt.subplot(122).imshow(mask_1and2, origin="lower", interpolation="nearest")
plt.show()

```



Note that this will fail if your template image is not a simple 2D image. To work around this you may use the shape optional argument of `ShapeList.get_mask`:

```

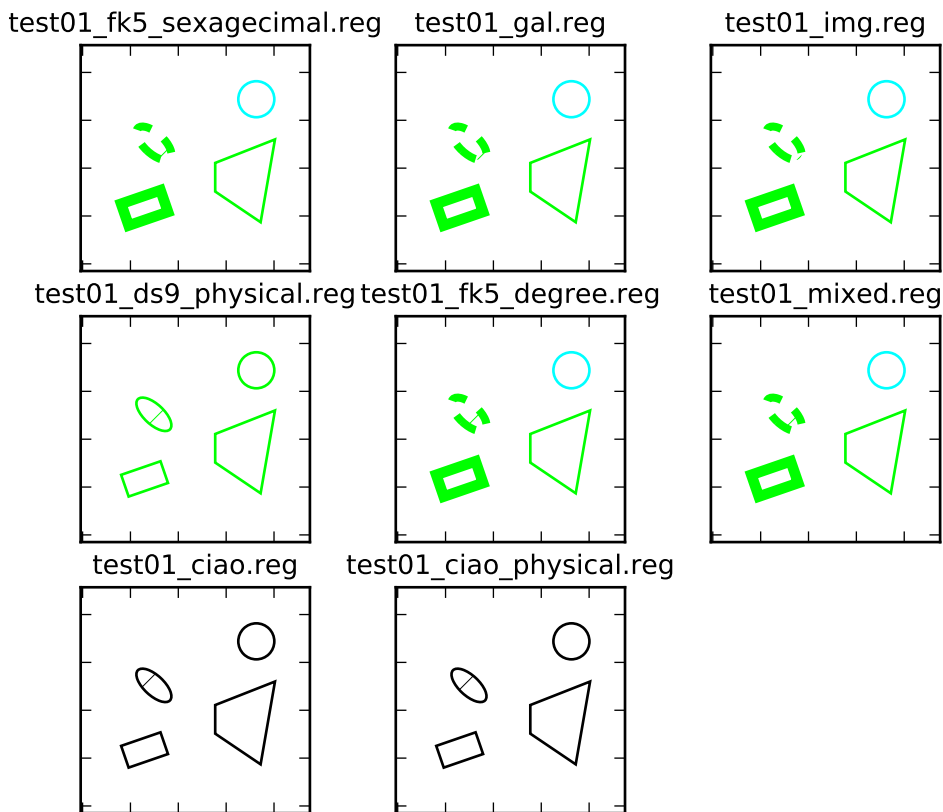
mymask = r2.get_mask(hdu=f[0], shape=(1024, 1024))

```

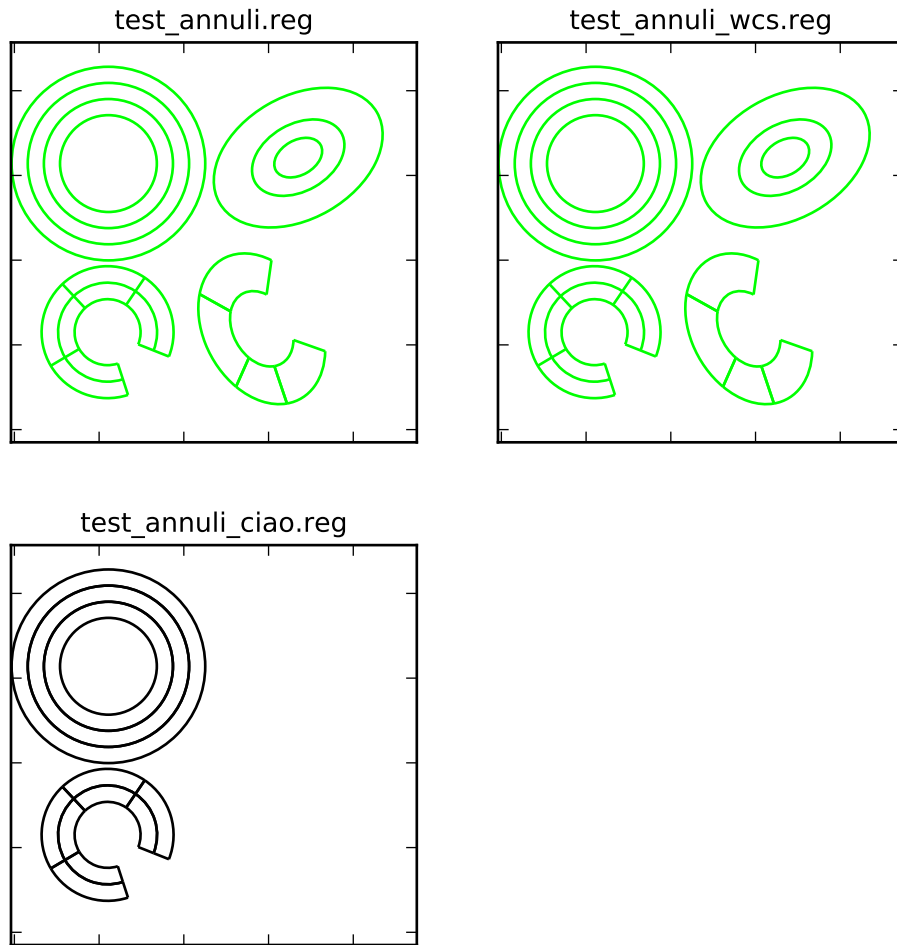




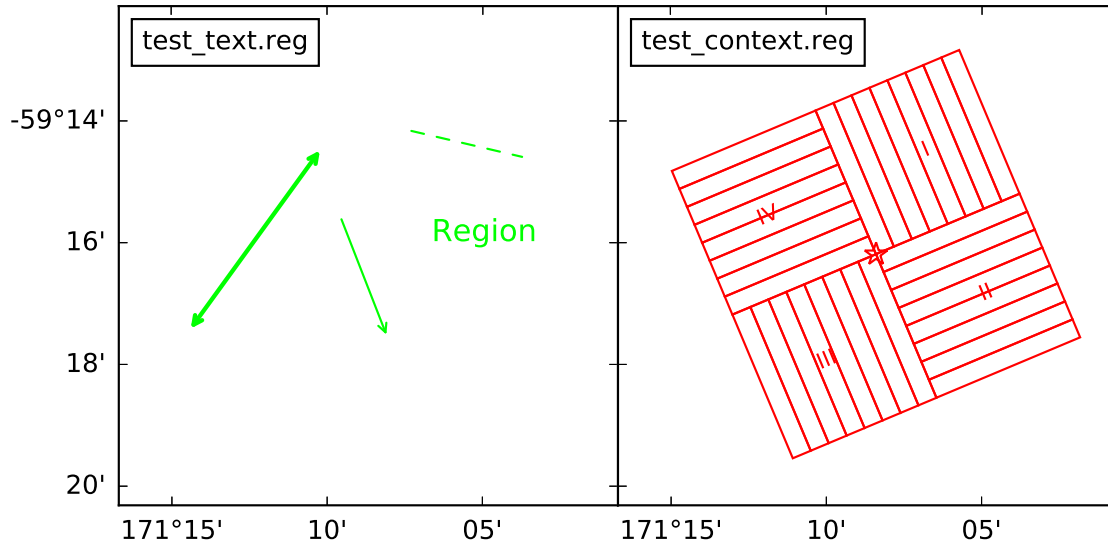
3.1 demo\_region01.py



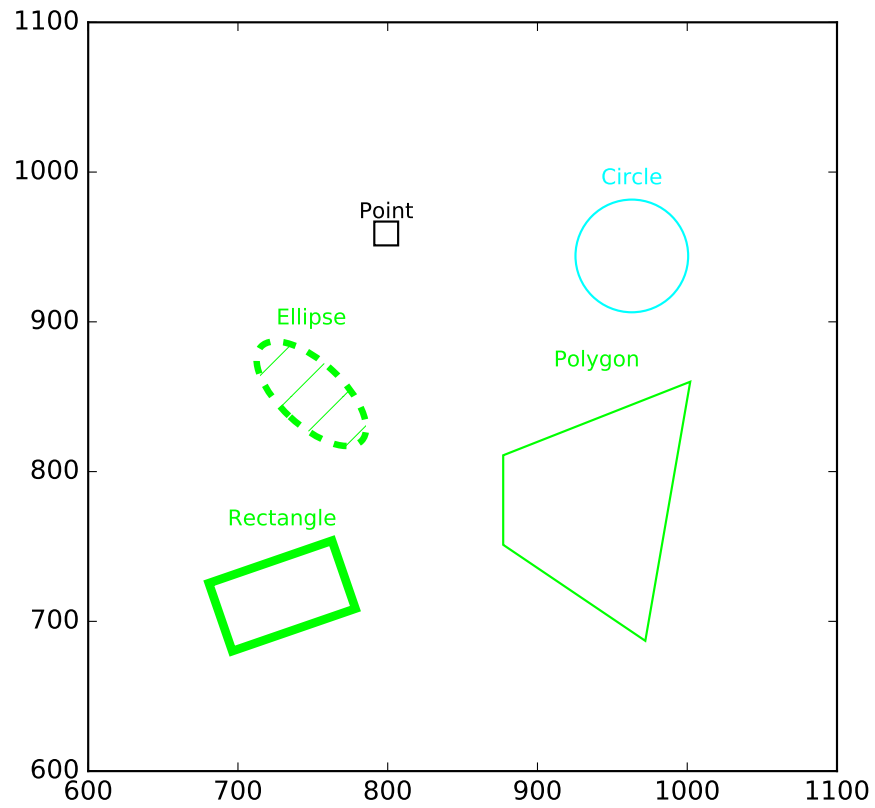
## 3.2 demo\_region02.py



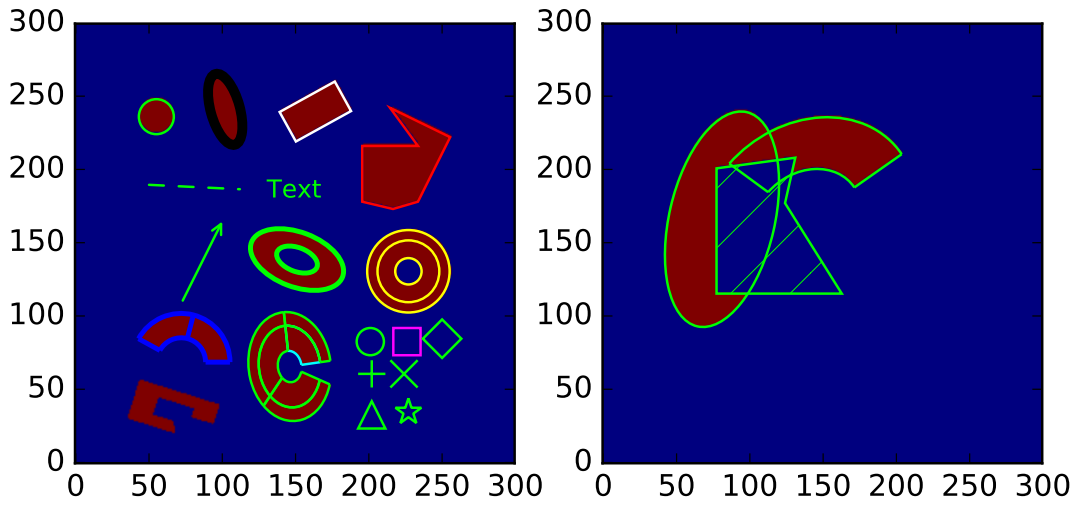
### 3.3 demo\_region03.py



### 3.4 demo\_region04.py



### 3.5 demo\_region\_filter01.py





pyregion: a Python parser for ds9 region files

- Code : <https://github.com/astropy/pyregion>
- Docs : <http://pyregion.readthedocs.io/>

See also the in-development regions package at <https://github.com/astropy/regions> a new astronomy package for regions based on Astropy.

## 4.1 Functions

<code>get_mask(region, hdu[, origin])</code>	Get mask.
<code>open(fname)</code>	Open, read and parse DS9 region file.
<code>parse(region_string)</code>	Parse DS9 region string into a ShapeList.
<code>test([package, test_path, args, plugins, ...])</code>	Run the tests using <code>py.test</code> .

### 4.1.1 get\_mask

`pyregion.get_mask(region, hdu, origin=1)`  
Get mask.

#### Parameters

**region** : ShapeList

List of Shape

**hdu** : ImageHDU

FITS image HDU

**origin** : float

TODO: document me

**Returns****mask** : array

Boolean mask

**Examples**

```
>>> from astropy.io import fits
>>> from pyregion import read_region_as_imagecoord, get_mask
>>> hdu = fits.open("test.fits")[0]
>>> region = "test01.reg"
>>> reg = read_region_as_imagecoord(open(region), f[0].header)
>>> mask = get_mask(reg, hdu)
```

## 4.1.2 open

`pyregion.open(fname)`

Open, read and parse DS9 region file.

**Parameters****fname** : str

Filename

**Returns****shapes** : ShapeList

List of Shape

## 4.1.3 parse

`pyregion.parse(region_string)`

Parse DS9 region string into a ShapeList.

**Parameters****region\_string** : str

Region string

**Returns****shapes** : ShapeList

List of Shape

## 4.1.4 test

`pyregion.test(package=None, test_path=None, args=None, plugins=None, verbose=False, pastebin=None, remote_data=False, pep8=False, pdb=False, coverage=False, open_files=False, **kwargs)`Run the tests using `pytest`. A proper set of arguments is constructed and passed to `pytest.main`.**Parameters****package** : str, optional

The name of a specific package to test, e.g. 'io.fits' or 'utils'. If nothing is specified all default tests are run.

**test\_path** : str, optional

Specify location to test by path. May be a single file or directory. Must be specified absolutely or relative to the calling directory.

**args** : str, optional

Additional arguments to be passed to `pytest.main` in the `args` keyword argument.

**plugins** : list, optional

Plugins to be passed to `pytest.main` in the `plugins` keyword argument.

**verbose** : bool, optional

Convenience option to turn on verbose output from `py.test`. Passing True is the same as specifying `'-v'` in `args`.

**pastebin** : {'failed', 'all', None}, optional

Convenience option for turning on `py.test` pastebin output. Set to `'failed'` to upload info for failed tests, or `'all'` to upload info for all tests.

**remote\_data** : bool, optional

Controls whether to run tests marked with `@remote_data`. These tests use online data and are not run by default. Set to True to run these tests.

**pep8** : bool, optional

Turn on PEP8 checking via the `pytest-pep8` plugin and disable normal tests. Same as specifying `'--pep8 -k pep8'` in `args`.

**pdb** : bool, optional

Turn on PDB post-mortem analysis for failing tests. Same as specifying `'--pdb'` in `args`.

**coverage** : bool, optional

Generate a test coverage report. The result will be placed in the directory `htmlcov`.

**open\_files** : bool, optional

Fail when any tests leave files open. Off by default, because this adds extra run time to the test suite. Works only on platforms with a working `lsof` command.

**parallel** : int, optional

When provided, run the tests in parallel on the specified number of CPUs. If `parallel` is negative, it will use the all the cores on the machine. Requires the `pytest-xdist` plugin installed. Only available when using Astropy 0.3 or later.

**kwargs**

Any additional keywords passed into this function will be passed on to the astropy test runner. This allows use of test-related functionality implemented in later versions of astropy without explicitly updating the package template.

## 4.2 Classes

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Shape(shape\_name, shape\_params)

Shape.

Continued on next page

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<code>ShapeList(shape_list[, comment_list])</code>	A list of <code>Shape</code> objects.
--	---------------------------------------

---

## 4.2.1 Shape

**class** `pyregion.Shape(shape_name, shape_params)`

Bases: `object`

`Shape`.

### Parameters

**shape\_name** : str

Shape name

**shape\_params** : list

List of parameters

### Examples

```
>>> import pyregion
>>> region_string = 'fk5;circle(290.96388,14.019167,843.31194)"'
>>> shape_list = pyregion.parse(region_string)
>>> shape = shape_list[0]
>>> print(shape.__dict__)
{'attr': ([], {}),
 'comment': None,
 'continued': None,
 'coord_format': 'fk5',
 'coord_list': [290.96388, 14.019167, 0.23425331666666666],
 'exclude': False,
 'name': 'circle',
 'params': [Number(290.96388), Number(14.019167), Ang(843.31194)]}
```

### Methods Summary

---

`set_exclude()`

---

### Methods Documentation

`set_exclude()`

## 4.2.2 ShapeList

**class** `pyregion.ShapeList(shape_list, comment_list=None)`

Bases: `list`

A list of `Shape` objects.

### Parameters

**shape\_list** : list

List of `pyregion.Shape` objects

**comment\_list** : list, None

List of comment strings for each argument

## Methods Summary

<code>as_imagecoord(header)</code>	New shape list in image coordinates.
<code>check_imagecoord()</code>	Are all shapes in image coordinates?
<code>get_filter([header, origin])</code>	Get filter.
<code>get_mask([hdu, header, shape])</code>	Create a 2-d mask.
<code>get_mpl_patches_texts([properties_func, ...])</code>	Often, the regions files implicitly assume the lower-left corner of the image as a coordinate (1,1).
<code>write(outfile)</code>	Write this shape list to a region file.

## Methods Documentation

**as\_imagecoord**(*header*)

New shape list in image coordinates.

### Parameters

**header** : `Header`

FITS header

### Returns

**shape\_list** : `ShapeList`

New shape list, with coordinates of the each shape converted to the image coordinate using the given header information.

**check\_imagecoord**()

Are all shapes in image coordinates?

Returns True if yes, and False if not.

**get\_filter**(*header=None, origin=1*)

Get filter. Often, the regions files implicitly assume the lower-left corner of the image as a coordinate (1,1). However, the python convention is that the array index starts from 0. By default (*origin=1*), coordinates of the returned mpl artists have coordinate shifted by (1, 1). If you do not want this shift, use *origin=0*.

### Parameters

**header** : `astropy.io.fits.Header`

FITS header

**origin** : {0, 1}

Pixel coordinate origin

### Returns

**filter** : `TODO`

Filter object

**get\_mask**(*hdu=None, header=None, shape=None*)

Create a 2-d mask.

#### Parameters

**hdu** : `astropy.io.fits.ImageHDU`

FITS image HDU

**header** : `Header`

FITS header

**shape** : tuple

Image shape

#### Returns

**mask** : `numpy.array`

Boolean mask

#### Examples

```
get_mask(hdu=f[0]) get_mask(shape=(10,10)) get_mask(header=f[0].header, shape=(10,10))
```

**get\_mpl\_patches\_texts**(*properties\_func=None, text\_offset=5.0, origin=1*)

Often, the regions files implicitly assume the lower-left corner of the image as a coordinate (1,1). However, the python convention is that the array index starts from 0. By default (*origin=1*), coordinates of the returned mpl artists have coordinate shifted by (1, 1). If you do not want this shift, use *origin=0*.

**write**(*outfile*)

Write this shape list to a region file.

#### Parameters

**outfile** : str

File name

### 5.1 2.1 (unreleased)

#### 5.1.1 Other Changes and Additions

- Support for angular units of ‘d’ and ‘r’ added.

### 5.2 2.0 (Oct 14, 2017)

This is a major new release of **pyregion**. There are some API changes (listed below), but overall our goal was to keep backwards-compatibility as much as possible while fixing code and installation issues and refactor the internals to use Astropy more.

We note that we are developing a new **regions** package that is supposed to become a superset of the functionality that is now in **pyregion** and might be moved in the Astropy core package as **astropy.regions** in the future. The main difference is that it represents regions as classes and uses Astropy angle and coordinate objects, allowing for easier region-based analysis. It is not feature complete, especially the DS9 region file parser is not a complete replacement for **pyregion** yet. Still, you are encouraged to try it out ( <http://astropy-regions.readthedocs.io/> ), give feedback or even contribute.

For **pyregion**, the plan is to continue to do bugfixes and releases, but to keep API changes to a minimum to avoid breaking existing scripts or pipelines. If you have any questions or issues or requests, please open an issue in the **pyregion** issue tracker on Github.

#### 5.2.1 API Changes

- Removed `rot_wrt_axis` parameter from `ShapeList` and internal methods.
- `ShapeList.as_imagecoord` no longer accepts a `astropy.wcs.WCS` object. The conversion from pixel to image coordinates depends on the center of the image defined in `astropy.io.fits.Header` in order to agree with DS9.

- `pyregion.ds9_region_parser`
  - `RegionParser.sky_to_image` now calls its first parameter `shape_list` instead of `l`.
- `pyregion.extern`
  - `kapteyn_celestial` removed.
- `pyregion.wcs_converter`
  - `convert_to_imagecoord` changed signature with the switch to Astropy and takes a Shape object.
  - `convert_physical_to_imagecoord` changed signature to accept a Shape object.
- `pyregion.wcs_helper`
  - All public methods and constants removed. They are replaced by Astropy, or replaced by private methods.

## 5.2.2 Other Changes and Additions

- Astropy is used for all sky to image coordinate conversions. Science results may change, as [SIP](#) and [distortion paper](#) corrections are now used if present in the FITS file.
- Headers with more than 2 axes are now supported; only the celestial axes are used.
- Rotation angles are measured from the Y-axis instead of the X-axis, in order to agree with DS9 and potentially other astronomy software. This is a change from previous behavior, but only affects images with non-orthogonal axes. Previously, this behavior was controlled by the `rot_wrt_axis` parameter.
- Astropy 1.0 is now required.
- Shape conversion for multi-dimensional HDU does not raise exceptions.
- Parser supports hex color in attributes

## 5.3 1.2 (Aug 11, 2016)

- <https://pypi.org/project/pyregion/1.2/>
- The changelog for this release is incomplete.
- We'll start collecting a complete changelog starting after this release.
- This release brings major changes to the code, docs and test setup, the package was converted to an Astropy affiliated package.
- There are only a few bugfixes and there should be no changes that break scripts or change results for pyregion users.

## 5.4 1.1.4 (Oct 26, 2014)

- <https://pypi.org/project/pyregion/1.1.4/>
- The changelog for this release is incomplete.
- Change tag attribute from string to list of strings. [#26]



## 5.5 1.1 (March 15, 2013)

- <https://pypi.org/project/pyregion/1.1/>
- No changelog available

## 5.6 1.0 (Sep 14, 2010)

- <https://pypi.org/project/pyregion/1.0/>
- First stable release



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