buzzard Documentation

Release 0.6.2

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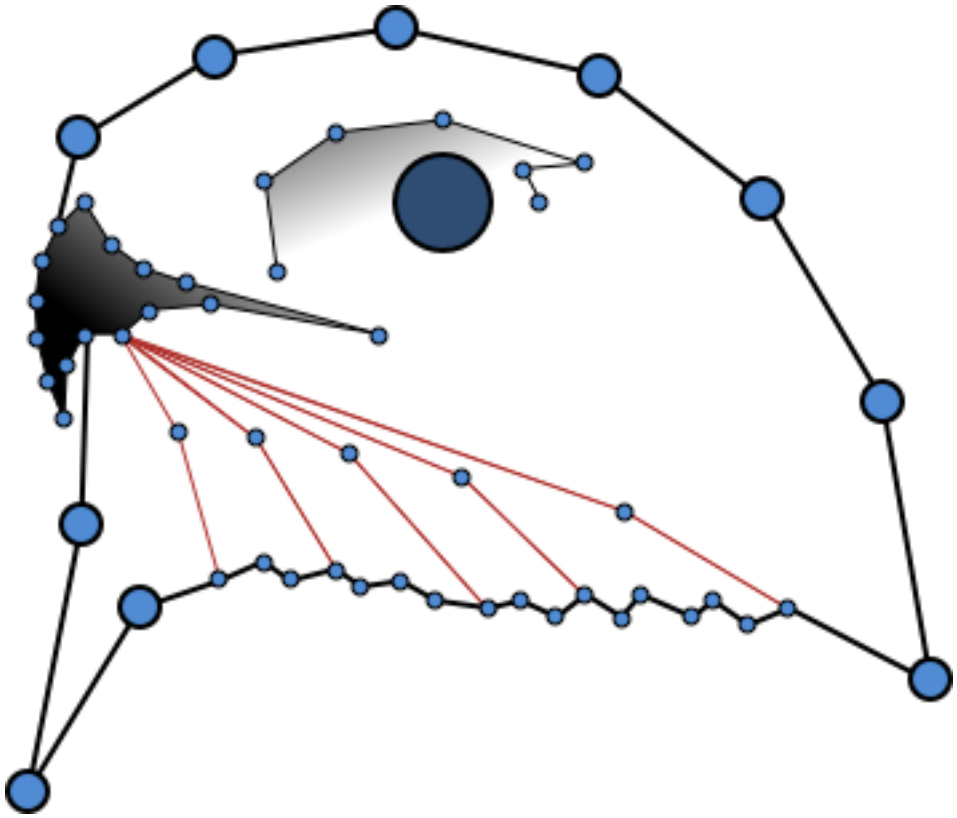
Jun 14, 2019

CONTENTS

In a nutshell, `buzzard` reads and writes geospatial raster and vector data.

Repository is located here: https://github.com/airware/buzzard



CHAPTER

ONE

API

1.1 Dataset

1.1.1 Dataset

class buzzard.**Dataset**(*sr_work=None*, *sr_fallback=None*, *sr_forced=None*, *analyse_transformation=True*, *allow_none_geometry=False*, *allow_interpolation=False*, *max_active=inf*, *debug_observers=()*, ***kwargs*)

Dataset is a class that stores references to sources. A source is either a raster, or a vector. A *Dataset* allows:

- quick manipulations by optionally assigning a key to each registered source, (see *Sources Registering* below)
- closing all source at once by closing the Dataset object.

But also inter-sources operations, like:

- spatial reference harmonization (see *On the fly re-projections in buzzard* below),
- workload scheduling on pools when using async rasters (see *Scheduler* below),
- other features in the future (like data visualization).

For actions specific to opened sources, see those classes:

- *GDALFileRaster*
- *GDALMemRaster*
- *NumpyRaster*
- *CachedRasterRecipe*
- *GDALFileVector*
- *GDALMemoryVector*

> **Warning:** This class is not equivalent to the *gdal.Dataset* class.

Parameters

sr_work: None or string In order to set a spatial reference, use a string that can be converted to WKT by GDAL.

(see *On the fly re-projections in buzzard* below)

sr_fallback: None or string In order to set a spatial reference, use a string that can be converted to WKT by GDAL.

(see *On the fly re-projections in buzzard* below)

sr_forced: None or string In order to set a spatial reference, use a string that can be converted to WKT by GDAL.

(see *On the fly re-projections in buzzard* below)

analyse_transformation: bool Whether or not to perform a basic analysis on two *sr* to check their compatibility.

if True: Read the *buzz.env.significant* variable and raise an exception if a spatial reference conversions is too lossy in precision.

if False: Skip all checks.

(see *On the fly re-projections in buzzard* below)

allow_none_geometry: bool Whether or not a vector geometry should raise an exception when encountering a None geometry

allow_interpolation: bool Whether or not a raster geometry should raise an exception when remapping with interpolation is necessary.

max_active: nbr >= 1 Maximum number of pooled sources active at the same time. (see *Sources activation / deactivation* below)

debug_observers: sequence of object Entry points to observe what is happening in the Dataset's sheduler.

Examples

```
>>> import buzzard as buzz
```

Creating a Dataset.

```
>>> ds = buzz.Dataset()
```

Opening a file and registering it under the 'roofs' key. There are four ways to the access an opened source.

```
>>> r = ds.open_vector('roofs', 'path/to/roofs.shp')
... feature_count = len(ds.roofs)
... feature_count = len(ds['roofs'])
... feature_count = len(ds.get('roofs'))
... feature_count = len(r)
```

Opening a file anonymously. There is only one way to access the source.

```
>>> r = ds.aopen_raster('path/to/dem.tif')
... data_type = r.dtype
```

Opening, reading and closing two raster files with context management.

```
>>> with ds.open_raster('rgb', 'path/to/rgb.tif').close:
...     data_type = ds.rgb.fp
...     arr = ds.rgb.get_data()
```

```
>>> with ds.aopen_raster('path/to/rgb.tif').close as rgb:
...     data_type = rgb.dtype
...     arr = rgb.get_data()
```

Creating two files

```
>>> ds.create_vector('targets', 'path/to/targets.geojson', 'point', driver=
↪'GeoJSON')
... geometry_type = ds.targets.type
```

```
>>> with ds.acreate_raster('/tmp/cache.tif', ds.dem.fp, 'float32', 1).delete as␣
↪cache:
...     file_footprint = cache.fp
...     cache.set_data(dem.get_data())
```

Sources Types

- **Raster sources**
  - GDAL drivers http://www.gdal.org/formats_list.html (e.g. 'GTIff', 'JPEG', 'PNG', ...)
  - numpy.ndarray
  - recipes
- **Vector sources**
  - OGR drivers: https://www.gdal.org/ogr_formats.html (e.g. 'ESRI Shapefile', 'GeoJSON', 'DXF', ...)

Sources Registering

There are always two ways to create a source, with a key or anonymously.

When creating a source using a key, said key (e.g. the string "my_source_name") must be provided by user. Each key identify one source and should thus be unique. There are then three ways to access that source:

- from the object returned by the method that created the source,
- from the Dataset with the attribute syntax: *ds.my_source_name*,
- from the Dataset with the item syntax: ds["my_source_name"].

All keys should be unique.

When creating a source anonymously you don't have to provide a key, but the only way to access this source is to use the object returned by the method that created the source.

Sources activation / deactivation

The sources that inherit from *APooledEmissary* (like *GDALFileVector* and *GDALFileRaster*) are flexible about their underlying driver object. Those sources may be temporary deactivated (useful to limit the number of file descriptors active), or activated multiple time at the same time (useful to perfom concurrent reads).

Those sources are automatically activated and deactivated given the current needs and constraints. Setting a *max_active* lower than *np.inf* in the Dataset constructor, will ensure that no more than *max_active* driver objects are active at the same time, by deactivating the LRU ones.

On the fly re-projections in buzzard

A Dataset may perform spatial reference conversions on the fly, like a GIS does. Several modes are available, a set of rules define how each mode work. Those conversions concern both read operations and write operations, all are performed by the OSR library.

Those conversions are only perfomed on vector's data/metadata and raster's Footprints. This implies that classic raster warping is not included (yet) in those conversions, only raster shifting/scaling/rotation work.

The z coordinates of vectors geometries are also converted, on the other hand elevations are not converted in DEM rasters.

If *analyse_transformation* is set to *True* (default), all coordinates conversions are tested against *buzz.env.significant* on file opening to ensure their feasibility or raise an exception otherwise. This system is naive and very restrictive, use with caution. Although, disabling those tests is not recommended, ignoring floating point precision errors can create unpredictable behaviors at the pixel level deep in your code. Those bugs can be witnessed when zooming to infinity with tools like *qgis* or *matplotlib*.

On the fly re-projections in buzzard - Terminology

sr Spatial reference

sr_work The sr of all interactions with a Dataset (i.e. Footprints, extents, Polygons...), may be None.

sr_stored The sr that can be found in the metadata of a raster/vector storage, may be None.

sr_virtual The sr considered to be written in the metadata of a raster/vector storage, it is often the same as *sr_stored*. When a raster/vector is read, a conversion is performed from *sr_virtual* to *sr_work*. When writing vector data, a conversion is performed from *sr_work* to *sr_virtual*.

sr_forced A *sr_virtual* provided by user to ignore all *sr_stored*. This is for example useful when the *sr* stored in the input files are corrupted.

sr_fallback A *sr_virtual* provided by user to be used when *sr_stored* is missing. This is for example useful when an input file can't store a *sr* (e.g. DFX).

On the fly re-projections in buzzard - Dataset parameters and modes

mode	sr_work	sr_fallback	sr_forced	How is the *sr_virtual* of a source determined
1	None	None	None	Use *sr_stored*, no conversion is performed for the lifetime of this Dataset
2	string	None	None	Use *sr_stored*, if None raises an exception
3	string	string	None	Use *sr_stored*, if None it is considered to be *sr_fallback*
4	string	None	string	Use *sr_forced*

On the fly re-projections in buzzard - Use cases

- **If all opened files are known to be written in a same sr in advance, use *mode 1*.** No conversions will be performed, this is the safest way to work.
- **If all opened files are known to be written in the same sr but you wish to work in a different sr, use *mode 4*.** The huge benefit of this mode is that the *driver* specific behaviors concerning spatial references have no impacts on the data you manipulate.

- **On the other hand if you don't have a priori information on files' *sr*, *mode 2* or *mode 3* should be used.**

> **Warning:** Side note: Since the GeoJSON driver cannot store a *sr*, it is impossible to open or create a GeoJSON file in *mode 2*.

On the fly re-projections in buzzard - Examples

mode 1 - No conversions at all

```
>>> ds = buzz.Dataset()
```

mode 2 - Working with WGS84 coordinates

```
>>> ds = buzz.Dataset(
...     sr_work='WGS84',
... )
```

mode 3 - Working in UTM with DXF files in WGS84 coordinates

```
>>> ds = buzz.Dataset(
...     sr_work='EPSG:32632',
...     sr_fallback='WGS84',
... )
```

mode 4 - Working in UTM with unreliable LCC input files

```
>>> ds = buzz.Dataset(
...     sr_work='EPSG:32632',
...     sr_forced='EPSG:27561',
..  )
```

Scheduler

To handle *async rasters* living in a Dataset, a thread is to manage requests made to those rasters. It will start as soon as you create an *async raster* and stop when the Dataset is closed or collected. If one of your callbacks to be called by the scheduler raises an exception, the scheduler will stop and the exception will be propagated to the main thread as soon as possible.

Thread-safety

Thread safety is one of the main concern of buzzard. Everything is thread-safe except:

- The raster write methods
- The vector write methods
- The raster read methods when using the *GDAL::MEM* driver
- The vector read methods when using the *GDAL::Memory* driver

__del__()

property close

Close the Dataset with a call or a context management. The *close* attribute returns an object that can be both called and used in a with statement

The Dataset can be closed manually or automatically when garbage collected, it is safer to do it manually.

The internal steps are:

- Stopping the scheduler
- Joining the mp.Pool that have been automatically allocated
- Closing all sources

Examples

```
>>> ds = buzz.Dataset()
... # code...
... ds.close()
```

```
>>> with buzz.Dataset().close as ds
...     # code...
```

Caveat

When using a scheduler, some memory leaks may still occur after closing a Dataset. Possible origins:

- https://bugs.python.org/issue34172 (update your python to >=3.6.7)
- Gdal cache not flushed (not a leak)
- The gdal version
- https://stackoverflow.com/a/1316799 (not a leak)
- Some unknown leak in the python *threading* or *multiprocessing* standard library
- Some unknown library leaking memory on the *C* side
- Some unknown library storing data in global variables

You can use a *debug_observer* with an *on_object_allocated* method to track large objects allocated in the scheduler. It will likely not be the source of the problem. If you even find a source of leaks please contact the buzzard team. https://github.com/airware/buzzard/issues

__getitem__(*key*)

Retrieve a source from its key

__contains__(*item*)

Is key or source registered in Dataset

items()

Generate the pair of (keys_of_source, source) for all proxies

keys()

Generate all source keys

values()

Generate all proxies

__len__()
Retrieve source count registered within this Dataset

property proj4
Dataset's work spatial reference in WKT proj4. Returns None if *mode 1*.

property wkt
Dataset's work spatial reference in WKT format. Returns None if *mode 1*.

property active_count
Count how many driver objects are currently active

activate_all()
Activate all deactivable proxies. May raise an exception if the number of sources is greater than *max_activated*

deactivate_all()
Deactivate all deactivable proxies. Useful to flush all files to disk

property pools
Get the Pool Container.

```
>>> help(PoolsContainer)
```

1.1.2 Pool Container

class buzzard.**PoolsContainer**
Manages thread/process pools and aliases for a Dataset

alias(*key*, *pool_or_none*)
Register the given pool under the given key in this Dataset. The key can then be used to refer to that pool from within the async raster constructors.

Parameters

key: hashable (like a string)

pool_or_none: multiprocessing.pool.Pool or multiprocessing.pool.ThreadPool or None

manage(*pool*)
Add the given pool to the list of pools that must be terminated upon Dataset closing.

Parameters

pool: multiprocessing.pool.Pool or multiprocessing.pool.ThreadPool

__len__()
Number of pools registered in this Dataset

__iter__()
Generator of pools registered in this Dataset

__getitem__(*key*)
Pool or none getter from alias

__contains__(*obj*)
Is pool or alias registered in this Dataset

1.1.3 Source Constructors

Rasters Sources Using GDAL

Dataset.**open_raster**(*key*, *path*, *driver='GTiff'*, *options=()*, *mode='r'*)

Open a raster file within this Dataset under *key*. Only metadata are kept in memory.

```
>>> help(GDALFileRaster)
```

Parameters

key: hashable (like a string) File identifier within Dataset

To avoid using a *key*, you may use *aopen_raster()*

path: string

driver: string gdal driver to use when opening the file http://www.gdal.org/formats_list.html

options: sequence of str options for gdal

mode: one of {'r', 'w'}

Returns

source: GDALFileRaster

Example

```
>>> ds.open_raster('ortho', '/path/to/ortho.tif')
>>> file_proj4 = ds.ortho.proj4_stored
```

```
>>> ds.open_raster('dem', '/path/to/dem.tif', mode='w')
>>> nodata_value = ds.dem.nodata
```

See Also

- *Dataset.aopen_raster()*: To skip the *key* assigment
- *buzzard.open_raster()*: To skip the *key* assigment and the explicit *Dataset* instanciation

Dataset.**create_raster**(*key*, *path*, *fp*, *dtype*, *channel_count*, *channels_schema=None*, *driver='GTiff'*, *options=()*, *sr=None*, *ow=False*, ***kwargs*)

Create a raster file and register it under *key* within this Dataset. Only metadata are kept in memory.

The raster's values are initialized with *channels_schema['nodata']* or *0*.

```
>>> help(GDALFileRaster)
>>> help(GDALMemRaster)
```

Parameters

key: hashable (like a string) File identifier within Dataset

To avoid using a *key*, you may use `acreate_raster()`

path: string Anything that makes sense to GDAL:

- A path to a file
- An empty string when using *driver=MEM*
- A path or an xml string when using *driver=VRT*

fp: Footprint Description of the location and size of the raster to create.

dtype: numpy type (or any alias)

channel_count: integer number of channels

channels_schema: dict or None Channel(s) metadata. (see *Channels schema fields* below)

driver: string gdal driver to use when opening the file http://www.gdal.org/formats_list.html

options: sequence of str options for gdal http://www.gdal.org/frmt_gtiff.html

sr: string or None Spatial reference of the new file.

In order not to set a spatial reference, use *None*.

In order to set a spatial reference, use a string that can be converted to WKT by GDAL.

ow: bool Overwrite. Whether or not to erase the existing files.

Returns

source: GDALFileRaster or GDALMemRaster The type depends on the *driver* parameter

Example

```
>>> ds.create_raster('dem_copy', 'dem_copy.tif', ds.dem.fp, ds.dsm.dtype, len(ds.
↪dem))
>>> array = ds.dem.get_data()
>>> ds.dem_copy.set_data(array)
```

Channel schema fields

Fields: 'nodata': None or number 'interpretation': None or str 'offset': None or number 'scale': None or number 'mask': None or str

Interpretation values: undefined, grayindex, paletteindex, redband, greenband, blueband, alphaband, hueband, saturationband, lightnessband, cyanband, magentaband, yellowband, blackband

Mask values: all_valid, per_dataset, alpha, nodata

Additionally:

- A field missing or None is kept to default value.
- A field can be passed as

- a value: All bands are set to this value
- a sequence of values of length *channel_count*: All bands will be set to their respective state

Caveat

When using the GTiff driver, specifying a *mask* or *interpretation* field may lead to unexpected results.

See Also

- *Dataset.acreate_raster()*: To skip the *key* assigment
- *buzzard.create_raster()*: To skip the *key* assigment and the explicit *Dataset* instanciation

Dataset.**aopen_raster**(*path*, *driver='GTiff'*, *options=()*, *mode='r'*)

Open a raster file anonymously within this Dataset. Only metadata are kept in memory.

See *open_raster()*

Example

```
>>> ortho = ds.aopen_raster('/path/to/ortho.tif')
>>> file_wkt = ortho.wkt_stored
```

See Also

- *Dataset.open_raster()*: To assign a *key* to this source within the *Dataset*
- *buzzard.open_raster()*: To skip the explicit *Dataset* instanciation

Dataset.**acreate_raster**(*path*, *fp*, *dtype*, *channel_count*, *channels_schema=None*, *driver='GTiff'*, *options=()*, *sr=None*, *ow=False*, ***kwargs*)

Create a raster file anonymously within this Dataset. Only metadata are kept in memory.

See *create_raster()*

Example

```
>>> mask = ds.acreate_raster('mask.tif', ds.dem.fp, bool, 1, options=['SPARSE_
↪OK=YES'])
>>> open_options = mask.open_options
```

```
>>> channels_schema = {
...     'nodata': -32767,
...     'interpretation': ['blackband', 'cyanband'],
... }
>>> out = ds.acreate_raster('output.tif', ds.dem.fp, 'float32', 2, channels_
↪schema)
>>> band_interpretation = out.channels_schema['interpretation']
```

See Also

- *Dataset.create_raster()*: To assign a *key* to this source within the *Dataset*
- *buzzard.create_raster()*: To skip the explicit *Dataset* instanciation

Rasters Sources Using NumPy

Dataset.**wrap_numpy_raster**(*key*, *fp*, *array*, *channels_schema=None*, *sr=None*, *mode='w'*, ***kwargs*)

Register a numpy array as a raster under *key* within this Dataset.

```
>>> help(NumpyRaster)
```

Parameters

key: hashable (like a string) File identifier within Dataset

To avoid using a *key*, you may use *awrap_numpy_raster()*

fp: Footprint of shape (Y, X) Description of the location and size of the raster to create.

array: ndarray of shape (Y, X) or (Y, X, C)

channels_schema: dict or None Channel(s) metadata. (see *Channels schema fields* below)

sr: string or None Spatial reference of the new file

In order not to set a spatial reference, use *None*.

In order to set a spatial reference, use a string that can be converted to WKT by GDAL.

Returns

source: NumpyRaster

Channel schema fields

Fields: 'nodata': None or number 'interpretation': None or str 'offset': None or number 'scale': None or number 'mask': None or str

Interpretation values: undefined, grayindex, paletteindex, redband, greenband, blueband, alphaband, hueband, saturationband, lightnessband, cyanband, magentaband, yellowband, blackband

Mask values: all_valid, per_dataset, alpha, nodata

Additionally:

- A field missing or None is kept to default value.
- A field can be passed as
  - a value: All bands are set to this value
  - a sequence of values of length *channel_count*: All bands will be set to their respective state

See Also

- *Dataset.awrap_numpy_raster()*: To skip the *key* assigment
- *buzzard.wrap_numpy_raster()*: To skip the *key* assigment and the explicit *Dataset* instanciation

Dataset.**awrap_numpy_raster**(*fp*, *array*, *channels_schema=None*, *sr=None*, *mode='w'*, ***kwargs*)

Register a numpy array as a raster anonymously within this Dataset.

See Also

- *Dataset.wrap_numpy_raster()*: To assign a *key* to this source within the *Dataset*
- *buzzard.wrap_numpy_raster()*: To skip the *key* assigment and the explicit *Dataset* instanciation

Rasters Sources Using Recipes

Dataset.**create_raster_recipe**(*key*, *fp*, *dtype*, *channel_count*, *channels_schema=None*, *sr=None*, *compute_array=None*, *merge_arrays=<function concat_arrays>*, *queue_data_per_primitive=mappingproxy({})*, *convert_footprint_per_primitive=None*, *computation_pool='cpu'*, *merge_pool='cpu'*, *resample_pool='cpu'*, *computation_tiles=None*, *max_computation_size=None*, *max_resampling_size=None*, *automatic_remapping=True*, *debug_observers=()*)

Warning: This method is not yet implemented. It exists for documentation purposes.

Create a *raster recipe* and register it under *key* within this Dataset.

A *raster recipe* implements the same interfaces as all other rasters, but internally it computes data on the fly by calling a callback. The main goal of the *raster recipes* is to provide a boilerplate-free interface that automatize those cumbersome tasks:

- tiling,
- parallelism
- caching
- file reads
- resampling
- lazy evaluation
- backpressure prevention and
- optimised task scheduling.

If you are familiar with *create_cached_raster_recipe* two parameters are new here: *automatic_remapping* and *max_computation_size*.

Parameters

key: see *Dataset.create_raster()*

fp: see *Dataset.create_raster()*

dtype: see *Dataset.create_raster()*

channel_count: see *Dataset.create_raster()*

channels_schema: see *Dataset.create_raster()*

sr: see *Dataset.create_raster()*

compute_array: callable see *Computation Function* below

merge_arrays: callable see *Merge Function* below

queue_data_per_primitive: dict of hashable (like a string) to a *queue_data* method pointer see *Primitives* below

convert_footprint_per_primitive: None or dict of hashable (like a string) to a callable see *Primitives* below

computation_pool: see *Pools* below

merge_pool: see *Pools* below

resample_pool: see *Pools* below

computation_tiles: None or (int, int) or numpy.ndarray of Footprint see *Computation Tiling* below

max_computation_size: None or int or (int, int) see *Computation Tiling* below

max_resampling_size: None or int or (int, int) Optionally define a maximum resampling size. If a larger resampling has to be performed, it will be performed tile by tile in parallel.

automatic_remapping: bool see *Automatic Remapping* below

debug_observers: sequence of object Entry points that observe what is happening with this raster in the Dataset's scheduler.

Returns

source: NocacheRasterRecipe

Computation Function

The function that will map a Footprint to a numpy.ndarray. If *queue_data_per_primitive* is not empty, it will map a Footprint and primitive arrays to a numpy.ndarray.

It will be called in parallel according to the *computation_pool* parameter provided at construction.

The function will be called with the following positional parameters:

- **fp: Footprint of shape (Y, X)** The location at which the pixels should be computed
- **primitive_fps: dict of hashable to Footprint** For each primitive defined through the *queue_data_per_primitive* parameter, the input Footprint.
- **primitive_arrays: dict of hashable to numpy.ndarray** For each primitive defined through the *queue_data_per_primitive* parameter, the input numpy.ndarray that was automatically computed.

- **raster: CachedRasterRecipe or None** The Raster object of the ongoing computation.

It should return either:

- **a single ndarray of shape (Y, X) if only one channel was computed**
- **a single ndarray of shape (Y, X, C) if one or more channels were computed**

If *computation_pool* points to a process pool, the *compute_array* function must be picklable and the *raster* parameter will be None.

Computation Tiling

You may sometimes want to have control on the Footprints that are requested to the *compute_array* function, for example:

- If pixels computed by *compute_array* are long to compute, you want to tile to increase parallelism.
- If the *compute_array* function scales badly in term of memory or time, you want to tile to reduce complexity.
- If *compute_array* can work only on certain Footprints, you want a hard constraint on the set of Footprint that can be queried from *compute_array*. (This may happen with *convolutional neural networks*)

To do so use the *computation_tiles* or *max_computation_size* parameter (not both).

If *max_computation_size* is provided, a Footprint to be computed will be tiled given this parameter.

If *computation_tiles* is a numpy.ndarray of Footprint, it should be a tiling of the *fp* parameter. Only the Footprints contained in this tiling will be asked to the *computation_tiles*. If *computation_tiles* is (int, int), a tiling will be constructed using Footprint.tile using those two ints.

Merge Function

The function that will map several pairs of Footprint/numpy.ndarray to a single numpy.ndarray. If the *computation_tiles* is None, it will never be called.

It will be called in parallel according to the *merge_pool* parameter provided at construction.

The function will be called with the following positional parameters:

- **fp: Footprint of shape (Y, X)** The location at which the pixels should be computed.
- **array_per_fp: dict of Footprint to numpy.ndarray** The pairs of Footprint/numpy.ndarray of each arrays that were computed by *compute_array* and that overlap with *fp*.
- **raster: CachedRasterRecipe or None** The Raster object of the ongoing computation.

It should return either:

- **a single ndarray of shape (Y, X) if only one channel was computed**
- **a single ndarray of shape (Y, X, C) if one or more channels were computed**

If *merge_pool* points to a process pool, the *merge_array* function must be picklable and the *raster* parameter will be None.

Automatic Remapping

When creating a recipe you give a *Footprint* through the *fp* parameter. When calling your *compute_array* function the scheduler will only ask for slices of *fp*. This means that the scheduler takes care of those boilerplate steps:

- If you request a *Footprint* on a different grid in a *get_data()* call, the scheduler **takes care of resampling** the outputs of your *compute*array* function.
- If you request a *Footprint* partially or fully outside of the raster's extent, the scheduler will call your *compute_array* function to get the interior pixels and then **pad the output with nodata**.

This system is flexible and can be deactivated by passing *automatic_remapping=False* to the constructor of a *NocacheRasterRecipe*, in this case the scheduler will call your *compute_array* function for any kind of *Footprint*; thus your function must be able to comply with any request.

Primitives

The *queue_data_per_primitive* and *convert_footprint_per_primitive* parameters can be used to create dependencies between *dependee async rasters* and the *raster recipe* being created. The dependee/dependent relation is called primitive/derived throughout buzzard. A derived recipe can itself be the primitive of another raster. Pipelines of any depth and width can be instanciated that way.

In *queue_data_per_primitive* you declare a *dependee* by giving it a key of your choice and the pointer to the *queue_data* method of *dependee* raster. You can parameterize the connection by *currying* the *channels*, *dst_nodata*, *interpolation* and *max_queue_size* parameters using *functools.partial*.

The *convert_footprint_per_primitive* dict should contain the same keys as *queue_data_per_primitive*. A value in the dict should be a function that maps a Footprint to another Footprint. It can be used for example to request larger rectangles of primitives data to compute a derived array.

e.g. If the primitive raster is an *rgb* image, and the derived raster only needs the green channel but with a context of 10 additional pixels on all 4 sides:

```
>>> derived = ds.create_raster_recipe(
...     # <other parameters>
...     queue_data_per_primitive={'green': functools.partial(primitive.queue_data,
↪ channels=1)},
...     convert_footprint_per_primitive={'green': lambda fp: fp.dilate(10)},
... )
```

Pools

The **_pool* parameters can be used to select where certain computations occur. Those parameters can be of the following types:

- A *multiprocessing.pool.ThreadPool*, should be the default choice.
- A *multiprocessing.pool.Pool*, a process pool. Useful for computations that requires the GIL or that leaks memory.
- *None*, to request the scheduler thread to perform the tasks itself. Should be used when the computation is very light.
- A *hashable* (like a *string*), that will map to a pool registered in the *Dataset*. If that key is missing from the *Dataset*, a *ThreadPool* with *multiprocessing.cpu_count()* workers will be automatically instanciated. When the Dataset is closed, the pools instanciated that way will be joined.

See Also

- `Dataset.acreate_raster_recipe()`: To skip the *key* assigment
- *`Dataset.create_raster_recipe()`*: For results *caching*
- *`Dataset.acreate_cached_raster_recipe()`*: To skip the *key* assigment

`Dataset.`**`create_cached_raster_recipe`**(*key*, *fp*, *dtype*, *channel_count*, *channels_schema=None*, *sr=None*, *compute_array=None*, *merge_arrays=<function concat_arrays>*, *cache_dir=None*, *ow=False*, *queue_data_per_primitive=mappingproxy({})*, *convert_footprint_per_primitive=None*, *computation_pool='cpu'*, *merge_pool='cpu'*, *io_pool='io'*, *resample_pool='cpu'*, *cache_tiles=(512, 512)*, *computation_tiles=None*, *max_resampling_size=None*, *debug_observers=()*)

Create a *cached raster recipe* and register it under *key* within this Dataset.

Compared to a *NocacheRasterRecipe*, in a *CachedRasterRecipe* the pixels are never computed twice. Cache files are used to store and reuse pixels from computations. The cache can even be reused between python sessions.

If you are familiar with *create_raster_recipe* four parameters are new here: *io_pool*, *cache_tiles*, *cache_dir* and *ow*. They are all related to file system operations.

See *create_raster_recipe* method, since it shares most of the features:

```
>>> help(CachedRasterRecipe)
```

Parameters

key: see *`Dataset.create_raster()`* method

fp: see *`Dataset.create_raster()`* method

dtype: see *`Dataset.create_raster()`* method

channel_count: see *`Dataset.create_raster()`* method

channels_schema: see *`Dataset.create_raster()`* method

sr: see *`Dataset.create_raster()`* method

compute_array: see *`Dataset.create_raster_recipe()`* method

merge_arrays: see *`Dataset.create_raster_recipe()`* method

cache_dir: str or pathlib.Path Path to the directory that holds the cache files associated with this raster. If cache files are present, they will be reused (or erased if corrupted). If a cache file is needed and missing, it will be computed.

ow: bool Overwrite. Whether or not to erase the old cache files contained in *cache_dir*.

> **Warning:** not only the tiles needed (hence computed) but all buzzard cache files in *cache_dir* will be deleted.

queue_data_per_primitive: see *`Dataset.create_raster_recipe()`* method

convert_footprint_per_primitive: see *Dataset.create_raster_recipe()* method

computation_pool: see *Dataset.create_raster_recipe()* method

merge_pool: see *Dataset.create_raster_recipe()* method

io_pool: see *Dataset.create_raster_recipe()* method

resample_pool: see *Dataset.create_raster_recipe()* method

cache_tiles: (int, int) or numpy.ndarray of Footprint A tiling of the *fp* parameter. Each tile will correspond to one cache file. if (int, int): Construct the tiling by calling Footprint.tile with this parameter

computation_tiles: if None: Use the same tiling as *cache_tiles* else: see *create_raster_recipe* method

max_resampling_size: None or int or (int, int) see *Dataset.create_raster_recipe()* method

debug_observers: sequence of object see *Dataset.create_raster_recipe()* method

Returns

source: CachedRasterRecipe

See Also

- *Dataset.create_raster_recipe()*: To skip the *caching*
- *Dataset.acreate_cached_raster_recipe()*: To skip the *key* assigment

Dataset.**acreate_cached_raster_recipe**(*fp*, *dtype*, *channel_count*, *channels_schema=None*, *sr=None*, *compute_array=None*, *merge_arrays=<function concat_arrays>*, *cache_dir=None*, *ow=False*, *queue_data_per_primitive=mappingproxy({})*, *convert_footprint_per_primitive=None*, *computation_pool='cpu'*, *merge_pool='cpu'*, *io_pool='io'*, *resample_pool='cpu'*, *cache_tiles=(512, 512)*, *computation_tiles=None*, *max_resampling_size=None*, *debug_observers=()*)

Create a cached raster reciped anonymously within this Dataset.

See Dataset.create_cached_raster_recipe

See Also

- *Dataset.create_raster_recipe()*: To skip the *caching*
- *Dataset.create_cached_raster_recipe()*: To assign a *key* to this source within the *Dataset*

Vectors Sources Using GDAL (OGR)

Dataset.**open_vector**(*key*, *path*, *layer=None*, *driver='ESRI Shapefile'*, *options=()*, *mode='r'*)

Open a vector file within this Dataset under *key*. Only metadata are kept in memory.

```
>>> help(GDALFileVector)
```

Parameters

key: hashable (like a string) File identifier within Dataset

To avoid using a *key*, you may use *aopen_vector()*

path: string

layer: None or int or string

driver: string ogr driver to use when opening the file http://www.gdal.org/ogr_formats.html

options: sequence of str options for ogr

mode: one of {'r', 'w'}

Returns

source: GDALFileVector

Example

```
>>> ds.open_vector('trees', '/path/to.shp')
>>> feature_count = len(ds.trees)
```

```
>>> ds.open_vector('roofs', '/path/to.json', driver='GeoJSON', mode='w')
>>> fields_list = ds.roofs.fields
```

See Also

- *Dataset.aopen_vector()*: To skip the *key* assigment
- *buzzard.open_vector()*: To skip the *key* assigment and the explicit *Dataset* instanciation

Dataset.**aopen_vector**(*path*, *layer=None*, *driver='ESRI Shapefile'*, *options=()*, *mode='r'*)

Open a vector file anonymously within this Dataset. Only metadata are kept in memory.

See *open_vector()*

Example

```
>>> trees = ds.aopen_vector('/path/to.shp')
>>> features_bounds = trees.bounds
```

See Also

- *Dataset.open_vector()*: To assign a *key* to this source within the *Dataset*
- *buzzard.open_vector()*: To skip the *key* assigment and the explicit *Dataset* instanciation

Dataset.**create_vector**(*key*, *path*, *type*, *fields=()*, *layer=None*, *driver='ESRI Shapefile'*, *options=()*, *sr=None*, *ow=False*)

Create an empty vector file and register it under *key* within this Dataset. Only metadata are kept in memory.

```
>>> help(GDALFileVector)
>>> help(GDALMemoryVector)
```

Parameters

key: hashable (like a string) File identifier within Dataset

To avoid using a *key*, you may use `acreate_vector()`

path: string Anything that makes sense to GDAL:

- A path to a file
- An empty string when using *driver=Memory*

type: string name of a wkb geometry type, without the *wkb* prefix.

list: http://www.gdal.org/ogr__core_8h.html#a800236a0d460ef66e687b7b65610f12a

fields: sequence of dict Attributes of fields, one dict per field. (see *Field Attributes* below)

layer: None or string

driver: string ogr driver to use when opening the file http://www.gdal.org/ogr_formats.html

options: sequence of str options for ogr

sr: string or None Spatial reference of the new file

In order not to set a spatial reference, use *None*.

In order to set a spatial reference, use a string that can be converted to WKT by GDAL.

ow: bool Overwrite. Whether or not to erase the existing files.

Returns

source: GDALFileVector or GDALMemoryVector The type depends on the *driver* parameter

Example

```
>>> ds.create_vector('lines', '/path/to.shp', 'linestring')
>>> geometry_type = ds.lines.type
>>> ds.lines.insert_data([[0, 0], [1, 1], [1, 2]])
```

```
>>> fields = [
    {'name': 'name', 'type': str},
    {'name': 'count', 'type': 'int32'},
    {'name': 'area', 'type': np.float64, 'width': 5, precision: 18},
    {'name': 'when', 'type': np.datetime64},
]
>>> ds.create_vector('zones', '/path/to.shp', 'polygon', fields)
>>> field0_type = ds.zones.fields[0]['type']
>>> ds.zones.insert_data(shapely.geometry.box(10, 10, 15, 15))
```

Field Attributes

Attributes:

- "name": string
- "type": string (see *Field Types* below)
- "precision": int
- "width": int
- "nullable": bool
- "default": same as *type*

An attribute missing or None is kept to default value.

Field Types

Type	Type names
Binary	"binary", bytes, np.bytes_, aliases of np.bytes_
Date	"date"
DateTime	"datetime", datetime.datetime, np.datetime64, aliases of np.datetime64
Time	"time"
Integer	"integer" np.int32, aliases of np.int32
Integer64	"integer64", int, np.int64, aliases of np.int64
Real	"real", float, np.float64, aliases of np.float64
String	"string", str, np.str_, aliases of np.str_
Integer64List	"integer64list", "int list"
IntegerList	"integerlist"
RealList	"reallist", "float list"

See Also

- *Dataset.acreate_vector()*: To skip the *key* assigment
- *buzzard.create_vector()*: To skip the *key* assigment and the explicit *Dataset* instanciation

Dataset.**acreate_vector**(*path*, *type*, *fields=()*, *layer=None*, *driver='ESRI Shapefile'*, *options=()*, *sr=None*, *ow=False*)

Create a vector file anonymously within this Dataset. Only metadata are kept in memory.

See *create_vector()*

Example

```
>>> lines = ds.acreate_vector('/path/to.shp', 'linestring')
>>> file_proj4 = lines.proj4_stored
```

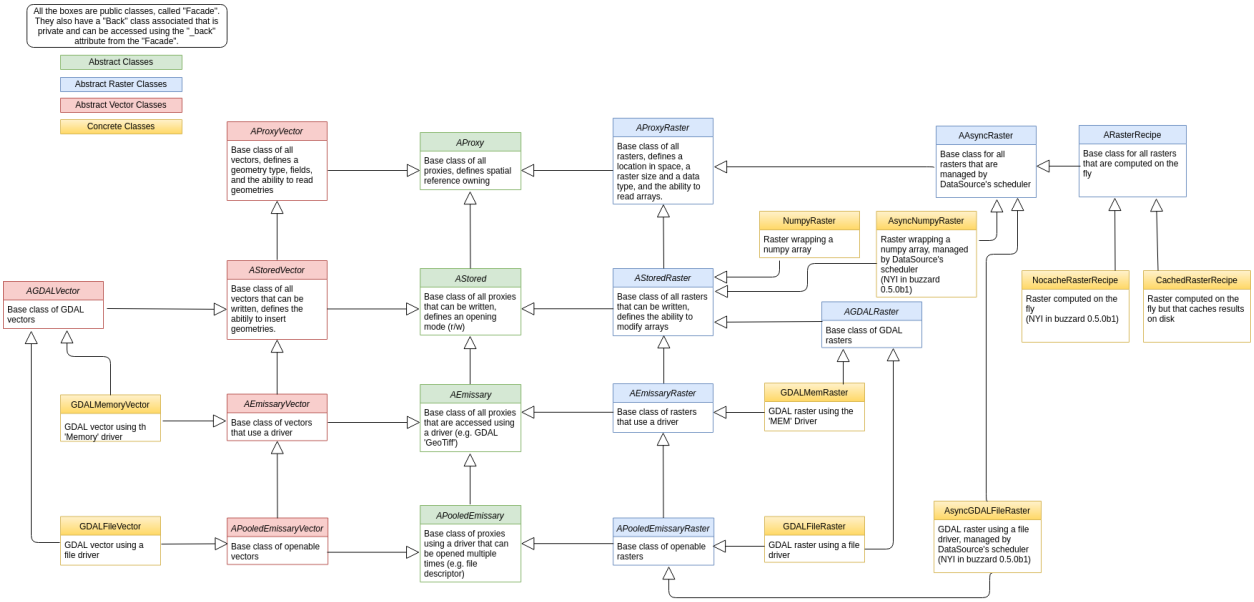
See Also

- *Dataset.create_vector()*: To assign a *key* to this source within the *Dataset*
- *buzzard.create_vector()*: To skip the *key* assigment and the explicit *Dataset* instanciation

1.2 Sources

All sources in buzzard can only be constructed from the Dataset methods, see *Source Constructors*

All sources in buzzard inherit from a series of abstract classes:



1.2.1 GDALFileRaster

class buzzard.**ASource**(*<implementation detail>*)

Base abstract class defining the common behavior of all sources opened in the Dataset.

Features Defined

- Has a *stored* spatial reference
- Has a *virtual* spatial reference that is influenced by the Dataset's opening mode
- Can be closed

property wkt_stored

The spatial reference that can be found in the metadata of a source, in wkt format.

string or None

property proj4_stored

The spatial reference that can be found in the metadata of a source, in proj4 format.

string or None

property wkt_virtual

The spatial reference considered to be written in the metadata of a source, in wkt format.

string or None

property proj4_virtual

The spatial reference considered to be written in the metadata of a source, in proj4 format.

string or None

get_keys()
Get the list of keys under which this source is registered to in the Dataset

property close
Close a source with a call or a context management. The *close* attribute returns an object that can be both called and used in a with statement

Examples

```
>>> ds.dem.close()
>>> with ds.dem.close:
        # code...
>>> with ds.acreate_raster('result.tif', fp, float, 1).close as result:
        # code...
>>> with ds.acreate_vector('results.shp', 'linestring').close as roofs:
        # code...
```

__del__()

class buzzard.**ASourceRaster**(*<implementation detail>*)
Base abstract class defining the common behavior of all rasters.

Features Defined

- Has a *stored* Footprint that defines the location of the raster
- Has a Footprint that is influenced by the Dataset's opening mode
- Has a length that defines how many channels are available
- Has a *channels_schema* that defines per channel attributes (e.g. nodata)
- Has a *dtype* (like np.float32)
- Has a *get_data* method that allows to read pixels in their current state to numpy arrays

property fp_stored

property fp

property channels_schema

property dtype

property nodata
Accessor for first channel's nodata value

get_nodata(*channel=0*)
Accessor for nodata value

__len__()
Return the number of channels

get_data(*fp=None*, *channels=None*, *dst_nodata=None*, *interpolation='cv_area'*, ***kwargs*)
Read a rectangle of data on several channels from the source raster.

If *fp* is not fully within the source raster, the external pixels are set to nodata. If nodata is missing, 0 is used. If *fp* is not on the same grid as the source raster, remapping is performed using *interpolation* algorithm. (It fails if the *allow_interpolation* parameter is set to False in *Dataset* (default)). When remapping, the nodata values are not interpolated, they are correctly spread to the output.

If *dst_nodata* is provided, nodata pixels are set to *dst_nodata*.

Warning: The alpha channels are currently resampled like any other channels, this behavior may change in the future. To normalize an *rgba* array after a resampling operation, use this piece of code:

```
>>> arr = np.where(arr[..., -1] == 255, arr, 0)
```

Warning: Bands in GDAL are indexed from 1. Channels in buzzard are indexed from 0.

Parameters

fp: Footprint of shape (Y, X) or None If None: return the full source raster

If Footprint: return this window from the raster

channels: None or int or slice or sequence of int (see *Channels Parameter* below) The channels to be read

dst_nodata: nbr or None nodata value in output array If None and raster.nodata is not None: raster.nodata is used If None and raster.nodata is None: 0 is used

interpolation: one of {'cv_area', 'cv_nearest', 'cv_linear', 'cv_cubic', 'cv_lanczos4'} or None OpenCV method used if intepolation is necessary

Returns

array: numpy.ndarray of shape (Y, X) or (Y, X, C)

- If the *channels* parameter is *-1*, the returned array is of shape (Y, X) when *C=1*, (Y, X, C) otherwise.
- If the *channels* parameter is an integer *>=0*, the returned array is of shape (Y, X).
- If the *channels* parameter is a sequence or a slice, the returned array is always of shape (Y, X, C), no matter the size of *C*.

(see *Channels Parameter* below)

Channels Parameter

type	value	meaning	output shape
NoneType	None (default)	All channels	(Y, X) or (Y, X, C)
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels	(Y, X, C)
int	0, 1, 2, -1, -2, -3	Channel *idx*	(Y, X)
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels	(Y, X, C)

class buzzard.**AStored**(<*implementation detail*>)

Base abstract class defining the common behavior of all sources that are stored somewhere (like RAM or disk).

Features Defined

- Has an opening mode

property mode
Open mode, one of {'r', 'w'}

class buzzard.**AStoredRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters that are stored somewhere (like RAM or disk).

Features Defined

- Has a *set_data* method that allows to write pixels to storage

set_data(*array*, *fp=None*, *channels=None*, *interpolation='cv_area'*, *mask=None*, ***kwargs*)
Write a rectangle of data to the destination raster. Each channel in *array* is written to one channel in *raster* in the same order as described by the *channels* parameter. An optional *mask* may be provided to only write certain pixels of *array*.

If *fp* is not fully within the destination raster, only the overlapping pixels are written. If *fp* is not on the same grid as the destination raster, remapping is automatically performed using the *interpolation* algorithm. (It fails if the *allow_interpolation* parameter is set to *False* in *Dataset* (default)). When interpolating:

- The nodata values are not interpolated, they are correctly spread to the output.
- At most one pixel may be lost at edges due to interpolation. Provide more context in *array* to compensate this loss.
- The mask parameter is also interpolated.

The alpha bands are currently resampled like any other band, this behavior may change in the future.

This method is not thread-safe.

Parameters

array: numpy.ndarray of shape (Y, X) or (Y, X, C) The values to be written

fp: Footprint of shape (Y, X) or None If None: write the full source raster If Footprint: write this window to the raster

channels: None or int or slice or sequence of int (see *Channels Parameter* below) The channels to be written.

interpolation: one of {'cv_area', 'cv_nearest', 'cv_linear', 'cv_cubic', 'cv_lanczos4'} or None
OpenCV method used if intepolation is necessary

mask: numpy array of shape (Y, X) and dtype *bool* OR inputs accepted by *Footprint.burn_polygons*

Channels Parameter

type	value	meaning
NoneType	None (default)	All channels
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels
int	0, 1, 2, -1, -2, -3	Channel *idx*
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels

Caveat

When using a Raster backed by a driver (like a GDAL driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Raster.

fill(*value*, *channels=None*, ***kwargs*)
Fill raster with value.

This method is not thread-safe.

Parameters

value: nbr

channels: int or sequence of int (see *Channels Parameter* below) The channels to be written

Channels Parameter

type	value	meaning
NoneType	None (default)	All channels
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels
int	0, 1, 2, -1, -2, -3	Channel *idx*
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels

Caveat

When using a Raster backed by a driver (like a GDAL driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Raster.

class buzzard.**AEmissary**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources that are backed by a driver.

Features Defined

- Has a *driver* (like "GTiff" for GDAL's geotiff driver)
- Has *open_options*
- Has a *path* (if the driver supports it)
- Can be deleted (if the driver supports it)

property driver
Get the driver name, such as 'GTiff' or 'GeoJSON'

property open_options
Get the list of options used for opening

property path
Get the file system path of this source, may be the empty string if not applicable

property delete
Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

property remove
Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

class buzzard.**AEmissaryRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters that are backed by a driver.

Features Defined

None

class buzzard.**APooledEmissary**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources that can deactivate and reactivate their underlying driver at will.

This is useful to balance the number of active file descriptors. This is useful to perform concurrent reads if the driver does no support it.

Features Defined

- An *activate* method to manually open the driver (Mostly useless feature since opening is automatic if necessary)
- A *deactivate* method to close the driver (Useful to flush data to disk)
- An *active_count* property
- An *active* property

activate()
Make sure that at least one driver object is active for this Raster/Vector

deactivate()
Collect all active driver object for this Raster/Vector. If a driver object is currently being used, will raise an exception.

property active_count
Count how many driver objects are currently active for this Raster/Vector

property active
Is there any driver object currently active for this Raster/Vector

class buzzard.**APooledEmissaryRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters that can deactivate and reactivate their underlying driver at will.

Features Defined

None

class buzzard.**GDALFileRaster**(<*implementation detail*>)
Concrete class defining the behavior of a GDAL raster using a file.

```
>>> help(Dataset.open_raster)
>>> help(Dataset.create_raster)
```

Features Defined

None

1.2.2 GDALMemRaster

class buzzard.**ASource**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources opened in the Dataset.

Features Defined

- Has a *stored* spatial reference
- Has a *virtual* spatial reference that is influenced by the Dataset's opening mode
- Can be closed

property wkt_stored
The spatial reference that can be found in the metadata of a source, in wkt format.

string or None

property proj4_stored
The spatial reference that can be found in the metadata of a source, in proj4 format.

string or None

property wkt_virtual
The spatial reference considered to be written in the metadata of a source, in wkt format.

string or None

property proj4_virtual
The spatial reference considered to be written in the metadata of a source, in proj4 format.

string or None

get_keys()
Get the list of keys under which this source is registered to in the Dataset

property close
Close a source with a call or a context management. The *close* attribute returns an object that can be both called and used in a with statement

Examples

```
>>> ds.dem.close()
>>> with ds.dem.close:
        # code...
>>> with ds.acreate_raster('result.tif', fp, float, 1).close as result:
        # code...
>>> with ds.acreate_vector('results.shp', 'linestring').close as roofs:
        # code...
```

__del__()

class buzzard.**ASourceRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters.

Features Defined

- Has a *stored* Footprint that defines the location of the raster
- Has a Footprint that is influenced by the Dataset's opening mode
- Has a length that defines how many channels are available
- Has a *channels_schema* that defines per channel attributes (e.g. nodata)
- Has a *dtype* (like np.float32)
- Has a *get_data* method that allows to read pixels in their current state to numpy arrays

property fp_stored

property fp

property channels_schema

property dtype

property nodata
Accessor for first channel's nodata value

get_nodata(*channel=0*)
Accessor for nodata value

__len__()
Return the number of channels

get_data(*fp=None*, *channels=None*, *dst_nodata=None*, *interpolation='cv_area'*, ***kwargs*)
Read a rectangle of data on several channels from the source raster.

If *fp* is not fully within the source raster, the external pixels are set to nodata. If nodata is missing, 0 is used. If *fp* is not on the same grid as the source raster, remapping is performed using *interpolation* algorithm. (It fails if the *allow_interpolation* parameter is set to False in *Dataset* (default)). When remapping, the nodata values are not interpolated, they are correctly spread to the output.

If *dst_nodata* is provided, nodata pixels are set to *dst_nodata*.

Warning: The alpha channels are currently resampled like any other channels, this behavior may change in the future. To normalize an *rgba* array after a resampling operation, use this piece of code:

```
>>> arr = np.where(arr[..., -1] == 255, arr, 0)
```

Warning: Bands in GDAL are indexed from 1. Channels in buzzard are indexed from 0.

Parameters

fp: Footprint of shape (Y, X) or None If None: return the full source raster

If Footprint: return this window from the raster

channels: None or int or slice or sequence of int (see *Channels Parameter* below) The channels to be read

dst_nodata: nbr or None nodata value in output array If None and raster.nodata is not None: raster.nodata is used If None and raster.nodata is None: 0 is used

interpolation: one of {'cv_area', 'cv_nearest', 'cv_linear', 'cv_cubic', 'cv_lanczos4'} or None OpenCV method used if intepolation is necessary

Returns

array: numpy.ndarray of shape (Y, X) or (Y, X, C)

- If the *channels* parameter is *-1*, the returned array is of shape (Y, X) when *C=1*, (Y, X, C) otherwise.
- If the *channels* parameter is an integer *>=0*, the returned array is of shape (Y, X).
- If the *channels* parameter is a sequence or a slice, the returned array is always of shape (Y, X, C), no matter the size of *C*.

(see *Channels Parameter* below)

Channels Parameter

type	value	meaning	output shape
NoneType	None (default)	All channels	(Y, X) or (Y, X, C)
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels	(Y, X, C)
int	0, 1, 2, -1, -2, -3	Channel *idx*	(Y, X)
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels	(Y, X, C)

class buzzard.**AStored**(<*implementation detail*>)

Base abstract class defining the common behavior of all sources that are stored somewhere (like RAM or disk).

Features Defined

- Has an opening mode

property mode
Open mode, one of {'r', 'w'}

class buzzard.**AStoredRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters that are stored somewhere (like RAM or disk).

Features Defined

- Has a *set_data* method that allows to write pixels to storage

set_data(*array*, *fp=None*, *channels=None*, *interpolation='cv_area'*, *mask=None*, ***kwargs*)
Write a rectangle of data to the destination raster. Each channel in *array* is written to one channel in *raster* in the same order as described by the *channels* parameter. An optional *mask* may be provided to only write certain pixels of *array*.

If *fp* is not fully within the destination raster, only the overlapping pixels are written. If *fp* is not on the same grid as the destination raster, remapping is automatically performed using the *interpolation* algorithm. (It fails if the *allow_interpolation* parameter is set to *False* in *Dataset* (default)). When interpolating:

- The nodata values are not interpolated, they are correctly spread to the output.
- At most one pixel may be lost at edges due to interpolation. Provide more context in *array* to compensate this loss.
- The mask parameter is also interpolated.

The alpha bands are currently resampled like any other band, this behavior may change in the future.

This method is not thread-safe.

Parameters

array: numpy.ndarray of shape (Y, X) or (Y, X, C) The values to be written

fp: Footprint of shape (Y, X) or None If None: write the full source raster If Footprint: write this window to the raster

channels: None or int or slice or sequence of int (see *Channels Parameter* below) The channels to be written.

interpolation: one of {'cv_area', 'cv_nearest', 'cv_linear', 'cv_cubic', 'cv_lanczos4'} or None
OpenCV method used if intepolation is necessary

mask: numpy array of shape (Y, X) and dtype *bool* OR inputs accepted by *Footprint.burn_polygons*

Channels Parameter

type	value	meaning
NoneType	None (default)	All channels
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels
int	0, 1, 2, -1, -2, -3	Channel *idx*
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels

Caveat

When using a Raster backed by a driver (like a GDAL driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Raster.

fill(*value*, *channels=None*, ***kwargs*)
Fill raster with value.

This method is not thread-safe.

Parameters

value: nbr

channels: int or sequence of int (see *Channels Parameter* below) The channels to be written

Channels Parameter

type	value	meaning
NoneType	None (default)	All channels
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels
int	0, 1, 2, -1, -2, -3	Channel *idx*
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels

Caveat

When using a Raster backed by a driver (like a GDAL driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Raster.

class buzzard.**AEmissary**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources that are backed by a driver.

Features Defined

- Has a *driver* (like "GTiff" for GDAL's geotiff driver)
- Has *open_options*
- Has a *path* (if the driver supports it)
- Can be deleted (if the driver supports it)

property driver
Get the driver name, such as 'GTiff' or 'GeoJSON'

property open_options
Get the list of options used for opening

property path
Get the file system path of this source, may be the empty string if not applicable

property delete
Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

property remove
Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

class buzzard.**AEmissaryRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters that are backed by a driver.

Features Defined

None

class buzzard.**GDALMemRaster**(<*implementation detail*>)
Concrete class defining the behavior of a GDAL raster using the "MEM" driver.

```
>>> help(Dataset.create_raster)
```

Features Defined

None

1.2.3 NumpyRaster

class buzzard.**ASource**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources opened in the Dataset.

Features Defined

- Has a *stored* spatial reference
- Has a *virtual* spatial reference that is influenced by the Dataset's opening mode
- Can be closed

property wkt_stored
The spatial reference that can be found in the metadata of a source, in wkt format.

string or None

property proj4_stored
The spatial reference that can be found in the metadata of a source, in proj4 format.

string or None

property wkt_virtual
The spatial reference considered to be written in the metadata of a source, in wkt format.

string or None

property proj4_virtual
The spatial reference considered to be written in the metadata of a source, in proj4 format.

string or None

get_keys()
Get the list of keys under which this source is registered to in the Dataset

property close
Close a source with a call or a context management. The *close* attribute returns an object that can be both called and used in a with statement

Examples

```
>>> ds.dem.close()
>>> with ds.dem.close:
        # code...
>>> with ds.acreate_raster('result.tif', fp, float, 1).close as result:
        # code...
>>> with ds.acreate_vector('results.shp', 'linestring').close as roofs:
        # code...
```

__del__()

class buzzard.**ASourceRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters.

Features Defined

- Has a *stored* Footprint that defines the location of the raster
- Has a Footprint that is influenced by the Dataset's opening mode
- Has a length that defines how many channels are available
- Has a *channels_schema* that defines per channel attributes (e.g. nodata)
- Has a *dtype* (like np.float32)
- Has a *get_data* method that allows to read pixels in their current state to numpy arrays

property fp_stored

property fp

property channels_schema

property dtype

property nodata
Accessor for first channel's nodata value

get_nodata(*channel=0*)
Accessor for nodata value

__len__()
Return the number of channels

get_data(*fp=None*, *channels=None*, *dst_nodata=None*, *interpolation='cv_area'*, ***kwargs*)
Read a rectangle of data on several channels from the source raster.

If *fp* is not fully within the source raster, the external pixels are set to nodata. If nodata is missing, 0 is used. If *fp* is not on the same grid as the source raster, remapping is performed using *interpolation* algorithm. (It fails if the *allow_interpolation* parameter is set to False in *Dataset* (default)). When remapping, the nodata values are not interpolated, they are correctly spread to the output.

If *dst_nodata* is provided, nodata pixels are set to *dst_nodata*.

Warning: The alpha channels are currently resampled like any other channels, this behavior may change in the future. To normalize an *rgba* array after a resampling operation, use this piece of code:

```
>>> arr = np.where(arr[..., -1] == 255, arr, 0)
```

Warning: Bands in GDAL are indexed from 1. Channels in buzzard are indexed from 0.

Parameters

fp: Footprint of shape (Y, X) or None If None: return the full source raster

If Footprint: return this window from the raster

channels: None or int or slice or sequence of int (see *Channels Parameter* below) The channels to be read

dst_nodata: nbr or None nodata value in output array If None and raster.nodata is not None: raster.nodata is used If None and raster.nodata is None: 0 is used

interpolation: one of {'cv_area', 'cv_nearest', 'cv_linear', 'cv_cubic', 'cv_lanczos4'} or None
OpenCV method used if intepolation is necessary

Returns

array: numpy.ndarray of shape (Y, X) or (Y, X, C)

- If the *channels* parameter is *-1*, the returned array is of shape (Y, X) when *C=1*, (Y, X, C) otherwise.
- If the *channels* parameter is an integer *>=0*, the returned array is of shape (Y, X).
- If the *channels* parameter is a sequence or a slice, the returned array is always of shape (Y, X, C), no matter the size of *C*.

(see *Channels Parameter* below)

Channels Parameter

type	value	meaning	output shape
NoneType	None (default)	All channels	(Y, X) or (Y, X, C)
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels	(Y, X, C)
int	0, 1, 2, -1, -2, -3	Channel *idx*	(Y, X)
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels	(Y, X, C)

class buzzard.**AStored**(<*implementation detail*>)

Base abstract class defining the common behavior of all sources that are stored somewhere (like RAM or disk).

Features Defined

- Has an opening mode

property mode

Open mode, one of {'r', 'w'}

class buzzard.**AStoredRaster**(<*implementation detail*>)

Base abstract class defining the common behavior of all rasters that are stored somewhere (like RAM or disk).

Features Defined

- Has a *set_data* method that allows to write pixels to storage

set_data(*array*, *fp=None*, *channels=None*, *interpolation='cv_area'*, *mask=None*, ***kwargs*)

Write a rectangle of data to the destination raster. Each channel in *array* is written to one channel in *raster* in the same order as described by the *channels* parameter. An optional *mask* may be provided to only write certain pixels of *array*.

If *fp* is not fully within the destination raster, only the overlapping pixels are written. If *fp* is not on the same grid as the destination raster, remapping is automatically performed using the *interpolation* algorithm. (It fails if the *allow_interpolation* parameter is set to *False* in *Dataset* (default)). When interpolating:

- The nodata values are not interpolated, they are correctly spread to the output.
- At most one pixel may be lost at edges due to interpolation. Provide more context in *array* to compensate this loss.
- The mask parameter is also interpolated.

The alpha bands are currently resampled like any other band, this behavior may change in the future.

This method is not thread-safe.

Parameters

array: numpy.ndarray of shape (Y, X) or (Y, X, C) The values to be written

fp: Footprint of shape (Y, X) or None If None: write the full source raster If Footprint: write this window to the raster

channels: None or int or slice or sequence of int (see *Channels Parameter* below) The channels to be written.

interpolation: one of {'cv_area', 'cv_nearest', 'cv_linear', 'cv_cubic', 'cv_lanczos4'} or None OpenCV method used if intepolation is necessary

mask: numpy array of shape (Y, X) and dtype *bool* OR inputs accepted by *Footprint.burn_polygons*

Channels Parameter

type	value	meaning
NoneType	None (default)	All channels
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels
int	0, 1, 2, -1, -2, -3	Channel *idx*
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels

Caveat

When using a Raster backed by a driver (like a GDAL driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Raster.

fill(*value*, *channels=None*, ***kwargs*)
Fill raster with value.

This method is not thread-safe.

Parameters

value: nbr

channels: int or sequence of int (see *Channels Parameter* below) The channels to be written

Channels Parameter

type	value	meaning
NoneType	None (default)	All channels
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels
int	0, 1, 2, -1, -2, -3	Channel *idx*
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels

Caveat

When using a Raster backed by a driver (like a GDAL driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Raster.

class buzzard.**NumpyRaster**(<*implementation detail*>)
Concrete class defining the behavior of a wrapped numpy array

```
>>> help(Dataset.wrap_numpy_raster)
```

Features Defined

- Has an *array* property that points to the numpy array provided at construction.

property array
Returns the Raster's full input data as a Numpy array

1.2.4 CachedRasterRecipe

class buzzard.**ASource**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources opened in the Dataset.

Features Defined

- Has a *stored* spatial reference
- Has a *virtual* spatial reference that is influenced by the Dataset's opening mode
- Can be closed

property wkt_stored
The spatial reference that can be found in the metadata of a source, in wkt format.

string or None

property proj4_stored
The spatial reference that can be found in the metadata of a source, in proj4 format.

string or None

property wkt_virtual
The spatial reference considered to be written in the metadata of a source, in wkt format.

string or None

property proj4_virtual
The spatial reference considered to be written in the metadata of a source, in proj4 format.

string or None

get_keys()
Get the list of keys under which this source is registered to in the Dataset

property close
Close a source with a call or a context management. The *close* attribute returns an object that can be both called and used in a with statement

Examples

```
>>> ds.dem.close()
>>> with ds.dem.close:
        # code...
>>> with ds.acreate_raster('result.tif', fp, float, 1).close as result:
        # code...
>>> with ds.acreate_vector('results.shp', 'linestring').close as roofs:
        # code...
```

__del__()

class buzzard.**ASourceRaster**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters.

Features Defined

- Has a *stored* Footprint that defines the location of the raster
- Has a Footprint that is influenced by the Dataset's opening mode
- Has a length that defines how many channels are available
- Has a *channels_schema* that defines per channel attributes (e.g. nodata)
- Has a *dtype* (like np.float32)
- Has a *get_data* method that allows to read pixels in their current state to numpy arrays

property fp_stored

property fp

property channels_schema

property dtype

property nodata
Accessor for first channel's nodata value

get_nodata(*channel=0*)
Accessor for nodata value

__len__()
Return the number of channels

get_data(*fp=None*, *channels=None*, *dst_nodata=None*, *interpolation='cv_area'*, ***kwargs*)
Read a rectangle of data on several channels from the source raster.

If *fp* is not fully within the source raster, the external pixels are set to nodata. If nodata is missing, 0 is used. If *fp* is not on the same grid as the source raster, remapping is performed using *interpolation* algorithm. (It fails if the *allow_interpolation* parameter is set to False in *Dataset* (default)). When remapping, the nodata values are not interpolated, they are correctly spread to the output.

If *dst_nodata* is provided, nodata pixels are set to *dst_nodata*.

> **Warning:** The alpha channels are currently resampled like any other channels, this behavior may change in the future. To normalize an *rgba* array after a resampling operation, use this piece of code:
>
> ```
> >>> arr = np.where(arr[..., -1] == 255, arr, 0)
> ```

> **Warning:** Bands in GDAL are indexed from 1. Channels in buzzard are indexed from 0.

Parameters

fp: Footprint of shape (Y, X) or None If None: return the full source raster

If Footprint: return this window from the raster

channels: None or int or slice or sequence of int (see *Channels Parameter* below) The channels to be read

dst_nodata: nbr or None nodata value in output array If None and raster.nodata is not None: raster.nodata is used If None and raster.nodata is None: 0 is used

interpolation: one of {'cv_area', 'cv_nearest', 'cv_linear', 'cv_cubic', 'cv_lanczos4'} or None OpenCV method used if intepolation is necessary

Returns

array: numpy.ndarray of shape (Y, X) or (Y, X, C)

- If the *channels* parameter is *-1*, the returned array is of shape (Y, X) when *C=1*, (Y, X, C) otherwise.
- If the *channels* parameter is an integer *>=0*, the returned array is of shape (Y, X).
- If the *channels* parameter is a sequence or a slice, the returned array is always of shape (Y, X, C), no matter the size of *C*.

(see *Channels Parameter* below)

Channels Parameter

type	value	meaning	output shape
NoneType	None (default)	All channels	(Y, X) or (Y, X, C)
slice	slice(None), slice(1), slice(0, 2), slice(2, 0, -1)	Those channels	(Y, X, C)
int	0, 1, 2, -1, -2, -3	Channel *idx*	(Y, X)
(int, ...)	[0], [1], [2], [-1], [-2], [-3], [0, 1], [-1, 2, 1]	Those channels	(Y, X, C)

class buzzard.**AAsyncRaster**(*<implementation detail>*)

Base abstract class defining the common behavior of all rasters that are managed by the Dataset's scheduler.

Features Defined

- Has a *queue_data*, a low level method that can be used to query several arrays at once.
- Has an *iter_data*, a higher level wrapper of *queue_data*.

queue_data(*fps*, *channels=None*, *dst_nodata=None*, *interpolation='cv_area'*, *max_queue_size=5*, ***kwargs*)

Read several rectangles of data on several channels from the source raster.

Using *queue_data* instead of multiple calls to *get_data* allows more parallelism. The *fps* parameter should contain a sequence of *Footprint* that will be mapped to *numpy.ndarray*. The first ones will be computed with a higher priority than the later ones.

Calling this method sends an asynchronous message to the Dataset's scheduler with the input parameters and a queue. On the input side of the queue, the scheduler will call the *put* method with each array requested. On the output side of the queue, the *get* method should be called to retrieve the requested arrays.

The output queue will be created with a max queue size of *max_queue_size*, the scheduler will be careful to prepare only the arrays that can fit in the output queue. Thanks to this feature: backpressure can be entirely avoided.

If you wish to cancel your request, loose the reference to the queue and the scheduler will gracefuly cancel the query.

In general you should use the *iter_data* method instead of the *queue_data* one, it is much safer to use. However you will need to pass the *queue_data* method of a raster, to create another raster (a recipe) that depends on the first raster.

see rasters' *get_data* documentation, it shares most of the concepts

Parameters

fps: sequence of Footprint The Footprints at which the raster should be sampled.

channels: see *get_data* method

dst_nodata: see *get_data* method

interpolation: see *get_data* method

max_queue_size: int Maximum number of arrays to prepare in advance in the underlying queue.

Returns

queue: queue.Queue of ndarray The arrays are put into the queue in the same order as in the *fps* parameter.

iter_data(*fps*, *channels=None*, *dst_nodata=None*, *interpolation='cv_area'*, *max_queue_size=5*, ***kwargs*)

Read several rectangles of data on several channels from the source raster.

The *iter_data* method is a higher level wrapper around the *queue_data* method. It returns a python generator and while waiting for data, it periodically probes the Dataset's scheduler to reraise an exception if it crashed.

If you wish to cancel your request, loose the reference to the iterable and the scheduler will gracefully cancel the query.

see rasters' *get_data* documentation, it shares most of the concepts see *queue_data* documentation, it is called from within the *iter_data* method

Parameters

fps: sequence of Footprint The Footprints at which the raster should be sampled.

channels: see *get_data* method

dst_nodata: see *get_data* method

interpolation: see *get_data* method

max_queue_size: int Maximum number of arrays to prepare in advance in the underlying queue.

Returns

iterable: iterable of ndarray The arrays are yielded into the generator in the same order as in the *fps* parameter.

class buzzard.**ARasterRecipe**(<*implementation detail*>)
Base abstract class defining the common behavior of all rasters that compute data on the fly through the Dataset's scheduler.

Features Defined

- Has a *primitives* property, a dict that lists the primitive rasters declared at construction.

property primitives
dict of primitive name to Source, deduced from the *queue_data_per_primitive* provided at construction.

class buzzard.**CachedRasterRecipe**(<*implementation detail*>)
Concrete class defining the behavior of a raster computed on the fly and fills a cache to avoid subsequent computations.

```
>>> help(Dataset.create_cached_raster_recipe)
```

property cache_tiles
Cache tiles provided or created at construction

property cache_dir
Cache directory path provided at construction

1.2.5 GDALFileVector

class buzzard.**ASource**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources opened in the Dataset.

Features Defined

- Has a *stored* spatial reference
- Has a *virtual* spatial reference that is influenced by the Dataset's opening mode
- Can be closed

property wkt_stored
The spatial reference that can be found in the metadata of a source, in wkt format.

string or None

property proj4_stored
The spatial reference that can be found in the metadata of a source, in proj4 format.

string or None

property wkt_virtual
The spatial reference considered to be written in the metadata of a source, in wkt format.

string or None

property proj4_virtual
The spatial reference considered to be written in the metadata of a source, in proj4 format.

string or None

get_keys()
Get the list of keys under which this source is registered to in the Dataset

property close
Close a source with a call or a context management. The *close* attribute returns an object that can be both called and used in a with statement

Examples

```
>>> ds.dem.close()
>>> with ds.dem.close:
        # code...
>>> with ds.acreate_raster('result.tif', fp, float, 1).close as result:
        # code...
>>> with ds.acreate_vector('results.shp', 'linestring').close as roofs:
        # code...
```

__del__()

class buzzard.**ASourceVector**(*<implementation detail>*)
Base abstract class defining the common behavior of all vectors.

Features Defined

- Has a *type* that defines the type of geometry (like "Polygon")
- Has *fields* that define the type of informations that is paired with each geometries
- Has a *stored* extent that allows to retrieve the current extent of all the geometries
- Has a length that indicates how many geometries this source contains.
- Has several read functions (like *iter_data*) to retrieve geometries in their current state to shapely objects

property type
Geometry type

property fields
Fields definition

property extent
Get the vector's extent in work spatial reference. (*x* then *y*)

Example

```
>>> minx, maxx, miny, maxy = ds.roofs.extent
```

property extent_stored
Get the vector's extent in stored spatial reference. (minx, miny, maxx, maxy)

property bounds
Get the vector's bounds in work spatial reference. (*min* then *max*)

Example

```
>>> minx, miny, maxx, maxy = ds.roofs.extent
```

property bounds_stored
Get the vector's bounds in stored spatial reference. (*min* then *max*)

__len__()
Return the number of features in vector

iter_data(*fields=None*, *geom_type='shapely'*, *mask=None*, *clip=False*, *slicing=slice(0, None, 1)*)
Create an iterator over vector's features

Parameters

fields: None or string or -1 or sequence of string/int Which fields to include in iteration

- if None, empty sequence or empty string: No fields included
- if -1: All fields included
- if string: Name of fields to include (separated by comma or space)
- if sequence: List of indices / names to include

geom_type: {'shapely', 'coordinates'} Returned geometry type

mask: None or Footprint or shapely geometry or (nbr, nbr, nbr, nbr) Add a spatial filter to iteration, only geometries not disjoint with mask will be included.

- if None: No spatial filter
- if Footprint or shapely polygon: Polygon
- if (nbr, nbr, nbr, nbr): Extent (minx, maxx, miny, maxy)

clip: bool Returns intersection of geometries and mask. Caveat: A clipped geometry might not be of the same type as the original geometry. e.g: polygon might be clipped to might be converted to one of those:

- polygon
- line
- point
- multipolygon
- multiline
- multipoint
- geometrycollection

slicing: slice Slice of the iteration to return. It is applied after spatial filtering

Yields

feature: geometry or (geometry,) or (geometry, *fields)

- If *geom_type* is 'shapely': geometry is a *shapely geometry*.
- If *geom_type* is *coordinates*: geometry is a *nested lists of numpy arrays*.
- If *fields* is not a sequence: *feature* is *geometry* or *(geometry, *fields)*, depending on the number of fields to yield.
- If *fields* is a sequence or a string: *feature* is *(geometry,)* or *(geometry, *fields)*. Use *fields=[-1]* to get a monad containing all fields.

Examples

```
>>> for polygon, volume, stock_type in ds.stocks.iter_data('volume,type'):
        print('area:{}m**2, volume:{}m**3'.format(polygon.area, volume))
```

```
>>> for polygon, in ds.stocks.iter_data([]):
        print('area:{}m**2'.format(polygon.area))
```

```
>>> for polygon in ds.stocks.iter_data():
        print('area:{}m**2'.format(polygon.area))
```

get_data (*index*, *fields=-1*, *geom_type='shapely'*, *mask=None*, *clip=False*)
Fetch a single feature in vector. See ASourceVector.iter_data

iter_geojson (*mask=None*, *clip=False*, *slicing=slice(0, None, 1)*)
Create an iterator over vector's features

Parameters

mask: None or Footprint or shapely geometry or (nbr, nbr, nbr, nbr) Add a spatial filter to iteration, only geometries not disjoint with mask will be included.

- if None: No spatial filter
- if Footprint or shapely polygon: Polygon
- if (nbr, nbr, nbr, nbr): Extent (minx, maxx, miny, maxy)

clip: bool Returns intersection of geometries and mask. Caveat: A clipped geometry might not be of the same type as the original geometry. e.g: polygon might be clipped to might be converted to one of those:

- polygon
- line
- point
- multipolygon
- multiline
- multipoint
- geometrycollection

slicing: slice Slice of the iteration to return. It is applied after spatial filtering

Returns

iterable of geojson feature (dict)

Example

```
>>> for geojson in ds.stocks.iter_geojson():
        print('exterior-point-count:{}, volume:{}m**3'.format(
            len(geojson['geometry']['coordinates'][0]),
            geojson['properties']['volume']
        ))
```

get_geojson(*index*, *mask=None*, *clip=False*)
Fetch a single feature in vector. See ASourceVector.iter_geojson

extent_origin
Descriptor object to manage deprecation

class buzzard.**AStored**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources that are stored somewhere (like RAM or disk).

Features Defined

- Has an opening mode

property mode
Open mode, one of {'r', 'w'}

class buzzard.**AStoredVector**(<*implementation detail*>)
Base abstract class defining the common behavior of all vectors that are stored somewhere (like RAM or disk).

Features Defined

- Has an *insert_data* method that allows to write geometries to storage

insert_data(*geom*, *fields=()*, *index=-1*)
Insert a feature in vector.

This method is not thread-safe.

Parameters

geom: shapely.base.BaseGeometry or nested sequence of coordinates

fields: sequence or dict Feature's fields, missing or None fields are defaulted.

- if empty sequence: Keep all fields defaulted
- if sequence of length len(self.fields): Fields to be set, same order as self.fields
- if dict: Mapping of fields to be set

index: int

- if -1: append feature
- else: insert feature at index (if applicable)

Example

```
>>> poly = shapely.geometry.box(10, 10, 42, 43)
>>> fields = {'volume': 42.24}
>>> ds.stocks.insert_data(poly, fields)
```

Caveat

When using a Vector backed by a driver (like an OGR driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Vector.

class buzzard.**AEmissary**(<*implementation detail*>)

Base abstract class defining the common behavior of all sources that are backed by a driver.

Features Defined

- Has a *driver* (like "GTiff" for GDAL's geotiff driver)
- Has *open_options*
- Has a *path* (if the driver supports it)
- Can be deleted (if the driver supports it)

property driver

Get the driver name, such as 'GTiff' or 'GeoJSON'

property open_options

Get the list of options used for opening

property path

Get the file system path of this source, may be the empty string if not applicable

property delete

Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

property remove

Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

class buzzard.**AEmissaryVector**(<*implementation detail*>)
Base abstract class defining the common behavior of all vectors that are backed by a driver.

Features Defined

- Has a *layer* (if the driver supports it)

property layer

class buzzard.**APooledEmissary**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources that can deactivate and reactivate their underlying driver at will.

This is useful to balance the number of active file descriptors. This is useful to perform concurrent reads if the driver does no support it.

Features Defined

- An *activate* method to manually open the driver (Mostly useless feature since opening is automatic if necessary)
- A *deactivate* method to close the driver (Useful to flush data to disk)
- An *active_count* property
- An *active* property

activate()
Make sure that at least one driver object is active for this Raster/Vector

deactivate()
Collect all active driver object for this Raster/Vector. If a driver object is currently being used, will raise an exception.

property active_count
Count how many driver objects are currently active for this Raster/Vector

property active
Is there any driver object currently active for this Raster/Vector

class buzzard.**APooledEmissaryVector**(<*implementation detail*>)
Base abstract class defining the common behavior of all vectors that can deactivate and reactivate their underlying driver at will.

Features Defined

None

class buzzard.**GDALFileVector**(<*implementation detail*>)
Concrete class defining the behavior of a GDAL vector using a file

```
>>> help(Dataset.open_vector)
>>> help(Dataset.create_vector)
```

Features Defined

None

1.2.6 GDALMemoryVector

class buzzard.**ASource**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources opened in the Dataset.

Features Defined

- Has a *stored* spatial reference
- Has a *virtual* spatial reference that is influenced by the Dataset's opening mode
- Can be closed

property wkt_stored
The spatial reference that can be found in the metadata of a source, in wkt format.

string or None

property proj4_stored
The spatial reference that can be found in the metadata of a source, in proj4 format.

string or None

property wkt_virtual
The spatial reference considered to be written in the metadata of a source, in wkt format.

string or None

property proj4_virtual
The spatial reference considered to be written in the metadata of a source, in proj4 format.

string or None

get_keys()
Get the list of keys under which this source is registered to in the Dataset

property close
Close a source with a call or a context management. The *close* attribute returns an object that can be both called and used in a with statement

Examples

```
>>> ds.dem.close()
>>> with ds.dem.close:
        # code...
>>> with ds.acreate_raster('result.tif', fp, float, 1).close as result:
        # code...
>>> with ds.acreate_vector('results.shp', 'linestring').close as roofs:
        # code...
```

__del__()

class buzzard.**ASourceVector**(<*implementation detail*>)
Base abstract class defining the common behavior of all vectors.

Features Defined

- Has a *type* that defines the type of geometry (like "Polygon")

- Has *fields* that define the type of informations that is paired with each geometries
- Has a *stored* extent that allows to retrieve the current extent of all the geometries
- Has a length that indicates how many geometries this source contains.
- Has several read functions (like *iter_data*) to retrieve geometries in their current state to shapely objects

property type
Geometry type

property fields
Fields definition

property extent
Get the vector's extent in work spatial reference. (*x* then *y*)

Example

```
>>> minx, maxx, miny, maxy = ds.roofs.extent
```

property extent_stored
Get the vector's extent in stored spatial reference. (minx, miny, maxx, maxy)

property bounds
Get the vector's bounds in work spatial reference. (*min* then *max*)

Example

```
>>> minx, miny, maxx, maxy = ds.roofs.extent
```

property bounds_stored
Get the vector's bounds in stored spatial reference. (*min* then *max*)

__len__()
Return the number of features in vector

iter_data(*fields=None*, *geom_type='shapely'*, *mask=None*, *clip=False*, *slicing=slice(0, None, 1)*)
Create an iterator over vector's features

Parameters

fields: None or string or -1 or sequence of string/int Which fields to include in iteration

- if None, empty sequence or empty string: No fields included
- if -1: All fields included
- if string: Name of fields to include (separated by comma or space)
- if sequence: List of indices / names to include

geom_type: {'shapely', 'coordinates'} Returned geometry type

mask: None or Footprint or shapely geometry or (nbr, nbr, nbr, nbr) Add a spatial filter to iteration, only geometries not disjoint with mask will be included.

- if None: No spatial filter
- if Footprint or shapely polygon: Polygon

- if (nbr, nbr, nbr, nbr): Extent (minx, maxx, miny, maxy)

clip: bool Returns intersection of geometries and mask. Caveat: A clipped geometry might not be of the same type as the original geometry. e.g: polygon might be clipped to might be converted to one of those:

- polygon
- line
- point
- multipolygon
- multiline
- multipoint
- geometrycollection

slicing: slice Slice of the iteration to return. It is applied after spatial filtering

Yields

feature: geometry or (geometry,) or (geometry, *fields)

- If *geom_type* is 'shapely': geometry is a *shapely geometry*.
- If *geom_type* is *coordinates*: geometry is a *nested lists of numpy arrays*.
- If *fields* is not a sequence: *feature* is *geometry* or *(geometry, *fields)*, depending on the number of fields to yield.
- If *fields* is a sequence or a string: *feature* is *(geometry,)* or *(geometry, *fields)*. Use *fields=[-1]* to get a monad containing all fields.

Examples

```
>>> for polygon, volume, stock_type in ds.stocks.iter_data('volume,type'):
        print('area:{}m**2, volume:{}m**3'.format(polygon.area, volume))
```

```
>>> for polygon, in ds.stocks.iter_data([]):
        print('area:{}m**2'.format(polygon.area))
```

```
>>> for polygon in ds.stocks.iter_data():
        print('area:{}m**2'.format(polygon.area))
```

get_data(*index*, *fields=-1*, *geom_type='shapely'*, *mask=None*, *clip=False*)
Fetch a single feature in vector. See ASourceVector.iter_data

iter_geojson(*mask=None*, *clip=False*, *slicing=slice(0, None, 1)*)
Create an iterator over vector's features

Parameters

mask: None or Footprint or shapely geometry or (nbr, nbr, nbr, nbr) Add a spatial filter to iteration, only geometries not disjoint with mask will be included.

- if None: No spatial filter

- if Footprint or shapely polygon: Polygon
- if (nbr, nbr, nbr, nbr): Extent (minx, maxx, miny, maxy)

clip: bool Returns intersection of geometries and mask. Caveat: A clipped geometry might not be of the same type as the original geometry. e.g: polygon might be clipped to might be converted to one of those:

- polygon
- line
- point
- multipolygon
- multiline
- multipoint
- geometrycollection

slicing: slice Slice of the iteration to return. It is applied after spatial filtering

Returns

iterable of geojson feature (dict)

Example

```
>>> for geojson in ds.stocks.iter_geojson():
        print('exterior-point-count:{}, volume:{}m**3'.format(
            len(geojson['geometry']['coordinates'][0]),
            geojson['properties']['volume']
        ))
```

get_geojson(*index*, *mask=None*, *clip=False*)
Fetch a single feature in vector. See ASourceVector.iter_geojson

extent_origin
Descriptor object to manage deprecation

class buzzard.**AStored**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources that are stored somewhere (like RAM or disk).

Features Defined

- Has an opening mode

property mode
Open mode, one of {'r', 'w'}

class buzzard.**AStoredVector**(<*implementation detail*>)
Base abstract class defining the common behavior of all vectors that are stored somewhere (like RAM or disk).

Features Defined

- Has an *insert_data* method that allows to write geometries to storage

insert_data(*geom*, *fields=()*, *index=-1*)
Insert a feature in vector.

This method is not thread-safe.

Parameters

geom: shapely.base.BaseGeometry or nested sequence of coordinates

fields: sequence or dict Feature's fields, missing or None fields are defaulted.

- if empty sequence: Keep all fields defaulted
- if sequence of length len(self.fields): Fields to be set, same order as self.fields
- if dict: Mapping of fields to be set

index: int

- if -1: append feature
- else: insert feature at index (if applicable)

Example

```
>>> poly = shapely.geometry.box(10, 10, 42, 43)
>>> fields = {'volume': 42.24}
>>> ds.stocks.insert_data(poly, fields)
```

Caveat

When using a Vector backed by a driver (like an OGR driver), the data might be flushed to disk only after the garbage collection of the driver object. To be absolutely sure that the driver cache is flushed to disk, call *.close* or *.deactivate* on this Vector.

class buzzard.**AEmissary**(<*implementation detail*>)
Base abstract class defining the common behavior of all sources that are backed by a driver.

Features Defined

- Has a *driver* (like "GTiff" for GDAL's geotiff driver)
- Has *open_options*
- Has a *path* (if the driver supports it)
- Can be deleted (if the driver supports it)

property driver
Get the driver name, such as 'GTiff' or 'GeoJSON'

property open_options
Get the list of options used for opening

property path
Get the file system path of this source, may be the empty string if not applicable

property delete
Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

property remove
Delete a source with a call or a context management. May raise an exception if not applicable or if *mode* = 'r' The *delete* attribute returns an object that can be both called and used in a with statement

Example

```
>>> ds.dem.delete()
>>> with ds.dem.delete:
        # code...
>>> with ds.acreate_raster('/tmp/tmp.tif', fp, float, 1).delete as tmp:
        # code...
>>> with ds.acreate_vector('/tmp/tmp.shp', 'polygon').delete as tmp:
        # code...
```

class buzzard.**AEmissaryVector**(<*implementation detail*>)
Base abstract class defining the common behavior of all vectors that are backed by a driver.

Features Defined

- Has a *layer* (if the driver supports it)

property layer

class buzzard.**GDALMemoryVector**(<*implementation detail*>)
Concrete class defining the behavior of a GDAL raster using the "Memory" driver

```
>>> help(Dataset.create_vector)
```

Features Defined

None

1.3 Footprint

class buzzard.**Footprint**(***kwargs*)

Immutable object representing the location and size of a spatially localized raster. All methods are thread-safe.

The `Footprint` class:

- is a toolbox class designed to position a rectangle in both image space and geometry space,
- its main purpose is to simplify the manipulation of windows in rasters,
- has many accessors,
- has many algorithms,
- is a constant object,
- is designed to work with any rectangle in space (like non north-up/west-left rasters),
- is independent from projections, units and files,
- uses `affine` library internally for conversions (https://github.com/sgillies/affine).

Warning: This class being complex and full python, the constructor is too slow for certain use cases (~0.5ms).

Method category		Method names
Footprint construction	from scratch	__init__, of_extent
	from `Footprint`	__and__, intersection, erode, dilate, ...
Conversion		extent, coords, geom, __geo_interface__
Accessors	Spatial - Size and vectors	size, width, height, diagvec, ...
	Spatial - Coordinates	tl, bl, br, tr, ...
	Spatial - Misc	area, length, semiminoraxis, ... x
	Raster - Size	rsize, rwidth, rheight, ...
	Raster - Indices	rtl, rbl, rbr, ttr, ...
	Raster - Misc	rarea, rlength, rsemiminoraxis, ...
	Affine transformations	pxsize, pxvec, angle, ...
Binary predicates		__eq__, ...
Numpy		shape, meshgrid_raster, meshgrid_spatial, slice_in, ...
Coordinates conversions		spatial_to_raster, raster_to_spatial
Geometry / Raster conversions		find_polygons, burn_polygons, ...
Tiling		tile, tile_count, tile_occurrence
Serialization		__str__, ...

Informations on geo transforms (gt) and affine matrices

- http://www.perrygeo.com/python-affine-transforms.html
- https://pypi.python.org/pypi/affine/1.0

GDAL ordering:

c	a	b	f	d	e
tlx	width of a pixel	row rotation	tly	column rotation	height of a pixel

```
>>> c, a, b, f, d, e = fp.gt
>>> tlx, dx, rx, tly, ry, dy = fp.gt
```

Matrix ordering:

a	b	c	d	e	f
width of a pixel	row rotation	tlx	column rotation	height of a pixel	tly

```
>>> a, b, c, d, e, f = fp.aff6
>>> dx, rx, tlx, ry, dy, tly = fp.aff6
```

There are only two ways to construct a Footprint, but several high level constructors exist, such as *.intersection*.

Usage 1

```
>>> buzz.Footprint(tl=(0, 10), size=(10, 10), rsize=(100, 100))
```

Usage 2

```
>>> buzz.Footprint(gt=(0, .1, 0, 10, 0, -.1), rsize=(100, 100))
```

Parameters

tl: (nbr, nbr) raster spatial top left coordinates

gt: (nbr, nbr, nbr, nbr, nbr, nbr) geotransforms with GDAL ordering

size: (nbr, nbr) Size of Footprint in space (unsigned)

rsize: (int, int) Size of raster in pixel (unsigned integers)

__and__(*other*)
Returns Footprint.intersection

classmethod of_extent(*extent*, *scale*)
Create a Footprint from a rectangle extent and a scale

Parameters

extent: (nbr, nbr, nbr, nbr) Spatial coordinates of (minx, maxx, miny, maxy) defining a rectangle

scale: nbr or (nbr, nbr) Resolution of output Footprint:

- if nbr: resolution = [a, -a]
- if (nbr, nbr): resolution [a, b]

clip(*startx*, *starty*, *endx*, *endy*)
Construct a new Footprint by clipping self using pixel indices

To clip using coordinates see *Footprint.intersection*.

Parameters

startx: int or None Same rules as regular python slicing

starty: int or None Same rules as regular python slicing

endx: int or None Same rules as regular python slicing

endy: int or None Same rules as regular python slicing

Returns

fp: Footprint The new clipped `Footprint`

`erode`(*count*)
Construct a new Footprint from self, eroding all edges by `count` pixels

`dilate`(*count*)
Construct a new Footprint from self, dilating all edges by `count` pixels

`intersection`(*self*, **objects*, *scale='self'*, *rotation='auto'*, *alignment='auto'*, *homogeneous=False*)
Construct a Footprint bounding the intersection of geometric objects, self being one of the of input geometry. Inputs' intersection is always within output Footprint.

Parameters

***objects: *object** Any object with a __geo_interface__ attribute defining a geometry, like a Footprint or a shapely object.

scale: one of {'self', 'highest', 'lowest'} or (nbr, nbr) or nbr 'self': Output Footprint's resolution is the same as self 'highest': Output Footprint's resolution is the highest one among the input Footprints 'lowest': Output Footprint's resolution is the lowest one among the input Footprints (nbr, nbr): Signed pixel size, aka scale nbr: Signed pixel width. Signed pixel height is assumed to be -width

rotation: one of {'auto', 'fit'} or nbr

'auto' If *scale* designate a Footprint object, its rotation is chosen Else, self's rotation is chosen

'fit' Output Footprint is the rotated minimum bounding rectangle

nbr Angle in degree

alignment: {'auto', 'tl', (nbr, nbr)}

'auto'

If *scale* and *rotation* designate the same Footprint object, its alignment is chosen

Else, 'tl' alignment is chosen

'tl': Ouput Footprint's alignement is the top left most point of the bounding rectangle of the intersection

(nbr, nbr): Coordinate of a point that lie on the grid. This point can be anywhere in space.

homogeneous: bool False: No effect True: Raise an exception if all input Footprints do not lie on the same grid as self.

Returns

Footprint

`move`(*tl*, *tr=None*, *br=None*, *round_coordinates=False*)
Create a copy of self moved by an Affine transformation by providing new points. *rsize* is always conserved

Usage cases

tl	tr	br	Affine transformations possible
coord	None	None	Translation
coord	coord	None	Translation, Rotation, Scale x and y uniformly with positive real
coord	coord	coord	Translation, Rotation, Scale x and y independently with reals

Parameters

tl: (nbr, nbr) New top left coordinates

tr: (nbr, nbr) New top right coordinates

br: (nbr, nbr) New bottom right coordinates

round_coordinates: bool Round the input coordinates with respect to *buzz.env.significant*, so that the output *Footprint* is as much similar as possible as the input *Footprint* regarding those properties: - angle - pxsize - pxsizex / pxsizey

This option helps a lot if the input coordinates suffered from floating point precision loss since it will cancel the noise in the resulting transformation matrix.

> **Warning:** Only work when *tr* and *br* are both provided

Returns

Footprint

property extent

Get the Footprint's extent (*x* then *y*)

Example

```
>>> minx, maxx, miny, maxy = fp.extent
>>> plt.imshow(arr, extent=fp.extent)
```

fp.extent from fp.bounds using numpy fancy indexing

```
>>> minx, maxx, miny, maxy = fp.bounds[[0, 2, 1, 3]]
```

property bounds

Get the Footprint's bounds (*min* then *max*)

Example

```
>>> minx, miny, maxx, maxy = fp.bounds
```

fp.bounds from fp.extent using numpy fancy indexing

```
>>> minx, miny, maxx, maxy = fp.extent[[0, 2, 1, 3]]
```

property coords
Get corners coordinates

Example

```
>>> tl, bl, br, tr = fp.coords
```

property poly
Convert self to shapely.geometry.Polygon

property __geo_interface__

property size
Spatial distances: (||raster left - raster right||, ||raster top - raster bottom||)

property sizex
Spatial distance: ||raster left - raster right||

property sizey
Spatial distance: ||raster top - raster bottom||

property width
Spatial distance: ||raster left - raster right||, alias for sizex

property height
Spatial distance: ||raster top - raster bottom||, alias for sizey

property w
Spatial distance: ||raster left - raster right||, alias for sizex

property h
Spatial distance: ||raster top - raster bottom||, alias for sizey

property lrvec
Spatial vector: (raster right - raster left)

property tbvec
Spatial vector: (raster bottom - raster top)

property diagvec
Spatial vector: (raster bottom right - raster top left)

property tl
Spatial coordinates: raster top left (x, y)

property tlx
Spatial coordinate: raster top left (x)

property tly
Spatial coordinate: raster top left (y)

property bl
Spatial coordinates: raster bottom left (x, y)

property blx
Spatial coordinate: raster bottom left (x)

property bly
Spatial coordinate: raster bottom left (y)

property br
Spatial coordinates: raster bottom right (x, y)

property brx
Spatial coordinate: raster bottom right (x)

property bry
Spatial coordinate: raster bottom right (y)

property tr
Spatial coordinates: raster top right (x, y)

property trx
Spatial coordinate: raster top right (x)

property try_
Spatial coordinate: raster top right (y) Don't forget the trailing underscore

property t
Spatial coordinates: raster top center (x, y)

property tx
Spatial coordinate: raster top center (x)

property ty
Spatial coordinate: raster top center (y)

property l
Spatial coordinates: raster center left (x, y)

property lx
Spatial coordinate: raster center left (x)

property ly
Spatial coordinate: raster center left (y)

property b
Spatial coordinates: raster bottom center (x, y)

property bx
Spatial coordinate: raster bottom center (x)

property by
Spatial coordinate: raster bottom center (y)

property r
Spatial coordinates: raster center right (x, y)

property rx
Spatial coordinate: raster center right (x)

property ry
Spatial coordinate: raster center right (y)

property c
Spatial coordinates: raster center (x, y)

property cx
Spatial coordinate: raster center (x)

property cy
Spatial coordinate: raster center (y)

property semiminoraxis
Spatial distance: half-size of the smaller side

property semimajoraxis
Spatial distance: half-size of the bigger side

property area
Area: pixel count

property length
Length: circumference of the outer ring

property rsize
Pixel quantities: (pixel per line, pixel per column)

property rsizex
Pixel quantity: pixel per line

property rsizey
Pixel quantity: pixel per column

property rwidth
Pixel quantity: pixel per line, alias for rsizex

property rheight
Pixel quantity: pixel per column, alias for rsizey

property rw
Pixel quantity: pixel per line, alias for rsizex

property rh
Pixel quantity: pixel per column, alias for rsizey

property rtl
Indices: raster top left pixel (x=0, y=0)

property rtlx
Index: raster top left pixel (x=0)

property rtly
Index: raster top left pixel (y=0)

property rbl
Indices: raster bottom left pixel (x=0, y)

property rblx
Index: raster bottom left pixel (x=0)

property rbly
Index: raster bottom left pixel (y)

property rbr
Indices: raster bottom right pixel (x, y)

property rbrx
Index: raster bottom right pixel (x)

property rbry
Index: raster bottom right pixel (y)

property rtr
Indices: raster top right pixel (x, y=0)

property rtrx
Index: raster top right pixel (x)

property rtry
Index: raster top right pixel (y=0)

property rt
Indices: raster top center pixel (x truncated, y=0)

property rtx
Index: raster top center pixel (x truncated)

property rty
Index: raster top center pixel (y=0)

property rl
Indices: raster center left pixel (x=0, y truncated)

property rlx
Index: raster center left pixel (x=0)

property rly
Index: raster center left pixel (y truncated)

property rb
Indices: raster bottom center pixel (x truncated, y)

property rbx
Index: raster bottom center pixel (x truncated)

property rby
Index: raster bottom center pixel (y)

property rr
Indices: raster center right pixel (x, y truncated)

property rrx
Index: raster center right pixel (x)

property rry
Index: raster center right pixel (y truncated)

property rc
Indices: raster center pixel (x truncated, y truncated)

property rcx
Index: raster center pixel (x truncated)

property rcy
Index: raster center pixel (y truncated)

property rsemiminoraxis
Pixel quantity: half pixel count (truncated) of the smaller side

property rsemimajoraxis
Pixel quantity: half pixel count (truncated) of the bigger side

property rarea
Pixel quantity: pixel count

property rlength
Pixel quantity: pixel count in the outer ring

property gt
First 6 numbers of the affine transformation matrix, GDAL ordering

property aff33
The affine transformation matrix

property aff23
Top two rows of the affine transformation matrix

property aff6
First 6 numbers of the affine transformation matrix, left-right/top-bottom ordering

property affine
Underlying affine object

property scale
Spatial vector: scale used in the affine transformation, np.abs(scale) == pxsize

property angle
Angle in degree: rotation used in the affine transformation, (0 is north-up)

property pxsize
Spatial distance: ||pixel bottom right - pixel top left|| (x, y)

property pxsizex
Spatial distance: ||pixel right - pixel left|| (x)

property pxsizey
Spatial distance: ||pixel bottom - pixel top|| (y)

property pxvec
Spatial vector: (pixel bottom right - pixel top left)

property pxtbvec
Spatial vector: (pixel bottom left - pixel top left)

property pxlrvec
Spatial vector: (pixel top right - pixel top left)

__eq__(*other*)
Returns self.equals

__ne__(*other*)
Returns not self.equals

share_area(*other*)
Binary predicate: Does other share area with self

Parameters

other: Footprint or shapely object

Returns

bool

equals(*other*)
Binary predicate: Is other Footprint exactly equal to self

Parameters

other: Footprint

Returns

bool

almost_equals(*other*)
Binary predicate: Is other Footprint almost equal to self with regard to buzz.env.significant.

Parameters

other: Footprint

Returns

bool

same_grid(*other*)
Binary predicate: Does other Footprint lie on the same grid as self

Parameters

other: Footprint

Returns

bool

property shape
Pixel quantities: (pixel per column, pixel per line)

property meshgrid_raster
Compute indice matrices

Returns

(x, y): (np.ndarray, np.ndarray) Raster indices matrices with shape = self.shape with dtype = env.default_index_dtype

property meshgrid_spatial
Compute coordinate matrices

Returns

(x, y): (np.ndarray, np.ndarray) Spatial coordinate matrices with shape = self.shape with dtype = float32

meshgrid_raster_in(*other*, *dtype=None*, *op=<ufunc 'floor'>*)
Compute raster coordinate matrices of *self* in *other* referential

Parameters

other: Footprint

dtype: None or convertible to np.dtype Output dtype If None: Use buzz.env.default_index_dtype

op: None or function operating on a vector Function to apply before casting output to dtype If None: Do not transform data before casting

Returns

(x, y): (np.ndarray, np.ndarray) Raster coordinate matrices with shape = self.shape with dtype = dtype

slice_in(*other*, *clip=False*)

Compute location of *self* inside *other* with slice objects. If other and self do not have the same rotation, operation is undefined

Parameters

other: Footprint

clip: bool

False Does nothing

True Clip the slices to other bounds. If other and self do not share area, at least one of the returned slice will have *slice.start == slice.stop*

Returns

(yslice, xslice): (slice, slice)

Example

Burn *small* into *big* if *small* is within *big* >>> big_data[small.slice_in(big)] = small_data

Burn *small* into *big* where overlapping >>> big_data[small.slice_in(big, clip=True)] = small_data[big.slice_in(small, clip=True)]

spatial_to_raster(*xy*, *dtype=None*, *op=<ufunc 'floor'>*)

Convert xy spatial coordinates to raster xy indices

Parameters

xy: sequence of numbers of shape (..., 2) Spatial coordinates

dtype: None or convertible to np.dtype Output dtype If None: Use buzz.env.default_index_dtype

op: None or vectorized function Function to apply before casting output to dtype If None: Do not transform data before casting

Returns

out_xy: np.ndarray Raster indices with shape = np.asarray(xy).shape with dtype = dtype

Prototype inspired from https://mapbox.github.io/rasterio/api/rasterio.io.html#rasterio.io.TransformMethodsMixin.index

raster_to_spatial (*xy*)
Convert xy raster coordinates to spatial coordinates

Parameters

xy: sequence of numbers of shape (..., 2) Raster coordinages

Returns

out_xy: np.ndarray Spatial coordinates with shape = np.asarray(xy).shape with dtype = dtype

find_lines (*arr*, *output_offset='middle'*, *merge=True*)
Create a list of line-strings from a mask. Works with connectivity 4 and 8. The input raster is preprocessed using *skimage.morphology.thin*. The output linestrings are postprocessed using *shapely.ops.linemerge*.

> **Warning:** All standalone pixels contained in arr will be ignored.

Parameters

arr: np.ndarray of bool of shape (self.shape)

output_offset: 'middle' or (nbr, nbr) Coordinate offset in meter if *middle*: substituted by *self.pxvec / 2*

Returns

list of shapely.geometry.LineString

Exemple

```
>>> import buzzard as buzz
>>> import numpy as np
>>> import networkx as nx
```

```
>>> with buzz.Env(allow_complex_footprint=1):
...     a = np.asarray([
...         [0, 1, 1, 1, 0],
...         [0, 1, 0, 0, 0],
...         [0, 1, 1, 1, 0],
...         [0, 1, 0, 0, 0],
...         [0, 1, 1, 0, 0],
...
...     ])
...     fp = buzz.Footprint(gt=(0, 1, 0, 0, 0, 1), rsize=(a.shape))
```

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```
...     lines = fp.find_lines(a, (0, 0))
...
...     # Display input / output
...     print(fp)
...     print(a.astype(int))
...     for i, l in enumerate(lines, 1):
...         print(f'edge-id:{i} of type:{type(l)} and length:{l.length}')
...         print(fp.burn_lines(l).astype(int) * i)
...
...     # Build a networkx graph
...     g = nx.Graph([(l.coords[0], l.coords[-1]) for l in lines])
...     print(repr(g.degree))
...
Footprint(tl=(0.000000, 0.000000), scale=(1.000000, 1.000000), angle=0.000000,
↪ rsize=(5, 5))
[[0 1 1 1 0]
 [0 1 0 0 0]
 [0 1 1 1 0]
 [0 1 0 0 0]
 [0 1 1 0 0]]
edge-id:1 of type:<class 'shapely.geometry.linestring.LineString'> and␣
↪length:2.0
[[0 0 0 0 0]
 [0 0 0 0 0]
 [0 1 1 1 0]
 [0 0 0 0 0]
 [0 0 0 0 0]]
edge-id:2 of type:<class 'shapely.geometry.linestring.LineString'> and␣
↪length:3.0
[[0 0 0 0 0]
 [0 0 0 0 0]
 [0 2 0 0 0]
 [0 2 0 0 0]
 [0 2 2 0 0]]
edge-id:3 of type:<class 'shapely.geometry.linestring.LineString'> and␣
↪length:4.0
[[0 3 3 3 0]
 [0 3 0 0 0]
 [0 3 0 0 0]
 [0 0 0 0 0]
 [0 0 0 0 0]]
DegreeView({(3.0, 2.0): 1, (1.0, 2.0): 3, (2.0, 4.0): 1, (3.0, 0.0): 1})
```

burn_lines(*obj*, *all_touched=False*, *labelize=False*)

Creates a 2d image from lines. Uses gdal.Polygonize.

Parameters

obj: shapely line or nested iterators over shapely lines

labelize: bool

- if *False*: Create a boolean mask
- if *True*: Create an integer matrix containing lines indices from order in input

Returns

np.ndarray

- of bool or uint8 or int
- of shape (self.shape)

find_polygons(*mask*)
Creates a list of polygons from a mask. Uses gdal.Polygonize.

> **Warning:** This method is not equivalent to *cv2.findContours* that considers that pixels are points and therefore returns the indices of the pixels of the contours of the features.
>
> This method consider that the pixels are areas and therefore returns the coordinates of the points that surrounds the features.

> **Warning:** Some inputs that may produce invalid polygons (see below) are fixed with the *shapely.geometry.Polygon.buffer* method.
>
> Shapely will issue several warnings while buzzard fixes the polygons.

```
>>> # 0 0 0 0 0 0 0
... # 0 1 1 1 0 0 0
... # 0 1 1 1 1 0 0
... # 0 1 1 1 0 1 0  <- This feature has a hole near an edge. GDAL␣
↪produces a self
... # 0 1 1 1 1 1 1     touching polygon without holes. A polygon with one␣
↪hole is
... # 0 1 1 1 1 1 1     returned with this method.
... # 0 0 0 0 0 0 0
```

Parameters

arr: np.ndarray of bool of shape (self.shape)

Returns

list of shapely.geometry.Polygon

burn_polygons(*obj*, *all_touched=False*, *labelize=False*)
Creates a 2d image from polygons. Uses gdal.RasterizeLayer.

> **Warning:** This method is not equivalent to *cv2.drawContours* that considers that pixels are points and therefore expect as input the indices of the outer pixels of each feature.
>
> This method consider that the pixels are areas and therefore expect as input the coordinates of the points surrounding the features.

Parameters

obj: shapely polygon or nested iterators over shapely polygons

all_touched: bool Burn all polygons touched

Returns

np.ndarray of bool or uint8 or int of shape (self.shape)

Examples

```
>>> burn_polygons(poly)
>>> burn_polygons([poly, poly])
>>> burn_polygons([poly, poly, [poly, poly], multipoly, poly])
```

tile(*size*, *overlapx=0*, *overlapy=0*, *boundary_effect='extend'*, *boundary_effect_locus='br'*)
Tile a Footprint to a matrix of Footprint

Parameters

size: (int, int) Tile width and tile height, in pixel

overlapx: int Width of a tile overlapping with each direct horizontal neighbors, in pixel

overlapy: int Height of a tile overlapping with each direct vertical neighbors, in pixel

boundary_effect: {'extend', 'exclude', 'overlap', 'shrink', 'exception'} Behevior at boundary effect locus

- **'extend'**
  - Preserve tile size
  - Preserve overlapx and overlapy
  - Sacrifice global bounds, results in tiles partially outside bounds at locus (if necessary)
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'overlap'**
  - Preserve tile size
  - Sacrifice overlapx and overlapy, results in tiles overlapping more at locus (if necessary)
  - Preserve global bounds
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'exclude'**
  - Preserve tile size
  - Preserve overlapx and overlapy
  - Preserve global bounds
  - Sacrifice tile count, results in tiles excluded at locus (if necessary)
  - Sacrifice boundary pixels coverage at locus (if necessary)
- **'shrink'**

  - Sacrifice tile size, results in tiles shrinked at locus (if necessary)
  - Preserve overlapx and overlapy
  - Preserve global bounds
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'exception'**
  - Raise an exception if tiles at locus do not lie inside the global bounds

boundary_effect_locus: {'br', 'tr', 'tl', 'bl'} Locus of the boundary effects

- 'br' : Boundary effect occurs at the bottom right corner of the raster, top left coordinates are preserved
- 'tr' : Boundary effect occurs at the top right corner of the raster, bottom left coordinates are preserved
- 'tl' : Boundary effect occurs at the top left corner of the raster, bottom right coordinates are preserved
- 'bl' : Boundary effect occurs at the bottom left corner of the raster, top right coordinates are preserved

Returns

np.ndarray

- of dtype=object (Footprint)
- of shape (M, N)
  - with M the line count
  - with N the column count

tile_count(*rowcount*, *colcount*, *overlapx=0*, *overlapy=0*, *boundary_effect='extend'*, *boundary_effect_locus='br'*)

Tile a Footprint to a matrix of Footprint

Parameters

rowcount: int Tile count per row

colcount: int Tile count per column

overlapx: int Width of a tile overlapping with each direct horizontal neighbors, in pixel

overlapy: int Height of a tile overlapping with each direct vertical neighbors, in pixel

boundary_effect: {'extend', 'exclude', 'overlap', 'shrink', 'exception'} Behevior at boundary effect locus

- **'extend'**
  - Preserve tile size
  - Preserve overlapx and overlapy
  - Sacrifice global bounds, results in tiles partially outside bounds at locus (if necessary)

  - Preserve tile count
  - Preserve boundary pixels coverage
- **'overlap'**
  - Preserve tile size
  - Sacrifice overlapx and overlapy, results in tiles overlapping more at locus (if necessary)
  - Preserve global bounds
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'exclude'**
  - Preserve tile size
  - Preserve overlapx and overlapy
  - Preserve global bounds
  - Preserve tile count
  - Sacrifice boundary pixels coverage at locus (if necessary)
- **'shrink'**
  - Sacrifice tile size, results in tiles shrinked at locus (if necessary)
  - Preserve overlapx and overlapy
  - Preserve global bounds
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'exception'**
  - Raise an exception if tiles at locus do not lie inside the global bounds

boundary_effect_locus: {'br', 'tr', 'tl', 'bl'} Locus of the boundary effects

- 'br' : Boundary effect occurs at the bottom right corner of the raster, top left coordinates are preserved
- 'tr' : Boundary effect occurs at the top right corner of the raster, bottom left coordinates are preserved

tile_occurrence(*size*, *pixel_occurrencex*, *pixel_occurrencey*, *boundary_effect='extend'*, *boundary_effect_locus='br'*)

Tile a Footprint to a matrix of Footprint Each pixel occur *pixel_occurrencex* * *pixel_occurrencey* times overall in the output

Parameters

size: (int, int) Tile width and tile height, in pixel

pixel_occurrencex: int Number of occurence of each pixel in a line of tile

pixel_occurrencey: int Number of occurence of each pixel in a column of tile

boundary_effect: {'extend', 'exclude', 'overlap', 'shrink', 'exception'} Behevior at boundary effect locus

- **'extend'**
  - Preserve tile size
  - Preserve overlapx and overlapy
  - Sacrifice global bounds, results in tiles partially outside bounds at locus (if necessary)
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'overlap'**
  - Preserve tile size
  - Sacrifice overlapx and overlapy results in tiles overlapping more at locus (if necessary)
  - Preserve global bounds
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'exclude'**
  - Preserve tile size
  - Preserve overlapx and overlapy
  - Preserve global bounds
  - Sacrifice tile count, results in tiles excluded at locus (if necessary)
  - Sacrifice boundary pixels coverage at locus (if necessary)
- **'shrink'**
  - Sacrifice tile size, results in tiles shrinked at locus (if necessary)
  - Preserve overlapx and overlapy
  - Preserve global bounds
  - Preserve tile count
  - Preserve boundary pixels coverage
- **'exception'** Raise an exception if tiles at locus do not lie inside the global bounds

boundary_effect_locus: {'br', 'tr', 'tl', 'bl'} Locus of the boundary effects

- 'br' : Boundary effect occurs at the bottom right corner of the raster top left coordinates are preserved
- 'tr' : Boundary effect occurs at the top right corner of the raster, bottom left coordinates are preserved
- 'tl' : Boundary effect occurs at the top left corner of the raster, bottom right coordinates are preserved
- 'bl' : Boundary effect occurs at the bottom left corner of the raster, top right coordinates are preserved

Returns

np.ndarray

- of dtype=object (Footpr

int) - of shape (M, N)

- with M the line count
- with N the column count

__str__()
Return str(self).

__repr__()
Return repr(self).

__reduce__()
Helper for pickle.

__hash__()
Return hash(self).

1.4 Env

class buzzard.**Env**(***kwargs*)
Context manager to update buzzard's states

Parameters

significant: int Number of significant digits for floating point comparisons Initialized to *9.0* see: https://github.com/airware/buzzard/wiki/Precision-system see: https://github.com/airware/buzzard/wiki/Floating-Point-Considerations

default_index_dtype: convertible to np.dtype Default numpy return dtype for array indices. Initialized to *np.int32* (signed to allow negative indices by default)

allow_complex_footprint: bool Whether to allow non north-up / west-left Footprints Initialized to *False*

Example

```
>>> import buzzard as buzz
>>> with buzz.Env(default_index_dtype='uint64'):
        ds = buzz.Dataset()
        dsm = ds.aopen_raster('dsm', 'path/to/dsm.tif')
        x, y = dsm.meshgrid_raster
        print(x.dtype)
numpy.uint64
```

__enter__()

__exit__(*exc_type=None*, *exc_val=None*, *exc_tb=None*)

buzzard.**env = <buzzard._env._CurrentEnv object>**

1.5 Misc.

buzzard.**open_raster**(**args*, ***kwargs*)
Shortcut for *Dataset().aopen_raster*

```
>>> help(Dataset.open_raster)
```

See Also

- *Dataset.open_raster()*
- *Dataset.aopen_raster()*

buzzard.**create_raster**(**args*, ***kwargs*)
Shortcut for *Dataset().acreate_raster*

```
>>> help(Dataset.create_raster)
```

See Also

- *Dataset.create_raster()*
- *Dataset.acreate_raster()*

buzzard.**wrap_numpy_raster**(**args*, ***kwargs*)
Shortcut for *Dataset().awrap_numpy_raster*

```
>>> help(Dataset.wrap_numpy_raster)
```

See Also

- *Dataset.wrap_numpy_raster()*
- *Dataset.awrap_numpy_raster()*

buzzard.**open_vector**(**args*, ***kwargs*)
Shortcut for *Dataset().aopen_vector*

```
>>> help(Dataset.open_vector)
```

See Also

- *Dataset.open_vector()*
- *Dataset.aopen_vector()*

buzzard.**create_vector**(**args*, ***kwargs*)
Shortcut for *Dataset().acreate_vector*

```
>>> help(Dataset.create_vector)
```

See Also

- *Dataset.create_vector()*
- *Dataset.acreate_vector()*

buzzard.utils.**concat_arrays**(*fp*, *array_per_fp*, *_*)

Concatenate arrays from *array_per_fp* to form *fp*.

This function is meant to be fed to the *merge_arrays* parameter when constructing a recipe.

CHAPTER

TWO

CAVEATS, FAQS AND DESIGN CHOICES

Buzzard has a lot of ambition but is still a young library with several caveats. Are you currently trying to determine if buzzard is the right choice for your project? We got you covered and listed here the use-cases that are currently poorly supported. The rest is a bliss!

2.1 Caveat List

2.1.1 Installation

→ `buzzard` installation is complex because of the `GDAL` and `rtree` dependencies.

→ The anaconda package does not exist

2.1.2 Rasters

→ Reading a raster file is currently internally performed by calls to GDAL drivers, and it might be too slow under certain circumstances. Tweaking the `GDAL_CACHEMAX` variable may improve performances.

→ On-the-fly reprojections is an ambitious feature of buzzard, but this feature only reaches its full potential with vectorial data. On-the-fly raster reprojections are currently partially supported. Those only work if the reprojection preserve angles, if not an exception is raised.

2.1.3 Floating point precision losses

→ The biggest plague of a GIS library is the floating point precision losses. On one hand those losses cannot be avoided (such as in a reprojection operation), and on the other hand certain operations can only be performed with noise-free numbers (such as the floor or ceil operations). The only solution is to round those numbers before critical operations. buzzard has its own way of dealing with this problem: it introduces a global variable to define the number of significant digits that should be considered as noise-less (9 by default).

This way buzzard tries to catch the errors early and raise exceptions. But despite all those efforts some bugs still occur when the noise reaches the significant digits, resulting in strange exceptions being raise.

However those bugs only occur when manipulating very small pixels along with very large coordinates, which is not usual (the ratio `coordinate/pixel-size` should not exceede `10 ** env.significant`).

2.1.4 The Footprint class

→ The Footprint class is long to instanciate (~0.5ms), several use cases involving masses of Footprints are impractical because of this.

→ The Footprint class is the key feature of buzzard, but its specifications are broader that its unit tests: the non-north-up rasters are not fully unit tested. To instanciate such a Footprint the `buzz.env.allow_complex_footprint` should be set to `True`. However those Footprints should work fine in general

→ The Footprint class lack some higher lever constructors to make several common construction schemes easier. However by using the intersection method of a Footprint on itself and tweaking the 3 optional parameters covers most of the missing use-cases.

2.1.5 The async rasters

→ Most of the async rasters as advertised in the doc or the examples are not yet implemented. Only the cached raster recipes are.

→ Using cached raster recipes has a side effect on a file system. Using a single cache directory from two different programs at the same time is an undefined behavior. Although it works fine when the cache files are already instantiated.

→ The scheduler that was written to support the async rasters is not proven to be bug free. Although it is filled with assertions that will most likely catch any remaining bug.

2.2 FAQs and design choices

The following list contains the FAQs or features that are often mistaken as bugs ;)

→ Why buzzard instead of fiona or rasterio that are much more mature and straightforward libraries?

The answer is simple: when working with large images and geometries altogether you can benefit from the higher level abstractions that buzzard provides.

→ Why can't I simply reproject shapely geometries using buzzard? Because buzzard does not aim to replace pyproj. When using the classic stack, each of osgeo's lib has its own wrapper. GEOS -> shapely OGR -> fiona GDAL -> rio OSR -> pyproj

Buzzard is transversal, it wraps enough OGR, GDAL and OSR so that you don't have import those most of the time. Some known exceptions are:

- Raster reprojection that does not preserve angles
- Shapely objects reprojection
- Contour lines generation

It might be the case that someday buzzard provides a transversal feature that replaces pyproj but nothing is planned.

→ In buzzard all sources (such as raster and vector files) are tied to a Dataset object. This is design choice has several advantages now and even more advantages in the long term.

→ buzzard is a binding for GDAL, but all the features that allows editing the attributes of an opened file are not exposed in buzzard. The wish here is to make buzzard as functional as possible.

→ The `with Dataset.close as ds:` syntax is chosen over the `with Dataset as ds:` syntax in order to stay consistent with the `with Source.close as src:` syntax, that itself exist because of the need for disambiguation with this other feature: `with Source.delete as src:`.

→ The Footprint class is an immutable object. This is not a bug.

→ Why is the Footprint class not directly implementing a shapely Polygon?

In the early versions of buzzard, it was the case. But method name conflicts became a big problem. And overall, it was not that useful. You can still use Footprint.poly to convert a Footprint to a shapely Polygon.

→ Why support non-north-up Footprints?

It was harder to design but cleaner in the end. Now that it is (mostly - missing unit tests at the moment) supported there is a hope that it creates new use cases.

→ Why are the get_data and set_data methods of a raster so complex?

Those methods accept **any** Footprint as a parameter, it includes Footprints that don't share alignment/scale/rotation/bounds with the raster source. It allows the user to forget about the file when designing a piece of code. The downside of this feature is that the user is not aware when a resource consuming resampling is performed. To avoid this problem, the Dataset class is by default configured to raise an error when an interpolation occurs.

→ If you ever wander in the buzzard source code you may notice that the Dataset class holds pointers to Source objects and vice versa (through dependency injection). This recursive dependency reveal the design choice of making the Dataset and the Source classes a **single** class. The Source objects should be seen as extensions of a Dataset object.

→ If you ever wander in the buzzard source code you will notice a complex separation of concern scheme in which a class is split between a `facade` and a `back` class.

This separation exists in order to allow garbage collection to be made, even if the Dataset instantiates a scheduler on a separate thread. The facade classes are manipulated by the user and have pointers towards the back classes, and the later have no references to the facade, while the scheduler only have pointers to the `back` classes. This way, when the facade are collected, the back are collected too. This separation also allows us to perform parameter checking only once in the facade classes, and then call the appropriate back implementation using dynamic dispatch.

CHAPTER

THREE

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