Telluric Documentation

Release v0.13.1

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CONTENTS:

telluric is a Python library to manage vector and raster geospatial data in an interactive and easy way.

The source code and issue tracker are hosted on GitHub, and all contributions and feedback are more than welcome. There is a public chat for users and developers too.

CHAPTER

ONE

INSTALLATION

You can install telluric using pip:

```
pip install telluric[vis]
```

telluric is a pure Python library, and therefore should work on Linux, OS X and Windows provided that you can install its dependencies. If you find any problem, please open an issue and we will take care of it.

> **Warning:** It is recommended that you **never ever use sudo** with pip because you might seriously break your system. Use venv, Pipenv, pyenv or conda to create an isolated development environment instead.

1.1 User Guide

1.1.1 Geometries on a map: `GeoVector`

[1]:
```
import telluric as tl
from telluric.constants import WGS84_CRS, WEB_MERCATOR_CRS
```

The simplest geometrical element in telluric is the GeoVector: it represents a shape in some coordinate reference system (CRS). The easiest way to create one is to use the `GeoVector.from_bounds` method:

[2]:
```
gv1 = tl.GeoVector.from_bounds(
    xmin=0, ymin=40, xmax=1, ymax=41, crs=WGS84_CRS
)
print(gv1)
```

```
GeoVector(shape=POLYGON ((0 40, 0 41, 1 41, 1 40, 0 40)), crs=CRS({'init': 'epsg:4326
↪'}))
```

If we print the object, we see its two defining elements: a shape (actually a shapely `BaseGeometry` object) and a CRS (in this case WGS84 or http://epsg.io/4326). Rather than reading a dull representation, we can directly visualize it in the notebook:

[3]:
```
gv1
```

```
/home/juanlu/Satellogic/telluric/telluric/plotting.py:141: UserWarning: Plotting a␣
↪limited representation of the data, use the .plot() method for further customization
  "Plotting a limited representation of the data, use the .plot() method for further␣
↪customization")
```

[3]:

You can ignore the warning for the moment. Advanced plotting techniques are not yet covered in this User Guide.

As you can see, we have an interactive Web Mercator map where we can display our shape. We can create more complex objects using the Shapely library:

[4]:
```
from shapely.geometry import Polygon

gv2 = tl.GeoVector(
    Polygon([(0, 40), (1, 40.1), (1, 41), (-0.5, 40.5), (0, 40)]),
    WGS84_CRS
)
print(gv2)
```

```
GeoVector(shape=POLYGON ((0 40, 1 40.1, 1 41, -0.5 40.5, 0 40)), crs=CRS({'init':
↪'epsg:4326'}))
```

And we can access any property of the underlying geometry using the same attribute name:

[5]:
```
print(gv1.centroid)
```

```
GeoVector(shape=POINT (0.5 40.5), crs=CRS({'init': 'epsg:4326'}))
```

[6]:
```
gv1.area  # Real area in square meters
```

[6]:
```
9422706289.175217
```

[7]:
```
gv1.is_valid
```

[7]:
```
True
```

[8]:
```
gv1.within(gv2)
```

[8]:
```
False
```

[9]:
```
gv1.difference(gv2)
```

```
/home/juanlu/Satellogic/telluric/telluric/plotting.py:141: UserWarning: Plotting a␣
↪limited representation of the data, use the .plot() method for further customization
  "Plotting a limited representation of the data, use the .plot() method for further␣
↪customization")
```

[9]:

1.1.2 Geometries with attributes: `GeoFeature` and `FeatureCollection`

The next object in the telluric hierarchy is the GeoFeature: a combination of a `GeoVector` + some attributes. These attributes can represent land use, types of buildings, and so forth.

[10]:
```
gf1 = tl.GeoFeature(
    gv1,
    {'name': 'One feature'}
)
gf2 = tl.GeoFeature(
    gv2,
```

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```
    {'name': 'Another feature'}
)
print(gf1)
print(gf2)
```

```
GeoFeature(Polygon, {'name': 'One feature'})
GeoFeature(Polygon, {'name': 'Another feature'})
```

But the most interesting thing is to combine these features into a FeatureCollection. A `FeatureCollection` is essentially a sequence of features, with some additional methods:

[11]:
```
fc = tl.FeatureCollection([gf1, gf2])
fc
```

```
/home/juanlu/Satellogic/telluric/telluric/plotting.py:141: UserWarning: Plotting a␣
↪limited representation of the data, use the .plot() method for further customization
  "Plotting a limited representation of the data, use the .plot() method for further␣
↪customization")
```

[11]:
```
<telluric.collections.FeatureCollection at 0x7f283ea41f60>
```

[12]:
```
print(fc.convex_hull)
```

```
GeoVector(shape=POLYGON ((0 40, -0.5 40.5, 0 41, 1 41, 1 40, 0 40)), crs=CRS({'init':
↪'epsg:4326'}))
```

[13]:
```
print(fc.envelope)
```

```
GeoVector(shape=POLYGON ((-0.5 40, 1 40, 1 41, -0.5 41, -0.5 40)), crs=CRS({'init':
↪'epsg:4326'}))
```

1.1.3 Input and Output

Apart from all the previous geospatial operations, we can also save these `FeatureCollection` objects to disk, for example using the GeoJSON or ESRI Shapefile formats:

[14]:
```
fc.save("test_fc.shp")
```

[15]:
```
!ls test_fc*
```

```
test_fc.cpg  test_fc.dbf  test_fc.json       test_fc.prj  test_fc.shp  test_fc.shx
```

[16]:
```
fc.save("test_fc.json")
```

[17]:
```
!python -m json.tool < test_fc.json | head -n28
```

```
{
    "type": "FeatureCollection",
    "crs": {
        "type": "name",
        "properties": {
            "name": "urn:ogc:def:crs:OGC:1.3:CRS84"
        }
    },
    "features": [
        {
```

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```
            "type": "Feature",
            "properties": {
                "name": "One feature",
                "highlight": {},
                "style": {}
            },
            "geometry": {
                "type": "Polygon",
                "coordinates": [
                    [
                        [
                            0.0,
                            40.0
                        ],
                        [
                            0.0,
                            41.0
                        ],
```

To retrieve this data from disk again, we can use another object, `FileCollection`, which behaves in the same way as a `FeatureCollection` but does some smart optimizations so the files are not read completely into memory:

[18]:
```
print(list(tl.FileCollection.open("test_fc.shp")))
```

```
[GeoFeature(Polygon, {'name': 'One feature', 'highlight': '{}', 'style': '{}'}),␣
↪GeoFeature(Polygon, {'name': 'Another feature', 'highlight': '{}', 'style': '{}'})]
```

1.1.4 Raster data: `GeoRaster2`

After reviewing how to read, manipulate and write vector data, we can use GeoRaster2 to do the same thing with raster data. `GeoRaster2` will read the raster lazily so we only retrieve the information that we need.

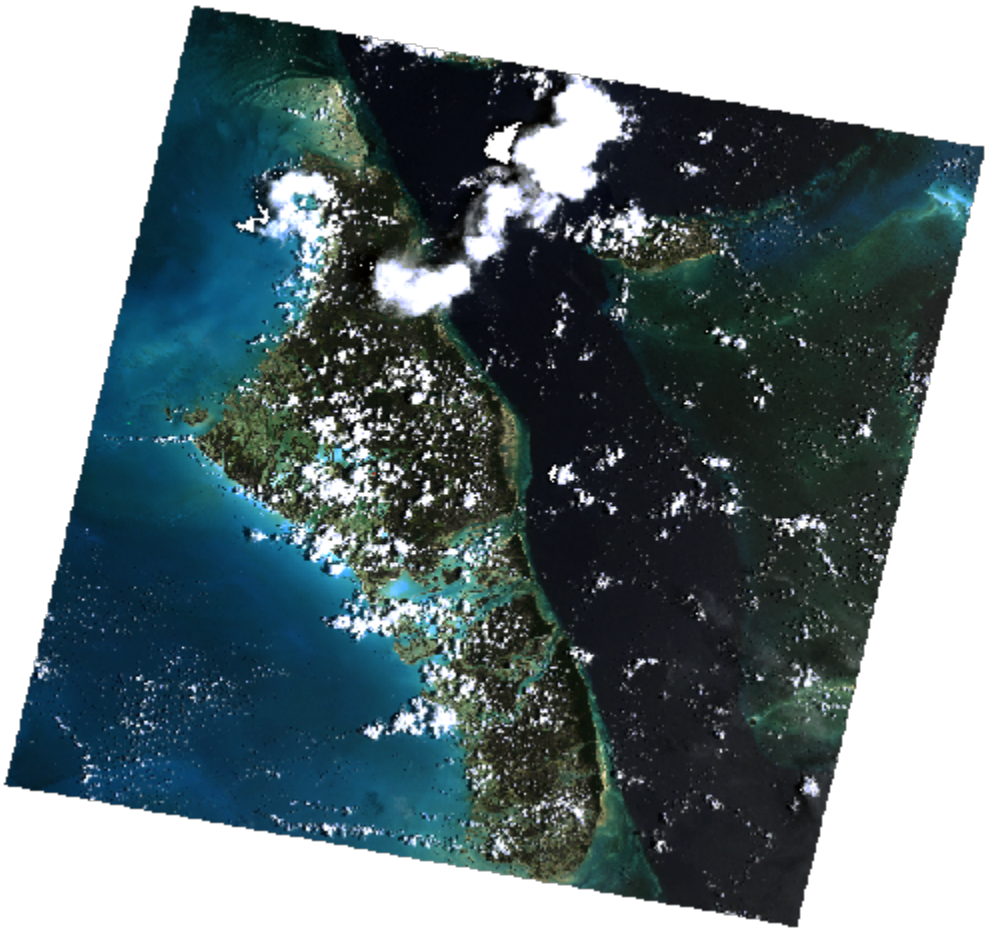
[19]:
```
# This will only save the URL in memory
rs = tl.GeoRaster2.open(
    "https://github.com/mapbox/rasterio/raw/master/tests/data/rgb_deflate.tif"
)

# These calls will fecth some GeoTIFF metadata
# without reading the whole image
print(rs.crs)
print(rs.footprint())
print(rs.band_names)
```

```
CRS({'init': 'epsg:32618'})
GeoVector(shape=POLYGON ((101984.9999999127 2826915, 339314.9999997905 2826915,␣
↪339314.9999998778 2611485, 101985.0000002096 2611485, 101984.9999999127 2826915)),␣
↪crs=CRS({'init': 'epsg:32618'}))
[0, 1, 2]
```

`GeoRaster2` also displays itself automatically:

[20]:
```
rs
```

[20]:



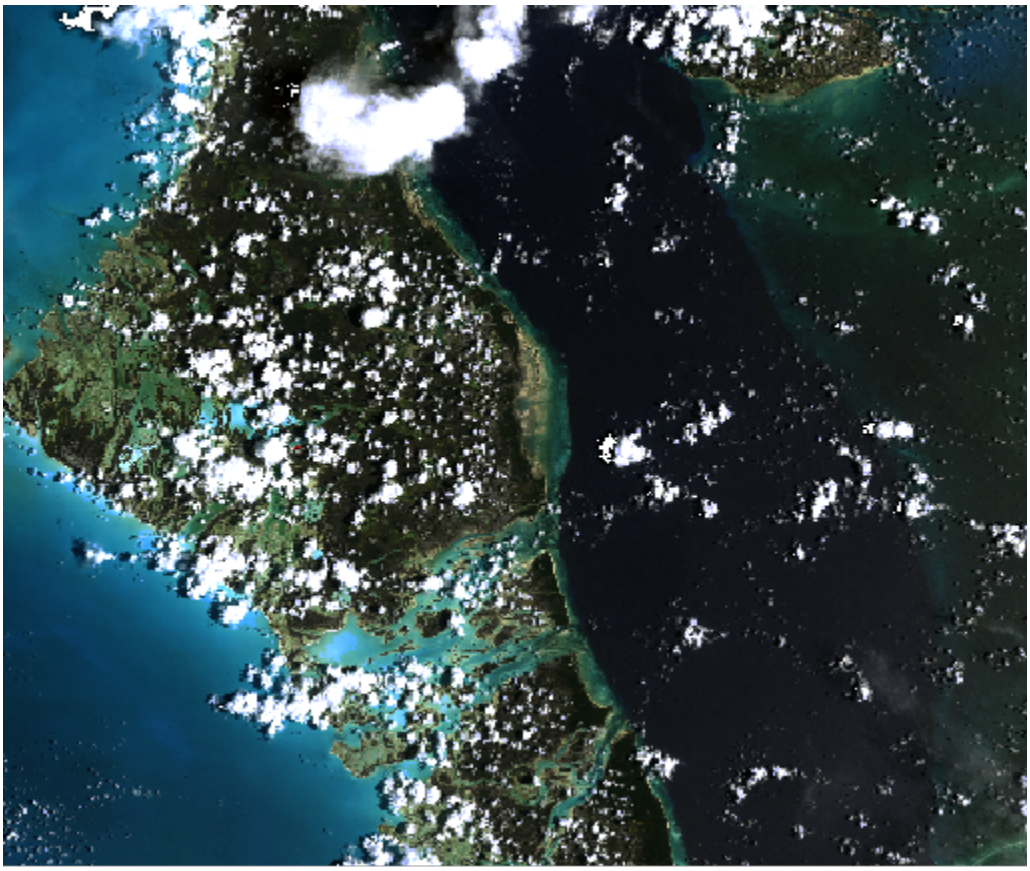
We can slice it like an array, or cropping some parts to discard others:

[21]:
```
rs.shape
```

[21]:
```
(3, 718, 791)
```

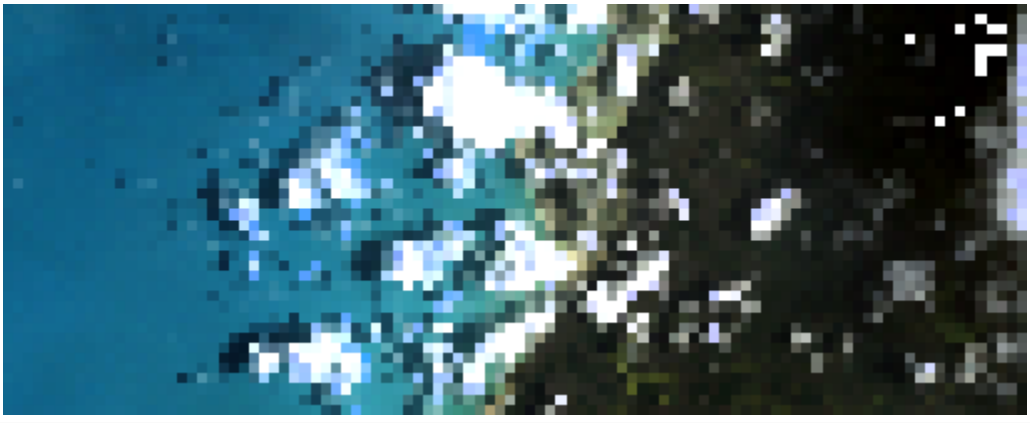
[22]:
```
rs.crop(rs.footprint().buffer(-50000))
```

[22]:



[23]:
```
rs[200:300, 200:240]
```

[23]:



And save again to GeoTIFF format using a variety of options:

[24]:
```
rs[200:300, 200:240].save("test_raster.tif")
```

1.1.5 Conclusion

There are many things not covered in this User Guide. The documentation of telluric is a work in progress, so we encourage you to read the full API reference and even contribute to the package!

1.2 API Reference

1.2.1 telluric.constants module

1.2.2 telluric.vectors module

1.2.3 telluric.features module

1.2.4 telluric.collections module

1.2.5 telluric.georaster module

1.2.6 telluric.plotting module

1.2.7 telluric.util package

1.3 Changelog

1.3.1 telluric 0.13.1 (2020-11-26)

Changes

- Fix imports when visualization dependencies are not installed (#281)
- Remove several deprecation warnings (#281)

1.3.2 telluric 0.13.0 (2020-11-25)

Changes

- Make visualization dependencies optional (#260)

1.3.3 telluric 0.12.1 (2020-08-10)

Bug fixes

- Check if the raster's footprint intersects the tile's footprint in `telluric.georaster.GeoRaster2.get_tile()` (#273)

1.3.4 telluric 0.12.0 (2020-08-02)

New features

- Preserve nodata value while saving rasters (#271)
- FileCollection created out of file-like object can be iterated (#272)

1.3.5 telluric 0.11.1 (2020-06-27)

Bug fixes

- Fix `telluric.collections.FileCollection.sort()` (#259)
- Fix potential bug in `ThreadContext` when it is uninitialized (#259)
- Disable transformation if source CRS equals to destination (#270)

1.3.6 telluric 0.11.0 (2019-12-02)

New features

- Now `MutableGeoRaster` inherits `nodata_value`

1.3.7 telluric 0.10.8 (2019-08-30)

Bug fixes

- Now reprojection retains nodata values

1.3.8 telluric 0.10.7 (2019-06-06)

New features

- Adding support of resources accesed through HTTP and HTTPS to VRT (#248)

Big fixes

- Remove unnecessary call of `fiona.Env` (#247)

1.3.9 telluric 0.10.6 (2019-05-02)

New features

- Creating COG with internal mask (#244)
- Removed pinning for pyproj (#245)

1.3.10 telluric 0.10.5 (2019-04-08)

Bug fixes

- Workaround to overcome impossible transformations (#241)

1.3.11 telluric 0.10.4 (2019-03-17)

Bug fixes

- Prevent image loading while copying (#235)

New features

- Refactored raster join implementation (#230)
- Changed default value of "nodata" in `GeoRaster2` constructor, now it is `None` (#231)
- Accelerate tests (#232)
- Added new method `telluric.georaster.GeoRaster2.mask_by_value()` (#233)
- Added new method `telluric.vectors.GeoVector.from_record()` (#238)
- Rasterio 1.0.21 compatibility (#239)
- Adding support to lazy resize that can use overviews if exist (#240)

1.3.12 telluric 0.10.3 (2019-01-10)

Bug fixes

- Fix `FeatureCollection` plotting (#229)

1.3.13 telluric 0.10.2 (2019-01-10)

New features

- SpatioTemporal Asset Catalog (STAC) compatibility (#223)
- Support custom schema in `telluric.collections.BaseCollection.save()` (#224)

Bug fixes

- Preserve the original schema while using `telluric.collections.BaseCollection.apply()` and `telluric.collections.BaseCollection.groupby()` (#225)
- Better handling of an empty collections (#226)
- Remove the reference to the raster object in the asset entry (#227)
- Retrieve mask in a safer way to avoid shrunk masks (#228)

1.3.14 telluric 0.10.1 (2018-12-27)

Bug fixes

- Fix masking by `GeoFeature` (#216)
- Fix issue in `GeoRaster.from_asset()` (#217, #220)
- `telluric.features.GeoFeature.envelope()` returns instance of `GeoVector` (#218)
- Use local tile server for visualization of `GeoFeatureWithRaster` (#221)
- `telluric.georaster.GeoRaster2.mask()` uses crop internally to reduce memory footprint (#219)
- `telluric.georaster.GeoRaster2.limit_to_bands()` is lazy (#222)

1.3.15 telluric 0.10.0 (2018-12-21)

New features

- Fiona 1.8.4 and Rasterio 1.0.13 compatibility (#207, #208)
- Support multiple rasters in a single `GeoFeatureWithRaster` (#209)
- Added new method `telluric.vectors.GeoVector.get_bounding_box()` (#213)

Bug fixes

- Remove hardcoded tile server port (#205)
- The internal state of the raster is not changed while saving (#210)
- Fix `telluric.georaster.GeoRaster2.save()` (#211)
- Fix bug in reproject (#212)
- Better handling of `telluric.features.GeoFeature.from_record()` (#214)

1.3.16 telluric 0.9.1 (2018-12-14)

New features

- LZW compression is used by default for creating COG rasters (#200)
- Added way to change port for local tile server (#202)

Bug fixes

- Fix iterating over `FileCollection` (#203)
- Fix fiona's GDAL environment issue (#204)

1.3.17 telluric 0.9.0 (2018-12-12)

New features

- Added new method `telluric.collections.FeatureCollection.from_georasters()` to create collections of rasters (#184)
- Visualization feature collection with rasters in Jupyter Notebook (#186)
- Added new method `telluric.collections.BaseCollection.apply()` (#188)
- Added new method `telluric.georaster.GeoRaster2.from_wms()` for creating rasters out of web services (#190, #192)
- Generalizing the process of making VRT files (#191, #193)
- Rasterio 1.0.11 compatibility (#194)
- Added new method `telluric.georaster.GeoRaster2.from_rasters()` to create raster out of a list of rasters (#195)
- Added support of several domains in a single VRT file (#196)

Bug fixes

- Reproject features before polygonization (#182)
- Fix `matplotlib.cm` call (#187)
- Fix `telluric.georaster.GeoRaster2.save()` (#197)
- Pin minimal version of Folium (#198)
- Fix rasterio's GDAL environment issue (#201)

1.3.18 telluric 0.8.0 (2018-11-18)

New features

- Interactive representation of rasters in Jupyter Notebook (#178)
- Fiona 1.8.1 and Rasterio 1.0.10 compatibility (#179, #180)

1.3.19 telluric 0.7.1 (2018-11-12)

Bug fixes

- Removed `pyplot` import from the module level to overcome issues at headless environments (#177)

1.3.20 telluric 0.7.0 (2018-11-06)

New features

- Added new method `telluric.georaster.GeoRaster2.chunks()` for iterating over the chunks of the raster (#169)

Bug fixes

- Workaround to overcome fiona's GDAL environment issue (#175)

1.3.21 telluric 0.6.0 (2018-11-05)

New features

- Added `resampling` parameter to `telluric.georaster.merge_all()` function (#166)
- New `telluric.vectors.GeoVector.tiles()` method for iterating over the tiles intersecting the bounding box of the vector (#167)
- Fiona 1.8.0 compatibility (#171)

Bug fixes

- Workaround to overcome rasterio's GDAL environment issue (#174)

1.3.22 telluric 0.5.0 (2018-10-26)

New features

- A new class `MutableGeoRaster` was added (#165)

1.3.23 telluric 0.4.1 (2018-10-23)

Bug fixes

- The right way to calculate `dest_resolution` in `telluric.georaster.merge_all()` if one is not provided (#163)
- Read mask only if it exists (#164)

1.3.24 telluric 0.4.0 (2018-10-19)

New features

- Rasterio 1.0.3 and higher compatibility (#152)
- Non-georeferenced images may be opened by providing `affine` and `crs` parameters to `telluric.georaster.GeoRaster2.open()` (#153)
- A new argument `crs` was added to `telluric.collections.FileCollection.open()` for opening vector files that dont't contain information about CRS (#156)
- A new `telluric.util.raster_utils.build_overviews()` utility was added (#158)

Bug fixes

- Treat 0 as legitimate value in `telluric.georaster.GeoRaster2.colorize()` (#160)
- Fix rasterization of an empty collection with callable `fill_value` (#161)

1.3.25 telluric 0.3.0 (2018-09-20)

New features

- New class `GeoFeatureWithRaster` that extends `GeoFeature`.

1.3.26 telluric 0.2.1 (2018-09-12)

Bug fixes

- Retrieve mask in a safer way in `telluric.georaster.GeoRaster2.save()` (#136)
- Fix affine calculation in `telluric.georaster.GeoRaster2.get_tile()` (#137)
- Convert dimensions to ints (#140)
- Masking areas outside the window in `telluric.georaster.GeoRaster2.get_window()` (#141)
- `telluric.georaster.merge_all()` does not crash for resolution in ROI units (#143, #146)
- Limit rasterio version to <1.0.3
- Add LICENSE into the MANIFEST (#147)

1.3.27 telluric 0.2.0 (2018-08-22)

New features

- Slicing a `FeatureCollection` now returns a `FeatureCollection` (#29, #32)
- Rasterization methods can now accept multiple fill values to produce nonbinary images (#34)
- `telluric.collections.FileCollection.save()` now saves types better (#20, #36)
- Merging functions and `telluric.georaster.GeoRaster2.empty_from_roi()` now support more ways to define the raster extent (#39, #57)

- Added utilities to convert to Cloud Optimized GeoTIFF (COG) and reproject files on disk (#45, #87)
- Raster data can be converted from/to different floating point formats thanks to enhancements in `telluric.georaster.GeoRaster2.astype()` (#33, #66)
- Added new method `telluric.georaster.GeoRaster2.colorize()` to colorize a band of a raster for visualization purposes (#81)
- Collections now have experimental "groupby/dissolve" functionality inspired by pandas and GeoPandas (#77, #98)
- Add a `telluric.georaster.PixelStrategy` enum with a new mode that allows the user to produce the "metadata" of a merge process (#68, #91)
- `telluric.vectors.GeoVector.rasterize()` can now accept a custom output CRS (#125)
- A new argument was added to the `GeoVector` constructor for disabling arguments validity checking (#126)
- Unnecessary CRS equality checking in `telluric.vectors.GeoVector.get_shape()` was removed for performance reasons (#127)

Deprecations and removals

- Rasterization methods no longer support specifying a "nodata" value, and an appropriate nodata value will be generated depending on the fill value(s) (#28, #34)
- Properties in the sense of the GeoJSON standard are now called "properties" instead of "attributes" for consistency (#84)
- Non georeferenced raster data is no longer supported (although we are considering re adding it under some restrictions) (#64, #74)
- It is not required for collections to be reprojected to output CRS for rasterization with *fill_value* (#125)

Bug fixes

- `telluric.vectors.GeoVector.from_record()` now treats `None` values properly (#37, #38)
- `GeoRaster2` methods and functions work with non isotropic resolution (#39)
- Cropping now behaves correctly with rasterio 1.0.0 (#44, #46)
- Crop size is now correctly computed for rasters in WGS84 (#61, #62)
- Fix rasterio 1.0.0 warnings regarding CRS comparison (#64, #74)
- `telluric.georaster.merge_all()` now is order independent and produces consistent results in all situations (#65, #62)
- `GeoRaster2` methods and functions work with rasters with positive y scale (#76, #78)
- `telluric.georaster.GeoRaster2.save()` with default arguments does not crash for small rasters anymore (#16, #53)
- `telluric.collections.FileCollection.save()` does not have side effects on heterogeneous collections anymore (#19, #24)
- Fix rasterization of points with default arguments (#9)

1.3.28 telluric 0.1.0 (2018-04-21)

Initial release

CHAPTER

TWO

INDICES AND TABLES

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