# Telluric Documentation

***Release 0.1.0***

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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.

# CHAPTER 1

# Installation

You can install telluric using pip:

```
pip install telluric
```

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`

```
In [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:

```
In [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:

```
In [3]: gv1
```

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

---

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:

```
In [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:

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

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

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

```
Out[6]: 9422706289.175217
```

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

```
Out[7]: True
```

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

```
Out[8]: False
```

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

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

### 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.

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

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

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

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

```
In [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'}))
```

```
In [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:

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

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

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

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

```
In [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": [
        {
            "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:

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

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

### 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.

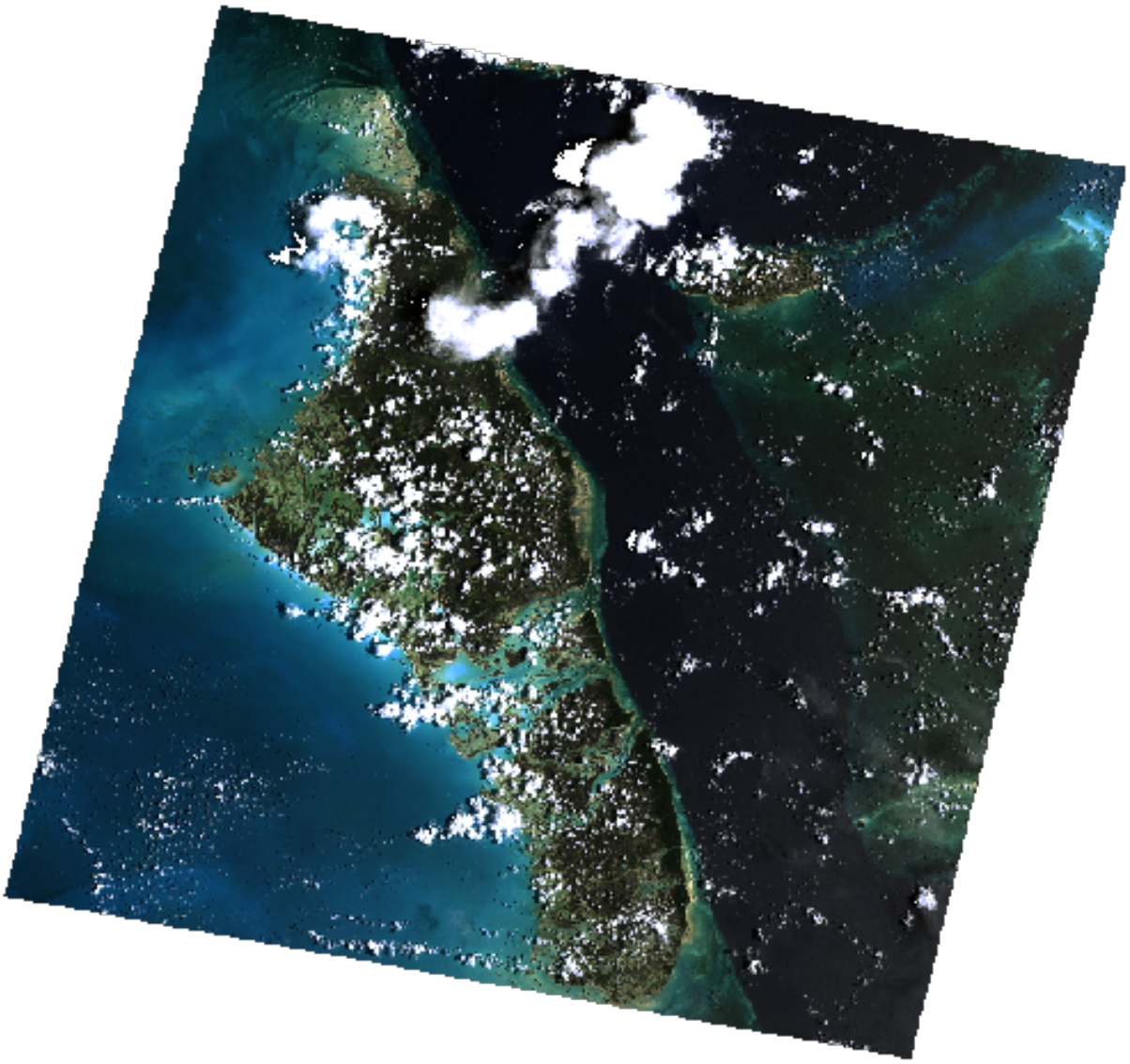
```
In [19]: # This will only save the URL in memory
         rs = tl.GeoRaster2.open(
             "https://github.com/mapbox/rasterio/raw/master/tests/data/rgb_deflate.tif"
         )

         # 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 261
[0, 1, 2]
```

`GeoRaster2` also displays itself automatically:

```
In [20]: rs
```

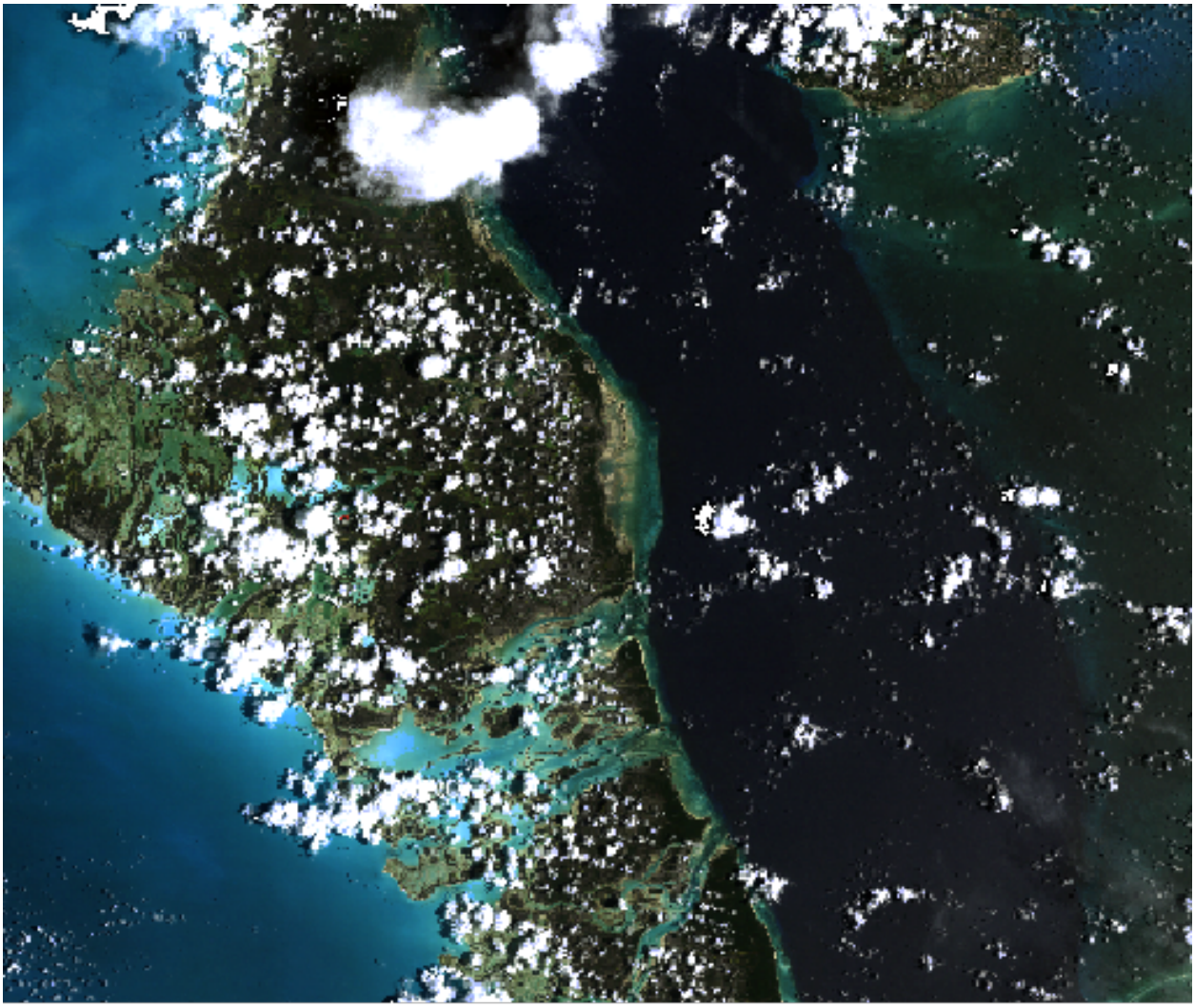


We can slice it like an array, or cropping some parts to discard others:

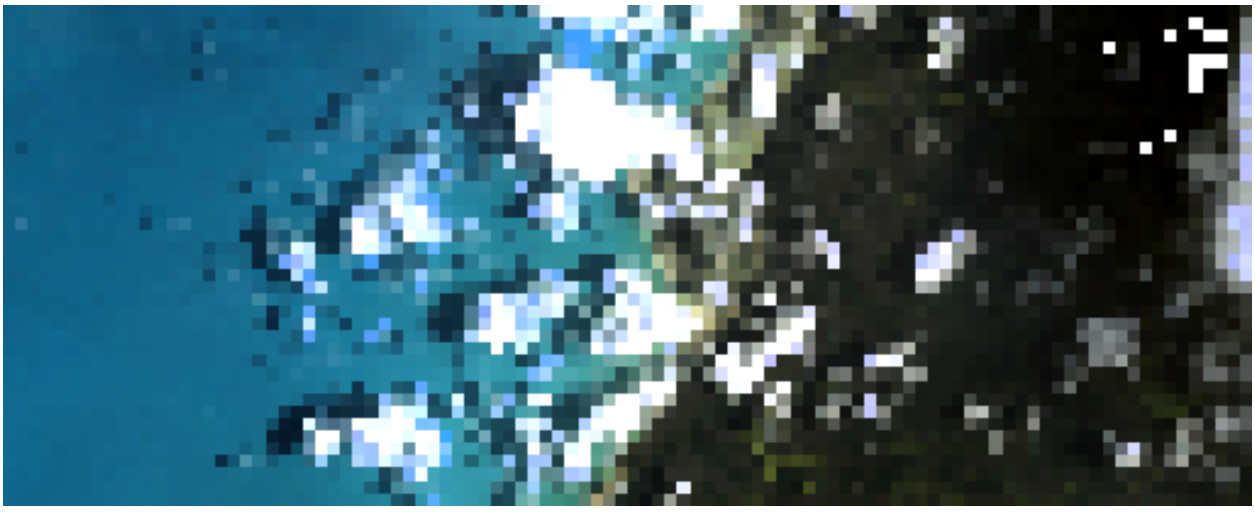
```
In [21]: rs.shape
```

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

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



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



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

```
In [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

Useful constants.

telluric.constants.**DEFAULT_CRS = CRS({'init': 'epsg:4326'})**
Default CRS, set to *WGS84_CRS*.

telluric.constants.**EQUAL_AREA_CRS = CRS({'proj': 'eck4'})**
Eckert IV CRS.

telluric.constants.**WEB_MERCATOR_CRS = CRS({'init': 'epsg:3857'})**
Web Mercator CRS.

telluric.constants.**WGS84_CRS = CRS({'init': 'epsg:4326'})**
WGS84 CRS.

### 1.2.2 telluric.vectors module

**class** telluric.vectors.**GeoVector**(*shape*, *crs=CRS({'init': 'epsg:4326'})*)
Geometric element with an associated CRS.

This class has also all the properties and methods of `shapely.geometry.BaseGeometry`.

**__init__**(*shape*, *crs=CRS({'init': 'epsg:4326'})*)
Initialize GeoVector.

**Parameters**

- **shape** (*shapely.geometry.BaseGeometry*) – Geometry.
- **crs** (*CRS (optional)*) – Coordinate Reference System, default to *telluric.constants.DEFAULT_CRS*.

**almost_equals**(*other*, *decimal=6*)
invariant to crs.

**equals_exact**(*other*, *tolerance*)
invariant to crs.

**classmethod from_bounds**(***, *xmin*, *ymin*, *xmax*, *ymax*, *crs=CRS({'init': 'epsg:4326'})*)
Creates GeoVector object from bounds.

This function only accepts keyword arguments.

**Parameters**

- **ymin, xmax, ymax** (*xmin,*) – Bounds of the GeoVector.
- **crs** (*CRS, dict*) – Projection, default to *telluric.constants.DEFAULT_CRS*.

#### Examples

```
>>> from telluric import GeoVector
>>> GeoVector.from_bounds(xmin=0, ymin=0, xmax=1, ymax=1)
GeoVector(shape=POLYGON ((0 0, 0 1, 1 1, 1 0, 0 0)), crs=CRS({'init':
↪'epsg:4326'}))
>>> GeoVector.from_bounds(xmin=0, xmax=1, ymin=0, ymax=1)
GeoVector(shape=POLYGON ((0 0, 0 1, 1 1, 1 0, 0 0)), crs=CRS({'init':
↪'epsg:4326'}))
```

**classmethod from_geojson** (*filename*)
Load vector from geojson.

**classmethod from_xyz** (*x*, *y*, *z*)
Creates GeoVector from Mercator slippy map values.

**get_shape** (*crs*)
Gets the underlying Shapely shape in a specified CRS.

This method deliberately does not have a default crs=self.crs to force the user to specify it.

**polygonize** (*width*, *cap_style_line=2*, *cap_style_point=1*)
Turns line or point into a buffered polygon.

**to_geojson** (*filename*)
Save vector as geojson.

telluric.vectors.**generate_tile_coordinates** (*roi*, *num_tiles*)
Yields N x M rectangular tiles for a region of interest.

**Parameters**

- **roi** (GeoVector) – Region of interest
- **num_tiles** (*tuple*) – Tuple (horizontal_tiles, vertical_tiles)

**Yields** *~telluric.vectors.GeoVector*

telluric.vectors.**generate_tile_coordinates_from_pixels** (*roi*, *scale*, *size*)
Yields N x M rectangular tiles for a region of interest.

**Parameters**

- **roi** (GeoVector) – Region of interest
- **scale** (*float*) – Scale factor (think of it as pixel resolution)
- **size** (*tuple*) – Pixel size in (width, height) to be multiplied by the scale factor

**Yields** *~telluric.vectors.GeoVector*

telluric.vectors.**get_dimension** (*geometry*)
Gets the dimension of a Fiona-like geometry element.

### 1.2.3 telluric.features module

**class** telluric.features.**GeoFeature** (*geovector*, *properties*)
GeoFeature object.

**__init__** (*geovector*, *properties*)
Initialize a GeoFeature object.

**Parameters**

- **geovector** (GeoVector) – Geometry.
- **properties** (*dict*) – Properties.

**get_shape**(*crs*)
Gets the underlying Shapely shape in a specified CRS.

telluric.features.**serialize_properties**(*properties*)
Serialize properties.

**Parameters** **properties** (*dict*) – Properties to serialize.

telluric.features.**transform_properties**(*properties*, *schema*)
Transform properties types according to a schema.

**Parameters**

- **properties** (*dict*) – Properties to transform.
- **schema** (*dict*) – Fiona schema containing the types.

### 1.2.4 telluric.collections module

**class** telluric.collections.**BaseCollection**

**dissolve**(*by=None*, *aggfunc=None*)
Dissolve geometries and rasters within *groupby*.

**filter**(*intersects*)
Filter results that intersect a given GeoFeature or Vector.

**get_values**(*key*)
Get all values of a certain property.

**groupby**(*by*)
Groups collection using a value of a property.

**Parameters** **by** (*str or callable*) – If string, name of the property by which to group. If callable, should receive a GeoFeature and return the category.

**Returns**

**Return type** _CollectionGroupBy

**is_empty**
True if all features are empty.

**map**(*map_function*)
Return a new FeatureCollection with the results of applying *map_function* to each element.

**rasterize**(*dest_resolution*, *, *polygonize_width=0*, *crs=CRS({'init': 'epsg:3857'})*, *fill_value=None*, *bounds=None*, *dtype=None*, ***polygonize_kwargs*)
Binarize a FeatureCollection and produce a raster with the target resolution.

**Parameters**

- **dest_resolution** (*float*) – Resolution in units of the CRS.
- **polygonize_width** (*int, optional*) – Width for the polygonized features (lines and points) in pixels, default to 0 (they won't appear).

- **crs** (*CRS, dict (optional)*) – Coordinate system, default to *telluric.constants.WEB_MERCATOR_CRS*.
- **fill_value** (*float or function, optional*) – Value that represents data, default to None (will default to `telluric.rasterization.FILL_VALUE`. If given a function, it must accept a single *GeoFeature* and return a numeric value.
- **nodata_value** (*float, optional*) – Nodata value, default to None (will default to `telluric.rasterization.NODATA_VALUE`.
- **bounds** (*GeoVector, optional*) – Optional bounds for the target image, default to None (will use the FeatureCollection convex hull).
- **dtype** (*numpy.dtype, optional*) – dtype of the result, required only if fill_value is a function.
- **polygonize_kwargs** (*dict*) – Extra parameters to the polygonize function.

**save** (*filename*, *driver=None*)
Saves collection to file.

**sort** (*by*, *desc=False*)
Sorts by given property or function, ascending or descending order.

**Parameters**

- **by** (*str or callable*) – If string, property by which to sort. If callable, it should receive a GeoFeature a return a value by which to sort.
- **desc** (*bool, optional*) – Descending sort, default to False (ascending).

**class** telluric.collections.**FeatureCollection** (*results*)

**__init__** (*results*)
Initialize FeatureCollection object.

**Parameters** **results** (*iterable*) – Iterable of *GeoFeature* objects.

**classmethod from_geovectors** (*geovectors*)
Builds new FeatureCollection from a sequence of *GeoVector* objects.

**exception** telluric.collections.**FeatureCollectionIOError**

**class** telluric.collections.**FileCollection** (*filename*, *crs*, *schema*, *length*)
FileCollection object.

**__init__** (*filename*, *crs*, *schema*, *length*)
Initialize a FileCollection object.

Use the *open()* method instead.

**classmethod open** (*filename*)
Creates a FileCollection from a file in disk.

**Parameters** **filename** (*str*) – Path of the file to read.

telluric.collections.**dissolve** (*collection*, *aggfunc=None*)
Dissolves features contained in a FeatureCollection and applies an aggregation function to its properties.

### 1.2.5 telluric.georaster module

**class** telluric.georaster.**GeoRaster2**(*image=None*, *affine=None*, *crs=None*, *filename=None*, *band_names=None*, *nodata=0*, *shape=None*, *footprint=None*, *temporary=False*)

Represents multiband georeferenced image, supporting nodata pixels. The name "GeoRaster2" is temporary.

conventions:

- .array is np.masked_array, mask=True on nodata pixels.
- .array is [band, y, x]
- .affine is affine.Affine
- .crs is rasterio.crs.CRS
- .band_names is list of strings, order corresponding to order in .array

**__init__**(*image=None*, *affine=None*, *crs=None*, *filename=None*, *band_names=None*, *nodata=0*, *shape=None*, *footprint=None*, *temporary=False*)

Create a GeoRaster object

**Parameters**

- **filename** – optional path/url to raster file for lazy loading
- **image** – optional supported: np.ma.array, np.array, TODO: PIL image
- **affine** – affine.Affine, or 9 numbers: [step_x, 0, origin_x, 0, step_y, origin_y, 0, 0, 1]
- **crs** – wkt/epsg code, e.g. {'init': 'epsg:32620'}
- **band_names** – e.g. ['red', 'blue'] or 'red'
- **shape** – raster image shape, optional
- **nodata** – if provided image is array (not masked array), treat pixels with value=nodata as nodata
- **temporary** – True means that file referenced by filename is temporary and will be removed by destructor, default False

**add_raster**(*other*, *merge_strategy*, *resampling*)

Return merge of 2 rasters, in geography of the first one.

merge_strategy - for pixels with values in both rasters.

**affine**

Raster affine.

**align_raster_to_mercator_tiles**()

Return new raster aligned to compasing tile.

**Returns** GeoRaster2

**apply_transform**(*transformation*, *resampling*)

Apply affine transformation on image & georeferencing.

as specific cases, implement 'resize', 'rotate', 'translate'

**astype**(*dst_type*, *in_range='dtype'*, *out_range='dtype'*, *clip_negative=False*)

Returns copy of the raster, converted to desired type Supported types: uint8, uint16, uint32, int8, int16, int32, float16, float32, float64

**Parameters**

- **dst_type** – desired type
- **in_range** – str or 2-tuple, default 'dtype': 'image': use image min/max as the intensity range, 'dtype': use min/max of the image's dtype as the intensity range, 2-tuple: use explicit min/max intensities, it is possible to use

  'min' or 'max' as tuple values - in this case they will be replaced by min or max intensity of image respectively
- **out_range** – str or 2-tuple, default 'dtype': 'dtype': use min/max of the image's dtype as the intensity range, 2-tuple: use explicit min/max intensities
- **clip_negative** – boolean, if *True* - clip the negative range, default False

**Returns** numpy array of values

**attributes**(*url*)
Without opening image, return size/bitness/bands/geography/....

**band_names**
Raster affine.

**bounds**()
Return image rectangle in pixels, as shapely.Polygon.

**center**()
Return footprint center in world coordinates, as GeoVector.

**colorize**(*colormap*, *band_name=None*, *vmin=None*, *vmax=None*)
Apply a colormap on a selected band.

colormap list: https://matplotlib.org/examples/color/colormaps_reference.html

**Parameters**

- **colormap**(*str*) –
- **name from this list https**(*Colormap*) –
- **band_name**(*str, optional*) –
- **of band to colorize, if none the first band will be used**(*Name*) –
- **vmax**(*vmin,*) –
- **and maximum range for normalizing array values, if None actual raster values will be used**(*minimum*) –

**Returns**

**Return type** *GeoRaster2*

**copy_with**(***kwargs*)
Get a copy of this GeoRaster with some attributes changed. NOTE: image is shallow-copied!

**corner**(*corner*)
Return footprint origin in world coordinates, as GeoVector.

**corners**()
Return footprint corners, as {corner_type -> GeoVector}.

**crop**(*vector*, *resolution=None*)
crops raster outside vector (convex hull) :param vector: GeoVector :param resolution: output resolution, None for full resolution :return: GeoRaster

**crs**
Raster crs.

**deepcopy_with**(***kwargs*)
Get a copy of this GeoRaster with some attributes changed. NOTE: image is shallow-copied!

**footprint**()
Return rectangle in world coordinates, as GeoVector.

**classmethod from_bytes**(*image_bytes*, *affine*, *crs*, *band_names=None*)
Create GeoRaster from image BytesIo object.

**Parameters**

- **image_bytes** – io.BytesIO object
- **affine** – rasters affine
- **crs** – rasters crs
- **band_names** – e.g. ['red', 'blue'] or 'red'

**classmethod from_tiles**(*tiles*)
Compose raster from tiles. return GeoRaster.

**get**(*point*)
Get the pixel values at the requested point.

**Parameters** **point** – A GeoVector(POINT) with the coordinates of the values to get

**Returns** numpy array of values

**get_tile**(*x_tile*, *y_tile*, *zoom*, *bands=None*, *blocksize=256*)
Convert mercator tile to raster window.

**Parameters**

- **x_tile** – x coordinate of tile
- **y_tile** – y coordinate of tile
- **zoom** – zoom level
- **bands** – list of indices of requested bads, default None which returns all bands
- **blocksize** – tile size (x & y) default 256, for full resolution pass None

**Returns** GeoRaster2 of tile

**get_window**(*window*, *bands=None*, *xsize=None*, *ysize=None*, *resampling=<Resampling.cubic: 2>*, *masked=True*, *boundless=False*)
Get window from raster.

**Parameters**

- **window** – requested window
- **bands** – list of indices of requested bads, default None which returns all bands
- **xsize** – tile x size default None, for full resolution pass None
- **ysize** – tile y size default None, for full resolution pass None
- **resampling** – which Resampling to use on reading, default Resampling.cubic
- **masked** – boolean, if *True* the return value will be a masked array. Default is True

**Returns** GeoRaster2 of tile

**height**
Raster height.

**image**
Raster bitmap in numpy array.

**image_corner**(*corner*)
Return image corner in pixels, as shapely.Point.

**intersect**(*other*)
Pixels outside either raster are set nodata

**is_aligned_to_mercator_tiles**()
Return True if image aligned to coordinates tiles.

**mask**(*vector*, *mask_shape_nodata=False*)
Set pixels outside vector as nodata.

**Parameters**

- **vector** – GeoVector, GeoFeature, FeatureCollection
- **mask_shape_nodata** – if True - pixels inside shape are set nodata, if False - outside shape is nodata

**Returns** GeoRaster2

**num_bands**
Raster number of bands.

**classmethod open**(*filename*, *band_names=None*, *lazy_load=True*, ***kwargs*)
Read a georaster from a file.

**Parameters**

- **filename** – url
- **band_names** – list of strings, or string. if None - will try to read from image, otherwise - these will be ['0', ..]
- **lazy_load** – if True - do not load anything

**Returns** GeoRaster2

**origin**()
Return footprint origin in world coordinates, as GeoVector.

**pixel_crop**(*bounds*, *xsize=None*, *ysize=None*, *window=None*)
Crop raster outside vector (convex hull).

**Parameters**

- **bounds** – bounds of requester portion of the image in image pixels
- **xsize** – output raster width, None for full resolution
- **ysize** – output raster height, None for full resolution
- **windows** – the bounds representation window on image in image pixels, optional

**Returns** GeoRaster

**project**(*dst_crs*, *resampling*)
Return reprojected raster.

**rectify**()
Rotate raster northwards.

**reduce**(*op*)
Reduce the raster to a score, using 'op' operation.

nodata pixels are ignored. op is currently limited to numpy.ma, e.g. 'mean', 'std' etc :returns list of per-band values

**reproject**(*dst_crs=None*, *resolution=None*, *dimensions=None*, *src_bounds=None*, *dst_bounds=None*, *target_aligned_pixels=False*, *resampling=<Resampling.cubic: 2>*, *creation_options=None*, ***kwargs*)
Return re-projected raster to new raster.

**Parameters**

- **dst_crs** (*rasterio.crs.CRS, optional*) – Target coordinate reference system.
- **resolution** (*tuple (x resolution, y resolution) or float, optional*) – Target resolution, in units of target coordinate reference system.
- **dimensions** (*tuple (width, height), optional*) – Output size in pixels and lines.
- **src_bounds** (*tuple (xmin, ymin, xmax, ymax), optional*) – Georeferenced extent of output (in source georeferenced units).
- **dst_bounds** (*tuple (xmin, ymin, xmax, ymax), optional*) – Georeferenced extent of output (in destination georeferenced units).
- **target_aligned_pixels** (*bool, optional*) – Align the output bounds based on the resolution. Default is *False*.
- **resampling** (*rasterio.enums.Resampling*) – Reprojection resampling method. Default is *cubic*.
- **creation_options** (*dict, optional*) – Custom creation options.
- **kwargs** (*optional*) – Additional arguments passed to transformation function.

**Returns** **out**

**Return type** *GeoRaster2*

**res_xy**()
Returns X and Y resolution.

**resize**(*ratio=None*, *ratio_x=None*, *ratio_y=None*, *dest_width=None*, *dest_height=None*, *dest_resolution=None*, *resampling=<Resampling.cubic: 2>*)
Provide either ratio, or ratio_x and ratio_y, or dest_width and/or dest_height.

**Returns** GeoRaster2

**resolution**()
Return resolution. if different in different axis - return geometric mean.

**save**(*filename*, *tags=None*, ***kwargs*)
Save GeoRaster to a file.

**Parameters**

- **filename** – url
- **tags** – tags to add to default namespace

optional parameters:

- GDAL_TIFF_INTERNAL_MASK: specifies whether mask is within image file, or additional .msk
- overviews: if True, will save with previews. default: True

- factors: list of factors for the overview, default: calculated based on raster width and height
- resampling: to build overviews. default: cubic
- tiled: if True raster will be saved tiled, default: False
- compress: any supported rasterio.enums.Compression value, default to LZW
- blockxsize: int, tile x size, default:256
- blockysize: int, tile y size, default:256
- creation_options: dict, key value of additional creation options
- nodata: if passed, will save with nodata value (e.g. useful for qgis)

**save_cloud_optimized**(*dest_url*, *aligned_to_mercator=False*, *resampling=<Resampling.gauss: 7>*)
Save as Cloud Optimized GeoTiff object to a new file.

**Parameters**

- **dest_url** – path to the new raster
- **aligned_to_mercator** – if True raster will be aligned to mercator tiles, default False
- **resampling** – which Resampling to use on reading, default Resampling.gauss

**Returns** new VirtualGeoRaster of the tiled object

**shape**
Raster shape.

**classmethod tags**(*filename*, *namespace=None*)
Extract tags from file.

**to_bytes**(*transparent=True*, *thumbnail_size=None*, *resampling=None*, *in_range='dtype'*, *out_range='dtype'*, *format='png'*)
Convert to selected format (discarding geo).

Optionally also resizes. Note: for color images returns interlaced. :param transparent: if True - sets alpha channel for nodata pixels :param thumbnail_size: if not None - resize to thumbnail size, e.g. 512 :param in_range: input intensity range :param out_range: output intensity range :param format : str, image format, default "png" :param resampling: one of Resampling enums

:return bytes

**to_pillow_image**(*return_mask=False*)
Return Pillow. Image, and optionally also mask.

**to_png**(*transparent=True*, *thumbnail_size=None*, *resampling=None*, *in_range='dtype'*, *out_range='dtype'*)
Convert to png format (discarding geo).

Optionally also resizes. Note: for color images returns interlaced. :param transparent: if True - sets alpha channel for nodata pixels :param thumbnail_size: if not None - resize to thumbnail size, e.g. 512 :param in_range: input intensity range :param out_range: output intensity range :param resampling: one of Resampling enums

:return bytes

**to_raster**(*vector*)
Return the vector in pixel coordinates, as shapely.Geometry.

**to_tiles**()
Yield slippy-map tiles.

**to_world**(*shape*, *dst_crs=None*)
Return the shape (provided in pixel coordinates) in world coordinates, as GeoVector.

**transform**
Raster affine.

**vectorize**(*condition=None*)
Return GeoVector of raster, excluding nodata pixels, subject to 'condition'.

**Parameters** **condition** – e.g. 42 < value < 142.

e.g. if no nodata pixels, and without condition - this == footprint().

**width**
Raster width.

**exception** telluric.georaster.**GeoRaster2Error**
Base class for exceptions in the GeoRaster class.

**exception** telluric.georaster.**GeoRaster2IOError**
Base class for exceptions in GeoRaster read/write.

**exception** telluric.georaster.**GeoRaster2NotImplementedError**
Base class for NotImplementedError in the GeoRaster class.

**exception** telluric.georaster.**GeoRaster2Warning**
Base class for warnings in the GeoRaster class.

**class** telluric.georaster.**MergeStrategy**
An enumeration.

telluric.georaster.**merge_all**(*rasters*, *roi=None*, *dest_resolution=None*, *merge_strategy=<MergeStrategy.UNION: 2>*, *shape=None*, *ul_corner=None*, *crs=None*)
Merge a list of rasters, cropping by a region of interest. There are cases that the roi is not precise enough for this cases one can use, the upper left corner the shape and crs to precisely define the roi. When roi is provided the ul_corner, shape and crs are ignored

telluric.georaster.**merge_two**(*one*, *other*, *merge_strategy=<MergeStrategy.UNION: 2>*, *silent=False*)
Merge two rasters into one.

**Parameters**

- **one** (GeoRaster2) – Left raster to merge.
- **other** (GeoRaster2) – Right raster to merge.
- **merge_strategy** (MergeStrategy) – Merge strategy, from *telluric.georaster.MergeStrategy* (default to "union").
- **silent** (*bool, optional*) – Whether to raise errors or return some result, default to False (raise errors).

**Returns**

**Return type** *GeoRaster2*

### 1.2.6 telluric.plotting module

Code for interactive vector plots.

telluric.plotting.**layer_from_element**(*element*, *style_function=None*)
Return Leaflet layer from shape.

**Parameters** **element** (telluric.vectors.GeoVector, telluric.features.GeoFeature, telluric.collections.BaseCollection) – Data to plot.

telluric.plotting.**plot**(*feature*, *mp=None*, *style_function=None*, ***map_kwargs*)
Plots a GeoVector in an ipyleaflet map.

**Parameters**

- **feature** (telluric.vectors.GeoVector, telluric.features.GeoFeature, telluric.collections.BaseCollection) – Data to plot.
- **mp** (*ipyleaflet.Map, optional*) – Map in which to plot, default to None (creates a new one).
- **style_function** (*func*) – Function that returns an style dictionary for
- **map_kwargs** (*kwargs, optional*) – Extra parameters to send to ipyleaflet.Map.

telluric.plotting.**simple_plot**(*feature*, *, *mp=None*, ***map_kwargs*)
Plots a GeoVector in a simple Folium map.

For more complex and customizable plots using Jupyter widgets, use the plot function instead.

**Parameters** **feature** (telluric.vectors.GeoVector, telluric.features.GeoFeature, telluric.collections.BaseCollection) – Data to plot.

telluric.plotting.**zoom_level_from_geometry**(*geometry*, *splits=4*)
Generate optimum zoom level for geometry.

### Notes

The obvious solution would be

```
>>> mercantile.bounding_tile(*geometry.get_shape(WGS84_CRS).bounds).z
```

However, if the geometry is split between two or four tiles, the resulting zoom level might be too big.

CHAPTER 2

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