pygeoapi Documentation

Release 0.13.0

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TABLE OF CONTENTS

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Welcome to the official pygeoapi documentation! Here you will find complete reference documentation on all aspects of the project.

Note: Did you know about the pygeoapi workshop[1]? Ready to get your hands dirty? Dive in!

[1] https://dive.pygeoapi.io

CHAPTER

ONE

INTRODUCTION

pygeoapi[2] is a Python server implementation of the OGC API suite of standards. The project emerged as part of the next generation OGC API[3] efforts in 2018 and provides the capability for organizations to deploy a RESTful OGC API endpoint using OpenAPI, GeoJSON, and HTML. pygeoapi is open source[4] and released under an MIT *License*.

1.1 Features

- out of the box modern OGC API server
- certified OGC Compliant and Reference Implementation * OGC API - Features * OGC API - Environmental Data Retrieval
- additionally implements * OGC API - Coverages * OGC API - Tiles * OGC API - Processes * OGC API - Records * SpatioTemporal Asset Library
- out of the box data provider plugins for rasterio, GDAL/OGR, Elasticsearch, PostgreSQL/PostGIS
- easy to use OpenAPI / Swagger documentation for developers
- supports JSON, GeoJSON, HTML and CSV output
- supports data filtering by spatial, temporal or attribute queries
- easy to install: install a full implementation via `pip` or `git`
- simple YAML configuration
- easy to deploy: via UbuntuGIS or the official Docker image
- flexible: built on a robust plugin framework to build custom data connections, formats and processes
- supports any Python web framework (included are Flask [default], Starlette)
- supports asynchronous processing and job management (OGC API - Processes)

[2] https://pygeoapi.io
[3] https://ogcapi.ogc.org
[4] https://opensource.org

1.2 Standards Support

Standards are at the core of pygeoapi. Below is the project's standards support matrix.

- Implementing: implements standard (good)
- Compliant: conforms to OGC compliance requirements (great)
- Reference Implementation: provides a reference for the standard (awesome!)

Standard	Support
OGC API - Features[5]	Reference Implementation
OGC API - Coverages[6]	Implementing
OGC API - Tiles[7]	Implementing
OGC API - Processes[8]	Implementing
OGC API - Records[9]	Implementing
OGC API - Environmental Data Retrieval[10]	Reference Implementation
SpatioTemporal Asset Catalog[11]	Implementing

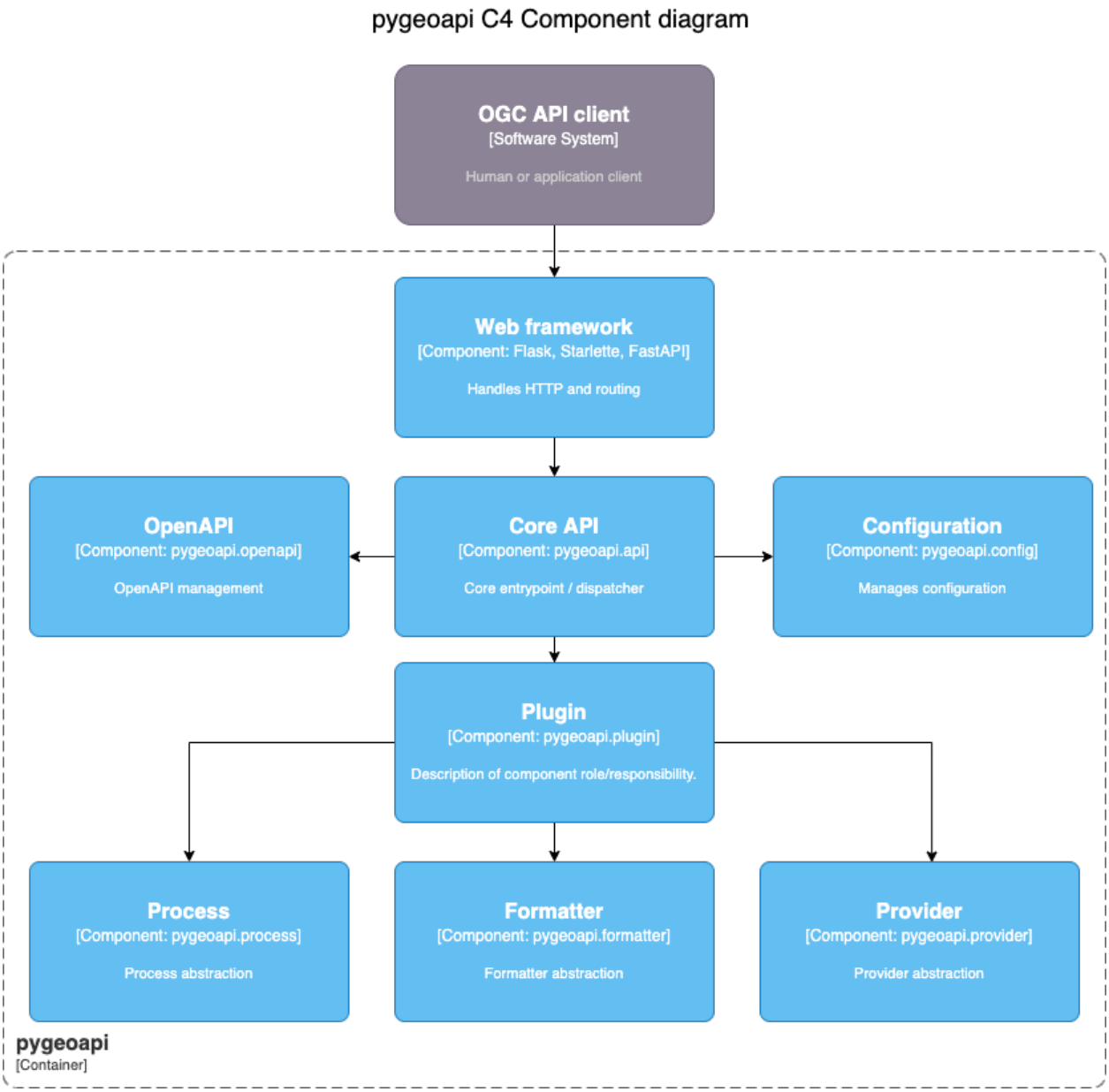
[5] https://www.ogc.org/standards/ogcapi-features
[6] https://github.com/opengeospatial/ogcapi-coverages
[7] https://github.com/opengeospatial/ogcapi-tiles
[8] https://github.com/opengeospatial/ogcapi-processes
[9] https://github.com/opengeospatial/ogcapi-records
[10] https://github.com/opengeospatial/ogcapi-environmental-data-retrieval
[11] https://stacspec.org

CHAPTER

TWO

HOW PYGEOAPI WORKS

pygeoapi is a Python-based HTTP server implementation of the OGC API standards. As a server implementation, pygeoapi listens to HTTP requests from web browsers, mobile or desktop applications and provides responses accordingly.



At its core, pygeoapi provides a core Python API that is driven by two required YAML configuration files, specified with the following environment variables:

- `PYGEOAPI_CONFIG`: runtime configuration settings
- `PYGEOAPI_OPENAPI`: the OpenAPI document autogenerated from the runtime configuration

See also:

Configuration for more details on pygeoapi settings

The core Python API provides the functionality to list, describe, query, and access geospatial data. From here, standard Python web frameworks like Flask[12], Django[13] and Starlette[14] provide the web API/wrapper atop the core Python API.

Note: pygeoapi ships with Flask and Starlette as web framework options.

[12] https://flask.palletsprojects.com
[13] https://www.djangoproject.com
[14] https://www.starlette.io

CHAPTER

THREE

INSTALL

pygeoapi is easy to install on numerous environments. Whether you are a user, administrator or developer, below are multiple approaches to getting pygeoapi up and running depending on your requirements.

3.1 Requirements and dependencies

pygeoapi runs on Python 3.

Core dependencies are included as part of a given pygeoapi installation procedure. More specific requirements details are described below depending on the platform.

3.2 For developers and the truly impatient

```
python -m venv pygeoapi
cd pygeoapi
. bin/activate
git clone https://github.com/geopython/pygeoapi.git
cd pygeoapi
pip install --upgrade pip
pip install -r requirements.txt
python setup.py install
cp pygeoapi-config.yml example-config.yml
vi example-config.yml  # edit as required
export PYGEOAPI_CONFIG=example-config.yml
export PYGEOAPI_OPENAPI=example-openapi.yml
pygeoapi openapi generate $PYGEOAPI_CONFIG > $PYGEOAPI_OPENAPI
pygeoapi serve
curl http://localhost:5000
```

3.3 pip

PyPI package info[15]

```
pip install pygeoapi
```

[15] https://pypi.org/project/pygeoapi

3.4 Docker

3.4.1 Using DockerHub

Docker image[16]

```
docker pull geopython/pygeoapi:latest
```

3.4.2 Using GitHub Container Registry

Docker image[17]

```
docker pull ghcr.io/geopython/pygeoapi:latest
```

3.5 Conda

Conda package info[18]

```
conda install -c conda-forge pygeoapi
```

3.6 UbuntuGIS

UbuntuGIS package (stable)[19]

UbuntuGIS package (unstable)[20]

```
apt-get install python3-pygeoapi
```

3.7 FreeBSD

FreeBSD port[21]

```
pkg install py-pygeoapi
```

[16] https://github.com/geopython/pygeoapi/pkgs/container/pygeoapi
[17] https://github.com/geopython/pygeoapi/pkgs/container/pygeoapi
[18] https://anaconda.org/conda-forge/pygeoapi
[19] https://launchpad.net/%7Eubuntugis/+archive/ubuntu/ppa/+sourcepub/10758317/+listing-archive-extra
[20] https://launchpad.net/~ubuntugis/+archive/ubuntu/ubuntugis-unstable/+sourcepub/10933910/+listing-archive-extra
[21] https://www.freshports.org/graphics/py-pygeoapi

3.8 Summary

Congratulations! Whichever of the abovementioned methods you chose, you have successfully installed pygeoapi onto your system.

CHAPTER

FOUR

CONFIGURATION

Once you have installed pygeoapi, it's time to setup a configuration. pygeoapi's runtime configuration is defined in the YAML[22] format which is then referenced via the `PYGEOAPI_CONFIG` environment variable. You can name the file whatever you wish; typical filenames end with `.yml`.

Note: A sample configuration can always be found in the pygeoapi GitHub[23] repository.

pygeoapi configuration contains the following core sections:

- `server`: server-wide settings
- `logging`: logging configuration
- `metadata`: server-wide metadata (contact, licensing, etc.)
- `resources`: dataset collections, processes and stac-collections offered by the server

Note: Standard YAML mechanisms[24] can be used (anchors, references, etc.) for reuse and compactness.

Configuration directives and reference are described below via annotated examples.

4.1 Reference

4.1.1 server

The `server` section provides directives on binding and high level tuning.

```
server:
  bind:
      host: 0.0.0.0  # listening address for incoming connections
      port: 5000  # listening port for incoming connections
  url: http://localhost:5000/  # url of server
  mimetype: application/json; charset=UTF-8  # default MIME type
  encoding: utf-8  # default server encoding
  language: en-US  # default server language
  gzip: false # default server config to gzip/compress responses to requests with␣
↪gzip in the Accept-Encoding header
```

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[22] https://en.wikipedia.org/wiki/YAML
[23] https://github.com/geopython/pygeoapi/blob/master/pygeoapi-config.yml
[24] https://en.wikipedia.org/wiki/YAML#Advanced_components

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```
  cors: true  # boolean on whether server should support CORS
  pretty_print: true  # whether JSON responses should be pretty-printed
  limit: 10  # server limit on number of items to return

  templates: # optional configuration to specify a different set of templates for␣
↪HTML pages. Recommend using absolute paths. Omit this to use the default provided␣
↪templates
    path: /path/to/jinja2/templates/folder # path to templates folder containing the␣
↪jinja2 template HTML files
    static: /path/to/static/folder # path to static folder containing css, js, images␣
↪and other static files referenced by the template

  map:  # leaflet map setup for HTML pages
      url: https://maps.wikimedia.org/osm-intl/{z}/{x}/{y}.png
      attribution: '<a href="https://wikimediafoundation.org/wiki/Maps_Terms_of_Use">
↪Wikimedia maps</a> | Map data &copy; <a href="https://openstreetmap.org/copyright">
↪OpenStreetMap contributors</a>'
  ogc_schemas_location: /opt/schemas.opengis.net  # local copy of http://schemas.
↪opengis.net

  manager:  # optional OGC API - Processes asynchronous job management
      name: TinyDB  # plugin name (see pygeoapi.plugin for supported process_manager
↪'s)
      connection: /tmp/pygeoapi-process-manager.db  # connection info to store jobs␣
↪(e.g. filepath)
      output_dir: /tmp/  # temporary file area for storing job results (files)
```

4.1.2 logging

The `logging` section provides directives for logging messages which are useful for debugging.

```
logging:
    level: ERROR  # the logging level (see https://docs.python.org/3/library/logging.
↪html#logging-levels)
    logfile: /path/to/pygeoapi.log  # the full file path to the logfile
```

Note: If `level` is defined and `logfile` is undefined, logging messages are output to the server's `stdout`.

4.1.3 metadata

The `metadata` section provides settings for overall service metadata and description.

```
metadata:
    identification:
        title: pygeoapi default instance  # the title of the service
        description: pygeoapi provides an API to geospatial data  # some descriptive␣
↪text about the service
        keywords:  # list of keywords about the service
            - geospatial
            - data
            - api
```

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```
        keywords_type: theme  # keyword type as per the ISO 19115 MD_KeywordTypeCode␣
↪codelist. Accepted values are discipline, temporal, place, theme, stratum
        terms_of_service: https://creativecommons.org/licenses/by/4.0/  # terms of␣
↪service
        url: http://example.org  # informative URL about the service
    license:  # licensing details
        name: CC-BY 4.0 license
        url: https://creativecommons.org/licenses/by/4.0/
    provider:  # service provider details
        name: Organization Name
        url: https://pygeoapi.io
    contact:  # service contact details
        name: Lastname, Firstname
        position: Position Title
        address: Mailing Address
        city: City
        stateorprovince: Administrative Area
        postalcode: Zip or Postal Code
        country: Country
        phone: +xx-xxx-xxx-xxxx
        fax: +xx-xxx-xxx-xxxx
        email: you@example.org
        url: Contact URL
        hours: Mo-Fr 08:00-17:00
        instructions: During hours of service. Off on weekends.
        role: pointOfContact
```

4.1.4 resources

The `resources` section lists 1 or more dataset collections to be published by the server. The key of the resource name is the advertised collection identifier.

The `resource.type` property is required. Allowed types are:

- `collection`
- `process`
- `stac-collection`

The `providers` block is a list of 1..n providers with which to operate the data on. Each provider requires a `type` property. Allowed types are:

- `feature`
- `coverage`
- `tile`

A collection's default provider can be qualified with `default: true` in the provider configuration. If `default` is not included, the *first* provider is assumed to be the default.

```
resources:
    obs:
        type: collection  # REQUIRED (collection, process, or stac-collection)
        visibility: default  # OPTIONAL
        title: Observations  # title of dataset
        description: My cool observations  # abstract of dataset
```

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```
        keywords:  # list of related keywords
            - observations
            - monitoring
        context:  # linked data configuration (see Linked Data section)
            - datetime: https://schema.org/DateTime
            - vocab: https://example.com/vocab#
              stn_id: "vocab:stn_id"
              value: "vocab:value"
        links:  # list of 1..n related links
            - type: text/csv  # MIME type
              rel: canonical  # link relations per https://www.iana.org/assignments/
↪link-relations/link-relations.xhtml
              title: data  # title
              href: https://github.com/mapserver/mapserver/blob/branch-7-0/msautotest/
↪wxs/data/obs.csv  # URL
              hreflang: en-US  # language
        extents:  # spatial and temporal extents
            spatial:  # required
                bbox: [-180,-90,180,90]  # list of minx, miny, maxx, maxy
                crs: http://www.opengis.net/def/crs/OGC/1.3/CRS84  # CRS
            temporal:  # optional
                begin: 2000-10-30T18:24:39Z  # start datetime in RFC3339
                end: 2007-10-30T08:57:29Z  # end datetime in RFC3339
        providers:  # list of 1..n required connections information
            # provider name
            # see pygeoapi.plugin for supported providers
            # for custom built plugins, use the import path (e.g. mypackage.provider.
↪MyProvider)
            # see Plugins section for more information
            - type: feature # underlying data geospatial type: (allowed values are:␣
↪feature, coverage, record, tile, edr)
              default: true  # optional: if not specified, the first provider␣
↪definition is considered the default
              name: CSV
              # transactions: DO NOT ACTIVATE unless you have setup access contol␣
↪beyond pygeoapi
              editable: true  # optional: if backend is writable, default is false
              data: tests/data/obs.csv  # required: the data filesystem path or URL,␣
↪depending on plugin setup
              id_field: id  # required for vector data, the field corresponding to␣
↪the ID
              uri_field: uri # optional field corresponding to the Uniform Resource␣
↪Identifier (see Linked Data section)
              time_field: datetimestamp  # optional field corresponding to the␣
↪temporal property of the dataset
              title_field: foo # optional field of which property to display as title/
↪label on HTML pages
              format:  # optional default format
                  name: GeoJSON  # required: format name
                  mimetype: application/json  # required: format mimetype
              options:  # optional options to pass to provider (i.e. GDAL creation)
                  option_name: option_value
              properties:  # optional: only return the following properties, in order
                  - stn_id
                  - value

    hello-world:  # name of process
```

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```
        type: collection  # REQUIRED (collection, process, or stac-collection)
        processor:
            name: HelloWorld  # Python path of process defition
```

See also:

Linked Data for optionally configuring linked data datasets

See also:

Customizing pygeoapi: plugins for more information on plugins

4.2 Publishing hidden resources

pygeoapi allows for publishing resources without advertising them explicitly via its collections and OpenAPI endpoints. The resource is available if the client knows the name of the resource apriori.

To provide hidden resources, the resource must provide a `visibility: hidden` property. For example, considering the following resource:

```
resources:
    foo:
        title: my hidden resource
        visibility: hidden
```

Examples:

```
curl https://example.org/collections  # resource foo is not advertised
curl https://example.org/openapi  # resource foo is not advertised
curl https://example.org/collections/foo  # user can access resource normally
```

4.3 Validating the configuration

To ensure your configuration is valid, pygeoapi provides a validation utility that can be run as follows:

```
pygeoapi config validate -c /path/to/my-pygeoapi-config.yml
```

4.4 Using environment variables

pygeoapi configuration supports using system environment variables, which can be helpful for deploying into 12 factor[25] environments for example.

Below is an example of how to integrate system environment variables in pygeoapi.

```
server:
    bind:
        host: ${MY_HOST}
        port: ${MY_PORT}
```

[25] https://12factor.net/

4.5 Hierarchical collections

Collections defined in the the `resources` section are identified by the resource key. The key of the resource name is the advertised collection identifier. For example, given the following:

```
resources:
  lakes:
    ...
```

The resulting collection will be made available at http://localhost:5000/collections/lakes

All collections are published by default to http://localhost:5000/collections. To enable hierarchical collections, provide the hierarchy in the resource key. Given the following:

```
resources:
  naturalearth/lakes:
    ...
```

The resulting collection will then be made available at http://localhost:5000/collections/naturalearth/lakes

Note: This functionality may change in the future given how hierarchical collection extension specifications evolve at OGC.

Note: Collection grouping is not available. This means that while URLs such as http://localhost:5000/collections/naturalearth/lakes function as expected, URLs such as http://localhost:5000/collections/naturalearth will not provide aggregate collection listing or querying. This functionality is also to be determined based on the evolution of hierarchical collection extension specifications at OGC.

4.6 Linked Data

pygeoapi supports structured metadata about a deployed instance, and is also capable of presenting data as structured data. JSON-LD[26] equivalents are available for each HTML page, and are embedded as data blocks within the corresponding page for search engine optimisation (SEO). Tools such as the Google Structured Data Testing Tool[27] can be used to check the structured representations.

The metadata for an instance is determined by the content of the *metadata* section of the configuration. This metadata is included automatically, and is sufficient for inclusion in major indices of datasets, including the Google Dataset Search[28].

For collections, at the level of item, the default JSON-LD representation adds:

- An `@id` for the item, which is the URL for that item. If uri_field is specified, it is used, otherwise the URL is to its HTML representation in pygeoapi.

[26] https://json-ld.org
[27] https://search.google.com/structured-data/testing-tool#url=https%3A%2F%2Fdemo.pygeoapi.io%2Fmaster
[28] https://developers.google.com/search/docs/data-types/dataset

- Separate GeoSPARQL/WKT and *schema.org/geo* versions of the geometry. *schema.org/geo* only supports point, line, and polygon geometries. Multipart lines are merged into a single line. The rest of the multipart geometries are transformed reduced and into a polygon via unary union or convex hull transform.
- `@context` for the GeoSPARQL and schema geometries.
- The unpacked properties block into the main body of the item.

For collections, at the level of items, the default JSON-LD representation adds:

- A schema.org itemList of the `@id` and `@type` of each feature in the collection.

The optional configuration options for collections, at the level of an item of items, are:

- If `uri_field` is specified, JSON-LD will be updated such that the `@id` has the value of `uri_field` for each item in a collection

---

Note: While this is enough to provide valid RDF (as GeoJSON-LD), it does not allow the *properties* of your items to be unambiguously interpretable.

---

pygeoapi currently allows for the extension of the `@context` to allow properties to be aliased to terms from vocabularies. This is done by adding a `context` section to the configuration of a `dataset`.

The default pygeoapi configuration includes an example for the `obs` sample dataset:

```
context:
    - datetime: https://schema.org/DateTime
    - vocab: https://example.com/vocab#
      stn_id: "vocab:stn_id"
      value: "vocab:value"
```

This is a non-existent vocabulary included only to illustrate the expected data structure within the configuration. In particular, the links for the `stn_id` and `value` properties do not resolve. We can extend this example to one with terms defined by schema.org:

```
context:
    - schema: https://schema.org/
      stn_id: schema:identifer
      datetime:
          "@id": schema:observationDate
          "@type": schema:DateTime
      value:
          "@id": schema:value
          "@type": schema:Number
```

Now this has been elaborated, the benefit of a structured data representation becomes clearer. What was once an unexplained property called `datetime` in the source CSV, it can now be expanded[29] to https://schema.org/observationDate, thereby eliminating ambiguity and enhancing interoperability. Its type is also expressed as https://schema.org/DateTime.

This example demonstrates how to use this feature with a CSV data provider, using included sample data. The implementation of JSON-LD structured data is available for any data provider but is currently limited to defining a `@context`. Relationships between items can be expressed but is dependent on such relationships being expressed by the dataset provider, not pygeoapi.

An example of a data provider that includes relationships between items is the SensorThings API provider. SensorThings API, by default, has relationships between entities within its data model. Setting the `intralink` field of the SensorThings provider to `true` sets pygeoapi to represent the relationship between configured entities as intra-pygeoapi links

[29] https://www.w3.org/TR/json-ld-api/#expansion-algorithms

or URIs. This relationship can further be maintained in the JSON-LD structured data using the appropiate `@context` with the sosa/ssn ontology. For example:

```
Things:
  context:
      - sosa: "http://www.w3.org/ns/sosa/"
        ssn: "http://www.w3.org/ns/ssn/"
        Datastreams: sosa:ObservationCollection

Datastreams:
  context:
      - sosa: "http://www.w3.org/ns/sosa/"
        ssn: "http://www.w3.org/ns/ssn/"
        Observations: sosa:hasMember
        Thing: sosa:hasFeatureOfInterest

Observations:
  context:
      - sosa: "http://www.w3.org/ns/sosa/"
        ssn: "http://www.w3.org/ns/ssn/"
        Datastream: sosa:isMemberOf
```

4.7 Summary

At this point, you have the configuration ready to administer the server.

CHAPTER

FIVE

ADMINISTRATION

Now that you have pygeoapi installed and a basic configuration setup, it's time to complete the administrative steps required before starting up the server. The remaining steps are:

- create OpenAPI document
- validate OpenAPI document
- set system environment variables

5.1 Creating the OpenAPI document

The OpenAPI document is a YAML configuration which is generated from the pygeoapi configuration, and describes the server information, endpoints, and parameters.

To generate the OpenAPI document, run the following:

```
pygeoapi openapi generate /path/to/my-pygeoapi-config.yml
```

This will dump the OpenAPI document as YAML to your system's `stdout`. To save to a file on disk, run:

```
pygeoapi openapi generate /path/to/my-pygeoapi-config.yml > /path/to/my-pygeoapi-
↪openapi.yml
```

You can also write to a file explicitly via the `--output-file` option:

```
pygeoapi openapi generate /path/to/my-pygeoapi-config.yml --output-file /path/to/my-
↪pygeoapi-openapi.yml
```

To generate the OpenAPI document as JSON, run:

```
pygeoapi openapi generate /path/to/my-pygeoapi-config.yml -f json > /path/to/my-
↪pygeoapi-openapi.json
```

Note: Generate as YAML or JSON? If your OpenAPI YAML definition is slow to render as JSON, saving as JSON to disk will help with performance at run-time.

Note: The OpenAPI document provides detailed information on query parameters, and dataset property names and their data types. Whenever you make changes to your pygeoapi configuration, always refresh the accompanying OpenAPI document.

See also:

OpenAPI for more information on pygeoapi's OpenAPI support

5.2 Validating the OpenAPI document

To ensure your OpenAPI document is valid, pygeoapi provides a validation utility that can be run as follows:

```
pygeoapi openapi validate /path/to/my-pygeoapi-openapi.yml
```

5.3 Setting system environment variables

Now, let's set our system environment variables.

In UNIX:

```
export PYGEOAPI_CONFIG=/path/to/my-pygeoapi-config.yml
export PYGEOAPI_OPENAPI=/path/to/my-pygeoapi-openapi.yml
# or if OpenAPI JSON
export PYGEOAPI_OPENAPI=/path/to/my-pygeoapi-openapi.json
```

In Windows:

```
set PYGEOAPI_CONFIG=/path/to/my-pygeoapi-config.yml
set PYGEOAPI_OPENAPI=/path/to/my-pygeoapi-openapi.yml
# or if OpenAPI JSON
set PYGEOAPI_OPENAPI=/path/to/my-pygeoapi-openapi.json
```

5.4 Summary

At this point you are ready to run the server. Let's go!

CHAPTER

SIX

RUNNING

Now we are ready to start up pygeoapi.

6.1 pygeoapi serve

The `pygeoapi serve` command starts up an instance using Flask as the default server. pygeoapi can be served via Flask WSGI[30] or Starlette ASGI[31].

Since pygeoapi is a Python API at its core, it can be served via numerous web server scenarios.

Note: Changes to either of the pygeoapi or OpenAPI configurations requires a server restart (configurations are loaded once at server startup for performance).

6.1.1 Flask WSGI

Web Server Gateway Interface (WSGI) is a standard for how web servers communicate with Python applications. By having a WSGI server, HTTP requests are processed into threads/processes for better performance. Flask is a WSGI implementation which pygeoapi utilizes to communicate with the core API.

```
HTTP request <--> Flask (pygeoapi/flask_app.py) <--> pygeoapi API (pygeoapi/api.py)
```

The Flask WSGI server can be run as follows:

```
pygeoapi serve --flask
pygeoapi serve  # uses Flask by default
```

To integrate pygeoapi as part of another Flask application, use Flask blueprints:

```
from flask import Flask
from pygeoapi.flask_app import BLUEPRINT as pygeoapi_blueprint

app = Flask(__name__)

app.register_blueprint(pygeoapi_blueprint, url_prefix='/oapi')


@app.route('/')
```

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[30] https://en.wikipedia.org/wiki/Web_Server_Gateway_Interface
[31] https://asgi.readthedocs.io

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```
def hello_world():
    return 'Hello, World!'
```

As a result, your application will be available at http://localhost:5000/ and pygeoapi will be available at http://localhost:5000/oapi

6.1.2 Starlette ASGI

Asynchronous Server Gateway Interface (ASGI) is standard interface between async-capable web servers, frameworks, and applications written in Python. ASGI provides the benefits of WSGI as well as asynchronous capabilities. Starlette is an ASGI implementation which pygeoapi utilizes to communicate with the core API in asynchronous mode.

```
HTTP request <--> Starlette (pygeoapi/starlette_app.py) <--> pygeoapi API (pygeoapi/
↪api.py)
```

The Starlette ASGI server can be run as follows:

```
pygeoapi serve --starlette
```

To integrate pygeoapi as part of another Starlette application:

```
from starlette.applications import Starlette
from starlette.responses import PlainTextResponse
from starlette.routing import Route
from pygeoapi.starlette_app import app as pygeoapi_app


async def homepage(request):
    return PlainTextResponse('Hello, World!')

app = Starlette(debug=True, routes=[
    Route('/', homepage),
])

app.mount('/oapi', pygeoapi_app)
```

As a result, your application will be available at http://localhost:5000/ and pygeoapi will be available at http://localhost:5000/oapi

6.2 Running in production

Running `pygeoapi serve` in production is not recommended or advisable. Preferred options are described below.

See also:

Docker for container-based production installations.

6.2.1 Apache and mod_wsgi

Deploying pygeoapi via mod_wsgi[32] provides a simple approach to enabling within Apache.

To deploy with mod_wsgi, your Apache instance must have mod_wsgi enabled within Apache. At this point, set up the following Python WSGI script:

```
import os

os.environ['PYGEOAPI_CONFIG'] = '/path/to/my-pygeoapi-config.yml'
os.environ['PYGEOAPI_OPENAPI'] = '/path/to/my-pygeoapi-openapi.yml'

from pygeoapi.flask_app import APP as application
```

Now configure in Apache:

```
WSGIDaemonProcess pygeoapi processes=1 threads=1
WSGIScriptAlias /pygeoapi /path/to/pygeoapi.wsgi process-group=pygeoapi application-
↪group=%{GLOBAL}

<Location /pygeoapi>
  Header set Access-Control-Allow-Origin "*"
</Location>
```

6.2.2 Gunicorn

Gunicorn[33] (for UNIX) is one of several Python WSGI HTTP servers that can be used for production environments.

```
HTTP request --> WSGI or ASGI server (gunicorn) <--> Flask or Starlette (pygeoapi/
↪flask_app.py or pygeoapi/starlette_app.py) <--> pygeoapi API
```

Note: Gunicorn is as easy to install as `pip install gunicorn`

Note: For a complete list of WSGI server implementations, see the WSGI server list[34].

6.2.3 Gunicorn and Flask

Gunicorn and Flask is simple to run:

```
gunicorn pygeoapi.flask_app:APP
```

Note: For extra configuration parameters like port binding, workers, and logging please consult the Gunicorn settings[35].

[32] https://modwsgi.readthedocs.io
[33] https://gunicorn.org
[34] https://wsgi.readthedocs.io/en/latest/servers.html
[35] http://docs.gunicorn.org/en/stable/settings.html

6.2.4 Gunicorn and Starlette

Running Gunicorn with Starlette requires the Uvicorn[36] which provides async capabilities along with Gunicorn. Uvicorn includes a Gunicorn worker class allowing you to run ASGI applications, with all of Uvicorn's performance benefits, while also giving you Gunicorn's fully-featured process management.

is simple to run from the command, e.g:

```
gunicorn pygeoapi.starlette_app:app -w 4 -k uvicorn.workers.UvicornWorker
```

Note: Uvicorn is as easy to install as `pip install uvicorn`

6.2.5 Django

Django[37] is a Python web framework that encourages rapid development and clean, pragmatic design. Assuming a Django install/enabled application:

```
pygeoapi serve --django
```

To integrate pygeoapi as part of another Django project in a pluggable way the truly impatient developers can see *examples/django/sample_project/README.md* for a complete Django application.

As a result, your Django application will be available at http://localhost:5000/ and pygeoapi will be available at http://localhost:5000/oapi

6.3 Summary

pygeoapi has many approaches for deploying depending on your requirements. Choose one that works for you and modify accordingly.

Note: Additional approaches are welcome and encouraged; see *Contributing* for more information on how to contribute to and improve the documentation

[36] https://www.uvicorn.org
[37] https://djangoproject.com

CHAPTER

SEVEN

DOCKER

pygeoapi provides an official Docker[38] image which is made available on both the geopython Docker Hub[39] and our GitHub Container Registry[40]. Additional Docker examples can be found in the pygeoapi GitHub repository[41], each with sample configurations, test data, deployment scenarios and provider backends.

The pygeoapi demo server[42] runs various services from Docker images which also serve as useful examples[43].

Note: Both Docker and Docker Compose[44] are required on your system to run pygeoapi images.

7.1 The basics

The official pygeoapi Docker image will start a pygeoapi Docker container using Gunicorn on internal port 80.

Either `IMAGE` can be called with the `docker` command, `geopython/pygeoapi` from DockerHub or `ghcr.io/geophython/pygeoapi` from the GitHub Container Registry. Examples below use `geopython/pygeoapi`.

To run with the default built-in configuration and data:

```
docker run -p 5000:80 -it geopython/pygeoapi run
# or simply
docker run -p 5000:80 -it geopython/pygeoapi
```

…then browse to http://localhost:5000

You can also run all unit tests to verify:

```
docker run -it geopython/pygeoapi test
```

[38] https://www.docker.com
[39] https://hub.docker.com/r/geopython/pygeoapi
[40] https://github.com/geopython/pygeoapi/pkgs/container/pygeoapi
[41] https://github.com/geopython/pygeoapi
[42] https://demo.pygeoapi.io
[43] https://github.com/geopython/demo.pygeoapi.io/tree/master/services
[44] https://docs.docker.com/compose/

7.2 Overriding the default configuration

Normally you would override the `default.config.yml` with your own `pygeoapi` configuration. This can be done via Docker Volume Mapping.

For example, if your config is in `my.config.yml`:

```
docker run -p 5000:80 -v $(pwd)/my.config.yml:/pygeoapi/local.config.yml -it␣
↪geopython/pygeoapi
```

For a cleaner approach, You can use `docker-compose` as per below:

```
version: "3"
services:
  pygeoapi:
    image: geopython/pygeoapi:latest
    volumes:
      - ./my.config.yml:/pygeoapi/local.config.yml
    ports:
      - "5000:80"
```

Or you can create a `Dockerfile` extending the base image and **copy** in your configuration:

```
FROM geopython/pygeoapi:latest
COPY ./my.config.yml /pygeoapi/local.config.yml
```

A corresponding example can be found in https://github.com/geopython/demo.pygeoapi.io/tree/master/services/pygeoapi_master

7.3 Deploying on a sub-path

By default the `pygeoapi` Docker image will run from the `root` path (`/`). If you need to run from a sub-path and have all internal URLs properly configured, you can set the `SCRIPT_NAME` environment variable.

For example to run with `my.config.yml` on `http://localhost:5000/mypygeoapi`:

```
docker run -p 5000:80 -e SCRIPT_NAME='/mypygeoapi' -v $(pwd)/my.config.yml:/pygeoapi/
↪local.config.yml -it geopython/pygeoapi
```

…then browse to **http://localhost:5000/mypygeoapi**

Below is a corresponding `docker-compose` approach:

```
version: "3"
services:
  pygeoapi:
    image: geopython/pygeoapi:latest
    volumes:
      - ./my.config.yml:/pygeoapi/local.config.yml
    ports:
      - "5000:80"
    environment:
     - SCRIPT_NAME=/pygeoapi
```

A corresponding example can be found in https://github.com/geopython/demo.pygeoapi.io/tree/master/services/pygeoapi_master

7.4 Summary

Docker is an easy and reproducible approach to deploying systems.

Note: Additional approaches are welcome and encouraged; see *Contributing* for more information on how to contribute to and improve the documentation

CHAPTER

EIGHT

TAKING A TOUR OF PYGEOAPI

At this point, you've installed pygeoapi, set configurations and started the server.

pygeoapi's default configuration comes setup with two simple vector datasets, a STAC collection and a sample process. Note that these resources are straightforward examples of pygeoapi's baseline functionality, designed to get the user up and running with as little barriers as possible.

Let's check things out. In your web browser, go to http://localhost:5000

8.1 Overview

All pygeoapi URLs have HTML and JSON representations. If you are working through a web browser, HTML is always returned as the default, whereas if you are working programmatically, JSON is always returned.

To explicitly ask for HTML or JSON, simply add `f=html` or `f=json` to any URL accordingly.

Each web page provides breadcrumbs for navigating up/down the server's data. In addition, the upper right of the UI always has JSON and JSON-LD links to provide you with the current page in JSON if desired.

8.2 Landing page

http://localhost:5000

The landing page provides a high level overview of the pygeoapi server (contact information, licensing), as well as specific sections to browse data, processes and geospatial files.

8.3 Collections

http://localhost:5000/collections

The collections page displays all the datasets available on the pygeoapi server with their title and abstract. Let's drill deeper into a given dataset.

8.4 Collection information

http://localhost:5000/collections/obs

Let's drill deeper into a given dataset. Here we can see the `obs` dataset is described along with related links (other related HTML pages, dataset download, etc.).

The 'View' section provides the default to start browsing the data.

The 'Queryables' section provides a link to the dataset's properties.

8.5 Vector data

8.5.1 Collection queryables

http://localhost:5000/collections/obs/queryables

The queryables endpoint provides the collection's queryable properties and associated datatypes.

8.5.2 Collection items

http://localhost:5000/collections/obs/items

This page displays a map and tabular view of the data. Features are clickable on the interactive map, allowing the user to drill into more information about the feature. The table also allows for drilling into a feature by clicking the link in a given table row.

Let's inspect the feature close to Toronto, Ontario, Canada[45].

8.5.3 Collection item

http://localhost:5000/collections/obs/items/297

This page provides an overview of the feature and its full set of properties, along with an interactive map.

See also:

Publishing vector data to OGC API - Features for more OGC API - Features request examples.

8.5.4 Transactions

Add an item to a collection (using curl[46]):

```
curl -XPOST -H "Content-Type: application/geo+json" http://localhost:5000/collections/
↪canada-metadata/items -d @new-item.json
```

Update an item in a collection (using curl[47]):

```
curl -XPUT -H "Content-Type: application/geo+json" http://localhost:5000/collections/
↪canada-metadata/items/item1 -d @updated-feature.json
```

[45] https://en.wikipedia.org/wiki/Toronto
[46] https://curl.se
[47] https://curl.se

Delete an item from a collection:

```
curl -XDELETE http://localhost:5000/collections/canada-metadata/items/item1
```

8.6 Raster data

8.6.1 Collection coverage domainset

This page provides information on a collection coverage spatial properties and axis information.

http://localhost:5000/collections/gdps-temperature/coverage/domainset

8.6.2 Collection coverage rangetype

This page provides information on a collection coverage rangetype (bands) information.

http://localhost:5000/collections/gdps-temperature/coverage/rangetype

8.6.3 Collection coverage data

This page provides a coverage in CoverageJSON format.

http://localhost:5000/collections/gdps-temperature/coverage

See also:

Publishing raster data to OGC API - Coverages for more OGC API - Coverages request exampless.

8.7 Tiles

A given collection or any data type can additionally be made available as tiles (map tiles, vector tiles, etc.). The following page provides an overview of a collection's tiles capabilities (tile matrix sets, URI templates, etc.)

http://localhost:5000/collections/lakes/tiles

8.7.1 URI templates

From the abovementioned page, we can find the URI template:

http://localhost:5000/collections/lakes/tiles/\protect\TU\textbracelefttileMatrixSetId\protect\TU\textbraceright/\protect\TU\textbracelefttileMatrix\protect\TU\textbraceright/\protect\TU\textbracelefttileRow\protect\TU\textbraceright/\protect\TU\textbracelefttileCol\protect\TU\textbraceright?f=mvt

8.7.2 Generic metadata

This page provides freeform tiles metadata.

http://localhost:5000/collections/lakes/tiles/WorldCRS84Quad/metadata

8.8 Metadata Records

http://localhost:5000/collections/metadata-records/items?q=crops&bbox=-142,42,-52,84

This page provides metadata catalogue search capabilities

See also:

Publishing metadata to OGC API - Records for more OGC API - Records request examples.

8.8.1 Transactions

See the *Transactions* section for examples.

8.9 Processes

The processes page provides a list of process integrated onto the server, along with a name and description.

Todo: Expand with more info once OAProc HTML is better flushed out.

See also:

Publishing processes via OGC API - Processes for more OGC API - Processes request examples.

8.10 Environmental data retrieval

http://localhost:5000/collections/edr-test

This page provides, in addition to a common collection description, specific link relations for EDR queries if the collection has an EDR capability, as well as supported parameter names to select.

http://localhost:5000/collections/edr-test/position?coords=POINT(111 13)&parameter-name=SST&f=json

This page executes a position query against a given parameter name, providing a response in CoverageJSON.

See also:

Publishing data to OGC API - Environmental Data Retrieval for more OGC API - EDR request examples.

8.11 SpatioTemporal Assets

http://localhost:5000/stac

This page provides a Web Accessible Folder view of raw geospatial data files. Users can navigate and click to browse directory contentsor inspect files. Clicking on a file will attempt to display the file's properties/metadata, as well as an interactive map with a footprint of the spatial extent of the file.

See also:

Publishing files to a SpatioTemporal Asset Catalog for more STAC request examples.

8.12 API Documentation

http://localhost:5000/openapi

http://localhost:5000/openapi?f=json

The API documentation links provide a Swagger[48] page of the API as a tool for developers to provide example request/response/query capabilities. A JSON representation is also provided.

See also:

OpenAPI

8.13 Conformance

http://localhost:5000/conformance

The conformance page provides a list of URLs corresponding to the OGC API conformance classes supported by the pygeoapi server. This information is typically useful for developers and client applications to discover what is supported by the server.

[48] https://en.wikipedia.org/wiki/Swagger_(software)

CHAPTER

NINE

OPENAPI

The OpenAPI specification[49] is an open specification for RESTful endpoints. OGC API specifications leverage OpenAPI to describe the API in great detail with developer focus.

The RESTful structure and payload are defined using JSON or YAML file structures (pygeoapi uses YAML). The basic structure is described here: https://swagger.io/docs/specification/basic-structure/

The official OpenAPI specification can be found on GitHub[50]. pygeoapi supports OpenAPI version 3.0.2.

As described in *Administration*, the pygeoapi OpenAPI document is automatically generated based on the configuration file:

The API is accessible at the `/openapi` endpoint, providing a Swagger-based webpage of the API description..

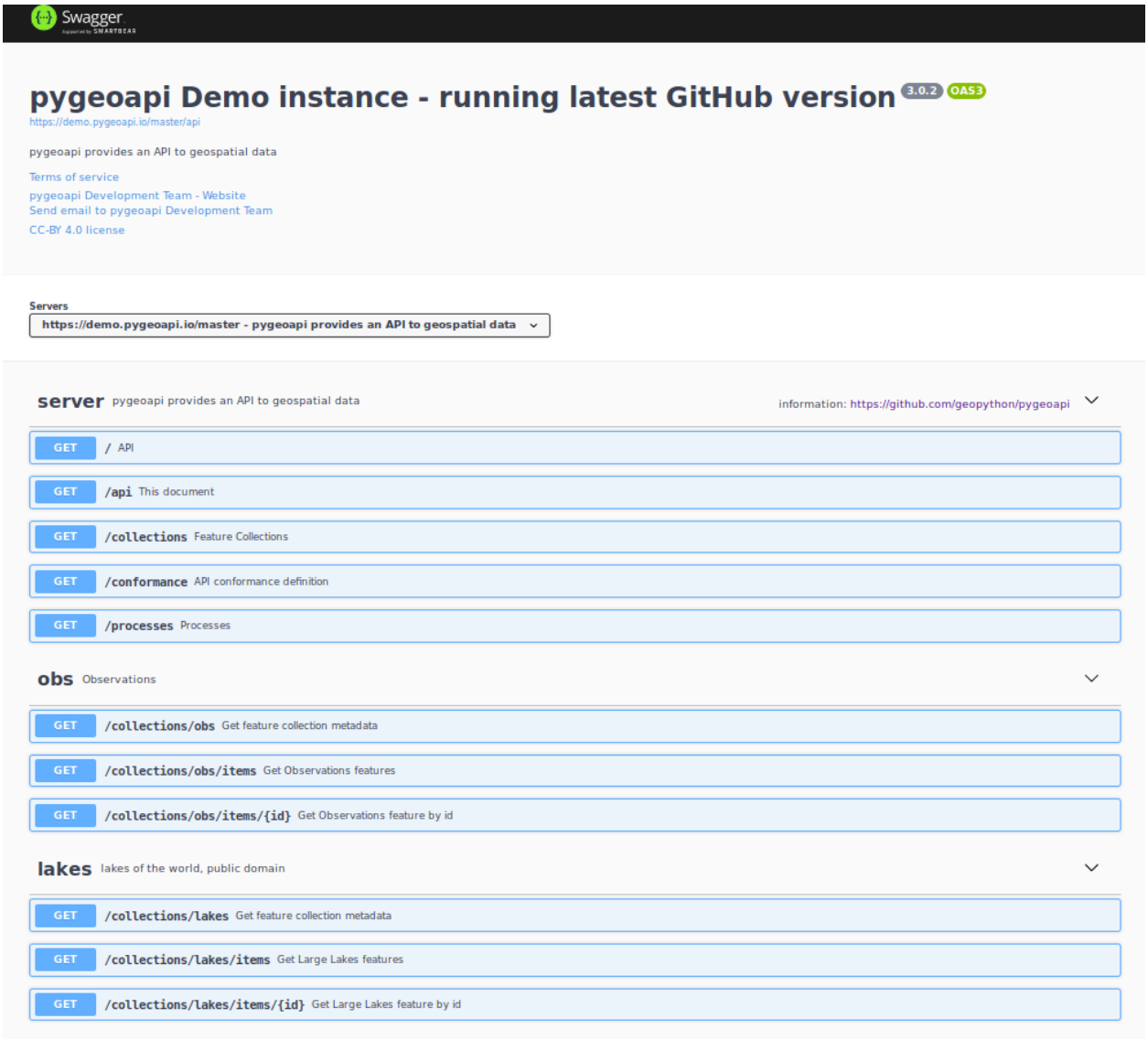
See also:

the pygeoapi demo OpenAPI/Swagger endpoint at https://demo.pygeoapi.io/master/openapi

9.1 Using OpenAPI via Swagger

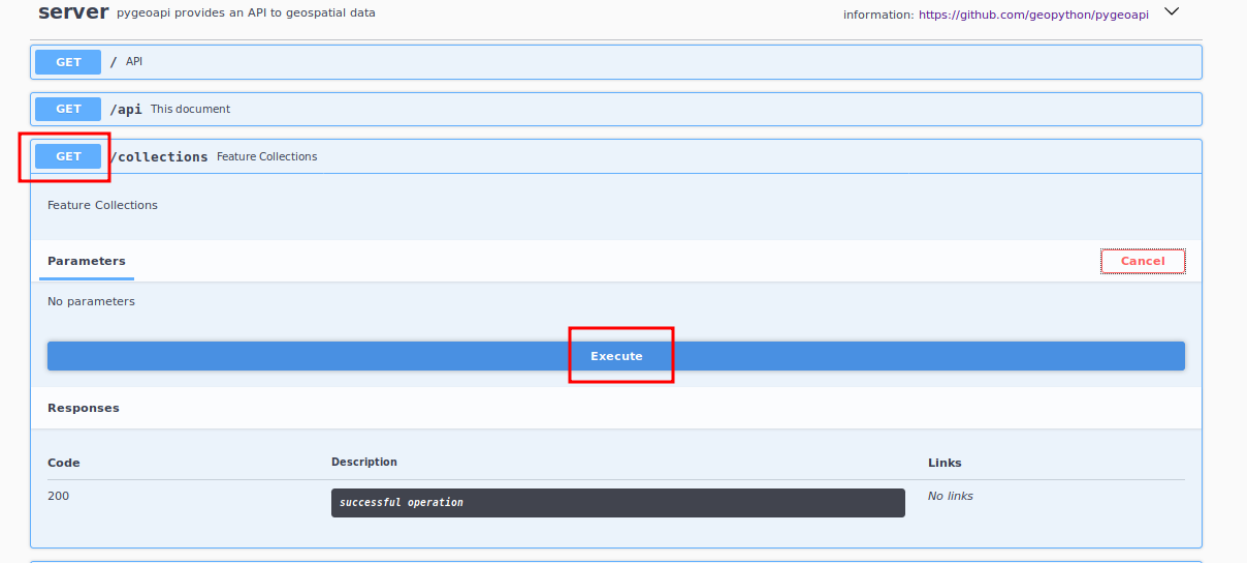
Accessing the Swagger webpage we have the following structure:

[49] https://swagger.io/docs/specification/about/
[50] https://github.com/OAI/OpenAPI-Specification/tree/master/versions

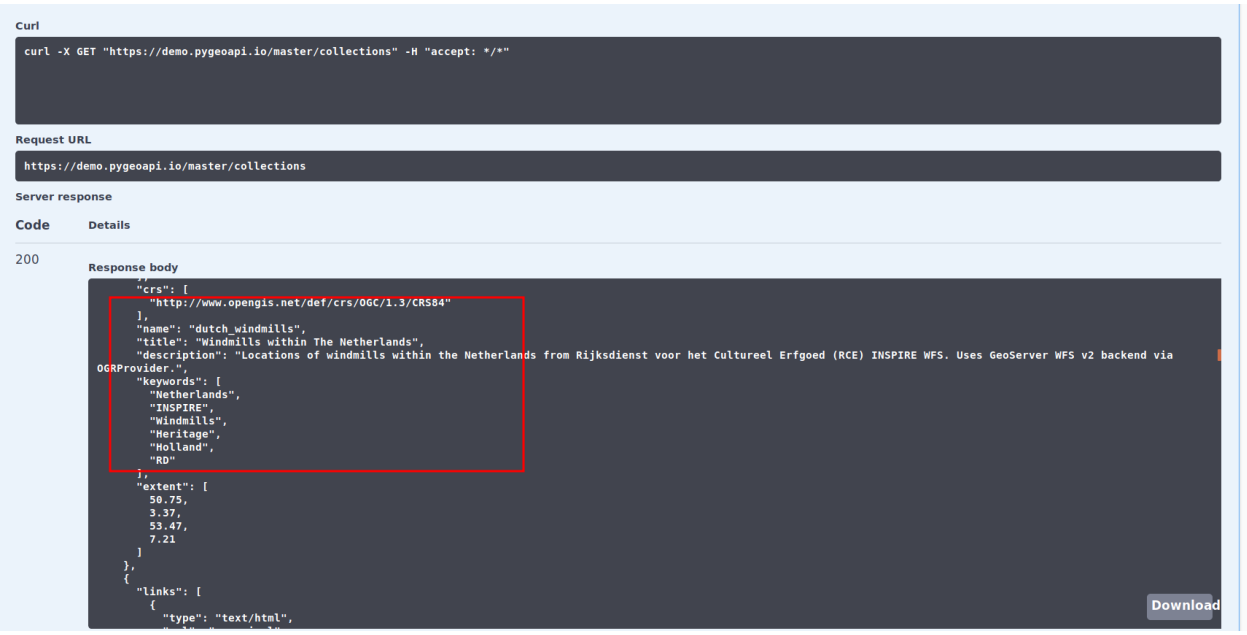


Notice that each dataset is represented as a RESTful endpoint under `collections`.

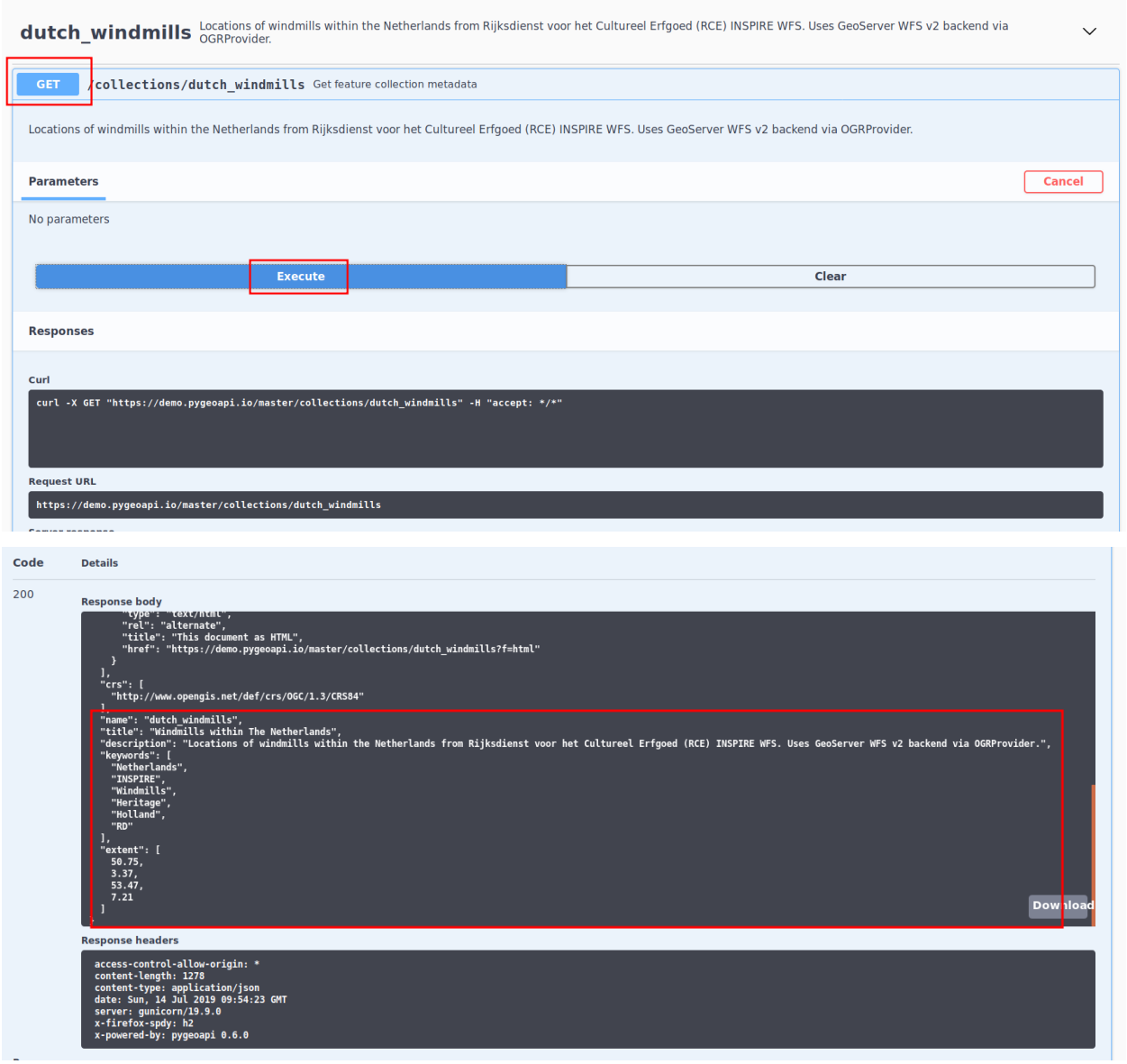
In this example we will test `GET` capability of data concerning windmills in the Netherlands. Let's start by accessing the service's dataset collections:



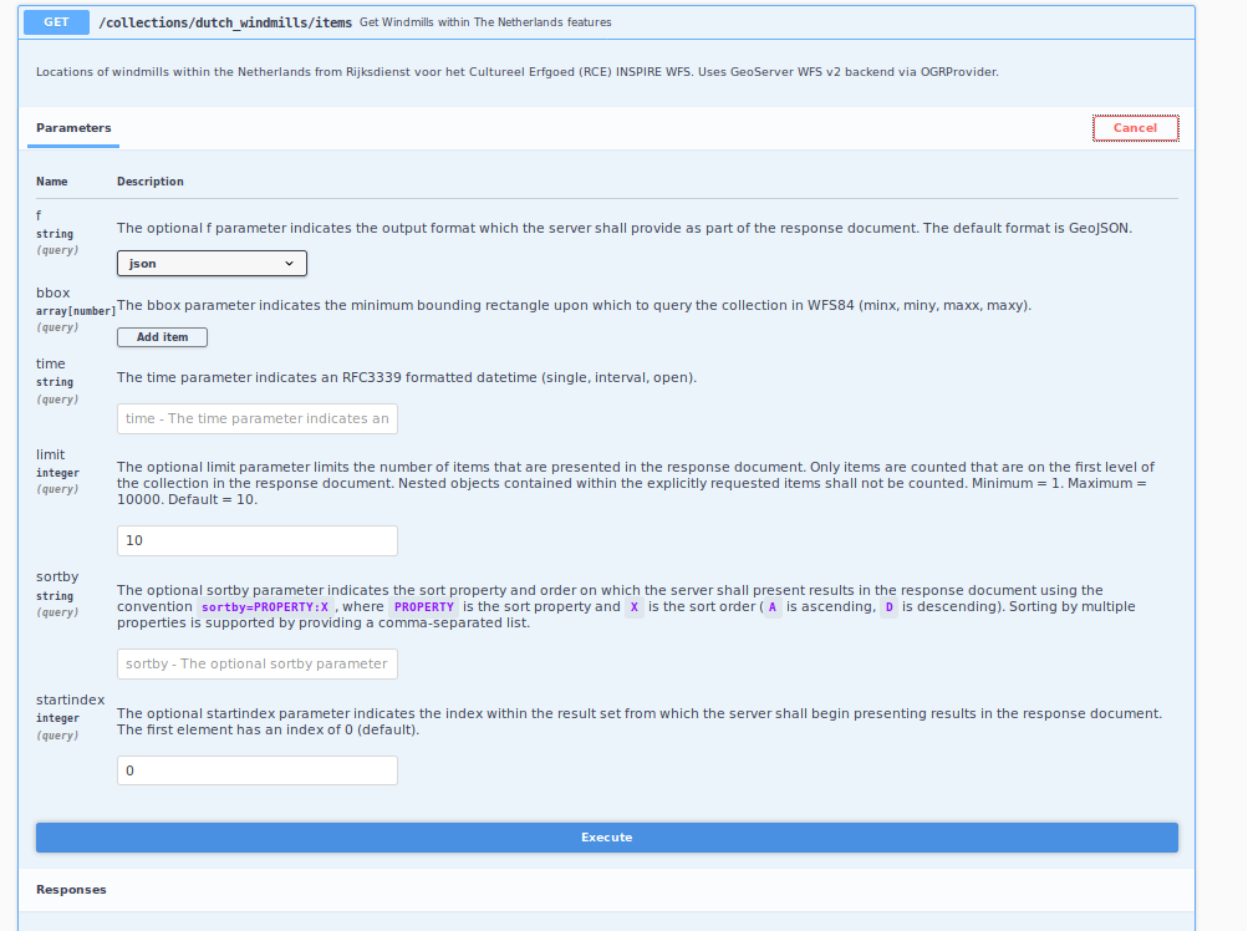
The service collection metadata will contain a description of each collection:



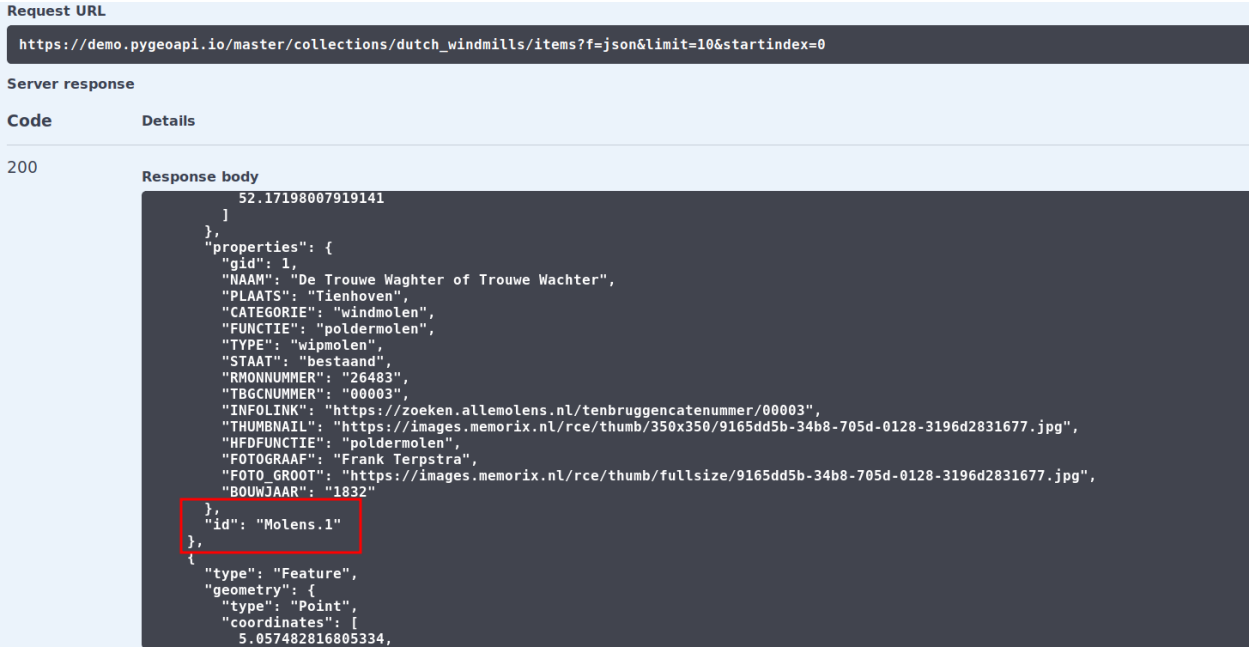
Here, we see that the `dutch_windmills` dataset is be available. Next, let's obtain the specific metadata of the dataset:



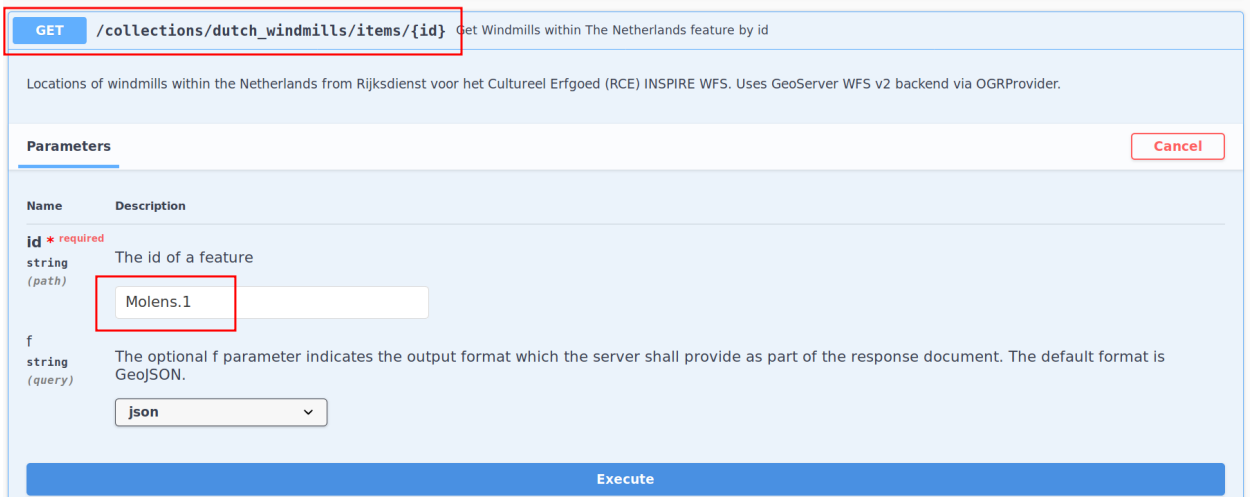
We also see that the dataset has an `items` endpoint which provides all data, along with specific parameters for filtering, paging and sorting:



For each item in our dataset we have a specific identifier. Notice that the identifier is not part of the GeoJSON properties, but is provided as a GeoJSON root property of `id`.



This identifier can be used to obtain a specific item from the dataset using the `items{id}` endpoint as follows:



9.2 Using OpenAPI via ReDoc

pygeoapi also supports OpenAPI document rendering via ReDoc[51].

ReDoc rendering is accessible at the same `/openapi` endpoint, adding `ui=redoc` to the request URL.

9.3 Summary

Using pygeoapi's OpenAPI and Swagger endpoints provides a useful user interface to query data, as well as for developers to easily understand pygeoapi when building downstream applications.

[51] https://redoc.ly/

CHAPTER

TEN

DATA PUBLISHING

Let's start working on integrating your data into pygeoapi. pygeoapi provides the capability to publish vector/coverage data, processes, catalogues, and exposing filesystems of geospatial data.

10.1 Providers overview

A key component to data publishing is the pygeoapi provider framework. Providers allow for configuring data files, databases, search indexes, other APIs, cloud storage, to be able to return back data to the pygeoapi API framework in a plug and play fashion.

10.1.1 Publishing vector data to OGC API - Features

OGC API - Features[52] provides geospatial data access functionality to vector data.

To add vector data to pygeoapi, you can use the dataset example in *Configuration* as a baseline and modify accordingly.

[52] https://www.ogc.org/standards/ogcapi-features

10.1.1.1 Providers

pygeoapi core feature providers are listed below, along with a matrix of supported query parameters.

Provider	property filters/display	resulttype	bbox	datetime	sortby	skipGeometry	CQL	transactions
CSV	✓/✓	results/hits	✗	✗	✗	✓	✗	✗
Elasticsearch	✓/✓	results/hits	✓	✓	✓	✓	✓	✓
ESRIFeatureService	✓/✓	results/hits	✓	✓	✓	✓	✗	✗
GeoJSON	✓/✓	results/hits	✗	✗	✗	✓	✗	✗
MongoDB	✓/✗	results	✓	✓	✓	✓	✗	✗
OGR	✓/✗	results/hits	✓	✗	✗	✓	✗	✗
PostgreSQL	✓/✓	results/hits	✓	✓	✓	✓	✓	✗
SQLiteGPKG	✓/✗	results/hits	✓	✗	✗	✓	✗	✗
SensorThingsAPI	✓/✓	results/hits	✓	✓	✓	✓	✗	✗
Socrata	✓/✓	results/hits	✓	✓	✓	✓	✗	✗

Below are specific connection examples based on supported providers.

10.1.1.2 Connection examples

CSV

To publish a CSV file, the file must have columns for x and y geometry which need to be specified in `geometry` section of the `provider` definition.

```
providers:
    - type: feature
      name: CSV
      data: tests/data/obs.csv
      id_field: id
      geometry:
          x_field: long
          y_field: lat
```

GeoJSON

To publish a GeoJSON file, the file must be a valid GeoJSON FeatureCollection.

```
providers:
    - type: feature
      name: GeoJSON
      data: tests/data/file.json
      id_field: id
```

Elasticsearch

Note: Elasticsearch 7 or greater is supported.

To publish an Elasticsearch index, the following are required in your index:

- indexes must be documents of valid GeoJSON Features
- index mappings must define the GeoJSON `geometry` as a `geo_shape`

```
providers:
    - type: feature
      name: Elasticsearch
      editable: true|false  # optional, default is false
      data: http://localhost:9200/ne_110m_populated_places_simple
      id_field: geonameid
      time_field: datetimefield
```

This provider has the support for the CQL queries as indicated in the table above.

See also:

CQL support for more details on how to use Common Query Language (CQL) to filter the collection with specific queries.

ESRI Feature Service

To publish an ESRI *Feature Service <https://enterprise.arcgis.com/en/server/latest/publish-services/windows/what-is-a-feature-service-.htm>* or *Map Service <https://enterprise.arcgis.com/en/server/latest/publish-services/windows/what-is-a-map-service.htm>* specify the URL for the service layer in the `data` field.

- `id_field` will often be `OBJECTID`, `objectid`, or `FID`.
- If the map or feature service is not shared publicly, the `username` and `password` fields can be set in the configuration to authenticate into the service.

```
providers:
    - type: feature
      name: ESRI
      data: https://sampleserver5.arcgisonline.com/arcgis/rest/services/NYTimes_
↪Covid19Cases_USCounties/MapServer/0
      id_field: objectid
      time_field: date_in_your_device_time_zone # Optional time field
      crs: 4326 # Optional crs (default is ESPG:4326)
      username: username # Optional ArcGIS username
      password: password # Optional ArcGIS password
```

OGR

GDAL/OGR[53] supports a wide range of spatial file formats, such as shapefile, dxf, gpx, kml, but also services such as WFS. Read the full list and configuration options at https://gdal.org/drivers/vector. Additional formats and features are available via the virtual format[54], use this driver for example for flat database files (CSV).

The OGR provider requires a recent (3+) version of GDAL to be installed.

```
providers:
    - type: feature
      name: OGR
      data:
        source_type: ESRI Shapefile
        source: tests/data/dutch_addresses_shape_4326/inspireadressen.shp
        source_options:
          ADJUST_GEOM_TYPE: FIRST_SHAPE
        gdal_ogr_options:
          SHPT: POINT
      id_field: fid
      layer: inspireadressen
```

```
providers:
    - type: feature
      name: OGR
      data:
        source_type: WFS
        source: WFS:https://geodata.nationaalgeoregister.nl/rdinfo/wfs?
        source_options:
            VERSION: 2.0.0
            OGR_WFS_PAGING_ALLOWED: YES
            OGR_WFS_LOAD_MULTIPLE_LAYER_DEFN: NO
         gdal_ogr_options:
            GDAL_CACHEMAX: 64
            GDAL_HTTP_PROXY: (optional proxy)
            GDAL_PROXY_AUTH: (optional auth for remote WFS)
            CPL_DEBUG: NO
      id_field: gml_id
      layer: rdinfo:stations
```

```
providers:
     - type: feature
       name: OGR
       data:
         source_type: ESRIJSON
         source: https://map.bgs.ac.uk/arcgis/rest/services/GeoIndex_Onshore/
↪boreholes/MapServer/0/query?where=BGS_ID+%3D+BGS_ID&outfields=*&orderByFields=BGS_
↪ID+ASC&f=json
         source_srs: EPSG:27700
         target_srs: EPSG:4326
         source_capabilities:
             paging: True
         open_options:
             FEATURE_SERVER_PAGING: YES
         gdal_ogr_options:
```

(continues on next page)

[53] https://gdal.org
[54] https://gdal.org/drivers/vector/vrt.html#vector-vrt

(continued from previous page)

```
            EMPTY_AS_NULL: NO
            GDAL_CACHEMAX: 64
            # GDAL_HTTP_PROXY: (optional proxy)
            # GDAL_PROXY_AUTH: (optional auth for remote WFS)
            CPL_DEBUG: NO
      id_field: BGS_ID
      layer: ESRIJSON
```

MongoDB

Note: Mongo 5 or greater is supported.

- each document must be a GeoJSON Feature, with a valid geometry.

```
providers:
    - type: feature
      name: MongoDB
      data: mongodb://localhost:27017/testdb
      collection: testplaces
```

PostgreSQL

Must have PostGIS installed.

Note: Geometry must be using EPSG:4326

```
providers:
    - type: feature
      name: PostgreSQL
      data:
          host: 127.0.0.1
          port: 3010 # Default 5432 if not provided
          dbname: test
          user: postgres
          password: postgres
          search_path: [osm, public]
      id_field: osm_id
      table: hotosm_bdi_waterways
      geom_field: foo_geom
```

This provider has support for the CQL queries as indicated in the Provider table above.

See also:

CQL support for more details on how to use Common Query Language (CQL) to filter the collection with specific queries.

SQLiteGPKG

Todo: add overview and requirements

SQLite file:

```
providers:
    - type: feature
      name: SQLiteGPKG
      data: ./tests/data/ne_110m_admin_0_countries.sqlite
      id_field: ogc_fid
      table: ne_110m_admin_0_countries
```

GeoPackage file:

```
providers:
    - type: feature
      name: SQLiteGPKG
      data: ./tests/data/poi_portugal.gpkg
      id_field: osm_id
      table: poi_portugal
```

SensorThings API

The STA provider is capable of creating feature collections from OGC SensorThings API endpoints. Three of the STA entities are configurable: Things, Datastreams, and Observations. For a full description of the SensorThings entity model, see here[55]. For each entity of `Things`, pygeoapi will expand all entities directly related to the `Thing`, including its associated `Location`, from which the geometry for the feature collection is derived. Similarly, `Datastreams` are expanded to include the associated `Thing`, `Sensor` and `ObservedProperty`.

The default id_field is `@iot.id`. The STA provider adds one required field, `entity`, and an optional field, `intralink`. The `entity` field refers to which STA entity to use for the feature collection. The `intralink` field controls how the provider is acted upon by other STA providers and is by default, False. If `intralink` is true for an adjacent STA provider collection within a pygeoapi instance, the expanded entity is instead represented by an intra-pygeoapi link to the other entity or it's `uri_field` if declared.

```
providers:
    - type: feature
      name: SensorThings
      data: https://sensorthings-wq.brgm-rec.fr/FROST-Server/v1.0/
      uri_field: uri
      entity: Datastreams
      time_field: phenomenonTime
      intralink: true
```

If all three entities are configured, the STA provider will represent a complete STA endpoint as OGC-API feature collections. The `Things` features will include links to the associated features in the `Datastreams` feature collection, and the `Observations` features will include links to the associated features in the `Datastreams` feature collection. Examples with three entities configured are included in the docker examples for SensorThings.

[55] http://docs.opengeospatial.org/is/15-078r6/15-078r6.html#figure_2

Socrata

To publish a *Socrata Open Data API (SODA) <https://dev.socrata.com/>* endpoint, pygeoapi heavily relies on *sodapy <https://github.com/xmunoz/sodapy>*.

- `data` is the domain of the SODA endpoint.
- `resource_id` is the 4x4 resource id pattern.
- `geom_field` is required for bbox queries to work.
- `token` is optional and can be included in the configuration to pass an *app token <https://dev.socrata.com/docs/app-tokens.html>* to Socrata.

```
providers:
   - type: feature
     name: Socrata
     data: https://soda.demo.socrata.com/
     resource_id: emdb-u46w
     id_field: earthquake_id
     geom_field: location
     time_field: datetime # Optional time_field for datetime queries
     token: my_token # Optional app token
```

10.1.1.3 Data access examples

- list all collections * http://localhost:5000/collections
- overview of dataset * http://localhost:5000/collections/foo
- queryables * http://localhost:5000/collections/foo/queryables
- browse features * http://localhost:5000/collections/foo/items
- paging * http://localhost:5000/collections/foo/items?offset=10&limit=10
- CSV outputs * http://localhost:5000/collections/foo/items?f=csv
- query features (spatial) * http://localhost:5000/collections/foo/items?bbox=-180,-90,180,90
- query features (attribute) * http://localhost:5000/collections/foo/items?propertyname=foo
- query features (temporal) * http://localhost:5000/collections/foo/items?datetime=2020-04-10T14:11:00Z
- query features (temporal) and sort ascending by a property (if no +/- indicated, + is assumed) * http://localhost:5000/collections/foo/items?datetime=2020-04-10T14:11:00Z&sortby=+datetime
- query features (temporal) and sort descending by a property * http://localhost:5000/collections/foo/items?datetime=2020-04-10T14:11:00Z&sortby=-datetime
- fetch a specific feature * http://localhost:5000/collections/foo/items/123

Note: `.../items` queries which return an alternative representation to GeoJSON (which prompt a download) will have the response filename matching the collection name and appropriate file extension (e.g. `my-dataset.csv`)

10.1.2 Publishing raster data to OGC API - Coverages

OGC API - Coverages[56] provides geospatial data access functionality to raster data.

To add raster data to pygeoapi, you can use the dataset example in *Configuration* as a baseline and modify accordingly.

10.1.2.1 Providers

pygeoapi core feature providers are listed below, along with a matrix of supported query parameters.

Provider	properties	subset	bbox	datetime
rasterio	✓	✓	✓	
xarray	✓	✓	✓	✓

Below are specific connection examples based on supported providers.

10.1.2.2 Connection examples

rasterio

The rasterio[57] provider plugin reads and extracts any data that rasterio is capable of handling.

```
providers:
    - type: coverage
      name: rasterio
      data: tests/data/CMC_glb_TMP_TGL_2_latlon.15x.15_2020081000_P000.grib2
      options:  # optional creation options
          DATA_ENCODING: COMPLEX_PACKING
      format:
          name: GRIB
          mimetype: application/x-grib2
```

Note: The rasterio provider `format.name` directive **requires** a valid GDAL raster driver short name[58].

xarray

The xarray[59] provider plugin reads and extracts NetCDF[60] and Zarr[61] data.

```
providers:
    - type: coverage
      name: xarray
      data: tests/data/coads_sst.nc
      # optionally specify x/y/time fields, else provider will attempt
      # to derive automagically
```

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[56] https://github.com/opengeospatial/ogcapi-coverages
[57] https://rasterio.readthedocs.io
[58] https://gdal.org/drivers/raster/index.html
[59] https://xarray.pydata.org
[60] https://en.wikipedia.org/wiki/NetCDF
[61] https://zarr.readthedocs.io/en/stable

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```
      x_field: lat
      x_field: lon
      time_field: time
      format:
         name: netcdf
         mimetype: application/x-netcdf

providers:
    - type: coverage
      name: xarray
      data: tests/data/analysed_sst.zarr
      format:
         name: zarr
         mimetype: application/zip
```

Note: Zarr[62] files are directories with files and subdirectories. Therefore a zip file is returned upon request for said format.

10.1.2.3 Data access examples

- list all collections * http://localhost:5000/collections
- overview of dataset * http://localhost:5000/collections/foo
- coverage rangetype * http://localhost:5000/collections/foo/coverage/rangetype
- coverage domainset * http://localhost:5000/collections/foo/coverage/domainset
- coverage access via CoverageJSON (default) * http://localhost:5000/collections/foo/coverage?f=json
- coverage access via native format (as defined in `provider.format.name`) * http://localhost:5000/collections/foo/coverage?f=GRIB
- coverage access with comma-separated properties * http://localhost:5000/collections/foo/coverage?properties=1,3
- coverage access with subsetting * http://localhost:5000/collections/foo/coverage?subset=lat(10,20)&subset=long(10,20)
- coverage with bbox * http://localhost:5000/collections/foo/coverage?bbox=10,10,20,20
- coverage with bbox and bbox CRS * http://localhost:5000/collections/foo/coverage?bbox=-8794239.772668611,5311971.846945471,-8348961.809495518,5621521.486192066&bbox=crs=3857

Note: `.../coverage` queries which return an alternative representation to CoverageJSON (which prompt a download) will have the response filename matching the collection name and appropriate file extension (e.g. `my-dataset.nc`)

[62] https://zarr.readthedocs.io/en/stable

10.1.3 Publishing map tiles to OGC API - Tiles

OGC API - Tiles[63] provides access to geospatial data in the form of tiles (map, vector, etc.).

pygeoapi can publish tiles from local or remote data sources (including cloud object storage). To integrate tiles from a local data source, it is assumed that a directory tree of static tiles has been created on disk. Examples of tile generation software include (but are not limited to):

- MapProxy[64]
- tippecanoe[65]

10.1.3.1 Providers

pygeoapi core tile providers are listed below, along with supported storage types.

Provider	local	remote
MVT	✓	✓

Below are specific connection examples based on supported providers.

10.1.3.2 Connection examples

MVT

The MVT provider plugin provides access to Mapbox Vector Tiles[66].

```
providers:
    - type: tile
      name: MVT
      data: tests/data/tiles/ne_110m_lakes  # local directory tree
      # data: https://example.org/ne_110m_lakes/{z}/{x}/{y}.pbf
      options:
          metadata_format: raw # default | tilejson
          zoom:
              min: 0
              max: 5
          schemes:
              - WorldCRS84Quad
      format:
          name: pbf
          mimetype: application/vnd.mapbox-vector-tile
```

[63] https://github.com/opengeospatial/ogcapi-tiles
[64] https://mapproxy.org
[65] https://github.com/mapbox/tippecanoe
[66] https://docs.mapbox.com/vector-tiles/reference

10.1.3.3 Data access examples

- list all collections * http://localhost:5000/collections
- overview of dataset * http://localhost:5000/collections/foo
- overview of dataset tiles * http://localhost:5000/collections/foo/tiles
- tile matrix metadata * http://localhost:5000/collections/lakes/tiles/WorldCRS84Quad/metadata
- tiles URI template * http://localhost:5000/collections/lakes/tiles/\protect\TU\textbraceleftttileMatrixSetId\protect\TU\textbraceright/\protect\TU\textbraceleftttileMatrix\protect\TU\textbraceright/\protect\TU\textbraceleftttileRow\protect\TU\textbraceright/\protect\TU\textbraceleftttileCol\protect\TU\textbraceright?f=mvt

10.1.4 Publishing processes via OGC API - Processes

OGC API - Processes[67] provides geospatial data processing functionality in a standards-based fashion (inputs, outputs).

pygeoapi implements OGC API - Processes functionality by providing a plugin architecture, thereby allowing developers to implement custom processing workflows in Python.

A sample[68] `hello-world` process is provided with the pygeoapi default configuration.

10.1.4.1 Configuration

```
processes:
    hello-world:
        processor:
            name: HelloWorld
```

10.1.4.2 Asynchronous support

By default, pygeoapi implements process execution (jobs) as synchronous mode. That is, when jobs are submitted, the process is executed and returned in real-time. Certain processes that may take time to execute, or be delegated to a scheduler/queue, are better suited to an asynchronous design pattern. This means that when a job is submitted in asynchronous mode, the server responds immediately with a reference to the job, which allows the client to periodically poll the server for the processing status of a given job.

pygeoapi provides asynchronous support by providing a 'manager' concept which, well, manages job execution. The manager concept is implemented as part of the pygeoapi *Customizing pygeoapi: plugins* architecture. pygeoapi provides a default manager implementation based on TinyDB[69] for simplicity. Custom manager plugins can be developed for more advanced job management capabilities (e.g. Kubernetes, databases, etc.).

```
server:
    manager:
        name: TinyDB
        connection: /tmp/pygeoapi-process-manager.db
        output_dir: /tmp/
```

[67] https://github.com/opengeospatial/ogcapi-processes
[68] https://github.com/geopython/pygeoapi/blob/master/pygeoapi/process/hello_world.py
[69] https://tinydb.readthedocs.io

10.1.4.3 Putting it all together

To summarize how pygeoapi processes and managers work together:

```
* process plugins implement the core processing / workflow functionality
* manager plugins control and manage how processes are executed
```

10.1.4.4 Processing examples

- list all processes * http://localhost:5000/processes
- describe the `hello-world` process * http://localhost:5000/processes/hello-world
- show all jobs * http://localhost:5000/jobs
- execute a job for the `hello-world` process * `curl -X POST "http://localhost:5000/processes/hello-world/execution" -H "Content-Type: application/json" -d "{\"inputs\":{\"name\": \"hi there2\"}}"`
- execute a job for the `hello-world` process with a raw response (default) * `curl -X POST "http://localhost:5000/processes/hello-world/execution" -H "Content-Type: application/json" -d "{\"inputs\":{\"name\": \"hi there2\"}}"`
- execute a job for the `hello-world` process with a response document * `curl -X POST "http://localhost:5000/processes/hello-world/execution" -H "Content-Type: application/json" -d "{\"inputs\":{\"name\": \"hi there2\"},\"response\":\"document\"}"`
- execute a job for the `hello-world` process in asynchronous mode * `curl -X POST "http://localhost:5000/processes/hello-world/execution" -H "Content-Type: application/json" -d "{\"mode\": \"async\", \"inputs\":{\"name\": \"hi there2\"}}"`

Todo: add more examples once OAProc implementation is complete

10.1.5 Publishing metadata to OGC API - Records

OGC API - Records[70] provides geospatial data access functionality to vector data.

To add vector data to pygeoapi, you can use the dataset example in *Configuration* as a baseline and modify accordingly.

10.1.5.1 Providers

pygeoapi core record providers are listed below, along with a matrix of supported query parameters.

Provider	properties (filters)	resulttype	q	bbox	datetime	sortby	properties (display)	transactions
ElasticsearchCatalogue	✓	results/hits	✓	✓	✓	✓	✗	
TinyDBCatalogue	✓	results/hits	✓	✓	✓	✓	✓	

[70] https://www.ogc.org/standards/ogcapi-records

Below are specific connection examples based on supported providers.

10.1.5.2 Connection examples

ElasticsearchCatalogue

Note: Elasticsearch 7 or greater is supported.

To publish an Elasticsearch index, the following are required in your index:

- indexes must be documents of valid OGC API - Records GeoJSON Features[71]
- index mappings must define the GeoJSON `geometry` as a `geo_shape`

```
providers:
    - type: record
      name: ElasticsearchCatalogue
      data: http://localhost:9200/some_metadata_index
      id_field: identifier
      time_field: datetimefield
```

TinyDBCatalogue

Note: Elasticsearch 7 or greater is supported.

To publish a TinyDB index, the following are required in your index:

- indexes must be documents of valid OGC API - Records GeoJSON Features[72]

```
providers:
    - type: record
      editable: true|false  # optional, default is false
      name: TinyDBCatalogue
      data: /path/to/file.db
      id_field: identifier
      time_field: datetimefield
```

10.1.5.3 Metadata search examples

- overview of record collection * http://localhost:5000/collections/metadata-records
- queryables * http://localhost:5000/collections/foo/queryables
- browse records * http://localhost:5000/collections/foo/items
- paging * http://localhost:5000/collections/foo/items?offset=10&limit=10
- CSV outputs * http://localhost:5000/collections/foo/items?f=csv
- query records (spatial) * http://localhost:5000/collections/foo/items?bbox=-180,-90,180,90

[71] https://raw.githubusercontent.com/opengeospatial/ogcapi-records/master/core/openapi/schemas/recordGeoJSON.yaml
[72] https://raw.githubusercontent.com/opengeospatial/ogcapi-records/master/core/openapi/schemas/recordGeoJSON.yaml

- query records (attribute) * http://localhost:5000/collections/foo/items?propertyname=foo
- query records (temporal) * http://localhost:5000/collections/my-metadata/items?datetime=2020-04-10T14:11:00Z
- query features (temporal) and sort ascending by a property (if no +/- indicated, + is assumed) * http://localhost:5000/collections/my-metadata/items?datetime=2020-04-10T14:11:00Z&sortby=datetime
- query features (temporal) and sort descending by a property * http://localhost:5000/collections/my-metadata/items?datetime=2020-04-10T14:11:00Z&sortby=-datetime
- fetch a specific record * http://localhost:5000/collections/my-metadata/items/123

10.1.6 Publishing data to OGC API - Environmental Data Retrieval

The OGC Environmental Data Retrieval (EDR) (API)[73] provides a family of lightweight query interfaces to access spatio-temporal data resources.

To add spatio-temporal data to pygeoapi for EDR query interfaces, you can use the dataset example in *Configuration* as a baseline and modify accordingly.

10.1.6.1 Providers

pygeoapi core EDR providers are listed below, along with a matrix of supported query parameters.

Provider	coords	parameter-name	datetime
xarray-edr	✓	✓	✓

Below are specific connection examples based on supported providers.

10.1.6.2 Connection examples

xarray-edr

The *xarray-edr* provider plugin reads and extracts NetCDF[74] and Zarr[75] data via xarray[76].

```
providers:
    - type: edr
      name: xarray-edr
      data: tests/data/coads_sst.nc
      # optionally specify x/y/time fields, else provider will attempt
      # to derive automagically
      x_field: lat
      x_field: lon
      time_field: time
      format:
         name: netcdf
         mimetype: application/x-netcdf
```

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[73] https://github.com/opengeospatial/ogcapi-coverages
[74] https://en.wikipedia.org/wiki/NetCDF
[75] https://zarr.readthedocs.io/en/stable
[76] https://xarray.pydata.org

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```
providers:
    - type: edr
      name: xarray-edr
      data: tests/data/analysed_sst.zarr
      format:
         name: zarr
         mimetype: application/zip
```

Note: Zarr[77] files are directories with files and subdirectories. Therefore a zip file is returned upon request for said format.

10.1.6.3 Data access examples

- list all collections * http://localhost:5000/collections
- overview of dataset * http://localhost:5000/collections/foo
- dataset position query * http://localhost:5000/collections/foo/position?coords=POINT(-75%2045)
- dataset position query for a specific parameter * http://localhost:5000/collections/foo/position?coords=POINT(-75%2045)&parameter-name=SST
- dataset position query for a specific parameter and time step * http://localhost:5000/collections/foo/position?coords=POINT(-75%2045)&parameter-name=SST&datetime=2000-01-16

10.1.7 Publishing files to a SpatioTemporal Asset Catalog

The SpatioTemporal Asset Catalog (STAC)[78] family of specifications aim to standardize the way geospatial asset metadata is structured and queried. A "spatiotemporal asset" is any file that represents information about the Earth at a certain place and time. The original focus was on scenes of satellite imagery, but the specifications now cover a broad variety of uses, including sources such as aircraft and drone and data such as hyperspectral optical, synthetic aperture radar (SAR), video, point clouds, lidar, digital elevation models (DEM), vector, machine learning labels, and composites like NDVI and mosaics. STAC is intentionally designed with a minimal core and flexible extension mechanism to support a broad set of use cases. This specification has matured over the past several years, and is used in numerous production deployments.

pygeoapi has two built-in providers to browse STAC catalogs: *FileSystem Provider* and *Hateoas Provider*.

10.1.7.1 Hateoas Provider

HATEOAS (Hypermedia as the Engine of Application State) is a way of implementing a REST application that allows the client to dynamically navigate to the appropriate resources by browsing hypermedia links. This type of navigation is similar to WEB navigation and requires a very precise data structure that must be respected to allow the HATEOAS Provider to behave correctly.

There are three component specifications (Catalog, Collection, Item) that together make up the core SpatioTemporal Asset Catalog specification. An Item represents a single spatiotemporal asset as GeoJSON. The Catalog specification provides structural elements, to group Items and Collections. Collections are catalogs, that add more required metadata and describe a group of related Items.

[77] https://zarr.readthedocs.io/en/stable
[78] https://stacspec.org

The full catalog structure of links down to sub-catalogs and Items, and their links back to their parents and roots, must be done with **relative** URL's for the HATEOAS Provider work correctly. The structural *rel* types include *root*, *parent*, *child*, *item*, and *collection*. Assets links must be **absolute** URL's. Other links can be absolute, especially if they describe a resource that makes less sense in the catalog, like derived_from or even license (it can be nice to include the license in the catalog, but some licenses live at a canonical online location which makes more sense to refer to directly). This enables the full catalog (excluding the assets) to be downloaded or copied to another location and to still be valid. This also implies no self link, as that link must be absolute.

So, the following rules must be respected:

1. Root documents (Catalogs / Collections) must be at the root of a directory tree containing the static catalog.
2. Catalogs must be named catalog.json and Collections must be named collection.json.
3. Sub-Catalogs or sub-Collections must be stored in subdirectories of their parent (and only 1 subdirectory deeper than a document's parent, e.g. …/sample/sub1/catalog.json).
4. Limit the number of Items in a Catalog or Collection, grouping / partitioning as relevant to the dataset.
5. Use structural elements (Catalog and Collection) consistently across each 'level' of your hierarchy. For example, if levels 2 and 4 of the hierarchy only contain Collections, don't add a Catalog at levels 2 and 4.
6. Items must be named <*id*>.json.
7. Items must be stored in subdirectories (1 level deeper) of their parent Catalog or Collection. The subdirectory must have the same name (<*id*>) as the Item without the *.json* extension. This means that each Item are contained in a unique subdirectory.
8. The links to the actual assets must be an absolute URL.

File examples

Structure of the catalog.json file

```
{
    "id": "STAC-Catalog",
    "stac_version": "1.0.0",
    "description": "A description of the STAC Catalog",
    "links": [
        {
            "rel": "root",
            "href": "./catalog.json",
            "type": "application/json"
        },
        {
            "rel": "child",
            "href": "./eo4ce/catalog.json",
            "type": "application/json"
        },
        {
            "rel": "child",
            "href": "./dem/catalog.json",
            "type": "application/json"
        }
    ],
    "stac_extensions": [],
    "title": "STAC Catalog"
}
```

The code above shows the root catalog. The sub-catalogs have an additional `rel` entry pointing to the parent.


```
{
    "id": "dem",
    "stac_version": "1.0.0",
    "description": "Digital Elevation Data",
    "links": [
        {
            "rel": "root",
            "href": "../catalog.json",
            "type": "application/json"
        },
        {
            "rel": "child",
            "href": "./hrdsm/collection.json",
            "type": "application/json"
        },
        {
            "rel": "parent",
            "href": "../catalog.json",
            "type": "application/json"
        }
    ],
    "stac_extensions": [],
    "title": "DEM"
}
```


Structure of the collection.json file

Collections are similar to Catalogs with extra fields.


```
{
    "id": "hrdsm",
    "stac_version": "1.0.0",
    "description": "High Resolution Digital Surface Model",
    "links": [
        {
            "rel": "root",
            "href": "../../catalog.json",
            "type": "application/json"
        },
        {
            "rel": "item",
            "href": "./arcticdem-frontiere-0/arcticdem-frontiere-0.json",
            "type": "application/json"
        },
        {
            "rel": "item",
            "href": "./arcticdem-frontiere-9/arcticdem-frontiere-9.json",
            "type": "application/json"
        },
        {
            "rel": "parent",
            "href": "../catalog.json",
            "type": "application/json"
        }
    ],
```


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```
    "stac_extensions": [],
    "extent": {
        "spatial": {
            "bbox": [
                [
                    -142.76516601842533,
                    59.65274347822059,
                    -138.41658819177135,
                    69.81052152420365
                ]
            ]
        },
        "temporal": {
            "interval": [
                [
                    "2014-09-03T14:00:00Z",
                    "2020-09-28T15:49:00.559166Z"
                ]
            ]
        }
    },
    "license": "proprietary"
}
```


Structure of the Item <id>.json file

The example below shows the content of a file named *arcticdem-frontiere-0.json*.


```
{
    "type": "Feature",
    "stac_version": "1.0.0",
    "id": "arcticdem-frontiere-0",
    "properties": {
        "layer:ids": [
            "dem-hrdsm"
        ],
        "collection": "hrdsm",
        "datetime": "2020-09-28T15:48:56.483794Z"
    },
    "geometry": {
        "type": "Polygon",
        "coordinates": [
            [
                [
                    -140.27389595735178,
                    59.65274347822059
                ],
                [
                    -138.41658819177135,
                    59.65274347822059
                ],
                [
                    -138.41658819177135,
                    60.579416456816496
                ],
```


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```
                [
                    -140.27389595735178,
                    60.579416456816496
                ],
                [
                    -140.27389595735178,
                    59.65274347822059
                ]
            ]
        ]
    },
    "links": [
        {
            "rel": "root",
            "href": "../../../catalog.json",
            "type": "application/json"
        },
        {
            "rel": "collection",
            "href": "../collection.json",
            "type": "application/json"
        },
        {
            "rel": "parent",
            "href": "../collection.json",
            "type": "application/json"
        }
    ],
    "assets": {
        "image": {
            "href": "http://absolute/path/to/the/ressource/arcticdem-frontiere-0.tif",
            "type": "image/tiff; application=geotiff; profile=cloud-optimized",
            "roles": []
        }
    },
    "bbox": [
        -140.27389595735178,
        59.65274347822059,
        -138.41658819177135,
        60.579416456816496
    ],
    "stac_extensions": [],
    "collection": "hrdsm"
}
```

HATEOAS Configuration

Configuring HATEOAS STAC Provider in pygeoapi is done by simply pointing the `data` provider property to the local directory or remote URL and specifying the root file name (catalog.json or collection.json) in the file_types property:

Connection examples

```
my-remote-stac-resource:
    type: stac-collection
    ...
    providers:
        - type: stac
          name: Hateoas
          data: https://datacube-dev-data-public.s3.ca-central-1.amazonaws.com/
↪catalog/water
          file_types: catalog.json

my-local-stac-resource:
    type: stac-collection
    ...
    providers:
        - type: stac
          name: Hateoas
          data: tests/stac
          file_types: catalog.json
```

10.1.7.2 FileSystem Provider

The FileSystem Provider implements STAC as a geospatial file browser through the server's file system, supporting any level of file/directory nesting/hierarchy.

Configuring STAC in pygeoapi is done by simply pointing the `data` provider property to the given directory and specifying allowed file types:

Connection examples

```
my-stac-resource:
    type: stac-collection
    ...
    providers:
        - type: stac
          name: FileSystem
          data: /Users/tomkralidis/Dev/data/gdps
          file_types:
              - .grib2
```

Note: `rasterio` and `fiona` are required for describing geospatial files.

pygeometa metadata control files

pygeoapi's STAC filesystem fuctionality supports pygeometa[79] MCF files residing in the same directory as data files. If an MCF file is found, it will be used as part of generating the STAC item metadata (e.g. a file named `birds.csv` having an associated `birds.yml` file). If no MCF file is found, then pygeometa will generate the STAC item metadata from configuration and by reading the data's properties.

Publishing ESRI Shapefiles

ESRI Shapefile publishing requires to specify all required component file extensions (`.shp`, `.shx`, `.dbf`) with the provider `file_types` option.

Data access examples

- STAC root page * http://localhost:5000/stac

From here, browse the filesystem accordingly.

See also:

Configuration for more information on publishing hidden resources.

[79] https://geopython.github.io/pygeometa

CHAPTER

ELEVEN

TRANSACTIONS

pygeoapi supports the OGC API - Features - Part 4: Create, Replace, Update and Delete[80] draft specification, allowing for transactional capabilities against feature and record data.

To enable transactions in pygeoapi, a given resource provider needs to be editable (via the configuration resource provider `editable: true` property). Note that the feature or record provider MUST support create/update/delete. See the *Publishing vector data to OGC API - Features* and *Publishing metadata to OGC API - Records* documentation for transaction support status of pygeoapi backends.

11.1 Access control

It should be made clear that authentication and authorization is beyond the responsibility of pygeoapi. This means that if a pygeoapi user enables transactions, they must provide access control explicity via another service.

[80] http://docs.ogc.org/DRAFTS/20-002.html

CHAPTER

TWELVE

CUSTOMIZING PYGEOAPI: PLUGINS

In this section we will explain how pygeoapi provides plugin architecture for data providers, formatters and processes.

Plugin development requires knowledge of how to program in Python as well as Python's package/module system.

12.1 Overview

pygeoapi provides a robust plugin architecture that enables developers to extend functionality. Infact, pygeoapi itself implements numerous formats, data providers and the process functionality as plugins.

The pygeoapi architecture supports the following subsystems:

- data providers
- output formats
- processes

The core pygeoapi plugin registry can be found in `pygeoapi.plugin.PLUGINS`.

Each plugin type implements its relevant base class as the API contract:

- data providers: `pygeoapi.provider.base`
- output formats: `pygeoapi.formatter.base`
- processes: `pygeoapi.process.base`

Todo: link PLUGINS to API doc

Plugins can be developed outside of the pygeoapi codebase and be dynamically loaded by way of the pygeoapi configuration. This allows your custom plugins to live outside pygeoapi for easier maintenance of software updates.

Note: It is recommended to store pygeoapi plugins outside of pygeoapi for easier software updates and package management

---

12.2 Example: custom pygeoapi vector data provider

Lets consider the steps for a vector data provider plugin (source code is located here: *Provider*).

12.2.1 Python code

The below template provides a minimal example (let's call the file `mycoolvectordata.py`:

```
from pygeoapi.provider.base import BaseProvider

class MyCoolVectorDataProvider(BaseProvider):
    """My cool vector data provider"""

    def __init__(self, provider_def):
        """Inherit from parent class"""

        super().__init__(provider_def)

    def get_fields(self):

        # open dat file and return fields and their datatypes
        return {
            'field1': 'string',
            'field2': 'string'
        }

    def query(self, offset=0, limit=10, resulttype='results',
              bbox=[], datetime_=None, properties=[], sortby=[],
              select_properties=[], skip_geometry=False, **kwargs):

        # optionally specify the output filename pygeoapi can use as part
        of the response (HTTP Content-Disposition header)
        self.filename = "my-cool-filename.dat"

        # open data file (self.data) and process, return
        return {
            'type': 'FeatureCollection',
            'features': [{
                'type': 'Feature',
                'id': '371',
                'geometry': {
                    'type': 'Point',
                    'coordinates': [ -75, 45 ]
                },
                'properties': {
                    'stn_id': '35',
                    'datetime': '2001-10-30T14:24:55Z',
                    'value': '89.9'
                }
            }]
        }

    def get_schema():
        # return a `dict` of a JSON schema (inline or reference)
        return ('application/geo+json', {'$ref': 'https://geojson.org/schema/Feature.
↪json'})
```

For brevity, the above code will always return the single feature of the dataset. In reality, the plugin developer would connect to a data source with capabilities to run queries and return a relevant result set, as well as implement the `get` method accordingly. As long as the plugin implements the API contract of its base provider, all other functionality is left to the provider implementation.

Each base class documents the functions, arguments and return types required for implementation.

Note: You can add language support to your plugin using *these guides*.

12.2.2 Connecting to pygeoapi

The following methods are options to connect the plugin to pygeoapi:

Option 1: Update in core pygeoapi:

- copy `mycoolvectordata.py` into `pygeoapi/provider`
- update the plugin registry in `pygeoapi/plugin.py:PLUGINS['provider']` with the plugin's shortname (say `MyCoolVectorData`) and dotted path to the class (i.e. `pygeoapi.provider.mycoolvectordata.MyCoolVectorDataProvider`)
- specify in your dataset provider configuration as follows:

```
providers:
    - type: feature
      name: MyCoolVectorData
      data: /path/to/file
      id_field: stn_id
```

Option 2: implement outside of pygeoapi and add to configuration (recommended)

- create a Python package of the `mycoolvectordata.py` module (see Cookiecutter[81] as an example)
- install your Python package onto your system (`python setup.py install`). At this point your new package should be in the `PYTHONPATH` of your pygeoapi installation
- specify in your dataset provider configuration as follows:

```
providers:
    - type: feature
      name: mycooldatapackage.mycoolvectordata.MyCoolVectorDataProvider
      data: /path/to/file
      id_field: stn_id
```

Note: The United States Geological Survey has created a Cookiecutter project for creating pygeoapi plugins. See the pygeoapi-plugin-cookiecutter[82] project to get started.

[81] https://github.com/audreyr/cookiecutter-pypackage
[82] https://code.usgs.gov/wma/nhgf/pygeoapi-plugin-cookiecutter

12.3 Example: custom pygeoapi raster data provider

Lets consider the steps for a raster data provider plugin (source code is located here: *Provider*).

12.3.1 Python code

The below template provides a minimal example (let's call the file `mycoolrasterdata.py`:

```
from pygeoapi.provider.base import BaseProvider

class MyCoolRasterDataProvider(BaseProvider):
    """My cool raster data provider"""

    def __init__(self, provider_def):
        """Inherit from parent class"""

        super().__init__(provider_def)
        self.num_bands = 4
        self.axes = ['Lat', 'Long']

    def get_coverage_domainset(self):
        # return a CIS JSON DomainSet

    def get_coverage_rangetype(self):
        # return a CIS JSON RangeType

    def query(self, bands=[], subsets={}, format_='json', **kwargs):
        # process bands and subsets parameters
        # query/extract coverage data

        # optionally specify the output filename pygeoapi can use as part
        of the response (HTTP Content-Disposition header)
        self.filename = "my-cool-filename.dat"

        if format_ == 'json':
            # return a CoverageJSON representation
            return {'type': 'Coverage', ...}  # trimmed for brevity
        else:
            # return default (likely binary) representation
            return bytes(112)
```

For brevity, the above code will always JSON for metadata and binary or CoverageJSON for the data. In reality, the plugin developer would connect to a data source with capabilities to run queries and return a relevant result set, As long as the plugin implements the API contract of its base provider, all other functionality is left to the provider implementation.

Each base class documents the functions, arguments and return types required for implementation.

12.4 Example: custom pygeoapi formatter

12.4.1 Python code

The below template provides a minimal example (let's call the file `mycooljsonformat.py`:

```
import json
from pygeoapi.formatter.base import BaseFormatter

class MyCoolJSONFormatter(BaseFormatter):
    """My cool JSON formatter"""

    def __init__(self, formatter_def):
        """Inherit from parent class"""

        super().__init__({'name': 'cooljson', 'geom': None})
        self.mimetype = 'application/json; subtype:mycooljson'

    def write(self, options={}, data=None):
        """custom writer"""

        out_data {'rows': []}

        for feature in data['features']:
            out_data.append(feature['properties'])

        return out_data
```

12.5 Processing plugins

Processing plugins are following the OGC API - Processes development. Given that the specification is under development, the implementation in `pygeoapi/process/hello_world.py` provides a suitable example for the time being.

12.6 Featured plugins

The following plugins provide useful examples of pygeoapi plugins implemented by downstream applications.

Plugin(s)	Organization/Project	Description
msc-pygeoapi[83]	Meteorological Service of Canada	processes for weather/climate/water data workflows
pygeoapi-kubernetes-papermill[84]	Euro Data Cube	processes for executing Jupyter notebooks via Kubernetes
local-outlier-factor-plugin[85]	Manaaki Whenua – Landcare Research	processes for local outlier detection
ogc-edc[86]	Euro Data Cube	coverage provider atop the EDC API
nldi_xstool[87]	United States Geological Survey	Water data processing
pygeometa-plugin[88]	pygeometa project	pygeometa as a service

[83] https://github.com/ECCC-MSC/msc-pygeoapi
[84] https://github.com/eurodatacube/pygeoapi-kubernetes-papermill
[85] https://github.com/manaakiwhenua/local-outlier-factor-plugin
[86] https://github.com/eurodatacube/ogc-edc/tree/oapi/edc_ogc/pygeoapi
[87] https://github.com/ACWI-SSWD/nldi_xstool
[88] https://geopython.github.io/pygeometa/pygeoapi-plugin

CHAPTER

THIRTEEN

HTML TEMPLATING

pygeoapi uses Jinja[89] as its templating engine to render HTML and Flask[90] to provide route paths of the API that returns HTTP responses. For complete details on how to use these modules, refer to the Jinja documentation[91] and the Flask documentation[92].

The default pygeoapi configuration has `server.templates` commented out and defaults to the pygeoapi `pygeoapi/templates` and `pygeoapi/static` folder. To point to a different set of template configuration, you can edit your configuration:

```
server:
  templates:
    path: /path/to/jinja2/templates/folder # jinja2 template HTML files
    static: /path/to/static/folder # css, js, images and other static files␣
↪referenced by the template
```

Note: the URL path to your static folder will always be `/static` in your deployed web instance of pygeoapi.

Your templates folder should mimic the same file names and structure of the default pygeoapi templates. Otherwise, you will need to modify `api.py` accordingly.

Note that you need only copy and edit the templates you are interested in updating. For example, if you are only interested in updating the `landing_page.html` template, then create your own version of the only that same file. When pygeoapi detects that a custom HTML template is being used, it will look for the custom template in `server.templates.path`. If it does not exists, pygeoapi will render the default HTML template for the given endpoint/requuest.

Linking to a static file in your HTML templates can be done using Jinja syntax and the exposed `config['server']['url']`:

```
<!-- CSS example -->
<link rel="stylesheet" href="{{ config['server']['url'] }}/static/css/default.css">
<!-- JS example -->
<script src="{{ config['server']['url'] }}/static/js/main.js"></script>
<!-- Image example with metadata -->
<img src="{{ config['server']['url'] }}/static/img/logo.png" title="{{ config[
↪'metadata']['identification']['title'] }}" />
```

[89] https://palletsprojects.com/p/jinja/
[90] https://palletsprojects.com/p/flask/
[91] https://jinja.palletsprojects.com
[92] https://flask.palletsprojects.com

13.1 Featured templates

The following themes provide useful examples of pygeoapi templates implemented by downstream applications.

Plugin(s)	Organization/Project	Description
pygeoapi-skin-dashboard[93]	GeoCat bv	skin for pygeoapi based on a typical dashboard interface

[93] https://github.com/GeoCat/pygeoapi-skin-dashboard

CHAPTER

FOURTEEN

CQL SUPPORT

14.1 Providers

As of now the available providers supported for CQL filtering are limited to *Elasticsearch* and *PostgreSQL*.

14.2 Limitations

Support of CQL is limited to Simple CQL filter[94] and thus it allows to query with the following predicates:

- comparison predicates
- spatial predicates
- temporal predicates

14.3 Formats

At the moment Elasticsearch supports only the CQL dialect with the JSON encoding CQL-JSON[95].

PostgreSQL supports both CQL-JSON and CQL-text dialects, CQL-JSON[96] and CQL-TEXT[97]

14.3.1 Queries

The PostgreSQL provider uses pygeofilter[98] allowing a range of filter expressions, see examples for:

- Comparison predicates[99]
- Spatial predicates[100]
- Temporal predicates[101]

Using Elasticsearch the following type of queries are supported right now:

[94] https://portal.ogc.org/files/96288#cql-core
[95] https://portal.ogc.org/files/96288#simple-cql-JSON
[96] https://portal.ogc.org/files/96288#simple-cql-JSON
[97] https://portal.ogc.org/files/96288#simple-cql-text
[98] https://github.com/geopython/pygeofilter
[99] https://portal.ogc.org/files/96288#simple-cql_comparison-predicates
[100] https://portal.ogc.org/files/96288#enhanced-spatial-operators
[101] https://portal.ogc.org/files/96288#simple-cql_temporal

- `between` predicate query
- Logical `and` query with `between` and `eq` expression
- Spatial query with `bbox`

14.3.2 Examples

A `BETWEEN` example for a specific property through an HTTP POST request:

```
curl --location --request POST 'http://localhost:5000/collections/nhsl_hazard_threat_
↪all_indicators_s_bc/items?f=json&limit=50&filter-lang=cql-json' \
--header 'Content-Type: application/query-cql-json' \
--data-raw '{
  "between": {
    "value": { "property": "properties.MHn_Intensity" },
    "lower": 0.59,
    "upper": 0.60
  }
}'
```

Or

```
curl --location --request POST 'http://localhost:5000/collections/recentearthquakes/
↪items?f=json&limit=10&filter-lang=cql-json'
--header 'Content-Type: application/query-cql-json'
--data-raw '{
  "between":{
    "value":{"property": "ml"},
    "lower":4,
    "upper":4.5
  }
}'
```

The same `BETWEEN` query using HTTP GET request formatted as CQL text and URL encoded as below:

```
curl "http://localhost:5000/collections/recentearthquakes/items?f=json&limit=10&
↪filter=ml%20BETWEEN%204%20AND%204.5"
```

An `EQUALS` example for a specific property:

```
curl --location --request POST 'http://localhost:5000/collections/recentearthquakes/
↪items?f=json&limit=10&filter-lang=cql-json'
--header 'Content-Type: application/query-cql-json'
--data-raw '{
    "eq":[{"property": "user_entered"},"APBE"]
}'
```

A `CROSSES` example via an HTTP GET request. The CQL text is passed via the `filter` parameter.

```
curl "http://localhost:5000/collections/hot_osm_waterways/items?f=json&
↪filter=CROSSES(foo_geom,%20LINESTRING(28%20-2,%2030%20-4))"
```

Note that the CQL text has been URL encoded. This is required in curl commands but when entering in a browser, plain text can be used e.g. `CROSSES(foo_geom, LINESTRING(28 -2, 30 -4))`.

CHAPTER

FIFTEEN

MULTILINGUAL SUPPORT

pygeoapi is language-aware and can handle multiple languages if these have been defined in pygeoapi's configuration (see *maintainer guide*). Providers can also handle multiple languages if configured. These may even be different from the languages that pygeoapi supports. Out-of-the-box, pygeoapi "speaks" English. System messages and exceptions are always English only.

The following sections provide more information how to use and set up languages in pygeoapi.

15.1 End user guide

There are 2 ways to affect the language of the results returned by pygeoapi, both for the HTML and JSON(-LD) formats:

1. After the requested pygeoapi URL, append a `lang=<code>` query parameter, where `<code>` should be replaced by a well-known language code. This can be an ISO 639-1 code (e.g. *de* for German), optionally accompanied by an ISO 3166-1 alpha-2 country code (e.g. *de-CH* for Swiss-German). Please refer to this W3C article[102] for more information or this list of language codes[103] for more examples. Another option is to send a complex definition with quality weights (e.g. *de-CH, de;q=0.9, en;q=0.8, fr;q=0.7, *;q=0.5*). pygeoapi will then figure out the best match for the requested language.

   For example, to view the pygeoapi landing page in Canadian-French, you could use this URL:

   https://demo.pygeoapi.io/master?lang=fr-CA

2. Alternatively, you can set an `Accept-Language` HTTP header for the requested pygeoapi URL. Language tags that are valid for the `lang` query parameter are also valid for this header value. Please note that if your client application (e.g. browser) is configured for a certain language, it will likely set this header by default, so the returned response should be translated to the language of your client app. If you don't want this, you can either change the language of your client app or append the `lang` parameter to the URL, which will override any language defined in the `Accept-Language` header.

[102] https://www.w3.org/International/articles/language-tags/
[103] http://www.lingoes.net/en/translator/langcode.htm

15.1.1 Notes

- If pygeoapi cannot find a good match to the requested language, the response is returned in the default language (US English mostly). The default language is the *first* language defined in pygeoapi's server configuration YAML (see *maintainer guide*).
- Even if pygeoapi *itself* supports the requested language, provider plugins may not support that particular language or perhaps don't even support any language at all. In that case the provider will reply in its own "unknown" language, which may not be the same language as the default pygeoapi server language set in the `Content-Language` HTTP response header.
- It is up to the creator of the provider to properly define at least 1 supported language in the provider configuration, as described in the *developer guide*. This will ensure that the `Content-Language` HTTP response header is always set properly.
- If pygeoapi found a match to the requested language, the response will include a `Content-Language` HTTP header, set to the best-matching server language code. This is the default behavior for most pygeoapi requests. However, note that some responses (e.g. exceptions) always have a `Content-Language: en-US` header, regardless of the requested language.
- For results returned by a **provider**, the `Content-Language` HTTP header will be set to the best-matching provider language or the best-matching pygeoapi server language if the provider is not language-aware.
- If the provider supports a requested language, but pygeoapi does *not* support that same language, the `Content-Language` header will contain both the provider language *and* the best-matching pygeoapi server language.
- Please note that the `Content-Language` HTTP response header only *indicates the language of the intended audience*. It does not necessarily mean that the content is actually written in that particular language.

15.2 Maintainer guide

Every pygeoapi instance should support at least 1 language. In the server configuration, there must be a `language` or a `languages` (note the *s*) property. The property can be set to a single language tag or a list of tags respectively.

If you wish to set up a multilingual pygeoapi instance, you will have to add more than 1 language to the server configuration YAML file (i.e. `pygeoapi-config.yml`). First, you will have to add the supported language tags/codes as a list. For example, if you wish to support American English and Canadian French, you could do:

```
server:
    bind: ...
    url: ...
    mimetype: ...
    encoding: ...
    languages:
        - en-US
        - fr-CA
```

Next, you will have to provide translations for the configured languages. This involves 3 steps:

1. *Add translations for configurable text values* in the pygeoapi configuration;
2. Verify if there are any Jinja2 HTML template translations for the configured language(s);
3. Make sure that the provider plugins you need can handle this language as well, if you have the ability to do so. See the *developer guide* for more details.

15.2.1 Notes

- The **first** language you define in the configuration determines the default language, i.e. the language that pygeoapi will use if no other language was requested or no best match for the requested language could be found.
- It is not possible to **disable** language support in pygeoapi. The functionality is always on and a `Content-Language` HTTP response header is always set. If results should be available in a single language, you'd have to set that language only in the pygeoapi configuration.
- Results returned from a provider may be in a different language than pygeoapi's own server language. The "raw" requested language is always passed on to the provider, even if pygeoapi itself does not support it. For more information, see the *end user guide* and the *developer guide*.

15.2.2 Add translations for configurable text values

For most of the text values in pygeoapi's server configuration where it makes sense, you can add translations. Consider the `metadata` section for example. The English-only version looks similar to this:

```
metadata:
    identification:
        title: pygeoapi default instance
        description: pygeoapi provides an API to geospatial data
        keywords:
            - geospatial
            - data
            - api
```

If you wish to make these text values available in English and French, you could use the following language struct:

```
metadata:
    identification:
        title:
            en: pygeoapi default instance
            fr: instance par défaut de pygeoapi
        description:
            en: pygeoapi provides an API to geospatial data
            fr: pygeoapi fournit une API aux données géospatiales
        keywords:
            en:
                - geospatial
                - data
                - api
            fr:
                - géospatiale
                - données
                - api
```

In other words: each plain text value should be replaced by a dictionary, where the language code is the key and the translated text represents the matching value. For lists, this can be applied as well (see `keywords` example above), as long as you nest the entire list under a language key instead of each list item.

A similar concept can be applied to the `title-field` property of the provider in a collection configuration. If a dataset contains multiple columns each representing the title element in a specific language, you can configure the title-field accordingly.

```
providers:
  - type: feature
    name: GeoJSON
    data: tests/data/ne_110m_lakes.geojson
    title_field:
      en: name_eng
      fr: nom_fre
      de: name_deu
```

Note that the example above uses generic language tags, but you can also supply more localized tags (with a country code) if required. pygeoapi should always be able find the best match to the requested language, i.e. if the user wants Swiss-French (*fr-CH*) but pygeoapi can only find *fr* tags, those values will be returned. However, if a *fr-CH* tag can also be found, that value will be returned and not the *fr* value.

Warning: A language struct is only translated if all language tags (keys) in the struct are valid locales.

Todo: Add docs on HTML templating.

15.3 Translator guide

Hardcoded strings in pygeoapi templates are translated using the Babel translation system. Translation files are stored on the */locale* folder. Translators can follow these steps to prepare their environment for translations.

1. Extract from latest code the keys to be translated. These keys are captured in a *.pot* file. Note that the *.pot* file is not to be stored in version control, but as an intermediary file used to update */locale/*/LC_MESSAGES/messages.po* files:

   ```
   pybabel extract -F babel-mapping.ini -o locale/messages.pot ./
   ```

2. Update the existing .po language file:

   ```
   pybabel update -d locale -l fr -i locale/messages.pot
   ```

3. Open the relevant .po file and contribute your translations. Then compile a .mo file to be used by the application:

   ```
   pybabel compile -d locale -l fr
   ```

Within jinja templates keys are prepared to be translated by wrapping them in:

```
{% trans %}Key{% endtrans %}
```

15.4 Developer guide

If you are a developer who wishes to create a pygeoapi provider plugin that "speaks" a certain language, you will have to fully implement this yourself. Needless to say, if your provider depends on some backend, it will only make sense to implement language support if the backend can be queried in another language as well.

You are free to set up the language support anyway you like, but there are a couple of steps you'll have to walk through:

1. You will have to define the supported languages in the provider configuration YAML. This can be done in a similar fashion as the `languages` configuration for pygeoapi itself, as described in the *maintainer guide* section above. For example, a TinyDB records provider that supports English and French could be set up like:

```
my-records:
    type: collection
    ..
    providers:
        - type: record
          name: TinyDBCatalogue
          data: ..
          languages:
              - en
              - fr
```

2. If your provider implements any of the `query`, `get` or `get_metadata` methods of the base class and you wish to make them language-aware, either add an implicit `**kwargs` parameter or an explicit `language=None` parameter to the method signature.

An example Python code block for a custom provider with a language-aware `query` method could look like this:

```
class MyCoolVectorDataProvider(BaseProvider):
"""My cool vector data provider"""

def __init__(self, provider_def):
    super().__init__(provider_def)

def query(self, offset=0, limit=10, resulttype='results', bbox=[],
          datetime_=None, properties=[], sortby=[], select_properties=[],
          skip_geometry=False, q=None, language=None):
    LOGGER.debug(f'Provider queried in {language.english_name} language')
    # Implement your logic here, returning JSON in the requested language
```

Alternatively, you could also use `**kwargs` in the `query` method and get the `language` value:

```
def query(self, **kwargs):
    LOGGER.debug(f"Provider locale set to: {kwargs.get('language')}")
    # Implement your logic here, returning JSON in the requested language
```

This is all that is required. The pygeoapi API class will make sure that the correct HTTP `Content-Language` headers are set on the response object.

15.4.1 Notes

- If your provider implements any of the aforementioned `query`, `get` and `get_metadata` methods, it **must** add a `**kwargs` or `language=None` parameter, even if it does not need to use the language parameter.
- Contrary to the pygeoapi server configuration, adding a `language` or `languages` (both are supported) property to the provider definition is **not** required and may be omitted. In that case, the passed-in `language` parameter language-aware provider methods (`query`, `get`, etc.) will be set to `None`. This results in the following behavior:
  - HTML responses returned from the providers will have the `Content-Language` header set to the best-matching pygeoapi server language.
  - JSON(-LD) responses returned from providers will **not** have a `Content-Language` header if `language` is `None`.
- If the provider supports a requested language, the passed-in `language` will be set to the best matching Babel Locale instance[104]. Note that this may be the provider default language if no proper match was found. No matter the output format, API responses returned from providers will always contain a best-matching `Content-Language` header if one ore more supported provider languages were defined.
- For general information about building plugins, please visit the *Customizing pygeoapi: plugins* page.

[104] http://babel.pocoo.org/en/latest/api/core.html#babel.core.Locale

CHAPTER

SIXTEEN

DEVELOPMENT

16.1 Codebase

The pygeoapi codebase exists at https://github.com/geopython/pygeoapi.

16.2 Testing

pygeoapi uses pytest[105] for managing its automated tests. Tests exist in `/tests` and are developed for providers, formatters, processes, as well as the overall API.

Tests can be run locally as part of development workflow. They are also run on pygeoapi's GitHub Actions setup[106] against all commits and pull requests to the code repository.

To run all tests, simply run `pytest` in the repository. To run a specific test file, run `pytest tests/test_api.py`, for example.

16.3 CQL extension lifecycle

16.3.1 Limitations

This workflow is valid only for the *CQL-JSON* format.

16.3.2 Schema

The Common Query Language (CQL) is the part 3 of the standard OGC API - Features. This extension has its specification available at OGC API - Features - Part 3: Filtering and the Common Query Language (CQL)[107] and the schema exists in development at cql.json[108].

[105] https://docs.pytest.org
[106] https://github.com/geopython/pygeoapi/blob/master/.github/workflows/main.yml
[107] https://portal.ogc.org/files/96288
[108] https://github.com/opengeospatial/ogcapi-features/blob/master/extensions/cql/standard/schema/cql.json

16.3.3 Model generation

pygeoapi uses a class-based python model interface to translate the schema into python objects defined by pydantic[109] models. The model is generated with the pre-processing of the schema through the utility `datamodel-codegen`:

```
# Generate from local downloaded json schema file
datamodel-codegen  --input ~/Download/cql-schema.json --input-file-type jsonschema --
↪output ./pygeoapi/models/cql_update.py --class-name CQLModel
```

16.3.4 How to merge

Once the new pydantic models have been generated then the content of the python file `cql_update.py` can be used to replace the old classes within the `cql.py` file. Update everything above the function `get_next_node` and then verify if the tests for the CQL are still passing, for example `test_post_cql_json_between_query` in `tests/test_elasticsearch__provider.py`.

16.4 Working with Spatialite on OSX

16.4.1 Using pyenv

It is common among OSX developers to use the package manager homebrew for the installation of pyenv to being able to manage multiple versions of Python. They can encounter errors about the load of some SQLite extensions that pygeoapi uses for handling spatial data formats. In order to run properly the server you are required to follow these steps below carefully.

Make Homebrew and pyenv play nicely together:

```
# see https://github.com/pyenv/pyenv/issues/106
alias brew='env PATH=${PATH//$(pyenv root)\/shims:/} brew'
```

Install python with the option to enable SQLite extensions:

```
LDFLAGS="-L/usr/local/opt/sqlite/lib -L/usr/local/opt/zlib/lib" CPPFLAGS="-I/usr/
↪local/opt/sqlite/include -I/usr/local/opt/zlib/include" PYTHON_CONFIGURE_OPTS="--
↪enable-loadable-sqlite-extensions" pyenv install 3.7.6
```

Configure SQLite from Homebrew over that one shipped with the OS:

```
export PATH="/usr/local/opt/sqlite/bin:$PATH"
```

Install Spatialite from Homebrew:

```
brew update
brew install spatialite-tools
brew libspatialite
```

Set the variable for the Spatialite library under OSX:

```
SPATIALITE_LIBRARY_PATH=/usr/local/lib/mod_spatialite.dylib
```

[109] https://pydantic-docs.helpmanual.io/

CHAPTER

SEVENTEEN

OGC COMPLIANCE

As mentioned in the *Introduction*, pygeoapi strives to implement the OGC API standards to be compliant as well as achieving reference implementation status. pygeoapi works closely with the OGC CITE team to achieve compliance through extensive testing as well as providing feedback in order to improve the tests.

17.1 CITE instance

The pygeoapi CITE instance is at https://demo.pygeoapi.io/cite

17.2 Setting up your own CITE testing instance

Please see the pygeoapi OGC Compliance[110] for up to date information as well as technical details on setting up your own CITE instance.

[110] https://github.com/geopython/pygeoapi/wiki/OGCCompliance

CHAPTER

EIGHTEEN

CONTRIBUTING

Please see the Contributing page[111] for information on contributing to the project.

[111] https://github.com/geopython/pygeoapi/blob/master/CONTRIBUTING.md

CHAPTER

NINETEEN

SUPPORT

19.1 Community

Please see the pygeoapi Community[112] page for information on the community, getting support, and how to get involved.

[112] https://pygeoapi.io/community

CHAPTER

TWENTY

FURTHER READING

The following list provides information on pygeoapi and OGC API efforts.

- Default pygeoapi presentation[113]
- OGC API[114]

[113] https://pygeoapi.io/presentations/default
[114] https://ogcapi.ogc.org

CHAPTER

TWENTYONE

LICENSE

21.1 Code

The MIT License (MIT)

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21.2 Documentation

The documentation is released under the Creative Commons Attribution 4.0 International (CC BY 4.0)[115] license.

[115] https://creativecommons.org/licenses/by/4.0

CHAPTER

TWENTYTWO

API DOCUMENTATION

Top level code documentation. Follow the links in each section for module/class member information.

22.1 API

Root level code of pygeoapi, parsing content provided by web framework. Returns content from plugins and sets responses.

class pygeoapi.api.**API**(*config*)

API object

__init__(*config*)

constructor

Parameters **config** – configuration dict

Returns *pygeoapi.API* instance

__weakref__

list of weak references to the object (if defined)

delete_job(*job_id*) → Tuple[dict[116], int[117], str[118]]

Delete a process job

Parameters **job_id** – job identifier

Returns tuple of headers, status code, content

get_exception(*status*, *headers*, *format_*, *code*, *description*) → Tuple[dict[119], int[120], str[121]]

Exception handler

Parameters

- **status** – HTTP status code
- **headers** – dict of HTTP response headers
- **format** – format string
- **code** – OGC API exception code
- **description** – OGC API exception code

Returns tuple of headers, status, and message

get_format_exception(*request*) → Tuple[dict[122], int[123], str[124]]

Returns a format exception.

Parameters **request** – An APIRequest instance.

Returns tuple of (headers, status, message)

class pygeoapi.api.**APIRequest**(*request*, *supported_locales*)

Transforms an incoming server-specific Request into an object with some generic helper methods and properties.

Note: Typically, this instance is created automatically by the *pre_process()* decorator. **Every** API method that has been routed to a REST endpoint should be decorated by the *pre_process()* function. Therefore, **all** routed API methods should at least have 1 argument that holds the (transformed) request.

The following example API method will:

- transform the incoming Flask/Starlette *Request* into an *APIRequest* using the *pre_process()* decorator;
- call *is_valid()* to check if the incoming request was valid, i.e. that the user requested a valid output format or no format at all (which means the default format);
- call *API.get_format_exception()* if the requested format was invalid;
- create a *dict* with the appropriate *Content-Type* header for the requested format and a *Content-Language* header if any specific language was requested.

```
@pre_process
def example_method(self, request: Union[APIRequest, Any], custom_arg):
    if not request.is_valid():
        return self.get_format_exception(request)

    headers = request.get_response_headers()

    # generate response_body here

    return headers, 200, response_body
```

The following example API method is similar as the one above, but will also allow the user to request a non-standard format (e.g. `f=xml`). If *xml* was requested, we set the *Content-Type* ourselves. For the standard formats, the *APIRequest* object sets the *Content-Type*.

```
@pre_process
def example_method(self, request: Union[APIRequest, Any], custom_arg):
    if not request.is_valid(['xml']):
        return self.get_format_exception(request)

    content_type = 'application/xml' if request.format == 'xml' else None
    headers = request.get_response_headers(content_type)

    # generate response_body here

    return headers, 200, response_body
```

Note that you don't *have* to call *is_valid()*, but that you can also perform a custom check on the requested output format by looking at the *format* property. Other query parameters are available through the *params* property as a *dict*. The request body is available through the *data* property.

Note: If the request data (body) is important, **always** create a new *APIRequest* instance using the *with_data()* factory method. The *pre_process()* decorator will use this automatically.

Parameters

- **request** – The web platform specific Request instance.
- **supported_locales** – List or set of supported Locale instances.

__init__ (*request*, *supported_locales*)
Initialize self. See help(type(self)) for accurate signature.

__weakref__
list of weak references to the object (if defined)

_get_format (*headers*) → Optional[str[125]]
Get *Request* format type from query parameters or headers.

Parameters **headers** – Dict of Request headers

Returns format value or None if not found/specified

_get_locale (*headers*, *supported_locales*)
Detects locale from "lang=<language>" param or *Accept-Language* header. Returns a tuple of (raw, locale) if found in params or headers. Returns a tuple of (raw default, default locale) if not found.

Parameters

- **headers** – A dict with Request headers
- **supported_locales** – List or set of supported Locale instances

Returns A tuple of (str, Locale)

static _get_params (*request*)
Extracts the query parameters from the *Request* object.

Parameters **request** – A Flask or Starlette Request instance

Returns *ImmutableMultiDict* or empty *dict*

property data
Returns the additional data send with the Request (bytes)

property format
Returns the content type format from the request query parameters or headers.

Returns Format name or None

get_linkrel (*format_: str[126]*) → str[127]
Returns the hyperlink relationship (rel) attribute value for the given API format string.

The string is compared against the request format and if it matches, the value 'self' is returned. Otherwise, 'alternate' is returned. However, if *format_* is 'json' and *no* request format was found, the relationship 'self' is returned as well (JSON is the default).

Parameters **format** – The format to compare the request format against.

Returns A string 'self' or 'alternate'.

get_request_headers (*headers*) → dict[128]
Obtains and returns a dictionary with Request object headers.

This method adds the headers of the original request and makes them available to the API object.

Returns A header dict

get_response_headers (*force_lang: babel.core.Locale = None*, *force_type: str[129] = None*, *force_encoding: str[130] = None*) → dict[131]
Prepares and returns a dictionary with Response object headers.

This method always adds a 'Content-Language' header, where the value is determined by the 'lang' query parameter or 'Accept-Language' header from the request. If no language was requested, the default pygeoapi language is used, unless a *force_lang* override was specified (see notes below).

A 'Content-Type' header is also always added to the response. If the user does not specify *force_type*, the header is based on the *format* APIRequest property. If that is invalid, the default MIME type *application/json* is used.

..note:: If a *force_lang* override is applied, that language is always set as the 'Content-Language', regardless of a 'lang' query parameter or 'Accept-Language' header. If an API response always needs to be in the same language, 'force_lang' should be set to that language.

Parameters

- **force_lang** – An optional Content-Language header override.
- **force_type** – An optional Content-Type header override.
- **force_encoding** – An optional Content-Encoding header override.

Returns A header dict

property headers

Returns the dictionary of the headers from the request.

Returns Request headers dictionary

is_valid(*additional_formats=None*) → bool[132]

Returns True if:

- the format is not set (None)
- the requested format is supported
- the requested format exists in a list if additional formats

---

Note: Format names are matched in a case-insensitive manner.

Parameters **additional_formats** – Optional additional supported formats list

Returns bool

property locale

Returns the user-defined locale from the request object. If no locale has been defined or if it is invalid, the default server locale is returned.

Note: The locale here determines the language in which pygeoapi should return its responses. This may not be the language that the user requested. It may also not be the language that is supported by a collection provider, for example. For this reason, you should pass the *raw_locale* property to the `l10n.get_plugin_locale()` function, so that the best match for the provider can be determined.

Returns babel.core.Locale

property params

Returns the Request query parameters dict

property path_info
Returns the web server request path info part

property raw_locale
Returns the raw locale string from the *Request* object. If no "lang" query parameter or *Accept-Language* header was found, *None* is returned. Pass this value to the `l10n.get_plugin_locale()` function to let the provider determine a best match for the locale, which may be different from the locale used by pygeoapi's UI.

Returns a locale string or None

classmethod with_data(*request*, *supported_locales*) → *pygeoapi.api.APIRequest*
Factory class method to create an *APIRequest* instance with data.

If the request body is required, an *APIRequest* should always be instantiated using this class method. The reason for this is, that the Starlette request body needs to be awaited (async), which cannot be achieved in the *__init__()* method of the *APIRequest*. However, *APIRequest* can still be initialized using *__init__()*, but then the *data* property value will always be empty.

Parameters

- **request** – The web platform specific Request instance.
- **supported_locales** – List or set of supported Locale instances.

Returns An *APIRequest* instance with data.

pygeoapi.api.**FORMAT_TYPES = {'html': 'text/html', 'json': 'application/json', 'jsonld': 'a**
Formats allowed for ?f= requests (order matters for complex MIME types)

pygeoapi.api.**HEADERS = {'Content-Type': 'application/json', 'X-Powered-By': 'pygeoapi 0.13**
Return headers for requests (e.g:X-Powered-By)

pygeoapi.api.**SYSTEM_LOCALE = Locale('en', territory='US')**
Locale used for system responses (e.g. exceptions)

pygeoapi.api.**gzip**(*func*)
Decorator that compresses the content of an outgoing API result instance if the Content-Encoding response header was set to gzip.

Parameters **func** – decorated function

Returns *func*

pygeoapi.api.**pre_process**(*func*)
Decorator that transforms an incoming Request instance specific to the web framework (i.e. Flask or Starlette) into a generic *APIRequest* instance.

Parameters **func** – decorated function

Returns *func*

pygeoapi.api.**validate_bbox**(*value=None*) → list[133]
Helper function to validate bbox parameter

Parameters **value** – *list* of minx, miny, maxx, maxy

Returns bbox as *list* of *float* values

pygeoapi.api.**validate_datetime**(*resource_def*, *datetime_=None*) → str[134]
Helper function to validate temporal parameter

Parameters

- **resource_def** – *dict* of configuration resource definition
- **datetime** – *str* of datetime parameter

Returns *str* of datetime input, if valid

pygeoapi.api.**validate_subset**(*value: str*[135]) → dict[136]
Helper function to validate subset parameter

Parameters **value** – *subset* parameter

Returns dict of axis/values

22.2 flask_app

Flask module providing the route paths to the api

pygeoapi.flask_app.**collection_coverage**(*collection_id*)
OGC API - Coverages coverage endpoint

Parameters **collection_id** – collection identifier

Returns HTTP response

pygeoapi.flask_app.**collection_coverage_domainset**(*collection_id*)
OGC API - Coverages coverage domainset endpoint

Parameters **collection_id** – collection identifier

Returns HTTP response

pygeoapi.flask_app.**collection_coverage_rangetype**(*collection_id*)
OGC API - Coverages coverage rangetype endpoint

Parameters **collection_id** – collection identifier

Returns HTTP response

pygeoapi.flask_app.**collection_items**(*collection_id*, *item_id=None*)
OGC API collections items endpoint

Parameters

- **collection_id** – collection identifier
- **item_id** – item identifier

Returns HTTP response

pygeoapi.flask_app.**collection_queryables**(*collection_id=None*)
OGC API collections querybles endpoint

Parameters **collection_id** – collection identifier

Returns HTTP response

pygeoapi.flask_app.**collections**(*collection_id=None*)
OGC API collections endpoint

Parameters **collection_id** – collection identifier

Returns HTTP response

pygeoapi.flask_app.**conformance**()
OGC API conformance endpoint

Returns HTTP response

pygeoapi.flask_app.**execute_process_jobs**(*process_id*)
OGC API - Processes execution endpoint

Parameters **process_id** – process identifier

Returns HTTP response

pygeoapi.flask_app.**get_collection_edr_query**(*collection_id*, *instance_id=None*)
OGC EDR API endpoints

Parameters

- **collection_id** – collection identifier
- **instance_id** – instance identifier

Returns HTTP response

pygeoapi.flask_app.**get_collection_tiles**(*collection_id=None*)
OGC open api collections tiles access point

Parameters **collection_id** – collection identifier

Returns HTTP response

pygeoapi.flask_app.**get_collection_tiles_data**(*collection_id=None*, *tileMatrixSetId=None*, *tileMatrix=None*, *tileRow=None*, *tileCol=None*)
OGC open api collection tiles service data

Parameters

- **collection_id** – collection identifier
- **tileMatrixSetId** – identifier of tile matrix set
- **tileMatrix** – identifier of {z} matrix index
- **tileRow** – identifier of {y} matrix index
- **tileCol** – identifier of {x} matrix index

Returns HTTP response

pygeoapi.flask_app.**get_collection_tiles_metadata**(*collection_id=None*, *tileMatrixSetId=None*)
OGC open api collection tiles service metadata

Parameters

- **collection_id** – collection identifier
- **tileMatrixSetId** – identifier of tile matrix set

Returns HTTP response

pygeoapi.flask_app.**get_job_result**(*job_id=None*)
OGC API - Processes job result endpoint

Parameters **job_id** – job identifier

Returns HTTP response

pygeoapi.flask_app.**get_job_result_resource**(*job_id*, *resource*)
OGC API - Processes job result resource endpoint

Parameters

- **job_id** – job identifier

- **resource** – job resource

Returns HTTP response

pygeoapi.flask_app.**get_jobs**(*job_id=None*)
OGC API - Processes jobs endpoint

Parameters **job_id** – job identifier

Returns HTTP response

pygeoapi.flask_app.**get_processes**(*process_id=None*)
OGC API - Processes description endpoint

Parameters **process_id** – process identifier

Returns HTTP response

pygeoapi.flask_app.**get_response**(*result: tuple*[137])
Creates a Flask Response object and updates matching headers.

Parameters **result** – The result of the API call. This should be a tuple of (headers, status, content).

Returns A Response instance.

pygeoapi.flask_app.**landing_page**()
OGC API landing page endpoint

Returns HTTP response

pygeoapi.flask_app.**openapi**()
OpenAPI endpoint

Returns HTTP response

pygeoapi.flask_app.**stac_catalog_path**(*path*)
STAC path endpoint

Parameters **path** – path

Returns HTTP response

pygeoapi.flask_app.**stac_catalog_root**()
STAC root endpoint

Returns HTTP response

22.3 Logging

Logging system

pygeoapi.log.**setup_logger**(*logging_config*)
Setup configuration

Parameters **logging_config** – logging specific configuration

Returns void (creates logging instance)

22.4 OpenAPI

pygeoapi.openapi.**gen_media_type_object**(*media_type*, *api_type*, *path*)
Generates an OpenAPI Media Type Object

Parameters

- **media_type** – MIME type
- **api_type** – OGC API type
- **path** – local path of OGC API parameter or schema definition

Returns *dict* of media type object

pygeoapi.openapi.**gen_response_object**(*description*, *media_type*, *api_type*, *path*)
Generates an OpenAPI Response Object

Parameters

- **description** – text description of response
- **media_type** – MIME type
- **api_type** – OGC API type

Returns *dict* of response object

pygeoapi.openapi.**get_oas**(*cfg*, *version='3.0'*)
Stub to generate OpenAPI Document

Parameters

- **cfg** – configuration object
- **version** – version of OpenAPI (default 3.0)

Returns OpenAPI definition YAML dict

pygeoapi.openapi.**get_oas_30**(*cfg*)
Generates an OpenAPI 3.0 Document

Parameters **cfg** – configuration object

Returns OpenAPI definition YAML dict

pygeoapi.openapi.**validate_openapi_document**(*instance_dict*)
Validate an OpenAPI document against the OpenAPI schema

Parameters **instance_dict** – dict of OpenAPI instance

Returns *bool* of validation

22.5 Plugins

See also:

Customizing pygeoapi: plugins

Plugin loader

exception pygeoapi.plugin.**InvalidPluginError**
Bases: Exception[138]

[138] https://docs.python.org/3/library/exceptions.html#Exception

Invalid plugin

__weakref__
list of weak references to the object (if defined)

pygeoapi.plugin.**PLUGINS = {'formatter': {'CSV': 'pygeoapi.formatter.csv_.CSVFormatter'}, '**
Loads provider plugins to be used by pygeoapi,formatters and processes available

pygeoapi.plugin.**load_plugin**(*plugin_type*, *plugin_def*)
loads plugin by name

Parameters

- **plugin_type** – type of plugin (provider, formatter)
- **plugin_def** – plugin definition

Returns plugin object

22.6 Utils

Generic util functions used in the code

class pygeoapi.util.**JobStatus**
Bases: enum.Enum[139]

Enum for the job status options specified in the WPS 2.0 specification

pygeoapi.util.**dategetter**(*date_property*, *collection*)
Attempts to obtain a date value from a collection.

Parameters

- **date_property** – property representing the date
- **collection** – dictionary to check within

Returns *str* (ISO8601) representing the date (allowing for an open interval using null)

pygeoapi.util.**file_modified_iso8601**(*filepath*)
Provide a file's ctime in ISO8601

Parameters **filepath** – path to file

Returns string of ISO8601

pygeoapi.util.**filter_dict_by_key_value**(*dict_*, *key*, *value*)
helper function to filter a dict by a dict key

Parameters

- **dict** – dict
- **key** – dict key
- **value** – dict key value

Returns filtered dict

pygeoapi.util.**filter_providers_by_type**(*providers*, *type*)
helper function to filter a list of providers by type

Parameters

[139] https://docs.python.org/3/library/enum.html#enum.Enum

- **providers** – list
- **type** – str

Returns filtered dict provider

pygeoapi.util.**format_datetime**(*value*, *format_='%Y-%m-%dT%H:%M:%S.%fZ'*)
Parse datetime as ISO 8601 string; re-present it in particular format for display in HTML

Parameters

- **value** – *str* of ISO datetime
- **format** – *str* of datetime format for strftime

Returns string

pygeoapi.util.**format_duration**(*start*, *end=None*)
Parse a start and (optional) end datetime as ISO 8601 strings, calculate the difference, and return that duration as a string.

Parameters

- **start** – *str* of ISO datetime
- **end** – *str* of ISO datetime, defaults to *start* for a 0 duration

Returns string

pygeoapi.util.**get_breadcrumbs**(*urlpath*)
helper function to make breadcrumbs from a URL path

Parameters **urlpath** – URL path

Returns *list* of *dict* objects of labels and links

pygeoapi.util.**get_envelope**(*coords_list: List[List[float*[140]*]]*)
helper function to get the envelope for a given coordinates list through the Shapely API.

Parameters **coords_list** – list of coordinates

Returns list of the envelope's coordinates

pygeoapi.util.**get_mimetype**(*filename*)
helper function to return MIME type of a given file

Parameters **filename** – filename (with extension)

Returns MIME type of given filename

pygeoapi.util.**get_path_basename**(*urlpath*)
Helper function to derive file basename

Parameters **urlpath** – URL path

Returns string of basename of URL path

pygeoapi.util.**get_provider_by_type**(*providers*, *provider_type*)
helper function to load a provider by a provider type

Parameters

- **providers** – list of providers
- **provider_type** – type of provider (feature)

Returns provider based on type

pygeoapi.util.**get_provider_default**(*providers*)
helper function to get a resource's default provider

Parameters **providers** – list of providers

Returns filtered dict

pygeoapi.util.**get_typed_value**(*value*)
Derive true type from data value

Parameters **value** – value

Returns value as a native Python data type

pygeoapi.util.**human_size**(*nbytes*)
Provides human readable file size

source: https://stackoverflow.com/a/14996816

Parameters

- **nbytes** – int of file size (bytes)
- **units** – list of unit abbreviations

Returns string of human readable filesize

pygeoapi.util.**is_url**(*urlstring*)
Validation function that determines whether a candidate URL should be considered a URI. No remote resource is obtained; this does not check the existence of any remote resource. :param urlstring: *str* to be evaluated as candidate URL. :returns: *bool* of whether the URL looks like a URL.

pygeoapi.util.**json_serial**(*obj*)
helper function to convert to JSON non-default types (source: https://stackoverflow.com/a/22238613) :param obj: *object* to be evaluated :returns: JSON non-default type to *str*

pygeoapi.util.**read_data**(*path*)
helper function to read data (file or networrk)

pygeoapi.util.**render_j2_template**(*config*, *template*, *data*, *locale_=None*)
render Jinja2 template

Parameters

- **config** – dict of configuration
- **template** – template (relative path)
- **data** – dict of data
- **locale** – the requested output Locale

Returns string of rendered template

pygeoapi.util.**str2bool**(*value*)
helper function to return Python boolean type (source: https://stackoverflow.com/a/715468)

Parameters **value** – value to be evaluated

Returns *bool* of whether the value is boolean-ish

pygeoapi.util.**to_json**(*dict_*, *pretty=False*)
Serialize dict to json

Parameters

- **dict** – *dict* of JSON representation

- **pretty** – *bool* of whether to prettify JSON (default is *False*)

Returns JSON string representation

pygeoapi.util.**url_join**(**parts*)
helper function to join a URL from a number of parts/fragments. Implemented because urllib.parse.urljoin strips subpaths from host urls if they are specified

Per https://github.com/geopython/pygeoapi/issues/695

Parameters **parts** – list of parts to join

Returns str of resulting URL

pygeoapi.util.**yaml_load**(*fh*)
serializes a YAML files into a pyyaml object

Parameters **fh** – file handle

Returns *dict* representation of YAML

22.7 Formatter package

Output formatter package

22.7.1 Base class

class pygeoapi.formatter.base.**BaseFormatter**(*formatter_def*)
Bases: object[141]

generic Formatter ABC

__init__(*formatter_def*)
Initialize object

Parameters **formatter_def** – formatter definition

Returns pygeoapi.formatter.base.BaseFormatter

__repr__()
Return repr(self).

__weakref__
list of weak references to the object (if defined)

write(*options={}*, *data=None*)
Generate data in specified format

Parameters

- **options** – CSV formatting options
- **data** – dict representation of GeoJSON object

Returns string representation of format

exception pygeoapi.formatter.base.**FormatterGenericError**
Bases: Exception[142]

formatter generic error

[141] https://docs.python.org/3/library/functions.html#object
[142] https://docs.python.org/3/library/exceptions.html#Exception

__weakref__
list of weak references to the object (if defined)

exception pygeoapi.formatter.base.**FormatterSerializationError**
Bases: *pygeoapi.formatter.base.FormatterGenericError*

formatter serialization error

22.7.2 csv

class pygeoapi.formatter.csv_.**CSVFormatter**(*formatter_def*)
Bases: *pygeoapi.formatter.base.BaseFormatter*

CSV formatter

__init__(*formatter_def*)
Initialize object

Parameters **formatter_def** – formatter definition

Returns *pygeoapi.formatter.csv_.CSVFormatter*

__repr__()
Return repr(self).

write(*options={}*, *data=None*)
Generate data in CSV format

Parameters

- **options** – CSV formatting options
- **data** – dict of GeoJSON data

Returns string representation of format

22.8 Process package

OGC process package, each process is an independent module

22.8.1 Base class

class pygeoapi.process.base.**BaseProcessor**(*processor_def*, *process_metadata*)
Bases: object[143]

generic Processor ABC. Processes are inherited from this class

__init__(*processor_def*, *process_metadata*)
Initialize object

Parameters

- **processor_def** – processor definition
- **process_metadata** – process metadata *dict*

Returns pygeoapi.processor.base.BaseProvider

[143] https://docs.python.org/3/library/functions.html#object

__repr__()
Return repr(self).

__weakref__
list of weak references to the object (if defined)

execute()
execute the process

Returns tuple of MIME type and process response

exception pygeoapi.process.base.**ProcessorExecuteError**
Bases: *pygeoapi.process.base.ProcessorGenericError*

query / backend error

exception pygeoapi.process.base.**ProcessorGenericError**
Bases: Exception[144]

processor generic error

__weakref__
list of weak references to the object (if defined)

22.8.2 hello_world

Hello world example process

class pygeoapi.process.hello_world.**HelloWorldProcessor**(*processor_def*)
Bases: *pygeoapi.process.base.BaseProcessor*

Hello World Processor example

__init__(*processor_def*)
Initialize object

Parameters **processor_def** – provider definition

Returns pygeoapi.process.hello_world.HelloWorldProcessor

__repr__()
Return repr(self).

execute(*data*)
execute the process

Returns tuple of MIME type and process response

pygeoapi.process.hello_world.**PROCESS_METADATA = {'description': {'en': 'An example process**
Process metadata and description

[144] https://docs.python.org/3/library/exceptions.html#Exception

22.9 Provider

Provider module containing the plugins wrapping data sources

22.9.1 Base class

class pygeoapi.provider.base.**BaseProvider**(*provider_def*)

Bases: object[145]

generic Provider ABC

__init__(*provider_def*)

Initialize object

Parameters **provider_def** – provider definition

Returns pygeoapi.provider.base.BaseProvider

__repr__()

Return repr(self).

__weakref__

list of weak references to the object (if defined)

_load_and_prepare_item(*item*, *identifier=None*, *raise_if_exists=True*)

Helper function to load a record, detect its idenfier and prepare a record item

Parameters

- **item** – *str* of incoming item data
- **identifier** – *str* of item identifier (optional)
- **raise_if_exists** – *bool* of whether to check if record already exists

Returns *tuple* of item identifier and item data/payload

create(*item*)

Create a new item

Parameters **item** – *dict* of new item

Returns identifier of created item

delete(*identifier*)

Deletes an existing item

Parameters **identifier** – item id

Returns *bool* of deletion result

get(*identifier*)

query the provider by id

Parameters **identifier** – feature id

Returns dict of single GeoJSON feature

get_coverage_domainset()

Provide coverage domainset

Returns CIS JSON object of domainset metadata

[145] https://docs.python.org/3/library/functions.html#object

get_coverage_rangetype()
Provide coverage rangetype

Returns CIS JSON object of rangetype metadata

get_data_path(*baseurl*, *urlpath*, *dirpath*)
Gets directory listing or file description or raw file dump

Parameters

- **baseurl** – base URL of endpoint
- **urlpath** – base path of URL
- **dirpath** – directory basepath (equivalent of URL)

Returns *dict* of file listing or *dict* of GeoJSON item or raw file

get_fields()
Get provider field information (names, types)

Returns dict of fields

get_metadata()
Provide data/file metadata

Returns *dict* of metadata construct (format determined by provider/standard)

get_schema(*schema_type: pygeoapi.provider.base.SchemaType = <SchemaType.item: 'item'>*)
Get provider schema model

Parameters **schema_type** – *SchemaType* of schema (default is 'item')

Returns tuple pair of *str* of media type and *dict* of schema (i.e. JSON Schema)

query()
query the provider

Returns dict of 0..n GeoJSON features or coverage data

update(*identifier*, *item*)
Updates an existing item

Parameters

- **identifier** – feature id
- **item** – *dict* of partial or full item

Returns *bool* of update result

exception pygeoapi.provider.base.**ProviderConnectionError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider connection error

exception pygeoapi.provider.base.**ProviderGenericError**
Bases: Exception[146]

provider generic error

__weakref__
list of weak references to the object (if defined)

[146] https://docs.python.org/3/library/exceptions.html#Exception

exception pygeoapi.provider.base.**ProviderInvalidDataError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider invalid data error

exception pygeoapi.provider.base.**ProviderInvalidQueryError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider invalid query error

exception pygeoapi.provider.base.**ProviderItemNotFoundError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider item not found query error

exception pygeoapi.provider.base.**ProviderNoDataError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider no data error

exception pygeoapi.provider.base.**ProviderNotFoundError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider not found error

exception pygeoapi.provider.base.**ProviderQueryError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider query error

exception pygeoapi.provider.base.**ProviderTypeError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider type error

exception pygeoapi.provider.base.**ProviderVersionError**
Bases: *pygeoapi.provider.base.ProviderGenericError*

provider incorrect version error

class pygeoapi.provider.base.**SchemaType**
Bases: enum.Enum[147]

An enumeration.

22.9.2 CSV provider

class pygeoapi.provider.csv_.**CSVProvider**(*provider_def*)
Bases: *pygeoapi.provider.base.BaseProvider*

CSV provider

load(*offset=0*, *limit=10*, *resulttype='results'*, *identifier=None*, *bbox=[]*, *datetime=None*, *properties=[]*, *select_properties=[]*, *skip_geometry=False*, *q=None*)
Load CSV data

Parameters

- **offset** – starting record to return (default 0)
- **limit** – number of records to return (default 10)
- **datetime** – temporal (datestamp or extent)

[147] https://docs.python.org/3/library/enum.html#enum.Enum

- **resulttype** – return results or hit limit (default results)
- **properties** – list of tuples (name, value)
- **select_properties** – list of property names
- **skip_geometry** – bool of whether to skip geometry (default False)
- **q** – full-text search term(s)

Returns dict of GeoJSON FeatureCollection

get(*identifier*, ***kwargs*)
query CSV id

Parameters **identifier** – feature id

Returns dict of single GeoJSON feature

get_fields()

Get provider field information (names, types)

Returns dict of fields

query(*offset=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime_=None*, *properties=[]*, *sortby=[]*, *select_properties=[]*, *skip_geometry=False*, *q=None*, ***kwargs*)
CSV query

Parameters

- **offset** – starting record to return (default 0)
- **limit** – number of records to return (default 10)
- **resulttype** – return results or hit limit (default results)
- **bbox** – bounding box [minx,miny,maxx,maxy]
- **datetime** – temporal (datestamp or extent)
- **properties** – list of tuples (name, value)
- **sortby** – list of dicts (property, order)
- **select_properties** – list of property names
- **skip_geometry** – bool of whether to skip geometry (default False)
- **q** – full-text search term(s)

Returns dict of GeoJSON FeatureCollection

22.9.3 Elasticsearch provider

22.9.4 GeoJSON

class pygeoapi.provider.geojson.**GeoJSONProvider**(*provider_def*)
Bases: *pygeoapi.provider.base.BaseProvider*

Provider class backed by local GeoJSON files

This is meant to be simple (no external services, no dependencies, no schema)

at the expense of performance (no indexing, full serialization roundtrip on each request)

Not thread safe, a single server process is assumed

This implementation uses the feature 'id' heavily and will override any 'id' provided in the original data. The feature 'properties' will be preserved.

TODO: * query method should take bbox * instead of methods returning FeatureCollections, we should be yielding Features and aggregating in the view * there are strict id semantics; all features in the input GeoJSON file must be present and be unique strings. Otherwise it will break. * How to raise errors in the provider implementation such that * appropriate HTTP responses will be raised

_load(*skip_geometry=None*, *properties=[]*, *select_properties=[]*)
Load and validate the source GeoJSON file at self.data

Yes loading from disk, deserializing and validation happens on every request. This is not efficient.

create(*new_feature*)
Create a new feature

Parameters **new_feature** – new GeoJSON feature dictionary

delete(*identifier*)
Deletes an existing feature

Parameters **identifier** – feature id

get(*identifier*, ***kwargs*)
query the provider by id

Parameters **identifier** – feature id

Returns dict of single GeoJSON feature

get_fields()

Get provider field information (names, types)

Returns dict of fields

query(*offset=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime_=None*, *properties=[]*, *sortby=[]*, *select_properties=[]*, *skip_geometry=False*, *q=None*, ***kwargs*)
query the provider

Parameters

- **offset** – starting record to return (default 0)
- **limit** – number of records to return (default 10)
- **resulttype** – return results or hit limit (default results)
- **bbox** – bounding box [minx,miny,maxx,maxy]
- **datetime** – temporal (datestamp or extent)
- **properties** – list of tuples (name, value)
- **sortby** – list of dicts (property, order)
- **select_properties** – list of property names
- **skip_geometry** – bool of whether to skip geometry (default False)
- **q** – full-text search term(s)

Returns FeatureCollection dict of 0..n GeoJSON features

update(*identifier*, *new_feature*)
Updates an existing feature id with new_feature

Parameters

- **identifier** – feature id
- **new_feature** – new GeoJSON feature dictionary

22.9.5 OGR

class pygeoapi.provider.ogr.**CommonSourceHelper**(*provider*)
Bases: *pygeoapi.provider.ogr.SourceHelper*

SourceHelper for most common OGR Source types: Shapefile, GeoPackage, SQLite, GeoJSON etc.

close()
OGR Driver-specific handling of closing dataset. If ExecuteSQL has been (successfully) called must close ResultSet explicitly. https://gis.stackexchange.com/questions/114112/explicitly-close-a-ogr-result-object-from-a-call-to-executesql # noqa

disable_paging()
Disable paged access to dataset (OGR Driver-specific)

enable_paging(*offset=- 1*, *limit=- 1*)
Enable paged access to dataset (OGR Driver-specific) using OGR SQL https://gdal.org/user/ogr_sql_dialect.html e.g. SELECT * FROM poly LIMIT 10 OFFSET 30

get_layer()
Gets OGR Layer from opened OGR dataset. When offset defined 1 or greater will invoke OGR SQL SELECT with LIMIT and OFFSET and return as Layer as ResultSet from ExecuteSQL on dataset. :return: OGR layer object

class pygeoapi.provider.ogr.**ESRIJSONHelper**(*provider*)
Bases: *pygeoapi.provider.ogr.CommonSourceHelper*

disable_paging()
Disable paged access to dataset (OGR Driver-specific)

enable_paging(*offset=- 1*, *limit=- 1*)
Enable paged access to dataset (OGR Driver-specific)

get_layer()
Gets OGR Layer from opened OGR dataset. When offset defined 1 or greater will invoke OGR SQL SELECT with LIMIT and OFFSET and return as Layer as ResultSet from ExecuteSQL on dataset. :return: OGR layer object

exception pygeoapi.provider.ogr.**InvalidHelperError**
Bases: Exception[148]

Invalid helper

class pygeoapi.provider.ogr.**OGRProvider**(*provider_def*)
Bases: *pygeoapi.provider.base.BaseProvider*

OGR Provider. Uses GDAL/OGR Python-bindings to access OGR Vector sources. References: https://pcjericks.github.io/py-gdalogr-cookbook/ https://gdal.org/ogr_formats.html (per-driver specifics).

In theory any OGR source type (Driver) could be used, although some Source Types are Driver-specific handling. This is handled in Source Helper classes, instantiated per Source-Type.

[148] https://docs.python.org/3/library/exceptions.html#Exception

The following Source Types have been tested to work: GeoPackage (GPKG), SQLite, GeoJSON, ESRI Shapefile, WFS v2.

_load_source_helper(*source_type*)
Loads Source Helper by name.

Parameters **type** (*Source*) – Source type name

Returns Source Helper object

_response_feature_collection(*layer*, *limit*, *skip_geometry=False*)
Assembles output from Layer query as GeoJSON FeatureCollection structure.

Returns GeoJSON FeatureCollection

_response_feature_hits(*layer*)
Assembles GeoJSON hits from OGR Feature count e.g: http://localhost:5000/collections/hotosm_bdi_waterways/items?resulttype=hits

Returns GeoJSON FeaturesCollection

get(*identifier*, ***kwargs*)
Get Feature by id

Parameters **identifier** – feature id

Returns feature collection

get_fields()
Get provider field information (names, types)

Returns dict of fields

query(*offset=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime_=None*, *properties=[]*, *sortby=[]*, *select_properties=[]*, *skip_geometry=False*, *q=None*, ***kwargs*)
Query OGR source

Parameters

- **offset** – starting record to return (default 0)
- **limit** – number of records to return (default 10)
- **resulttype** – return results or hit limit (default results)
- **bbox** – bounding box [minx,miny,maxx,maxy]
- **datetime** – temporal (datestamp or extent)
- **properties** – list of tuples (name, value)
- **sortby** – list of dicts (property, order)
- **select_properties** – list of property names
- **skip_geometry** – bool of whether to skip geometry (default False)
- **q** – full-text search term(s)

Returns dict of 0..n GeoJSON features

class pygeoapi.provider.ogr.**SourceHelper**(*provider*)
Bases: object[149]

Helper classes for OGR-specific Source Types (Drivers). For some actions Driver-specific settings or processing is required. This is delegated to the OGR SourceHelper classes.

[149] https://docs.python.org/3/library/functions.html#object

close()
OGR Driver-specific handling of closing dataset. Default is no specific handling.

disable_paging()
Disable paged access to dataset (OGR Driver-specific)

enable_paging(*offset=- 1*, *limit=- 1*)
Enable paged access to dataset (OGR Driver-specific)

get_layer()
Default action to get a Layer object from opened OGR Driver. :return:

class pygeoapi.provider.ogr.**WFSHelper**(*provider*)
Bases: *pygeoapi.provider.ogr.SourceHelper*

disable_paging()
Disable paged access to dataset (OGR Driver-specific)

enable_paging(*offset=- 1*, *limit=- 1*)
Enable paged access to dataset (OGR Driver-specific)

pygeoapi.provider.ogr.**_ignore_gdal_error**(*inst*, *fn*, **args*, ***kwargs*) → Any
Evaluate the function with the object instance.

Parameters

- **inst** – Object instance
- **fn** – String function name
- **args** – List of positional arguments
- **kwargs** – Keyword arguments

Returns Any function evaluation result

pygeoapi.provider.ogr.**_silent_gdal_error**(*f*)
Decorator function for gdal

22.9.6 postgresql

22.9.7 sqlite/geopackage

class pygeoapi.provider.sqlite.**SQLiteGPKGProvider**(*provider_def*)
Bases: *pygeoapi.provider.base.BaseProvider*

Generic provider for SQLITE and GPKG using sqlite3 module. This module requires install of libsqlite3-mod-spatialite TODO: DELETE, UPDATE, CREATE

_SQLiteGPKGProvider__get_where_clauses(*properties=[]*, *bbox=[]*)
Generarates WHERE conditions to be implemented in query. Private method mainly associated with query method.

Method returns part of the SQL query, plus tupple to be used in the sqlite query method

Parameters

- **properties** – list of tuples (name, value)
- **bbox** – bounding box [minx,miny,maxx,maxy]

Returns str, tuple

_SQLiteGPKGProvider__load()
Private method for loading spatiallite, get the table structure and dump geometry

Returns sqlite3.Cursor

_SQLiteGPKGProvider__response_feature(*row_data*, *skip_geometry=False*)
Assembles GeoJSON output from DB query

Parameters

- **row_data** – DB row result
- **skip_geometry** – whether to skip geometry (default False)

Returns *dict* of GeoJSON Feature

_SQLiteGPKGProvider__response_feature_hits(*hits*)
Assembles GeoJSON/Feature number

Returns GeoJSON FeaturesCollection

get(*identifier*, ***kwargs*)
Query the provider for a specific feature id e.g: /collections/countries/items/1

Parameters **identifier** – feature id

Returns GeoJSON FeaturesCollection

get_fields()

Get fields from sqlite table (columns are field)

Returns dict of fields

query(*offset=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime_=None*, *properties=[]*, *sortby=[]*, *select_properties=[]*, *skip_geometry=False*, *q=None*, ***kwargs*)
Query SQLite/GPKG for all the content. e,g: http://localhost:5000/collections/countries/items?limit=5&offset=2&resulttype=results&continent=Europe&admin=Albania&bbox=29.3373,-3.4099,29.3761,-3.3924 http://localhost:5000/collections/countries/items?continent=Africa&bbox=29.3373,-3.4099,29.3761,-3.3924

Parameters

- **offset** – starting record to return (default 0)
- **limit** – number of records to return (default 10)
- **resulttype** – return results or hit limit (default results)
- **bbox** – bounding box [minx,miny,maxx,maxy]
- **datetime** – temporal (datestamp or extent)
- **properties** – list of tuples (name, value)
- **sortby** – list of dicts (property, order)
- **select_properties** – list of property names
- **skip_geometry** – bool of whether to skip geometry (default False)
- **q** – full-text search term(s)

Returns GeoJSON FeaturesCollection

CHAPTER

TWENTYTHREE

INDICES AND TABLES

- genindex
- modindex
- search

PYTHON MODULE INDEX

p

INDEX

Symbols

A

B

C

D

E

F

G

H

I

J

L

M

O

P

Q

R

S

T

U

V

W

Y