pygeoapi Documentation

Release 0.9.dev0

pygeoapi team

2020-11-05

TABLE OF CONTENTS

Author the pygeoapi team

Contact pygeoapi at lists.osgeo.org

Release 0.9.dev0

Date 2020-11-05

CHAPTER

ONE

INTRODUCTION

pygeoapi is a Python server implementation of the OGC API suite of standards. The project emerged as part of the next generation OGC API 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 and released under an MIT *License*.

1.1 Features

- out of the box modern OGC API server
- certified OGC Compliant and Reference Implementation for OGC API - Features
- additionally implements OGC API - Coverages, OGC API - Processes and 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)

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!)

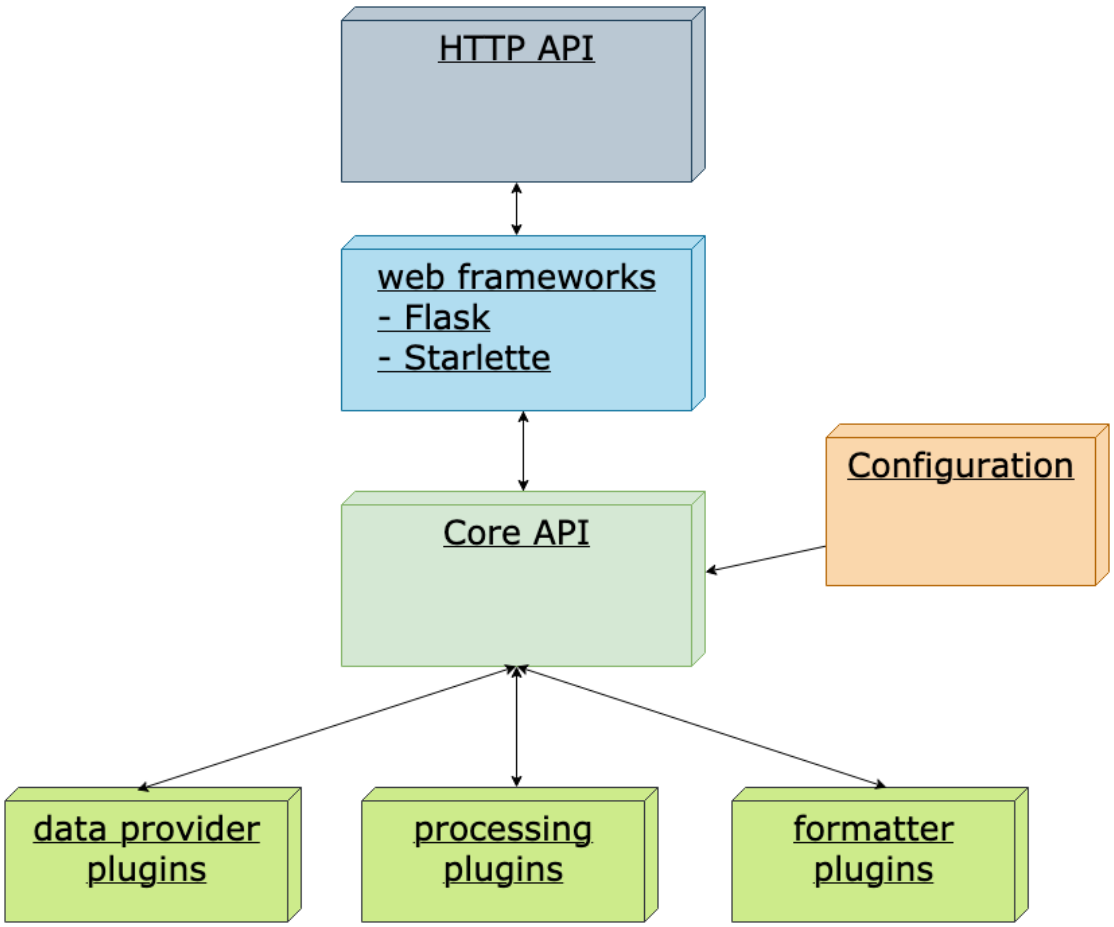
Standard	Support
OGC API - Features	Reference Implementation
OGC API - Coverages	Implementing
OGC API - Processes	Implementing
SpatioTemporal Asset Catalog	Implementing

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, Django and Starlette provide the web API/wrapper atop the core Python API.

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

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 -r requirements.txt
python setup.py install
cp pygeoapi-config.yml example-config.yml
vi example-config.yml
export PYGEOAPI_CONFIG=example-config.yml
export PYGEOAPI_OPENAPI=example-openapi.yml
pygeoapi generate-openapi-document -c $PYGEOAPI_CONFIG > $PYGEOAPI_OPENAPI
pygeoapi serve
curl http://localhost:5000
```

3.3 pip

PyPI package info

```
pip install pygeoapi
```

3.4 Docker

Docker image

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

3.5 Conda

Conda package info

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

3.6 UbuntuGIS

UbuntuGIS package (stable)

UbuntuGIS package (unstable)

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

3.7 FreeBSD

FreeBSD port

```
pkg install 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 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 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 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.

```yaml
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
  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
  map:  # leaflet map setup for HTML pages
      url: https://maps.wikimedia.org/osm-intl/{z}/{x}/{y}.png
```

(continues on next page)

(continued from previous page)

```
      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
```

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
        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
```

(continues on next page)

(continued from previous page)

```
        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 `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`

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)
        title: Observations  # title of dataset
        description: My cool observations  # abstract of dataset
        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
```

(continues on next page)

(continued from previous page)

```
            # 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)
              default: true  # optional: if not specified, the first provider␣
↪definition is considered the default
              name: CSV
              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
              time_field: datetimestamp  # optional field corresponding to the␣
↪temporal propert of the dataset
              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
        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 Using environment variables

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

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

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

4.3 Linked Data

pygeoapi supports structured metadata about a deployed instance, and is also capable of presenting data as structured data. JSON-LD 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 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.

For collections, at the level of an item or items, by default the JSON-LD representation adds:

- The GeoJSON JSON-LD vocabulary and context to the `@context`.
- An `@id` for each item in a collection, that is the URL for that item (resolving to its HTML representation in pygeoapi)

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 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.

4.4 CQL Filter

A fundamental operation performed by pygeoapi on a collection of features is that of querying in order to obtain a subset of the data which contains feature instances that satisfy some filtering criteria. The filtering criteria can be a simpler expression or an arbitrarily complex expression. To implement these enhanced filtering criteria in a request to a server, CQL is used. CQL extension on pygeoapi specifies how resource instances in a source collection should be filtered to identify a result set.

CQL helps in query operations to identify the subset of resources that should be included in a response document. Each resource instance in the source collection is evaluated using a CQL filtering expression. The overall filter expression always evaluates to true or false. If the expression evaluates to true, the resource instance satisfies the expression and is marked as being in the result set. If the overall filter expression evaluates to false, the data instance is not in the result set.

This section is implemented at provider level and based on OGC API - Features - Part 3: Common Query Language document that defines the schema for a JSON document and exposes the set of properties or keys that are used to construct CQL expressions for pygeoapi.

CQL filter extension can be enabled for a resource by adding `filters` section to the configuration of a resource in pygeoapi config file.

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

```
resources:
    obs:
        providers:
            extensions:
                - type: CQL
                filters:
                  - cql-text
                  - cql-json
```

4.5 Summary

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

CHAPTER

FIVE

CQL FILTER IMPLEMENTATION

pygeoapi is a Python server implementation of the OGC API suite of standards. OGC API standards define modular API building blocks to spatially enable Web API in a consistent way. This standard specifies the fundamental API building blocks for interacting with features. pygeoapi provides the capability for organizations to deploy a RESTful OGC API endpoint using OpenAPI, GeoJSON, and HTML. Project/code is structured to provide functionality via plugins where data can be fetched from any backend services like remote services or local files.

Querying is one of the fundamental operations performed on a collection of features. It is in order to obtain a subset of the data which contains feature instances that satisfy some filtering criteria. This project implements these enhanced filtering criteria in a request to a server. CQL is used to specify how resource instances in a source collection should be filtered to identify a result set. Typically, CQL is used here in query operations because it can be written in human readable format. So its the best query language that can be used to identify the subset of resources that should be included in a response document. Each resource instance in the source collection is evaluated using a filtering expression. The overall filter expression always evaluates to true or false. If the expression evaluates to true, the resource instance satisfies the expression and is marked as being in the result set. If the overall filter expression evaluates to false, the data instance is not in the result set.

This project is based on OGC API - Features - Part 3: Common Query Language document that defines the schema for a JSON document that exposes the set of properties or keys that may be used to construct CQL expressions for pygeoapi.

5.1 CQL Filter Predicates

The following CQL predicates are implemented in pygeoapi to support filtering functionality on features:

Simple Condition Predicate, Combination Predicate, Not Condition Predicate, Between Predicate, Like Predicate, In Predicate, Null Predicate, BBox Predicate, Spatial Predicate and Temporal Predicate

5.2 CQL Filter Implementation for Data Providers

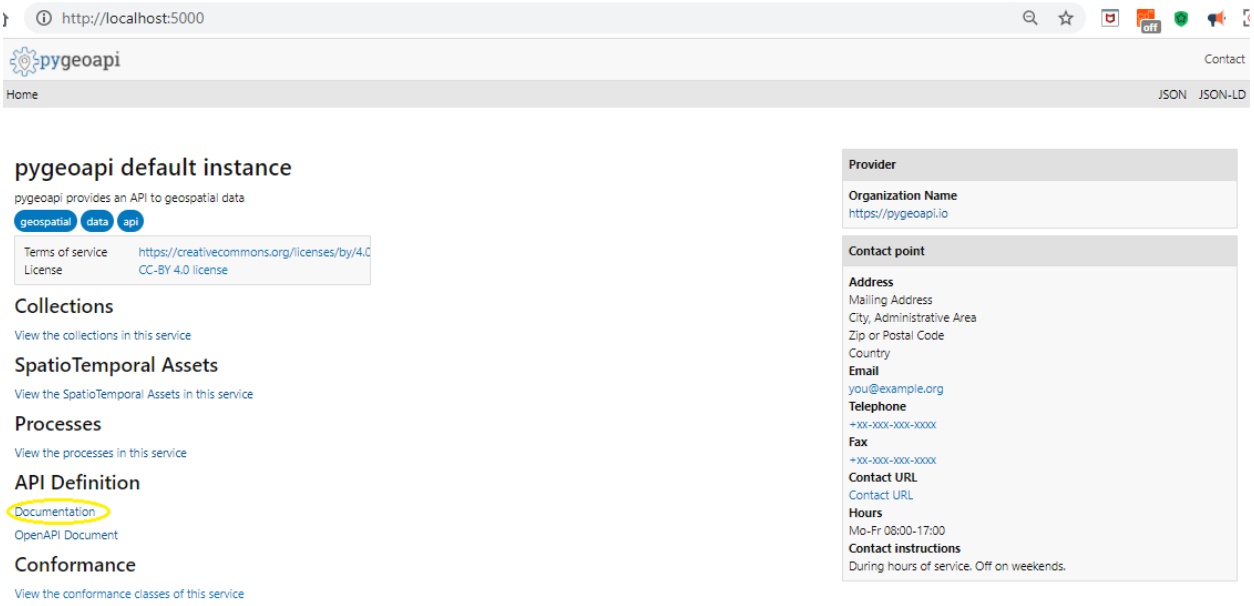
CQL implementation are provider for following data providers:

- **CQL for CSV and GeoJSON data providers:** Evaluation of the Abstract Syntax Tree to filter the feature collections supported by CSV and GeoJSON data providers. pycql library has implementation connection to databases using ORM, but in pygeoapi the data providers don't work with ORM. So the evaluation for all the CQL query operations are developed from scratch and by using efficient methodlogy. The evaluated output is the response from the API.
- **CQL for SQLite data provider:** Evaluation of the Abstract Syntax Tree to filter the feature collections supported by SQLite data provider. The AST of the CQL filter request is translated into SQL queries and then used as a request to the database. The evaluated output from the SQLite database is the response from the API.

- **CQL for PostGreSQL data provider:** Evaluation of the Abstract Syntax Tree to filter the feature collections supported by PostGreSQL data provider. Like SQLite quesries, the AST of the CQL filter request is translated into PostGreSQL queries by following the syntax of psycopg2 database adapter. The query is then used as a request to the database. The evaluated output from the PostGreSQL database is the response from the API.

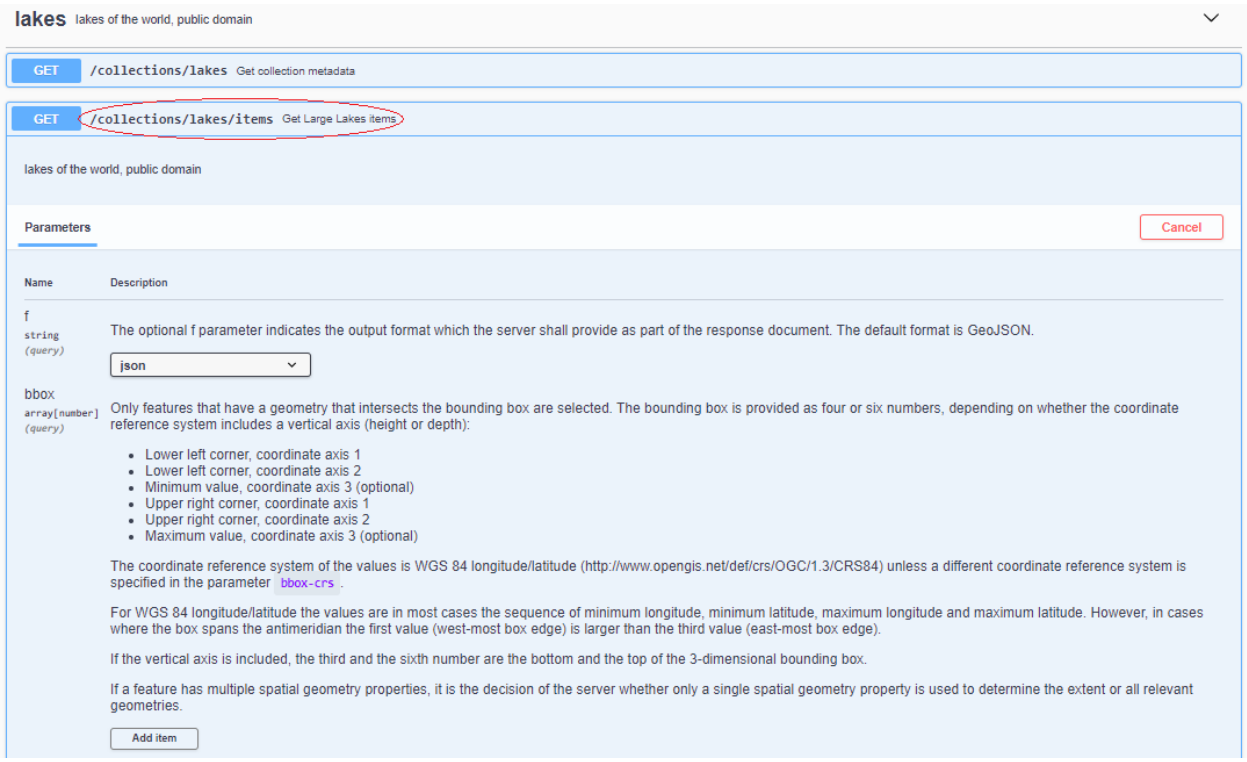
5.3 Steps to generate and execute CQL endpoints

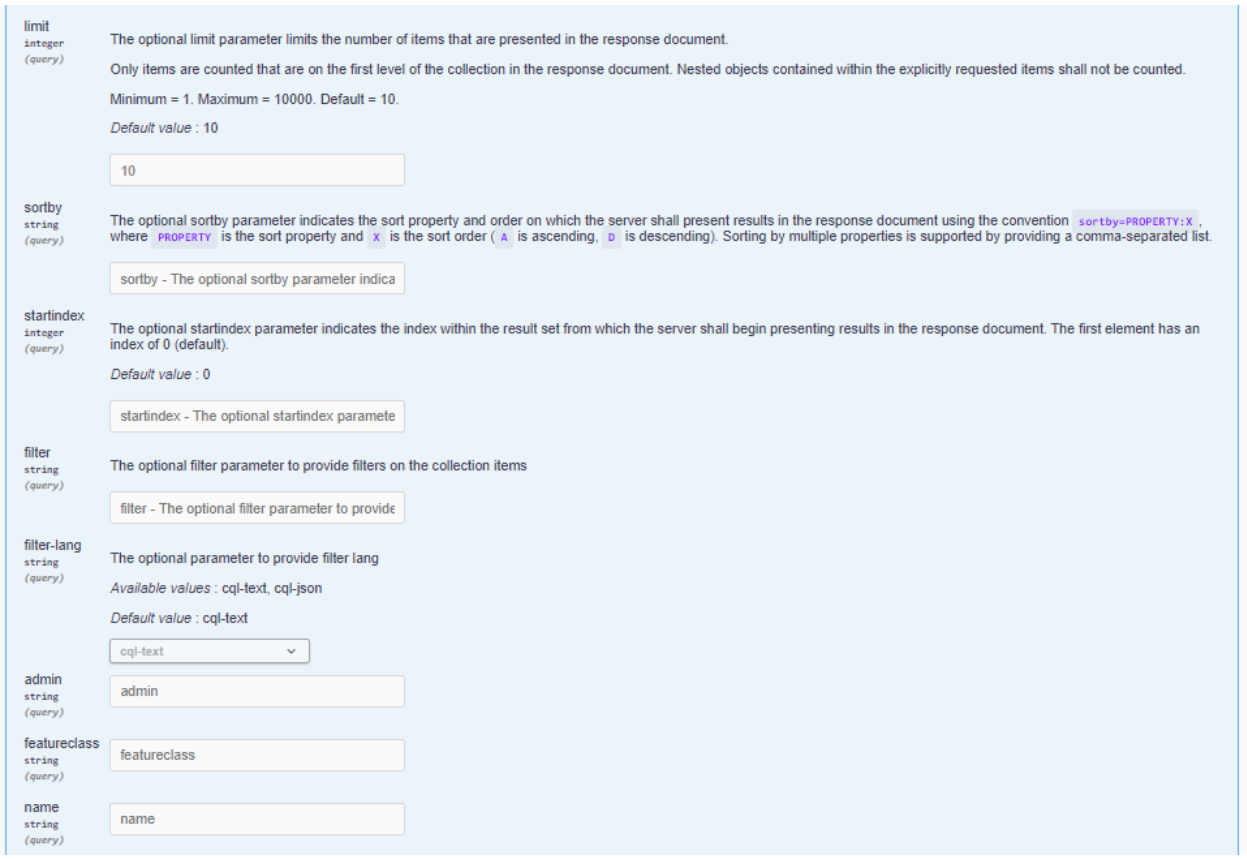
1. Install and run pygeoapi on localhost following the steps specified here
2. Go to OpenAPI documentation

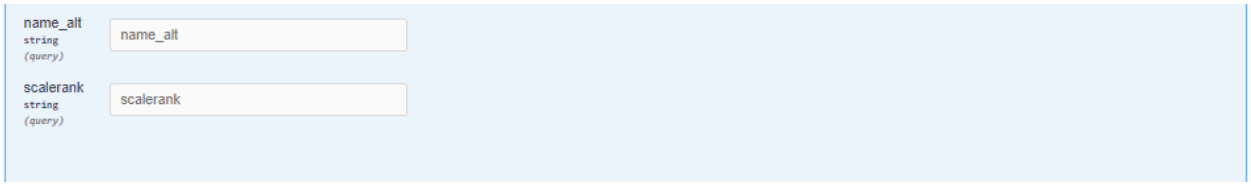


pygeoapi currently supports two collections obs and lakes from CSV and GeoJSON data providers in OpenAPI Documentation

3. Providing CQL query filter along with other query parameters. For the following parameters, the default value of limit is 10, startindex 0, CQL query language is in text, resulttype is results and output format is GeoJSON

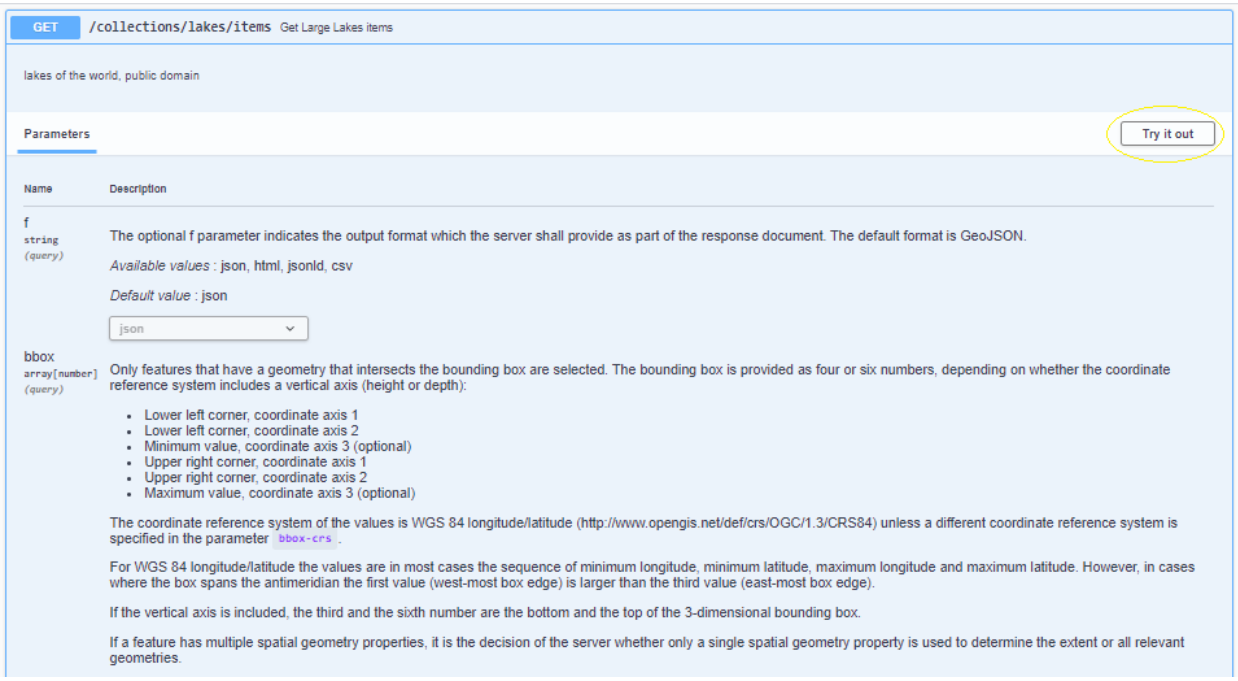

lakes lakes of the world, public domain
GET /collections/lakes Get collection metadata
GET /collections/lakes/items Get Large Lakes items
lakes of the world, public domain
Parameters
Cancel
Name
Description
f
string
(query)
The optional f parameter indicates the output format which the server shall provide as part of the response document. The default format is GeoJSON.
json
bbox
array[number]
(query)
Only features that have a geometry that intersects the bounding box are selected. The bounding box is provided as four or six numbers, depending on whether the coordinate reference system includes a vertical axis (height or depth):
Lower left corner, coordinate axis 1
Lower left corner, coordinate axis 2
Minimum value, coordinate axis 3 (optional)
Upper right corner, coordinate axis 1
Upper right corner, coordinate axis 2
Maximum value, coordinate axis 3 (optional)
The coordinate reference system of the values is WGS 84 longitude/latitude (http://www.opengis.net/def/crs/OGC/1.3/CRS84) unless a different coordinate reference system is specified in the parameter bbox-crs .
For WGS 84 longitude/latitude the values are in most cases the sequence of minimum longitude, minimum latitude, maximum longitude and maximum latitude. However, in cases where the box spans the antimeridian the first value (west-most box edge) is larger than the third value (east-most box edge).
If the vertical axis is included, the third and the sixth number are the bottom and the top of the 3-dimensional bounding box.
If a feature has multiple spatial geometry properties, it is the decision of the server whether only a single spatial geometry property is used to determine the extent or all relevant geometries.
Add item


limit
integer
(query)
The optional limit parameter limits the number of items that are presented in the response document.
Only items are counted that are on the first level of the collection in the response document. Nested objects contained within the explicitly requested items shall not be counted.
Minimum = 1. Maximum = 10000. Default = 10.
Default value : 10
10
sortby
string
(query)
The optional sortby parameter indicates the sort property and order on which the server shall present results in the response document using the convention sortby=PROPERTY:X , where PROPERTY is the sort property and X is the sort order (A is ascending, D is descending). Sorting by multiple properties is supported by providing a comma-separated list.
sortby - The optional sortby parameter indica
startindex
integer
(query)
The optional startindex parameter indicates the index within the result set from which the server shall begin presenting results in the response document. The first element has an index of 0 (default).
Default value : 0
startindex - The optional startindex paramete
filter
string
(query)
The optional filter parameter to provide filters on the collection items
filter - The optional filter parameter to provide
filter-lang
string
(query)
The optional parameter to provide filter lang
Available values : cql-text, cql-json
Default value : cql-text
cql-text
admin
string
(query)
admin
featureclass
string
(query)
featureclass
name
string
(query)
name

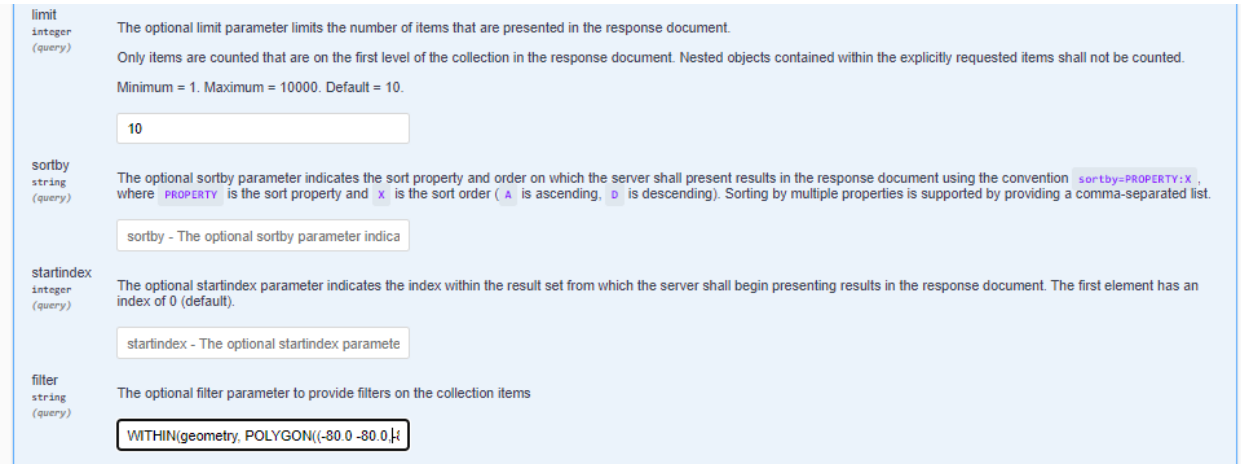


The parameter values of any collection item can be changed to generate different API endpoint

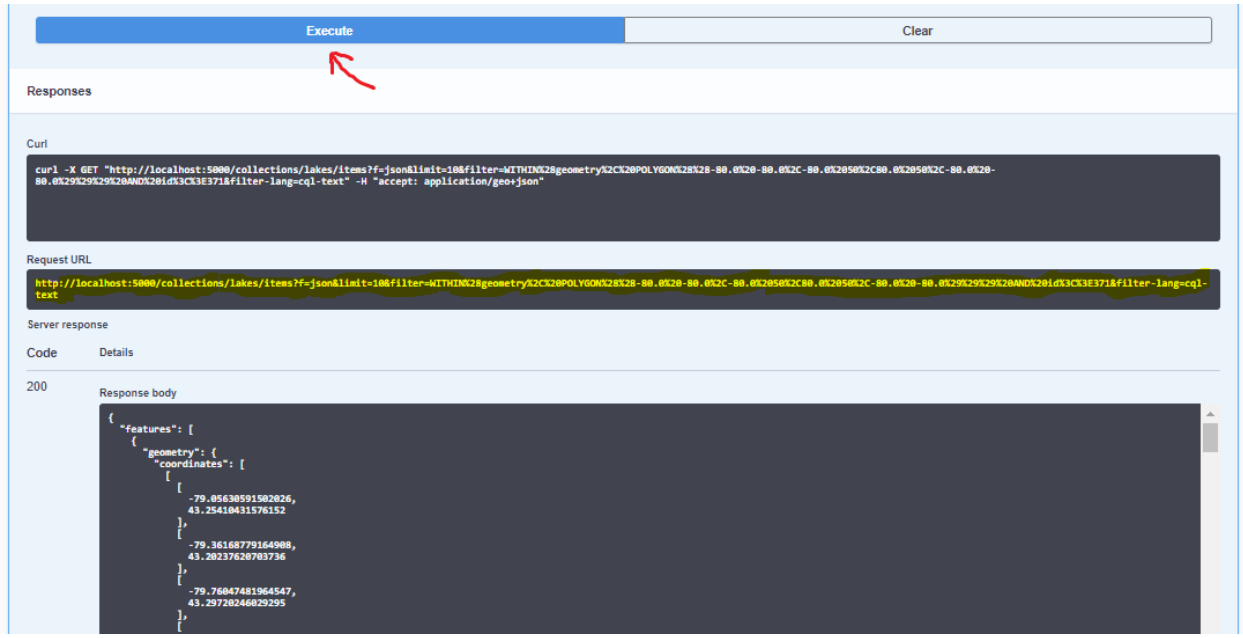
4. Click on Try it out to give the parameters value



5. Provide the CQL query parameter in text to filter the collection features Here assigning CQL filter as **WITHIN(geometry, POLYGON((-80.0 -80.0,-80.0 50,80.0 50,-80.0 -80.0))) AND id<>371** and keeping the default values of all the other parameters.



6. After filling the values of parameters (including CQL filter expression), click on execute. If the CQL expression is valid then an endpoint will be generated with Success code 200 and response body.



7. Furthermore the response body can be investigated by hitting the generated URL:

```
http://localhost:5000/collections/lakes/items?f=json&filter-lang=cql-text&
filter=WITHIN(geometry, POLYGON((-80.0 -80.0,-80.0 50,80.0 50,-80.0 -80.0)))
AND id<>371
```

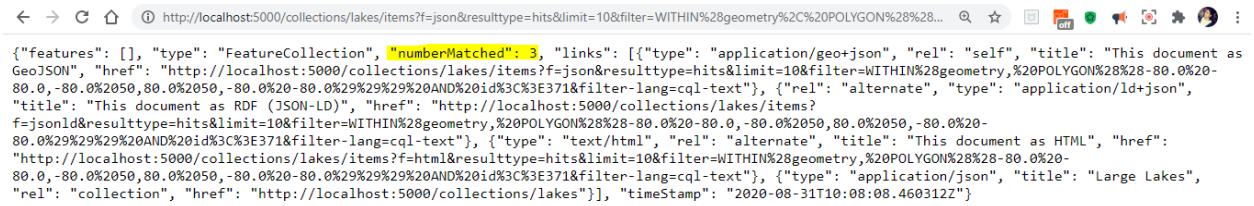
8. Since the output format was specified as GeoJSON the response from API is the following:

9. For the same CQL filter expression if the resulttype is chnaged to hits. The API response will have only the total count of features that satisfied the given fiter expression.

Requested API:

```
http://localhost:5000/collections/lakes/items?f=json&filter-lang=cql-text&resulttype=hits&
filter=WITHIN(geometry, POLYGON((-80.0 -80.0,-80.0 50,80.0 50,-80.0 -80.0)))
AND id<>371
```

Response:

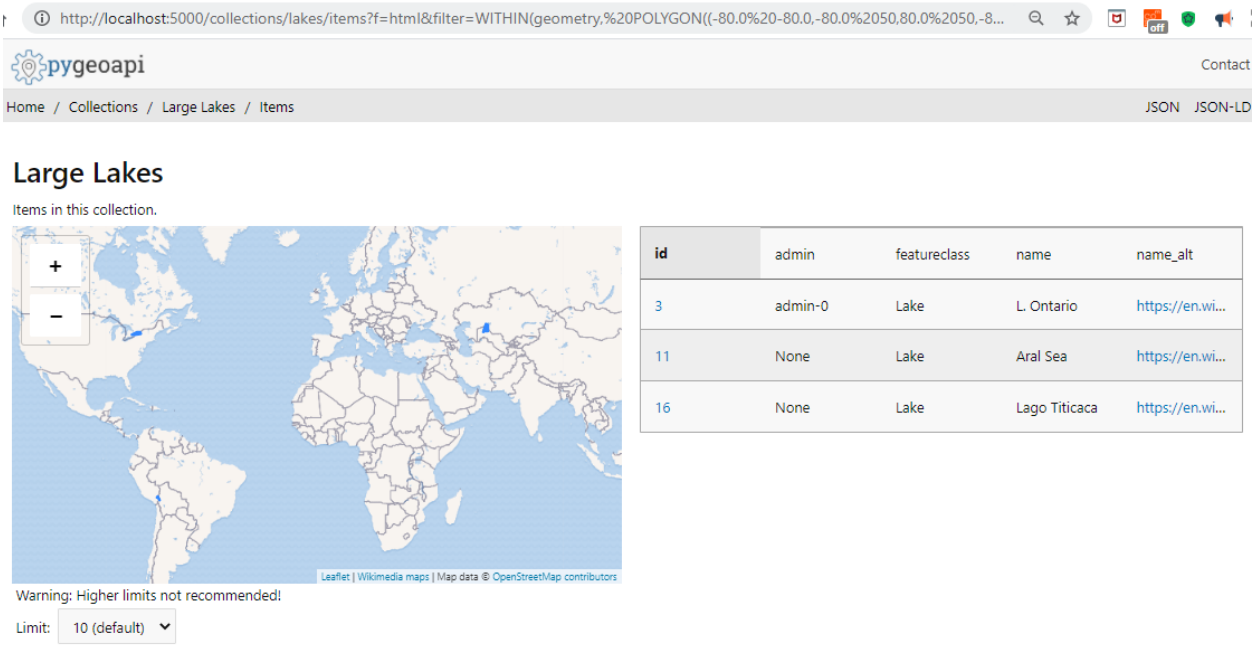


- To overlay the response from API on a map, we can change the output format of the endpoint from JSON to HTML

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&filter-lang=cql-text&
filter=WITHIN(geometry, POLYGON((-80.0 -80.0,-80.0 50,80.0 50,-80.0 -80.0)))
AND id<>371
```

Response:

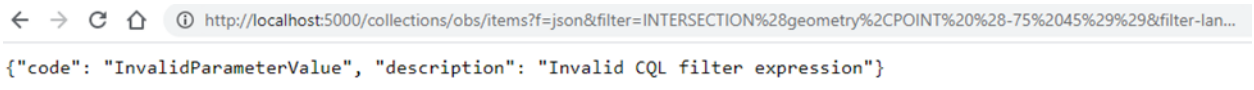


- If any invalid CQL filter expression is provided then the API raises an exception and the response is as follows:

Requested API:

```
http://localhost:5000/collections/obs/items?f=json&filter-lang=cql-text&
filter=INTERSECTION(geometry,POINT (-75 45))
```

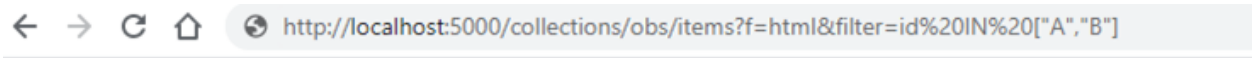
Response:



Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter-lang=cql-text&filter=id
IN ['A','B']
```

Response:

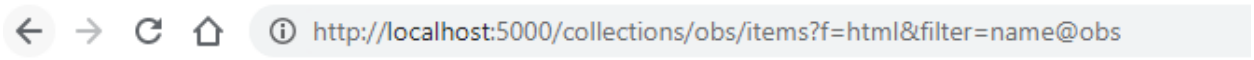


{"code": "InvalidParameterValue", "description": "Invalid CQL filter expression"}

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter-lang=cql-text&
filter=name@obs
```

Response:

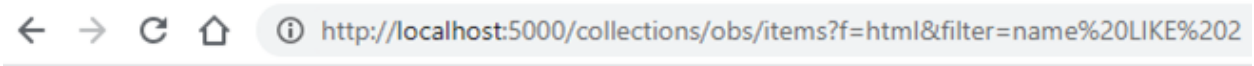


{"code": "InvalidParameterValue", "description": "Invalid CQL filter expression"}

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter-lang=cql-text&
filter=name LIKE 2
```

Response:



{"code": "InvalidParameterValue", "description": "Invalid CQL filter expression"}

5.4 Examples of CQL query filter

Following are few examples of CQL query filter implemented on pygeoapi data providers-

5.4.1 Getting started

The collections used for the project demonstration here are observation and lake features from CSV and GeoJSON data providers respectively.The attribute table for observation and lake features are as follows:

obs.csv

id	stn_id	datetime	value
371	35	2001-10-30T14:24:55Z	89.9
377	35	2002-10-30T18:31:38Z	93.9
238	2147	2007-10-30T08:57:29Z	103.5
297	2147	2003-10-30T07:37:29Z	93.5
964	604	2000-10-30T18:24:39Z	99.9

lakes.geojson

id	admin	featureclass	name	name_alt
0	None	Lake	Lake Baikal	https://en.wikip...
1	None	Lake	Lake Winnipeg	https://en.wikip...
2	None	Lake	Great Slave Lake	https://en.wikip...
3	admin-0	Lake	L. Ontario	https://en.wikip...
4	admin-0	Lake	L. Erie	https://en.wikip...
5	admin-0	Lake	Lake Superior	https://en.wikip...
6	admin-0	Lake	Lake Victoria	https://en.wikip...
7	None	Lake	Lake Ladoga	https://en.wikip...
8	None	Lake	Balqash Köli	Lake Balkhash
9	admin-0	Lake	Lake Tanganyika	https://en.wikip...
10	admin-0	Lake	Lake Malawi	Lake Nyasa
11	None	Lake	Aral Sea	https://en.wikip...
12	None	Lake	Vänern	None
13	None	Lake	Lake Okeechobee	https://en.wikip...

14	None	Lake	Lago de Nicaragua	https://en.wikip...
15	None	Lake	Lake Tana	https://en.wikip...
16	None	Lake	Lago Titicaca	https://en.wikip...
17	None	Lake	Lake Winnipegosis	https://en.wikip...
18	None	Lake	Lake Onega	https://en.wikip...
19	None	Lake	Great Salt Lake	https://en.wikip...
20	None	Lake	Great Bear Lake	https://en.wikip...
21	None	Lake	Lake Athabasca	https://en.wikip...
22	None	Lake	Reindeer Lake	https://en.wikip...
23	admin-0	Lake	Lake Huron	https://en.wikip...
24	admin-0	Lake	Lake Michigan	https://en.wikip...

For the following API requests the default value of limit is 10, startindex is 0 and CQL query language is text

5.4.2 Simple comparisons

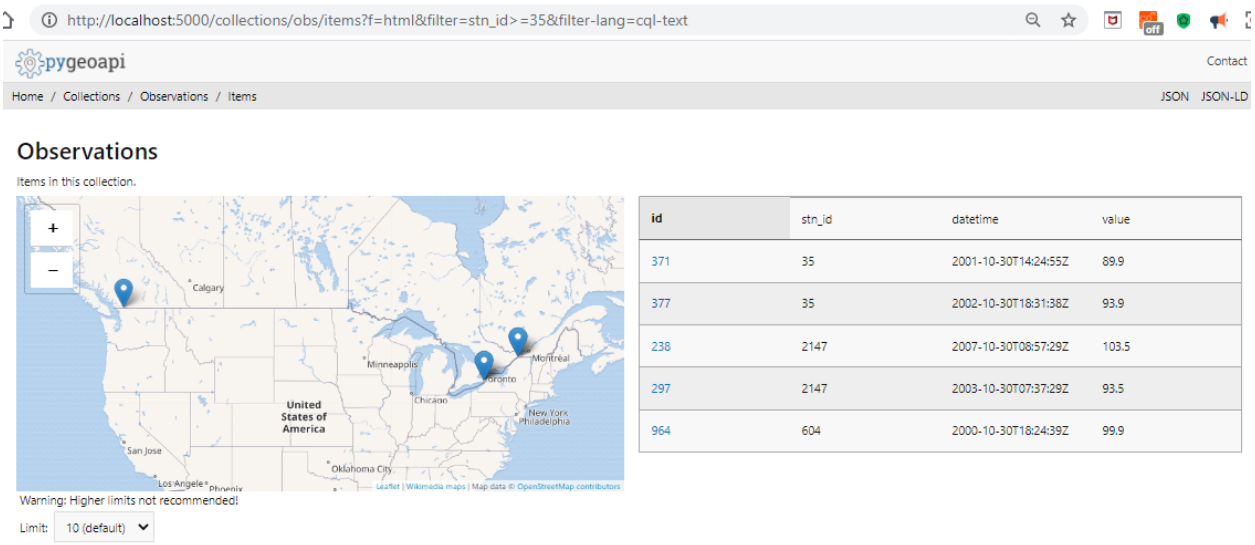
Let's get started with the simple examples. In CQL comparisons are expressed using plain text.

- The filter **stn_id >= 35** will filter the observations that have **stn_id** value greater than or equals to 35:

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter=stn_id>=35&filter-lang=cql-text
```

Response:

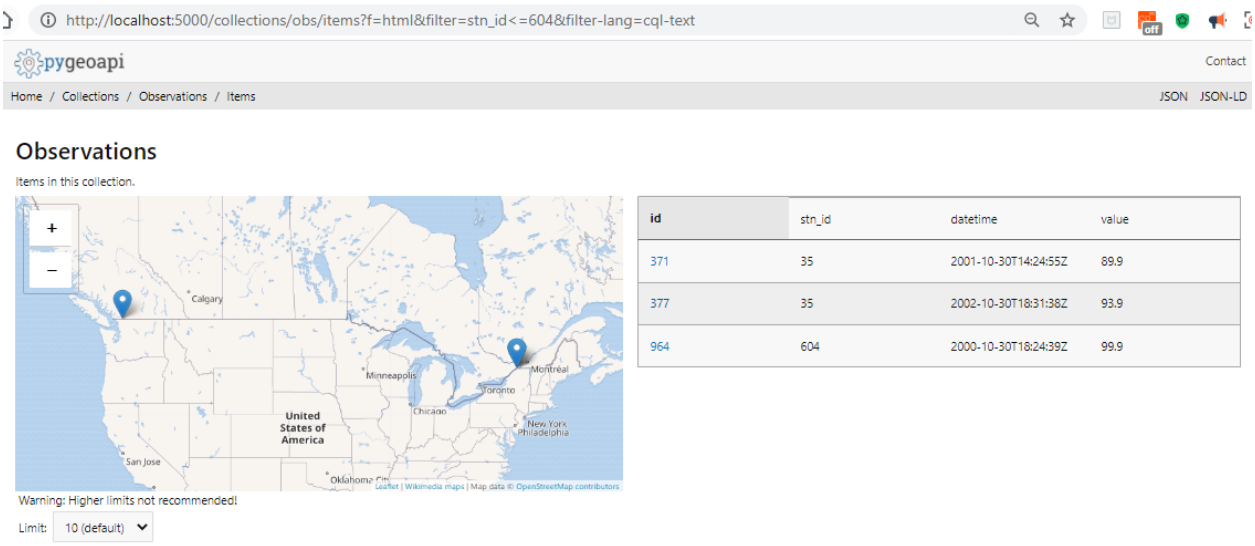


- The filter **stn_id <= 604** will select observations that have **stn_id** less than or equals than 604:

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter=stn_id<=604&filter-lang=cql-text
```

Response:



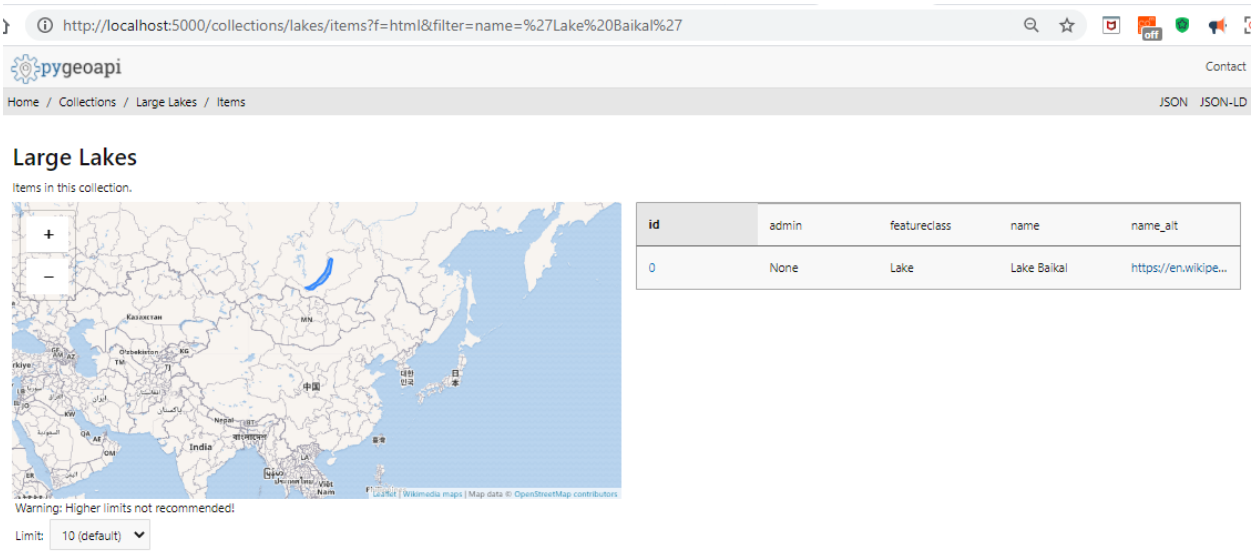
- If we want to look for Lake Baikal on the map, then the filter **name='Lake Baikal'** will fetch its details and display its location on the world's map.

The requested API to GeoJSON Data provider for filtering Lake Baikal should be:

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&filter-lang=cql-text&filter=name='Lake
Baikal'
```

Response:

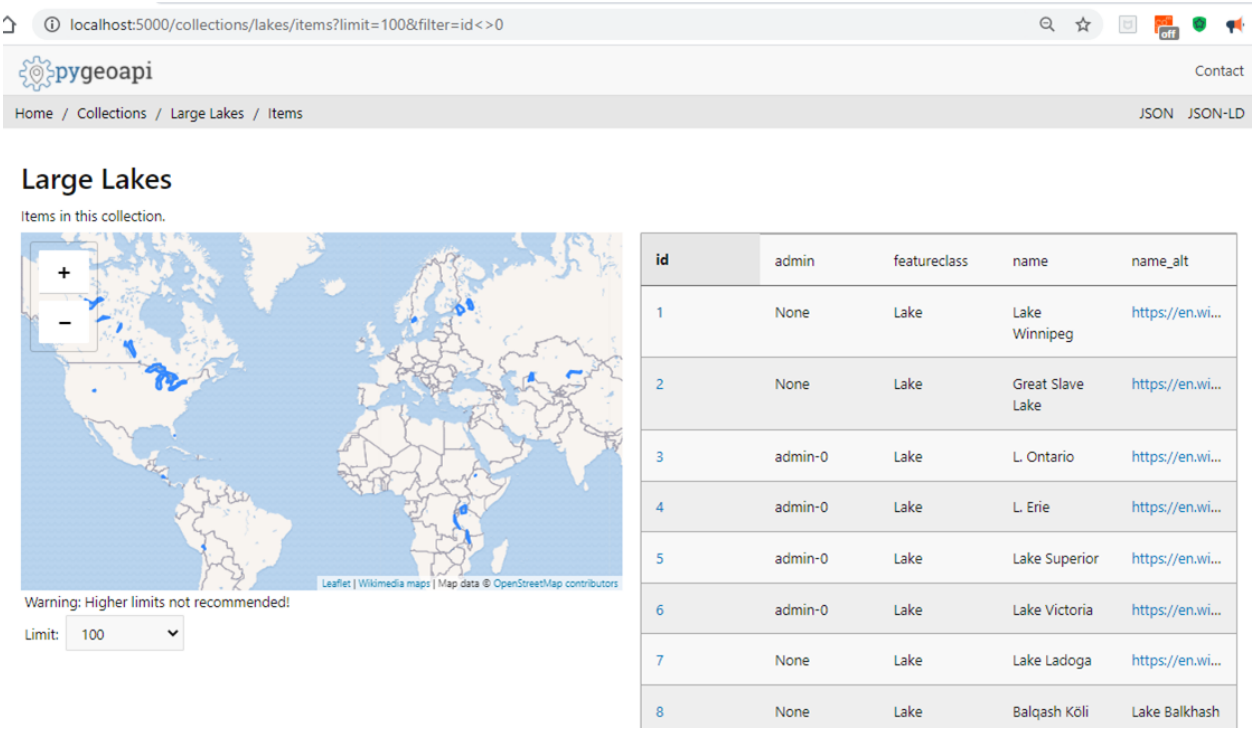


- To filter lakes whose **id** is not equals to 0, than the filter id<>0 will response with all the lake features except the one with **id=0**.

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=100&filter-lang=cql-text&filter=id<>0
```

Response:



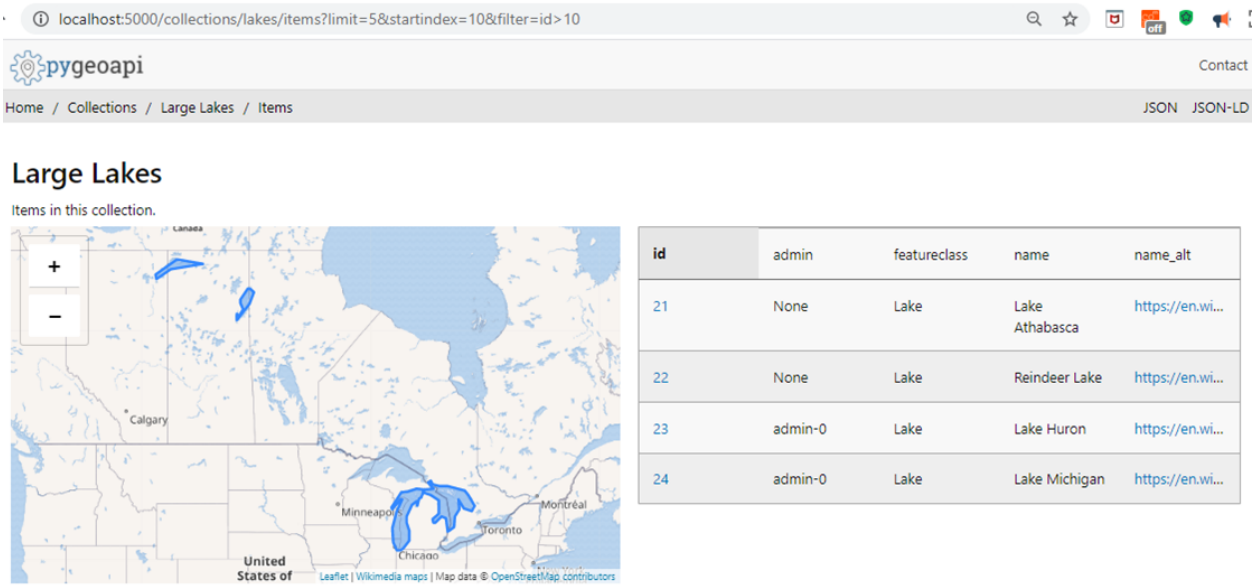
- If there is a requirement to fetch only 5 lakes starting from index 10 and having filter as **id>10**.

pygeoapi supports limit and startindex request parameters, so an API call is possible with CQL query filter along with other query parameters.

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=5&startindex=10&filter-lang=cql-text&fi
```

Response:



Due to the implementation of CQL extension on pygeoapi, all the simple comparison operations are now supported on any number of feature collections.

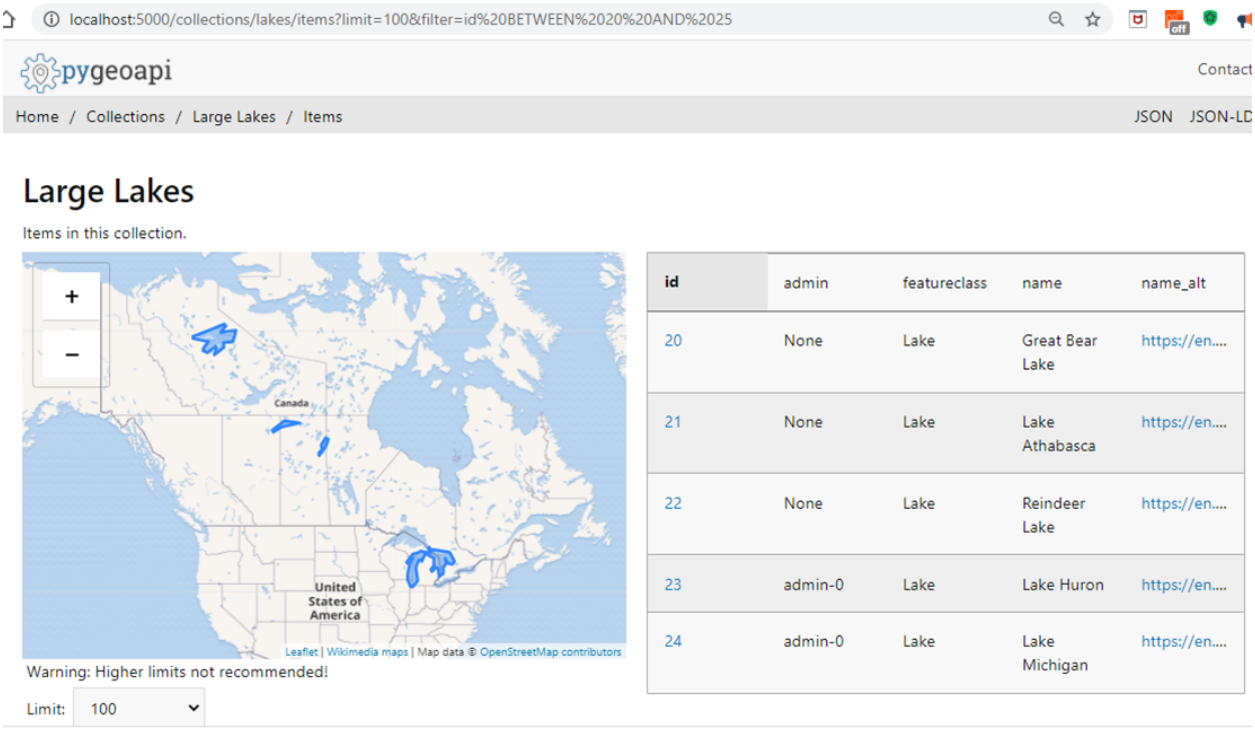
The common comparison operators are: <, >, <=, >=, =, <>

- To select a range of values the BETWEEN operator can be used like **id BETWEEN 20 AND 25**

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=100&filter-lang=cql-text&filter=id
BETWEEN 20 AND 25
```

Response:

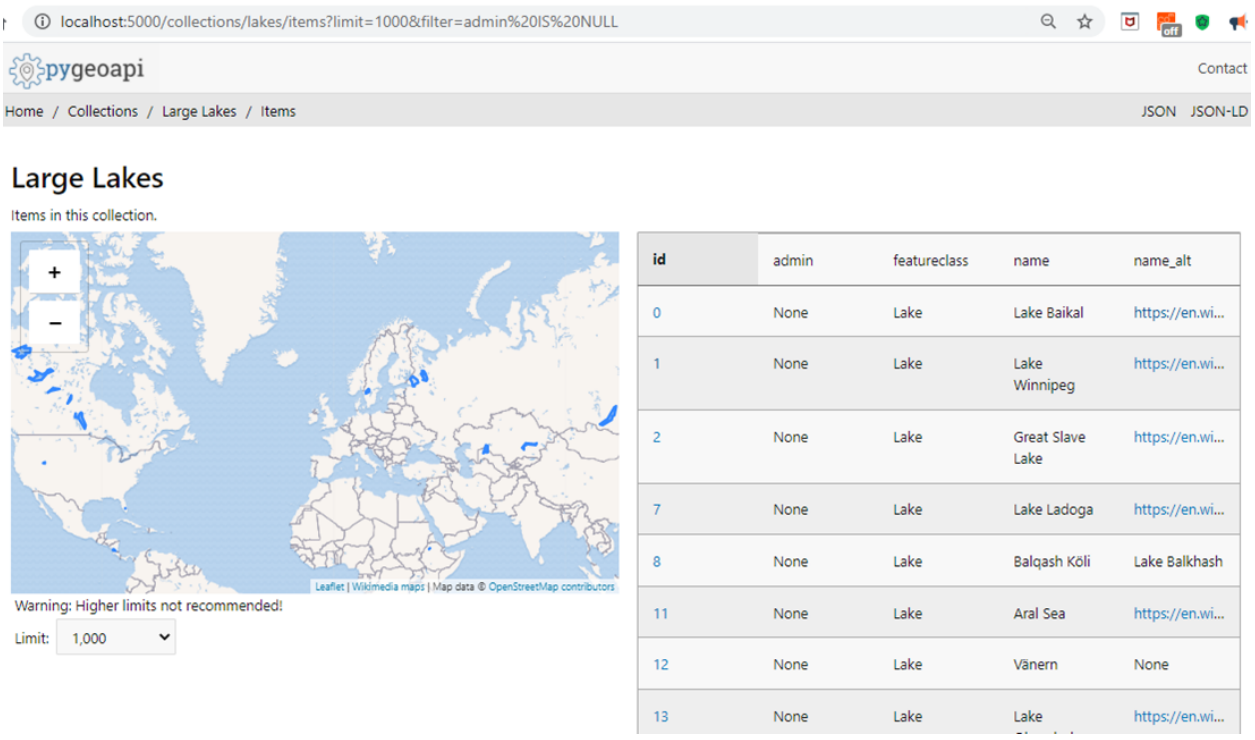


- If needed to filter out lake features with no admin then **admin IS NULL** will response with required lakes.

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=1000&filter-lang=cql-text&filter=admin
IS NULL
```

Response:



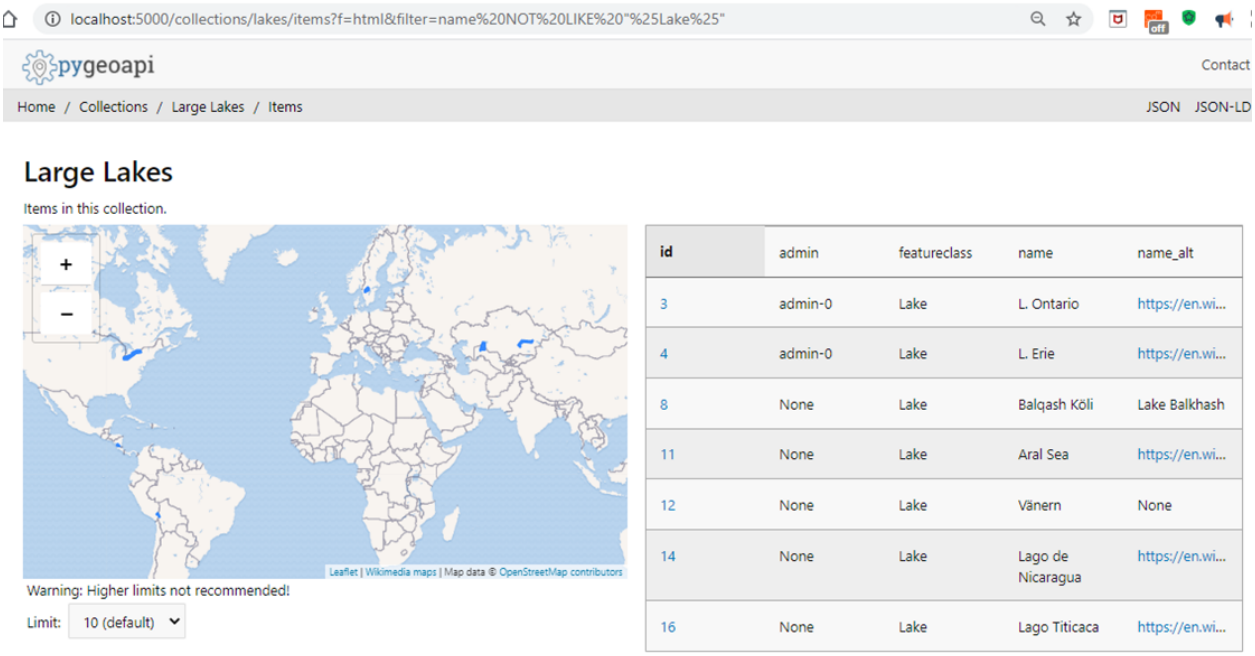
5.4.3 String comparisons

- In one of the above example we have already seen that comparison operators also support text values. For instance, to select only Lake Baikal, the filter was name='Lake Baikal'. But more general text/string comparisons can be made using the LIKE operator. name **NOT LIKE '%Lake%'** will extract all lakes that does not have 'Lake' anywhere in their name.

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&&filter-lang=cql-textfilter=name
NOT LIKE '%Lake%'
```

Response:

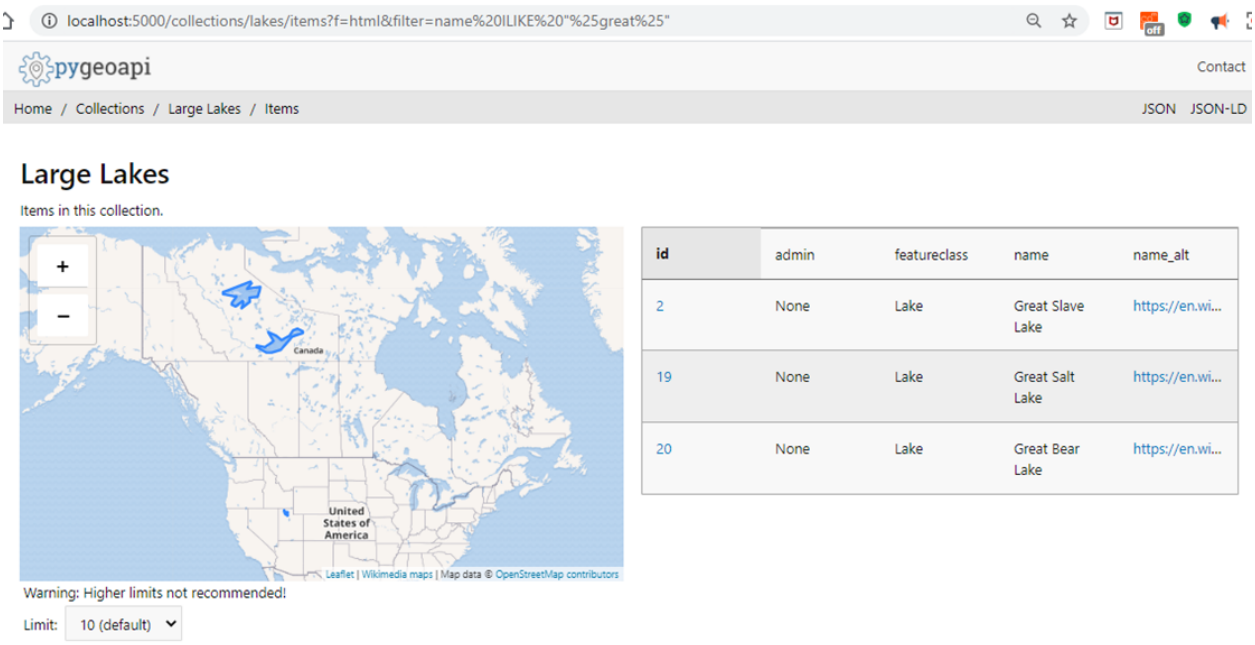


- Suppose we want to find all lakes whose name contains an 'great', regardless of letter case. We cannot use LIKE operator here as it is case sensitive. ILIKE operator can be used to ignore letter casing: **name ILIKE '%great%'**

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&filter-lang=cql-text&filter=name
ILIKE "%great%"
```

Response:



The comparison on strings can be performed with either of the following: LIKE, NOT LIKE, ILIKE , NOT LIKE

The CQL extension on pygeoapi supports all the above specified formats for comparing strings.

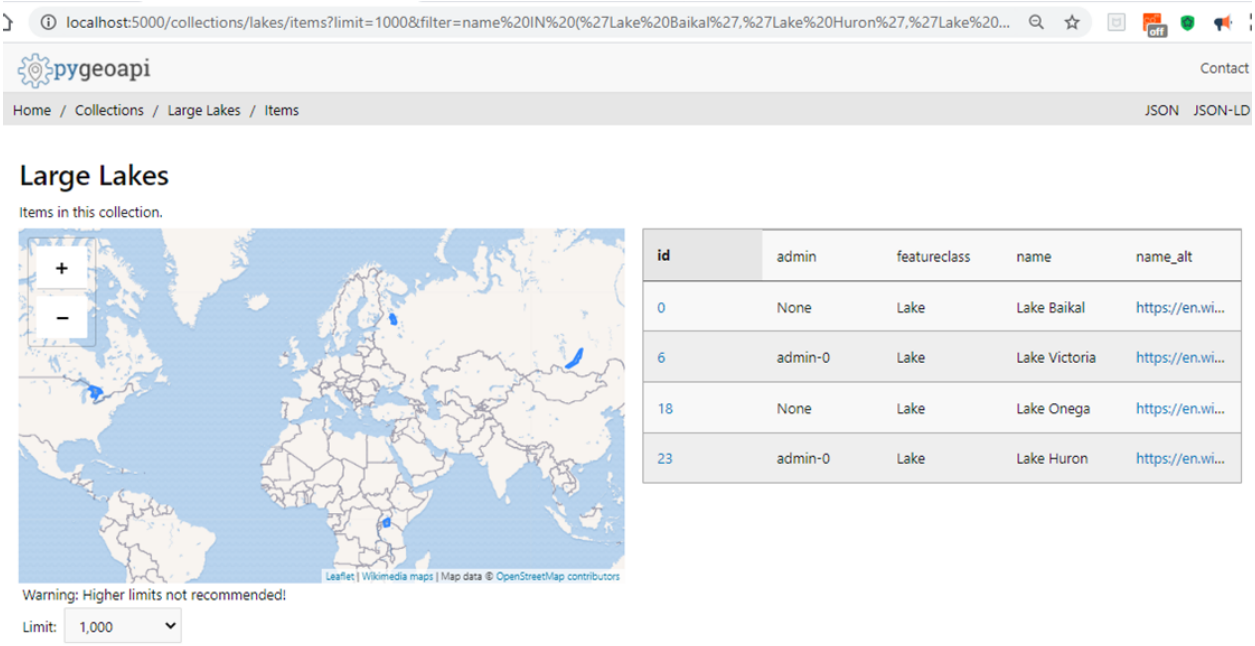
5.4.4 List comparisons

- If we want to extract only specific lakes whose **name** is in a given list, then we can use the IN operator specifying an attribute name as in **name IN ('Lake Baikal','Lake Huron','Lake Onega','Lake Victoria')**

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=1000&filter-lang=cql-text&
filter=name IN ('Lake Baikal','Lake Huron','Lake Onega','Lake Victoria')
```

Response:

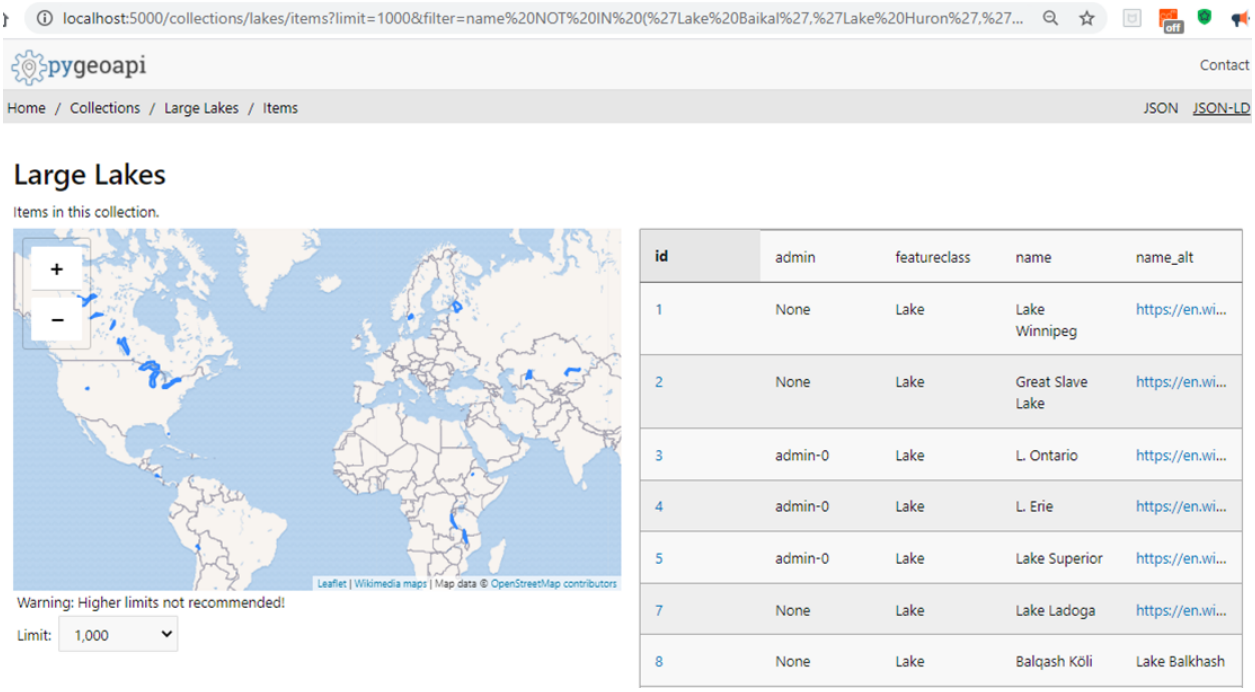


- If the requirement is to get all the lakes from the collection except the ones specified in the list then **name NOT IN ('Lake Baikal','Lake Huron','Lake Onega','Lake Victoria')** will serve our purpose.

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=1000&filter-lang=cql-text&
filter=name NOT IN ('Lake Baikal','Lake Huron','Lake Onega','Lake Victoria')
```

Response:



9	admin-0	Lake	Lake Tanganyika	https://en.wi...
10	admin-0	Lake	Lake Malawi	Lake Nyasa
11	None	Lake	Aral Sea	https://en.wi...
12	None	Lake	Vänern	None
13	None	Lake	Lake Okeechobee	https://en.wi...
14	None	Lake	Lago de Nicaragua	https://en.wi...
15	None	Lake	Lake Tana	https://en.wi...
16	None	Lake	Lago Titicaca	https://en.wi...
17	None	Lake	Lake Winnipegosis	https://en.wi...
19	None	Lake	Great Salt Lake	https://en.wi...

			Okeechobee	
14	None	Lake	Lago de Nicaragua	https://en.wi...
15	None	Lake	Lake Tana	https://en.wi...
16	None	Lake	Lago Titicaca	https://en.wi...
17	None	Lake	Lake Winnipegosis	https://en.wi...
19	None	Lake	Great Salt Lake	https://en.wi...
20	None	Lake	Great Bear Lake	https://en.wi...
21	None	Lake	Lake Athabasca	https://en.wi...
22	None	Lake	Reindeer Lake	https://en.wi...
24	admin-0	Lake	Lake Michigan	https://en.wi...

5.4.5 Combination filters

The CQL extension on pygeoapi is eligible to support filters that are a combination of more than one simple query filters.

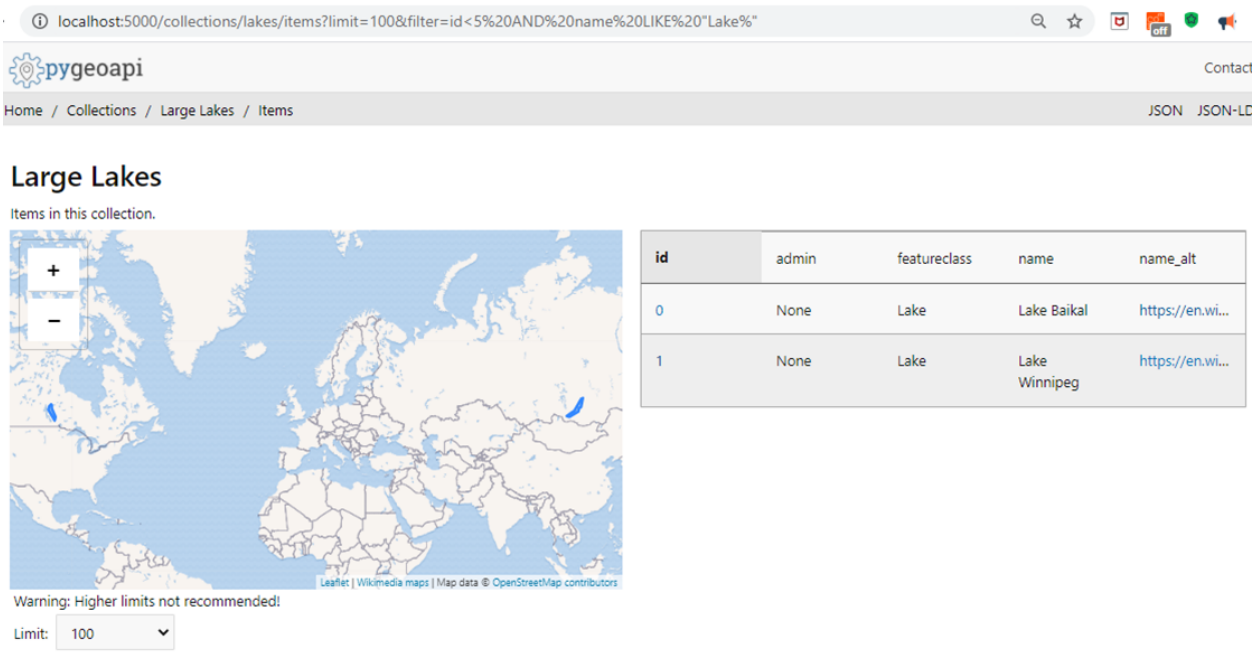
The logical operators are: AND, OR

- To extract all the lakes whose id is less than 5 and name starts with 'Lake' then the combination of two filters can be formed as **id<5 AND name LIKE "Lake%"**

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=100&filter-lang=cql-text&
filter=id<5 AND name LIKE "Lake%"
```

Response:

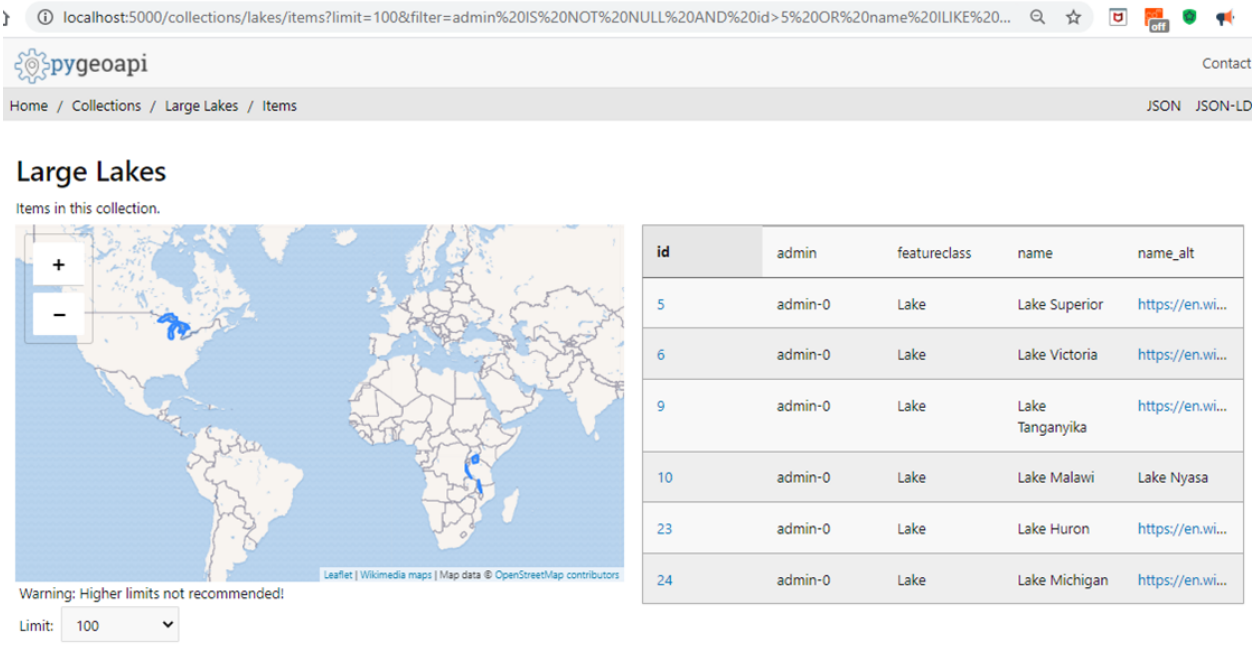


- Furthermore, if a lake has an admin and its id is greater than 5 or its name contains 'lake' string irrespective of letter case, then the complex CQL filter query will be like: **admin IS NOT NULL AND id>5 OR name ILIKE "%lake%**

Requested API:

```
http://localhost:5000/collections/lakes/items?limit=100&filter-lang=cql-text&
filter=admin IS NOT NULL AND id>5 OR name ILIKE "%lake%"
```

Response:



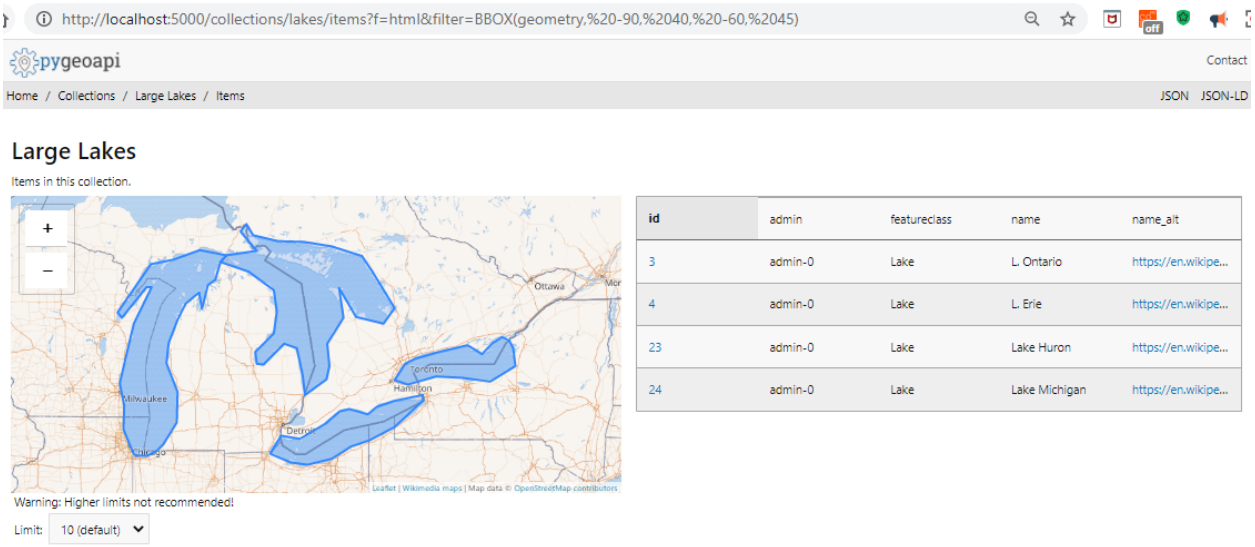
5.4.6 Spatial filters

- CQL provides a full set of geometric filter capabilities. Say, for example, if we want to display only the lakes that intersect the (-90,40,-60,45) bounding box. The filter will be **BBOX(geometry, -90, 40, -60, 45)**

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&filter-lang=cql-text&
filter=BBOX(geometry, -90, 40, -60, 45)
```

Response:

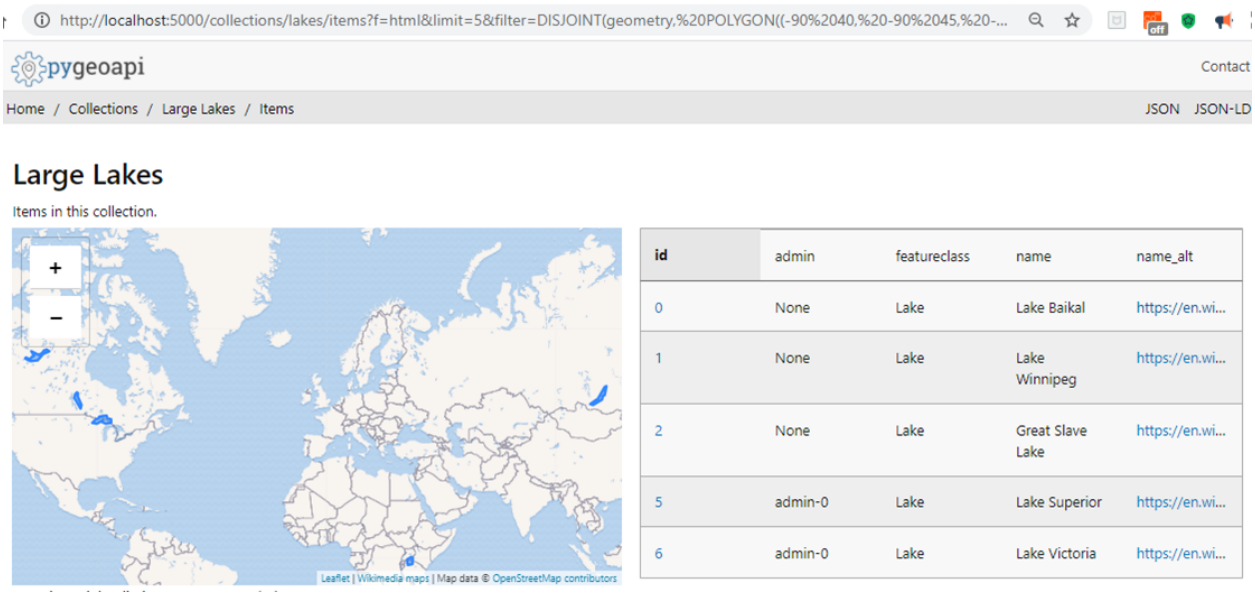


- Conversely, we can select the states that do not intersect the bounding box with the filter: **DISJOINT(the_geom, POLYGON((-90 40, -90 45, -60 45, -60 40, -90 40)))**

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&filter-lang=cql-text&
filter=DISJOINT(the_geom, POLYGON((-90 40, -90 45, -60 45, -60 40, -90 40))
```

Response:

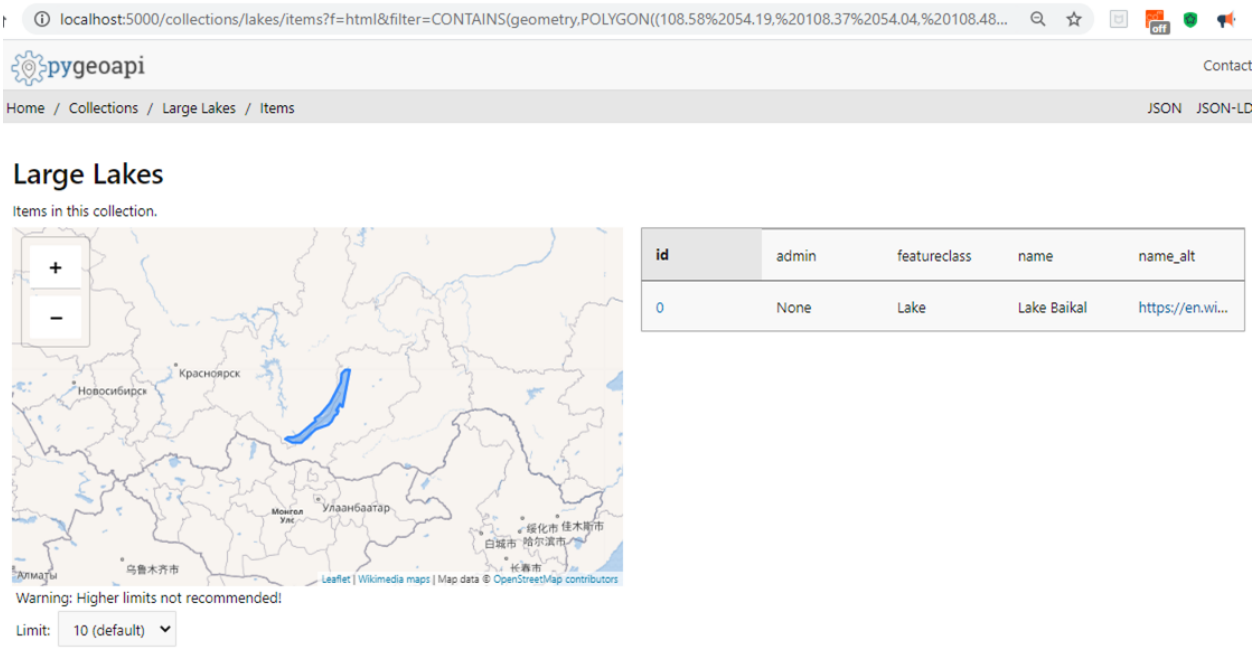


- If needed to extract the information of a lake that contains a particular geometry. Then **CONTAINS(geometry, POLYGON((108.58 54.19, 108.37 54.04, 108.48 53.94, 108.77 54.01, 108.77 54.11, 108.58 54.19)))** will return the feature that contains a polygon of specified coordinates.

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&filter-lang=cql-text&
filter=CONTAINS(geometry, POLYGON((108.58 54.19, 108.37 54.04, 108.48 53.94,
108.77 54.01, 108.77 54.11, 108.58 54.19)))
```

Response:

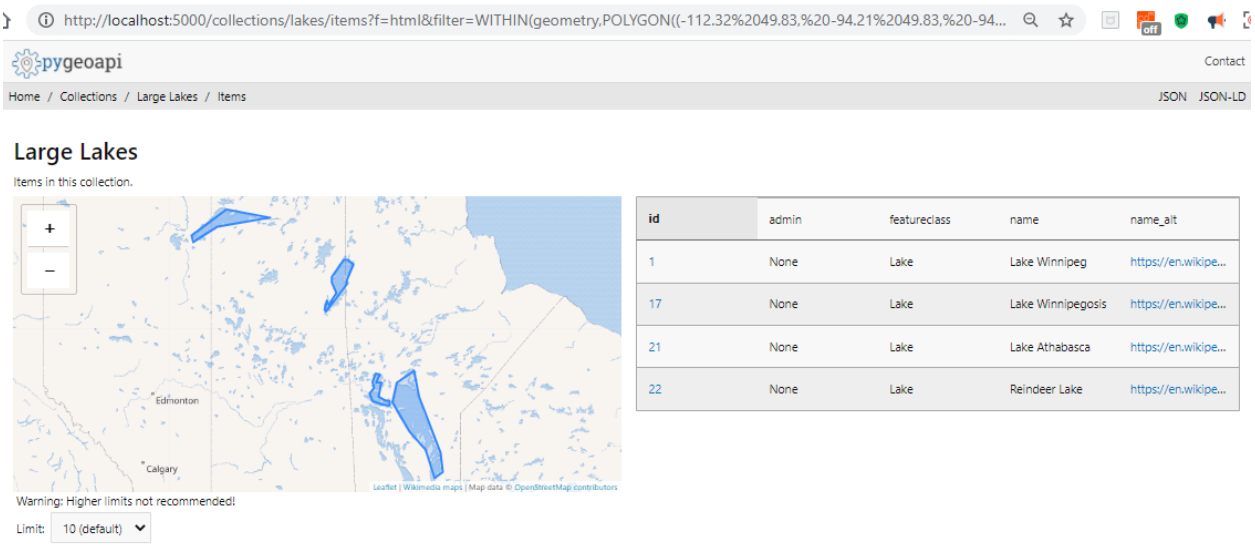


- But if needed to extract the information of lakes that are within a particular geometry. Then **WITHIN(geometry,POLYGON((-112.32 49.83, -94.21 49.83, -94.21 59.97, -112.32 59.97, -112.32 49.83)))** will return the features that are within a polygon of specified coordinates.

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&filter-lang=cql-text&
filter=WITHIN(geometry,POLYGON((-112.32 49.83, -94.21 49.83, -94.21 59.97,
-112.32 59.97, -112.32 49.83)))
```

Response:

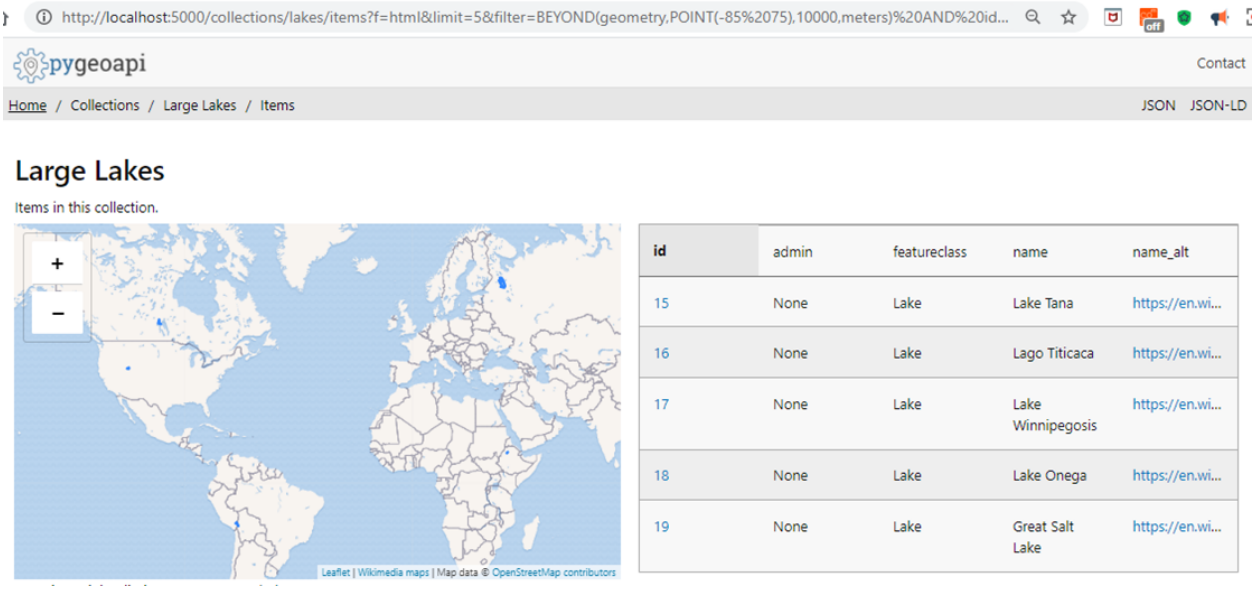


- To filter all the lakes that lies beyond 10000 meters from a location (-85 75) but its id should be between 15 and 25. Then the query filter can be **BEYOND(geometry,POINT(-85 75),10000,meters) AND id BETWEEN 15 AND 25**

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&limit=5&filter-lang=cql-text&
filter=BEYOND(geometry,POINT(-85 75),10000,meters) AND id BETWEEN 15 AND 25
```

Response:



- But if to filter all the lakes that lies within 10000 meters from a location (-85 75) but its id should be between 15

and 25. Then the query filter can be **DWITHIN(geometry,POINT(-85 75),10000,meters) AND id BETWEEN 15 AND 25**

Requested API:

```
http://localhost:5000/collections/lakes/items?f=html&limit=5&filter-lang=cql-text&
filter=DWITHIN(geometry,POINT(-85 75),10000,meters) AND id BETWEEN 15 AND 25
```

Response:

***No such lakes found*

The full list of geometric predicates are: EQUALS, DISJOINT, INTERSECTS, TOUCHES, CROSSES, WITHIN, CONTAINS, OVERLAPS, RELATE, DWITHIN, BEYOND

The CQL extension on pygeoapi supports all the above geometric predicates to perform spatial filters on any feature collection.

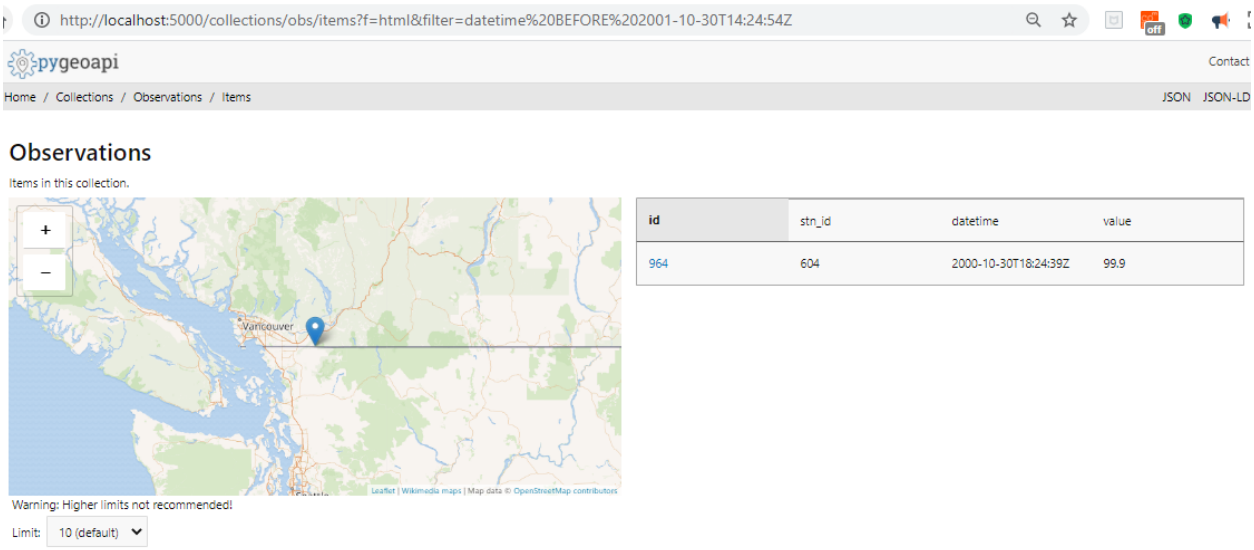
5.4.7 Temporal filters

- Get all the features whose time value is before a point in time such as **datetime BEFORE 2001-10-30T14:24:54Z**

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter-lang=cql-text&
filter=datetime BEFORE 2001-10-30T14:24:54Z
```

Response:

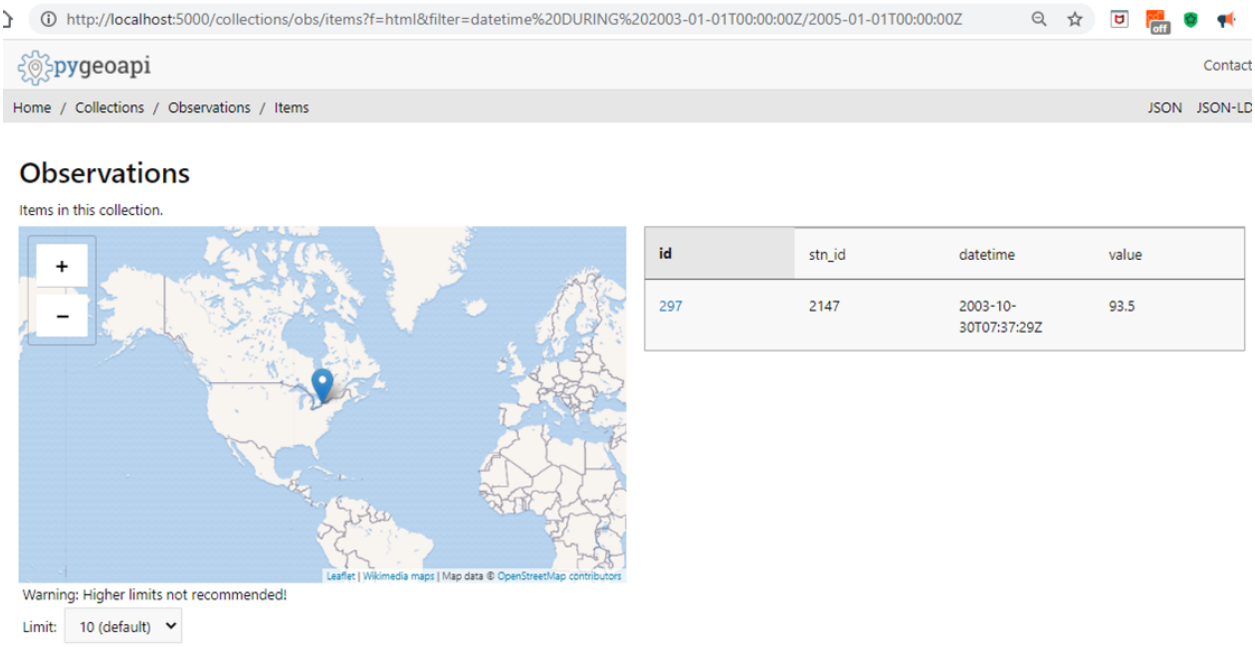


- Get all the features whose time value is during a time period such as **datetime DURING 2003-01-01T00:00:00Z/2005-01-01T00:00:00Z**

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter-lang=cql-text&
filter=datetime DURING 2003-01-01T00:00:00Z/2005-01-01T00:00:00Z
```

Response:

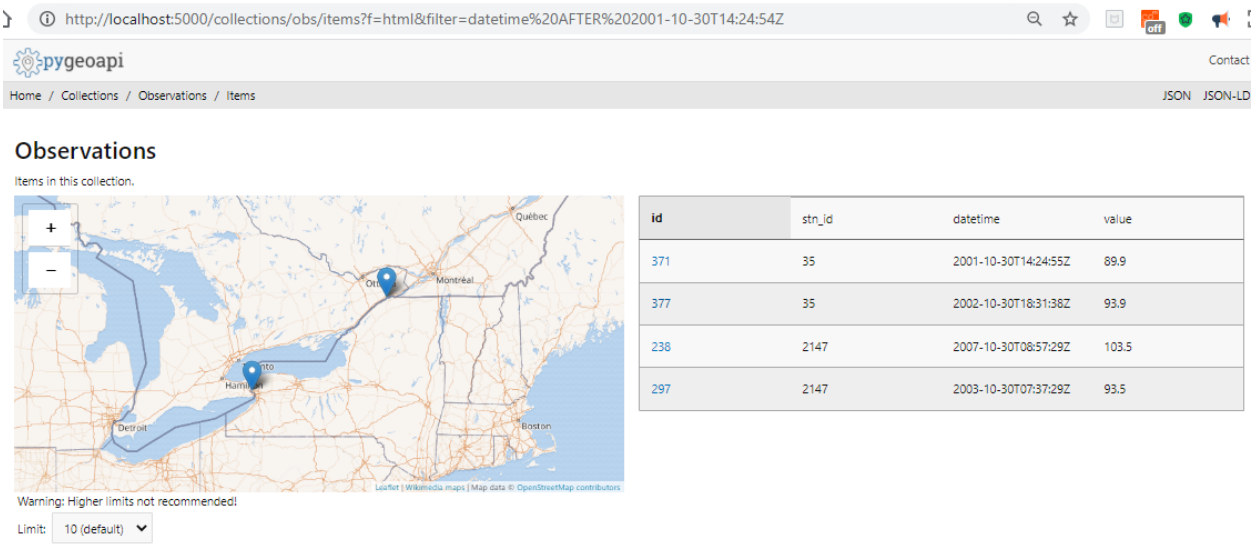


- Get all the features whose time value is after a point in time such as **datetime AFTER 2001-10-30T14:24:54Z**

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter-lang=cql-text&
filter=datetime AFTER 2001-10-30T14:24:54Z
```

Response:

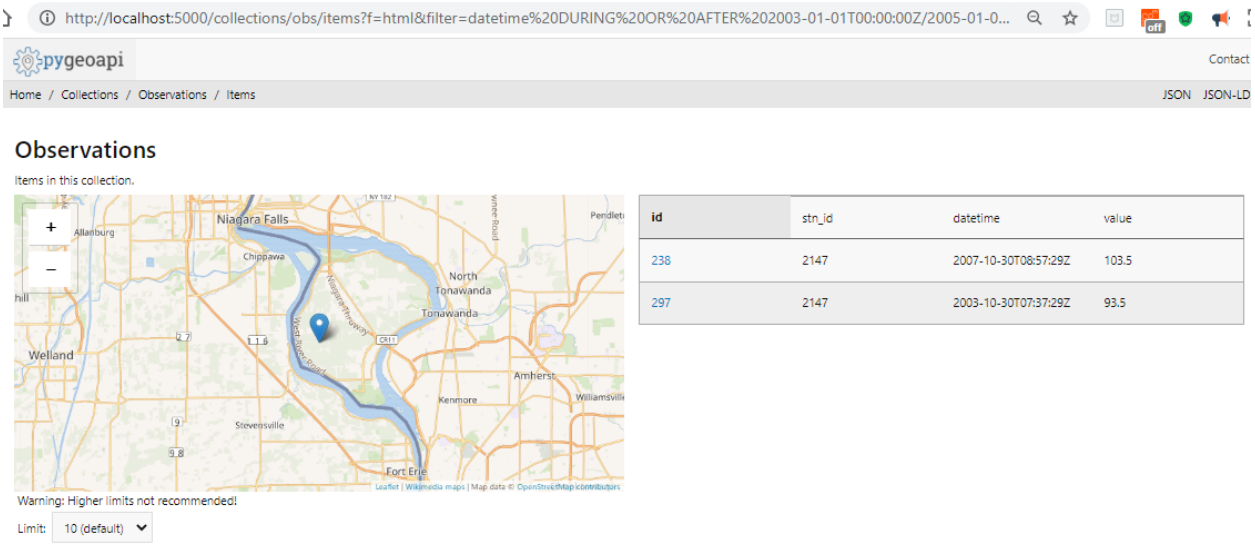


- Get all the features whose time value is during or after a time period such as **datetime DURING OR AFTER 2003-01-01T00:00:00Z/2005-01-01T00:00:00Z**

Requested API:

```
http://localhost:5000/collections/obs/items?f=html&filter-lang=cql-text&
filter=datetime DURING OR AFTER 2003-01-01T00:00:00Z/2005-01-01T00:00:00Z
```

Response:



CHAPTER

SIX

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
- set system environment variables

6.1 Creating the OpenAPI document

The OpenAPI document ia 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 generate-openapi-document -c /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 generate-openapi-document -c /path/to/my-pygeoapi-config.yml > /path/to/my-
↪pygeoapi-openapi.yml
```

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

6.2 Verifying configuration files

To ensure your YAML configurations are correctly formatted, you can use any YAML validator, or try the Python one-liner per below:

```
python -c 'import yaml, sys; yaml.safe_load(sys.stdin)' < /path/to/my-pygeoapi-config.
↪yml
python -c 'import yaml, sys; yaml.safe_load(sys.stdin)' < /path/to/my-pygeoapi-
↪openapi.yml
```

6.3 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
```

In Windows:

```
set PYGEOAPI_CONFIG=/path/to/my-pygeoapi-config.yml
set PYGEOAPI_OPENAPI=/path/to/my-pygeoapi-openapi.yml
```

6.4 Summary

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

CHAPTER

SEVEN

RUNNING

Now we are ready to start up pygeoapi.

7.1 pygeoapi serve

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

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).

7.1.1 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
```

7.1.2 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 Flask WSGI server can be run as follows:

```
pygeoapi serve --starlette
```

7.2 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.

7.2.1 Apache and mod_wsgi

Deploying pygeoapi via mod_wsgi 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>
```

7.2.2 Gunicorn

Gunicorn (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.

7.2.3 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.

7.2.4 Gunicorn and Starlette

Running Gunicorn with Starlette requires the Uvicorn 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 guvicorn`

7.3 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

CHAPTER

EIGHT

DOCKER

pygeoapi provides an official Docker image which is made available on the geopython Docker Hub. Additional Docker examples can be found in the pygeoapi GitHub repository, each with sample configurations, test data, deployment scenarios and provider backends.

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

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

8.1 The basics

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

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
```

8.2 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
```

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

8.3 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

8.4 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

NINE

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

9.1 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.

9.2 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.

9.3 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.

9.4 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.

9.5 Vector data

9.5.1 Collection queryables

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

The queryables endpoint provides a list of queryable properties and their associated datatypes.

9.5.2 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.

9.5.3 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.

9.6 Raster data

9.6.1 Collection coverage domainset

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

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

9.6.2 Collection coverage rangetype

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

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

9.6.3 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.

9.7 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.

9.8 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.

9.9 API Documentation

http://localhost:5000/openapi

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

The API documentation links provide a Swagger 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

9.10 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.

CHAPTER

TEN

OPENAPI

The OpenAPI specification 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. pygeoapi supports OpenAPI version 3.0.2.

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

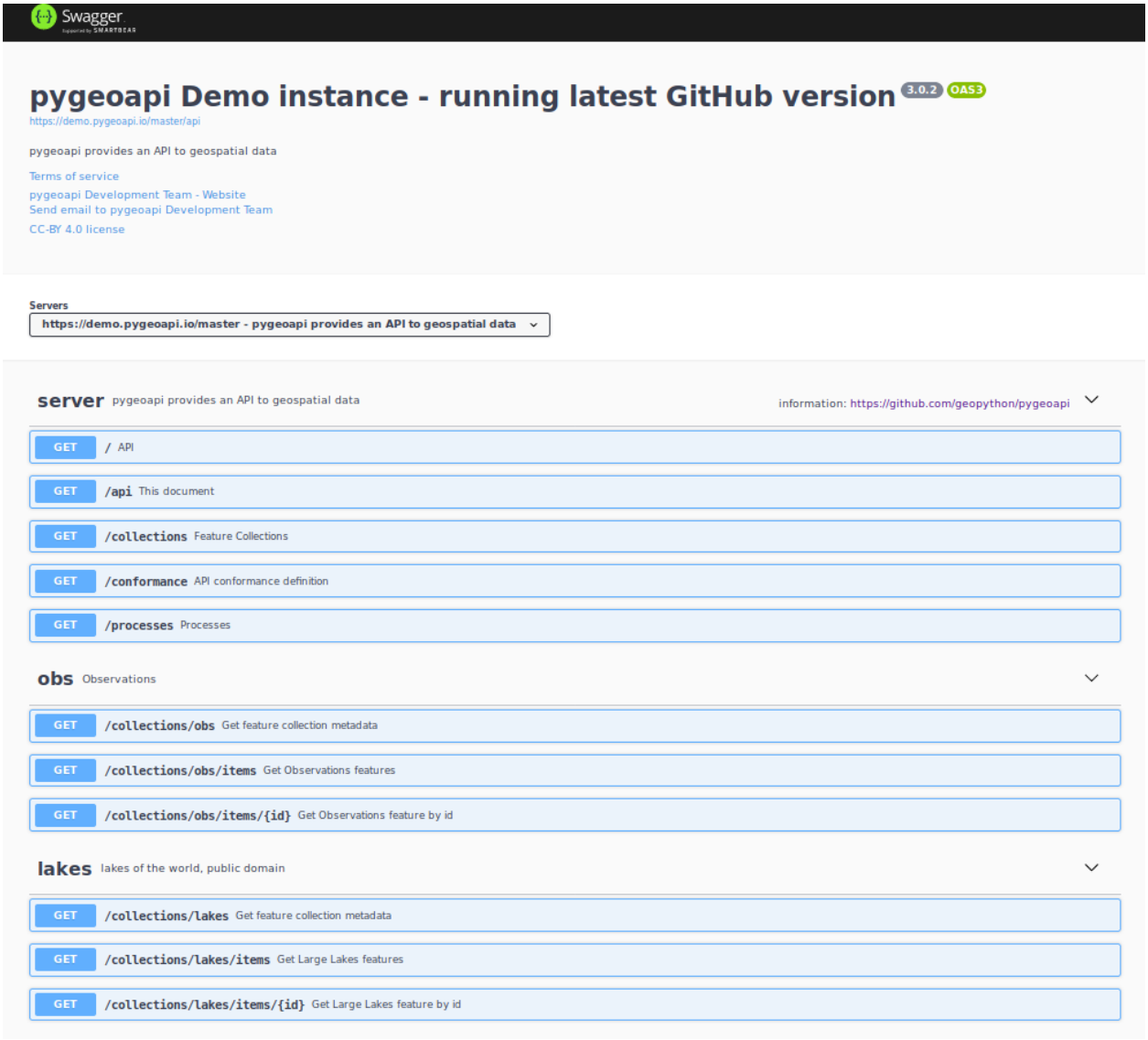
The API is accessible at the `/openapi` endpoint, providing a Swagger-based webpage of the API description..

See also:

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

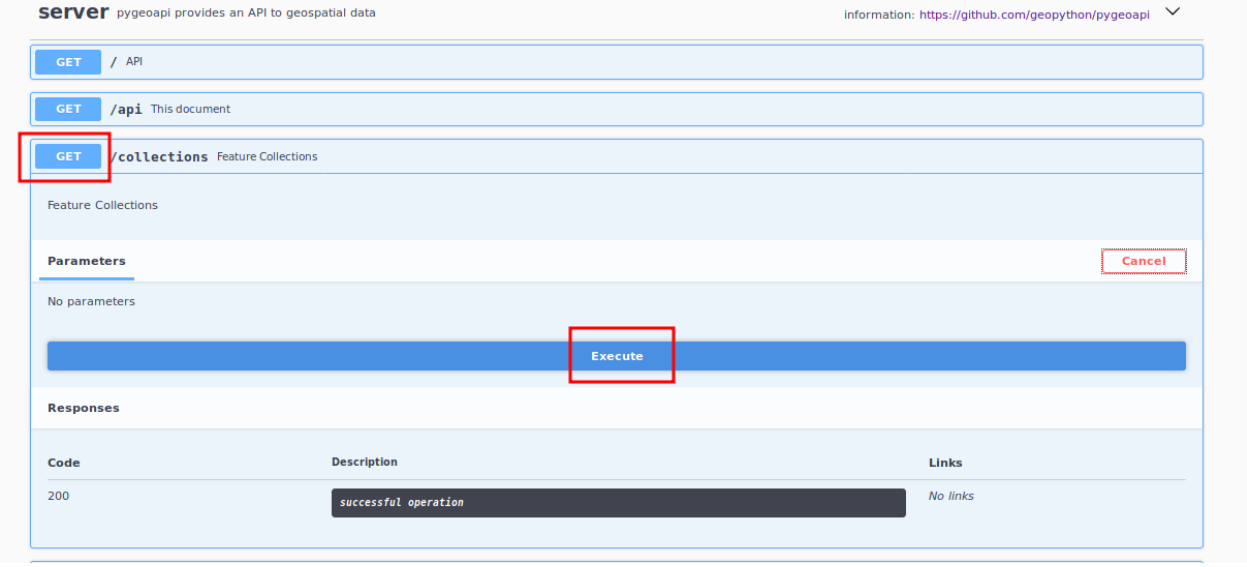
10.1 Using OpenAPI

Accessing the Swagger webpage we have the following structure:

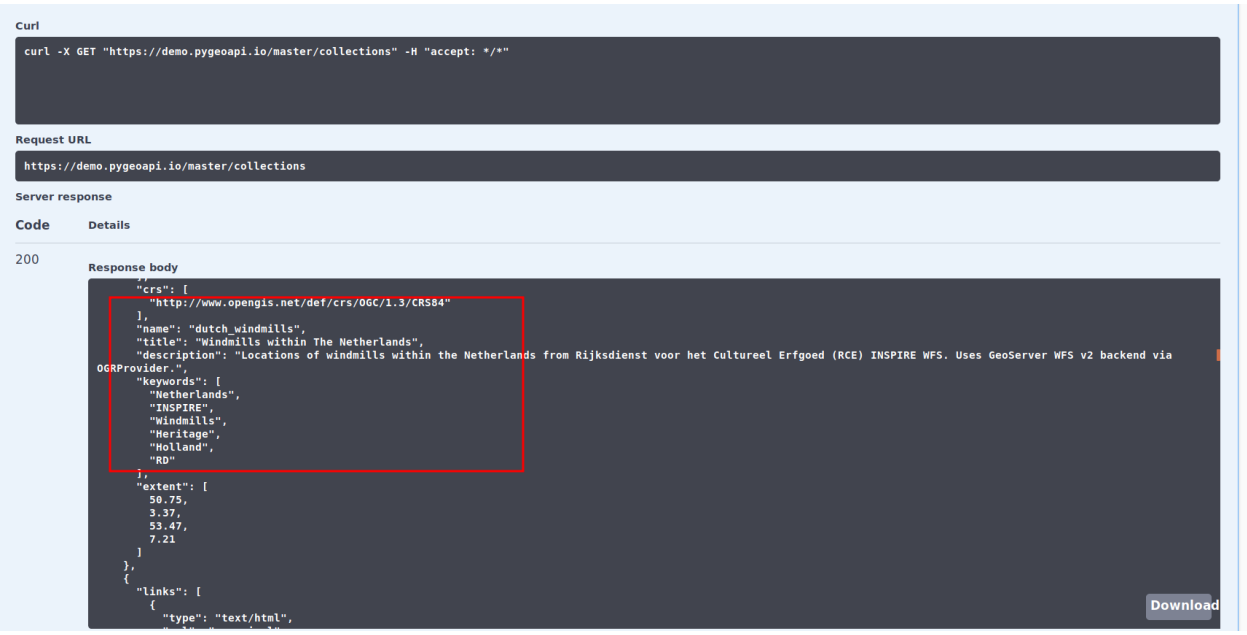


Notice that each dataset is represented as a RESTful endpoint under `collections`.

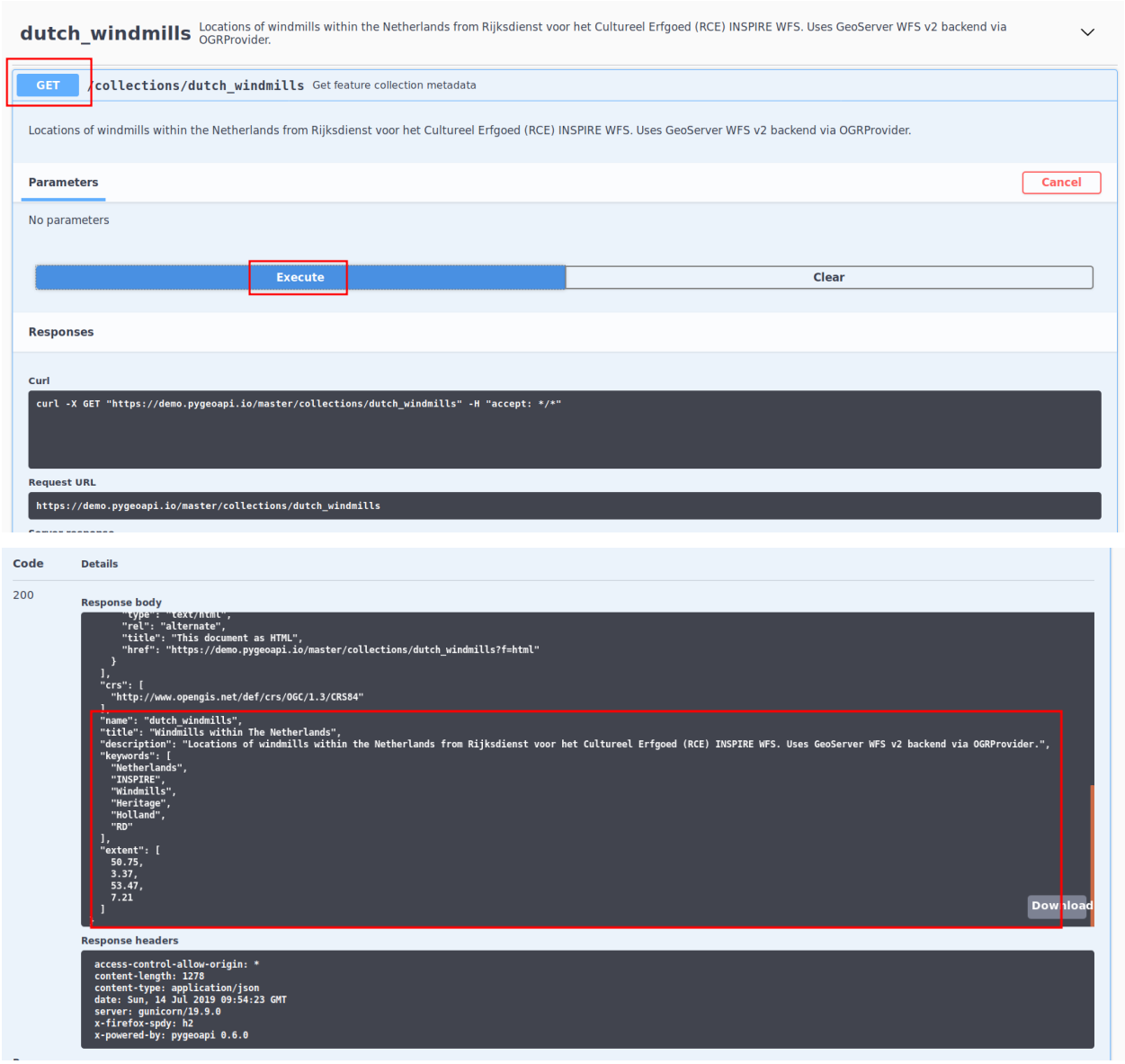
In this example we will test `GET` capability of data concerning windmills in the Netherlands. Let's start by accessing the service's dataset collections:



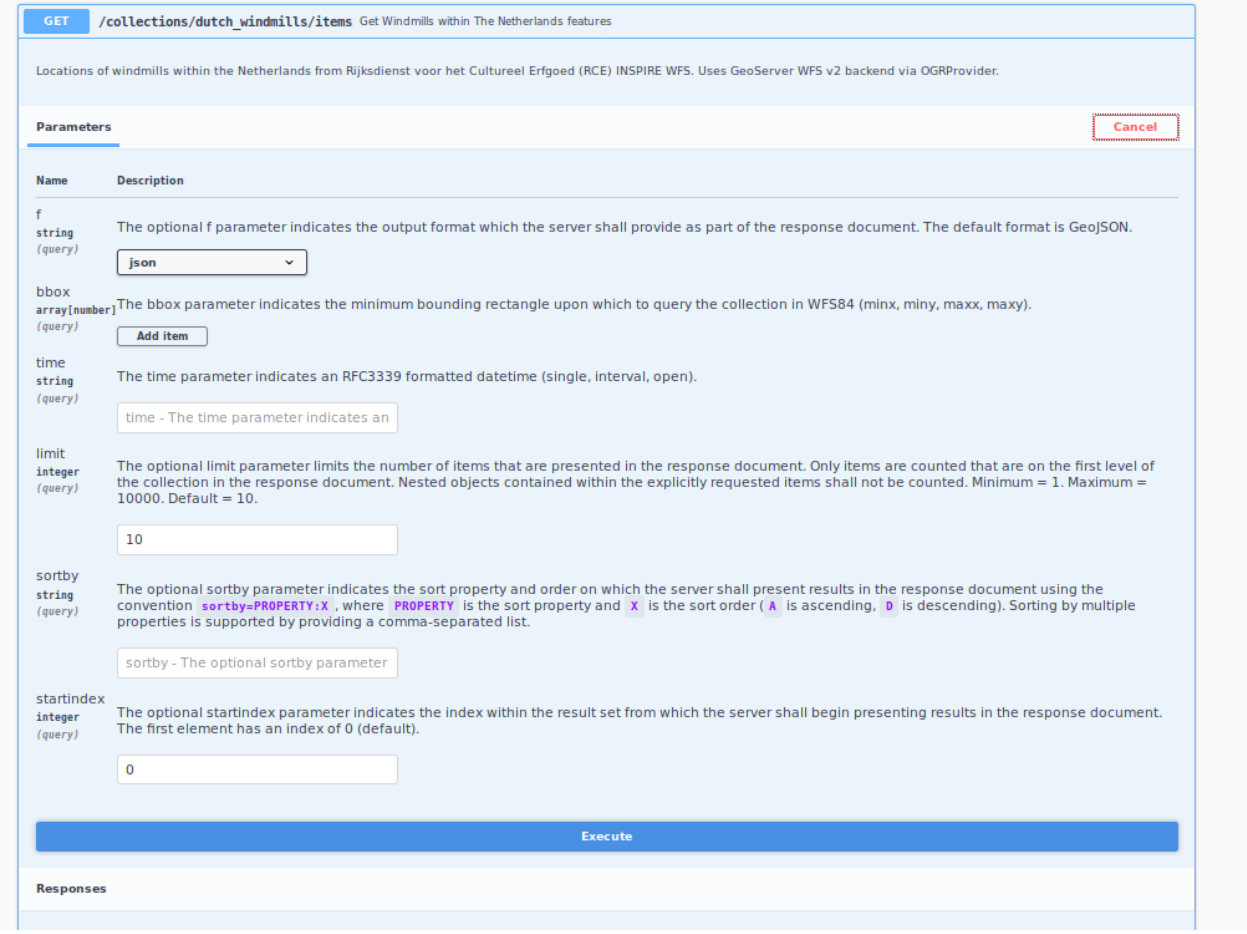
The service collection metadata will contain a description of each collection:



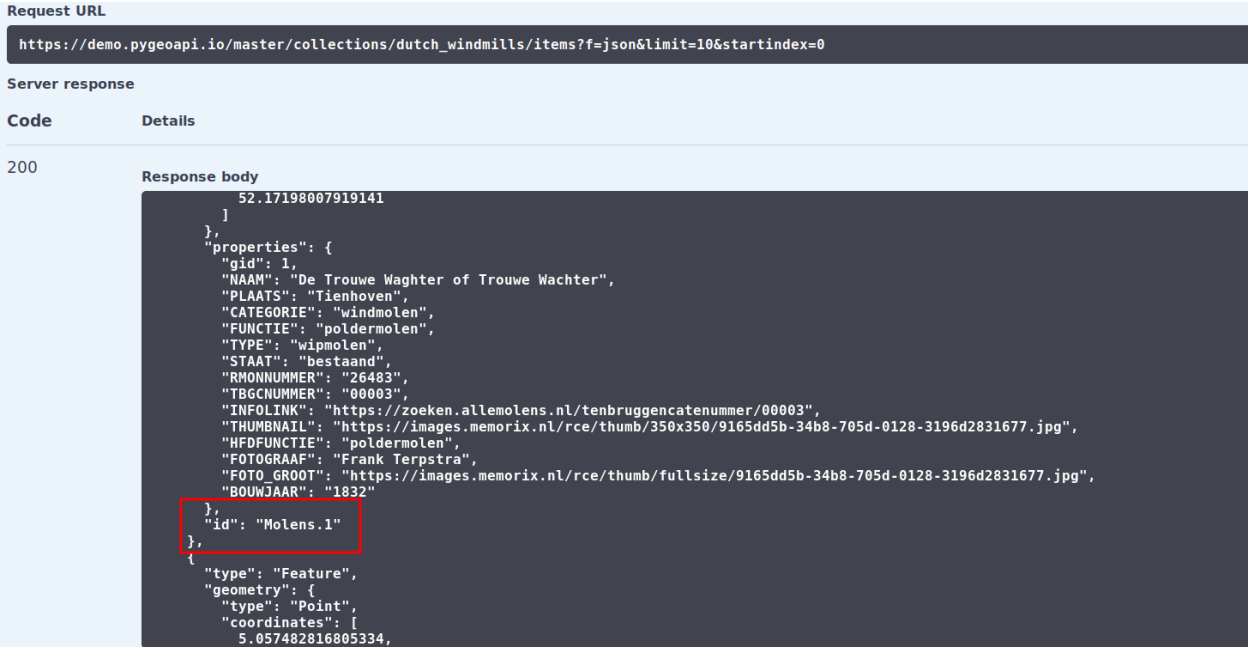
Here, we see that the `dutch_windmills` dataset is be available. Next, let's obtain the specific metadata of the dataset:



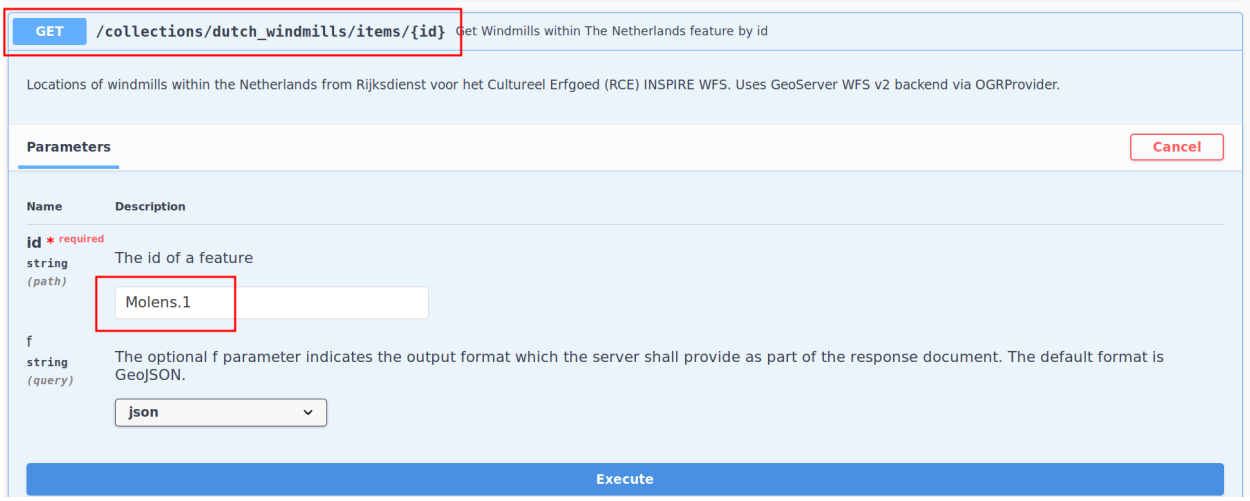
We also see that the dataset has an `items` endpoint which provides all data, along with specific parameters for filtering, paging and sorting:



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:



10.2 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.

CHAPTER

ELEVEN

DATA PUBLISHING

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

11.1 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.

11.1.1 Publishing vector data to OGC API - Features

OGC API - Features 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.

11.1.1.1 Providers

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

Provider	properties	resulttype	bbox	datetime	sortby
CSV	✓	results/hits			
Elasticsearch	✓	results/hits	✓	✓	✓
GeoJSON	✓	results/hits			
MongoDB	✓	results	✓	✓	✓
OGR	✓	results/hits	✓		
PostgreSQL	✓	results/hits	✓		
SQLiteGPKG	✓	results/hits	✓		

Below are specific connection examples based on supported providers.

11.1.1.2 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
      data: http://localhost:9200/ne_110m_populated_places_simple
      id_field: geonameid
      time_field: datetimefield
```

OGR

Todo: add overview and requirements

MongoDB

Todo: add overview and requirements

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

PostgreSQL

Todo: add overview and requirements

```
providers:
    - type: feature
      name: PostgreSQL
      data:
          host: 127.0.0.1
          dbname: test
          user: postgres
          password: postgres
          search_path: [osm, public]
      id_field: osm_id
      table: hotosm_bdi_waterways
      geom_field: foo_geom
```

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
```

11.1.1.3 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?startIndex=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
- fetch a specific feature - http://localhost:5000/collections/foo/items/123

11.1.2 Publishing raster data to OGC API - Coverages

OGC API - Coverages 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.

11.1.2.1 Providers

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

Provider	rangeSubset	subset
rasterio	✓	✓

Below are specific connection examples based on supported providers.

11.1.2.2 Connection examples

rasterio

The rasterio 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
```

(continues on next page)

(continued from previous page)

```
        options:  # optional creation options
            DATA_ENCODING: COMPLEX_PACKING
        format:
            name: GRIB2
            mimetype: application/x-grib2
```

11.1.2.3 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=GRIB2
- coverage access with comma-separated rangeSubset - http://localhost:5000/collections/foo/coverage?rangeSubset=1,3
- coverage access with subsetting - http://localhost:5000/collections/foo/coverage?subset=lat(10,20)&subset=long(10,20)

11.1.3 Publishing processes via OGC API - Processes

OGC API - Processes 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 `hello-world` process is provided with the pygeoapi default configuration.

11.1.3.1 Configuration

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

11.1.3.2 Processing examples

- list all processes - http://localhost:5000/processes
- describe the `hello-world` process - http://localhost:5000/processes/hello-world
- show all jobs for the `hello-world` process - http://localhost:5000/processes/hello-world/jobs
- execute a job for the `hello-world` process - `curl -X POST "http://localhost:5000/processes/hello-world/jobs" -H "Content-Type: application/json" -d "{\ "inputs\":[{\"id\":\"name\",\"type\":\"text/plain\",\"value\":\"hi there2\ "}]}"`

- execute a job for the `hello-world` process with a raw response - `curl -X POST "http://localhost:5000/processes/hello-world/jobs?response=raw" -H "Content-Type: application/json" -d "{\"inputs\":[{\"id\":\"name\",\"type\":\"text/plain\",\"value\":\"hi there2\"}]}"`

Todo: add more examples once OAProc implementation is complete

11.1.4 Publishing files to a SpatioTemporal Asset Catalog

The SpatioTemporal Asset Catalog (STAC) specification provides an easy approach for describing geospatial assets. STAC is typically implemented for imagery and other raster data.

pygeoapi implements STAC as an geospatial file browser through the FileSystem provider, 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:

11.1.4.1 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.

11.1.4.2 Data access examples

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

From here, browse the filesystem accordingly.

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"""

        BaseProvider.__init__(self, provider_def)

    def get_fields(self):

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

    def query(self, startindex=0, limit=10, resulttype='results',
              bbox=[], datetime=None, properties=[], sortby=[]):

        # 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'
                }
            }]
        }
```

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.

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 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
```

BEGIN

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"""

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

(continues on next page)

(continued from previous page)

```
    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'):
        # process bands and subsets parameters
        # query/extract coverage data
        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.

END

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"""

        BaseFormatter.__init__(self, {'name': 'cooljson', 'geom': None})
        self.mimetype = 'text/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.

CHAPTER

THIRTEEN

DEVELOPMENT

13.1 Codebase

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

13.2 Testing

pygeoapi uses pytest 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 Travis setup 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.

13.3 Working with Spatialite on OSX

13.3.1 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
```

CHAPTER

FOURTEEN

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.

14.1 CITE instance

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

14.2 Setting up your own CITE testing instance

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

CHAPTER

FIFTEEN

CONTRIBUTING

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

CHAPTER

SIXTEEN

SUPPORT

16.1 Community

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

CHAPTER

SEVENTEEN

FURTHER READING

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

- Default pygeoapi presentation
- OGC API

CHAPTER

EIGHTEEN

LICENSE

18.1 Code

The MIT License (MIT)

Copyright © 2018-2020 Tom Kralidis

- – *

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

18.2 Documentation

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

CHAPTER

NINETEEN

API DOCUMENTATION

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

19.1 API

Root level code of pygeoapi, parsing content provided by webframework. Returns content from plugins and sets reponses

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)

execute_process(*headers*, *args*, *data*, *process*)
Execute process

Parameters

- **headers** – dict of HTTP headers
- **args** – dict of HTTP request parameters
- **data** – process data
- **process** – name of process

Returns tuple of headers, status code, content

get_collection_items(*headers*, *args*, *dataset*, *pathinfo=None*)
Queries collection

Parameters

- **headers** – dict of HTTP headers
- **args** – dict of HTTP request parameters
- **dataset** – dataset name
- **pathinfo** – path location

Returns tuple of headers, status code, content

pygeoapi.api.**FORMATS = ['json', 'html', 'jsonld']**
Formats allowed for ?f= requests

pygeoapi.api.**HEADERS = {'Content-Type': 'application/json', 'X-Powered-By': 'pygeoapi 0.9**
Return headers for requests (e.g:X-Powered-By)

pygeoapi.api.**check_format**(*args*, *headers*)
check format requested from arguments or headers

Parameters

- **args** – dict of request keyword value pairs
- **headers** – dict of request headers

Returns format value

pygeoapi.api.**pre_process**(*func*)
Decorator performing header copy and format checking before sending arguments to methods

Parameters **func** – decorated function

Returns *func*

19.2 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.**landing_page**()
OGC API landing page endpoint

Returns HTTP response

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

Returns HTTP response

pygeoapi.flask_app.**process_jobs**(*process_id=None*)
OGC API - Processes jobs endpoint

Parameters **process_id** – process identifier

Returns HTTP response

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

Parameters **process_id** – process identifier

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

19.3 Logging

Logging system

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

Parameters **logging_config** – logging specific configuration

Returns void (creates logging instance)

19.4 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

19.5 Plugins

See also:

Customizing pygeoapi: plugins

Plugin loader

exception pygeoapi.plugin.**InvalidPluginError**
Bases: Exception

Invalid plugin

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

pygeoapi.plugin.**PLUGINS = {'extensions': {'CQL': 'pygeoapi.cql.CQLHandler'}, 'formatter':**
Loads provider plugins to be used by pygeoapi,formatters and processes availablecql classes 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

19.6 Utils

Generic util functions used in the code

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

Parameters

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

Returns *str* (ISO8601) representing the date. ('..' if null or "now", allowing for an open interval).

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.**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_extension_by_type**(*providers*, *extension_type*)
helper function to check the provider's extension support by an extension type

Parameters

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

Returns extension based on type

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.**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.**render_j2_template**(*config*, *template*, *data*)
render Jinja2 template

Parameters

- **config** – dict of configuration
- **template** – template (relative path)
- **data** – dict of data

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

Parameters **fh** – file handle

Returns *dict* representation of YAML

19.7 Formatter package

Output formatter package

19.7.1 Base class

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

generic Formatter ABC

__init__(*formatter_def*)
Initialize object

Parameters **formatter_def** – formatter definition

Returns pygeoapi.providers.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

19.7.2 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

19.8 Process package

OGC process package, each process is an independent module

19.8.1 Base class

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

generic Processor ABC. Processes are inherited from this class

__init__(*processor_def*, *process_metadata*)
Initialize object :param processor_def: processor definition :returns: pygeoapi.processors.base.BaseProvider

__repr__()
Return repr(self).

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

execute()
execute the process :returns: dict of process response

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

query / backend error

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

19.8.2 hello_world

Hello world example process

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

Hello World Processor example

__init__(*provider_def*)
Initialize object :param provider_def: provider definition :returns: pygeoapi.process.hello_world.HelloWorldProcessor

__repr__()
Return repr(self).

execute(*data*)
execute the process :returns: dict of process response

pygeoapi.process.hello_world.**PROCESS_METADATA = {'description': 'Hello World process', 'ex**
Process metadata and description

19.9 Provider

Provider module containing the plugins wrapping data sources

19.9.1 Base class

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

generic Provider ABC

__init__(*provider_def*)
Initialize object

Parameters **provider_def** – provider definition

Returns pygeoapi.providers.base.BaseProvider

__repr__()
Return repr(self).

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

create(*new_feature*)
Create a new feature

delete(*identifier*)
Deletes an existing feature

Parameters **identifier** – feature id

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

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)

query()
query the provider

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

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

Parameters

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

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

provider connection error

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

provider generic error

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

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.**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

19.9.2 CSV provider

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

CSV provider

_load(*identifier=None*)
Load CSV data

Parameters **identifier** – feature id

get(*identifier*)
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(*startindex=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime=None*, *properties=[]*, *sortby=[]*, *cql_expression=None*, *identifier=None*)
CSV query

Parameters

- **startindex** – 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)
- **cql_expression** – string of cql filter expression
- **identifier** – feature id

Returns dict of GeoJSON FeatureCollection

19.9.3 Elasticsearch provider

class pygeoapi.provider.elasticsearch_.**ElasticsearchProvider**(*provider_def*)
Bases: *pygeoapi.provider.base.BaseProvider*

Elasticsearch Provider

esdoc2geojson(*doc*)
generate GeoJSON *dict* from ES document

Parameters **doc** – *dict* of ES document

Returns GeoJSON *dict*

get(*identifier*)
Get ES document by id

Parameters **identifier** – feature id

Returns dict of single GeoJSON feature

get_fields()

Get provider field information (names, types)

Returns dict of fields

mask_prop(*property_name*)
generate property name based on ES backend setup

Parameters **property_name** – property name

Returns masked property name

query(*startindex=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime=None*, *properties=[]*, *sortby=[]*)
query Elasticsearch index

Parameters

- **startindex** – 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)

Returns dict of 0..n GeoJSON features

19.9.4 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()
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*)
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(*startindex=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime=None*, *properties=[]*, *sortby=[]*, *cql_expression=None*)
query the provider

Parameters

- **startindex** – 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)
- **cql_expression** – string of filter expression

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

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

get_layer()
Gets OGR Layer from opened OGR dataset. When startindex 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

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.

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*)
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*)
Get Feature by id

Parameters **identifier** – feature id

Returns feature collection

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

Returns dict of fields

query(*startindex=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime=None*, *properties=[]*, *sortby=[]*)
Query OGR source

Parameters

- **startindex** – 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)

Returns dict of 0..n GeoJSON features

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

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.

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(*startindex=- 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(*startindex=- 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

19.9.6 postgresql

class pygeoapi.provider.postgresql.**DatabaseConnection**(*conn_dic*, *table*, *context='query'*)
Bases: object

Database connection class to be used as 'with' statement. The class returns a connection object.

class pygeoapi.provider.postgresql.**PostgreSQLProvider**(*provider_def*)
Bases: *pygeoapi.provider.base.BaseProvider*

Generic provider for Postgresql based on psycopg2 using sync approach and server side cursor (using support class DatabaseCursor)

_PostgreSQLProvider__get_where_clauses(*properties=[]*, *bbox=[]*)
Generarates WHERE conditions to be implemented in query. Private method mainly associated with query method :param properties: list of tuples (name, value) :param bbox: bounding box [minx,miny,maxx,maxy]

Returns psycopg2.sql.Composed or psycopg2.sql.SQL

_PostgreSQLProvider__response_feature(*row_data*)
Assembles GeoJSON output from DB query

Parameters **row_data** – DB row result

Returns *dict* of GeoJSON Feature

_PostgreSQLProvider__response_feature_hits(*hits*)
Assembles GeoJSON/Feature number e.g: http://localhost:5000/collections/hotosm_bdi_waterways/items?resulttype=hits

Returns GeoJSON FeaturesCollection

get(*identifier*)
Query the provider for a specific feature id e.g: /collections/hotosm_bdi_waterways/items/13990765

Parameters **identifier** – feature id

Returns GeoJSON FeaturesCollection

get_fields()
Get fields from PostgreSQL table (columns are field)

Returns dict of fields

get_next(*cursor*, *identifier*)
Query next ID given current ID

Parameters **identifier** – feature id

Returns feature id

get_previous(*cursor*, *identifier*)
Query previous ID given current ID

Parameters **identifier** – feature id

Returns feature id

query(*startindex=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime=None*, *properties=[]*, *sortby=[]*, *cql_expression=None*)
Query Postgis for all the content. e,g: http://localhost:5000/collections/hotosm_bdi_waterways/items?limit=1&resulttype=results

Parameters

- **startindex** – 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)
- **cql_expression** – cql query filter expression

Returns GeoJSON FeaturesCollection

19.9.7 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*)
Assembles GeoJSON output from DB query

Parameters **row_data** – DB row result

Returns *dict* of GeoJSON Feature

_SQLiteGPKGProvider__response_feature_hits(*hits*)
Assembles GeoJSON/Feature number

Returns GeoJSON FeaturesCollection

get(*identifier*)
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(*startindex=0*, *limit=10*, *resulttype='results'*, *bbox=[]*, *datetime=None*, *properties=[]*, *sortby=[]*, *cql_expression=None*)
Query SQLite/GPKG for all the content. e,g: http://localhost:5000/collections/countries/items?limit=5&startindex=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

- **startindex** – 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)

Returns GeoJSON FeaturesCollection

CHAPTER

TWENTY

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

W

Y