

How to implement OGC API – Moving Features with pygeoapi and MobilityDB

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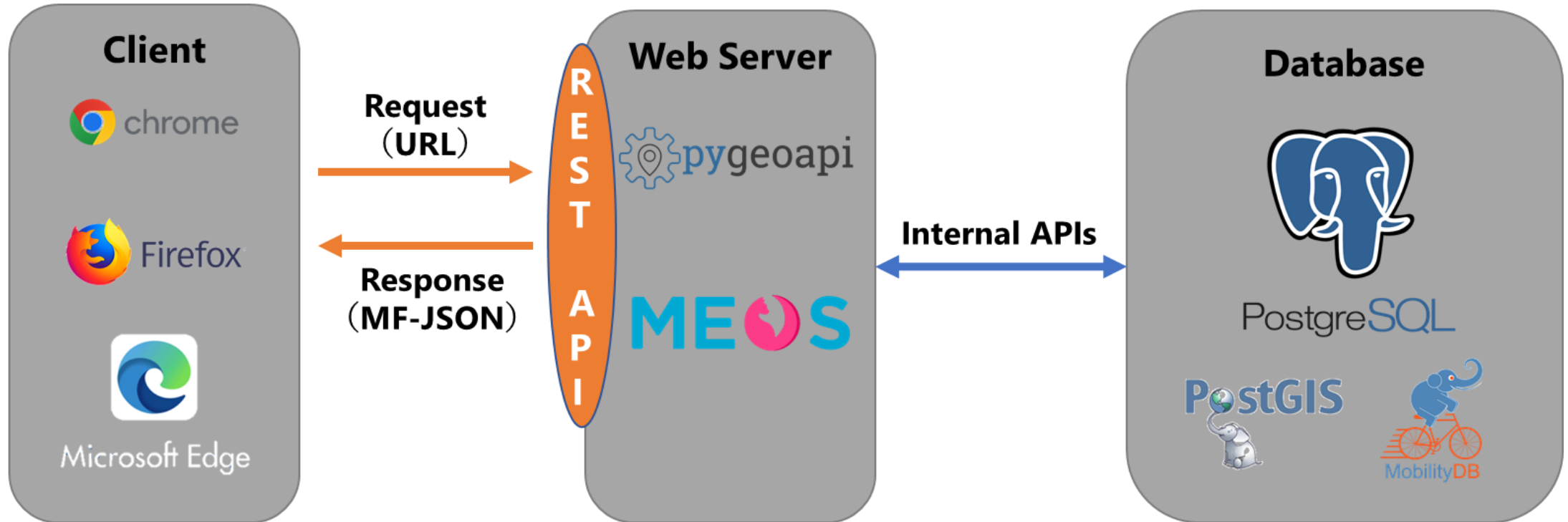
(AIST)



A brief explanation of pygeoapi and install it

1. Overall architecture
2. What is pygeoapi
3. How to install (using Docker)

Overall architecture



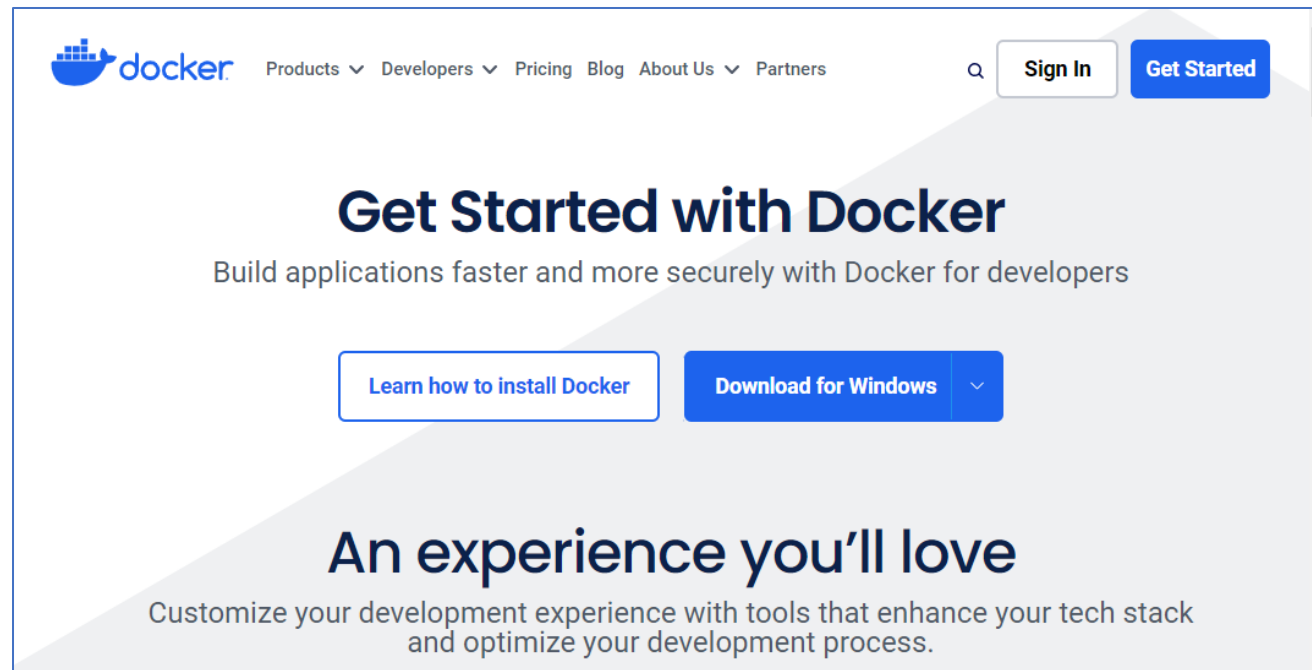
What is pygeoapi

- Python server implementation of the OGC API standard
 - Providing the ability to deploy RESTful OGC API endpoints using OpenAPI, GeoJSON, and HTML
- Features
 - Easy-to-install, ready-to-use, state-of-the-art OGC API server
 - Easy-to-use OpenAPI/Swagger for developers
 - Built on a robust plugin framework Custom data connections, formats, and processes can be built



How to install (using Docker)

- Install docker
 - https://www.docker.com/get_started/




How to install (using Docker)

- Pull Docker image
 - `docker pull ghcr.io/taehoonk/pygeoapi-mf-api:latest`
 - `docker pull ghcr.io/taehoonk/pygeoapi-mf-api-mobilitydb:latest`
 - `docker-compose up`
 - **localhost:5050**
- Optional
 - Checking the status of docker application

How to install (using Docker)

[30 mins] Verify that each API works properly using Swagger

- Checking the localhost
 - <http://localhost:5050/>

[Contact](#)

Home[json](#)[jsonld](#)

pygeoapi Demo instance - running latest GitHub version

pygeoapi provides an API to geospatial data

[geospatial](#)[data](#)[api](#)

Terms of service
License
URL

<https://creativecommons.org/licenses/by/4.0/>
[CC-BY 4.0 license](#)
<https://github.com/geopython/pygeoapi>

Collections

[View the collections in this service](#)

Processes

[View the processes in this service](#)

Jobs

[Browse jobs](#)

API Definition

Documentation: [Swagger UI](#) [ReDoc](#)

[OpenAPI Document](#)

Conformance

[View the conformance classes of this service](#)

Tile Matrix Sets

Provider

pygeoapi Development Team
<https://pygeoapi.io>

Contact point

Address
Mailing Address
City, Administrative Area
Zip or Postal Code
Canada
Email
you@example.org
Telephone
[+xx-xxx-xxx-xxxx](#)
Fax
[+xx-xxx-xxx-xxxx](#)
Contact URL
[Contact URL](#)
Hours
Hours of Service
Contact instructions
During hours of service. Off on weekends.

NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

A brief explanation of MobilityDB

1. What is MobilityDB
2. Process flow from MovingFeature to MobilityDB
3. Process flow from TemporalGeometry to MobilityDB
4. Process flow from TemporalProperties to MobilityDB

What is MobilityDB

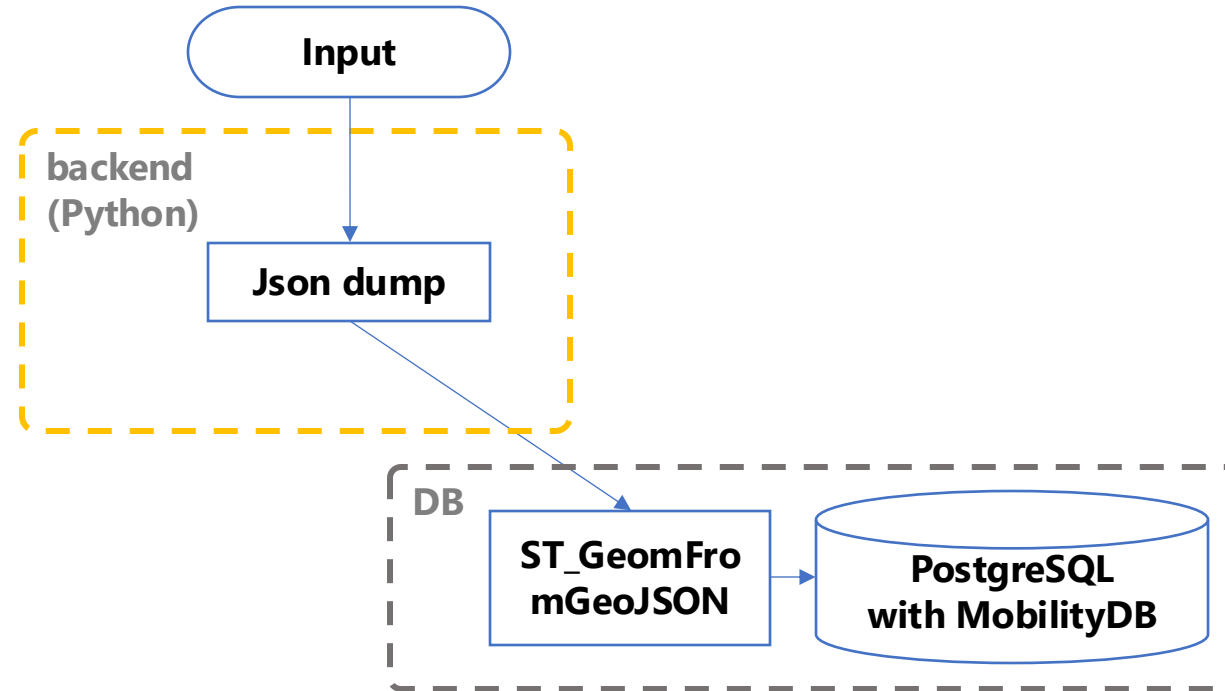
- Postgres extensions for geospatial traces of moving objects such as GPS traces
- To the PostgreSQL database and its spatial extension PostGIS, Spatiotemporal object support has been added
- Example of MobilityDB specific types:
 - **tgeogpoint, tfloat, ttext, etc...**



What is MobilityDB

- Functions used to handle
 - Postgres (PostGIS)
 - MovingFeature Geometry -> ST_GeomFromGeoJSON
 - GeoJSON response -> st_asgeojson()
 - Postgres (MobilityDB)
 - subTrajectory parameter -> tstzspan()
 - leaf parameter -> tstzset()
 - bbox parameter -> stboxx(), stboxz()
 - temporalGeometry, temporalProperty GET request -> extent()
 - PyMEOS
 - MFJSON interconversion -> from_mfjson(), as_mfjson()

Process flow from MovingFeature to MobilityDB



[mfeature]

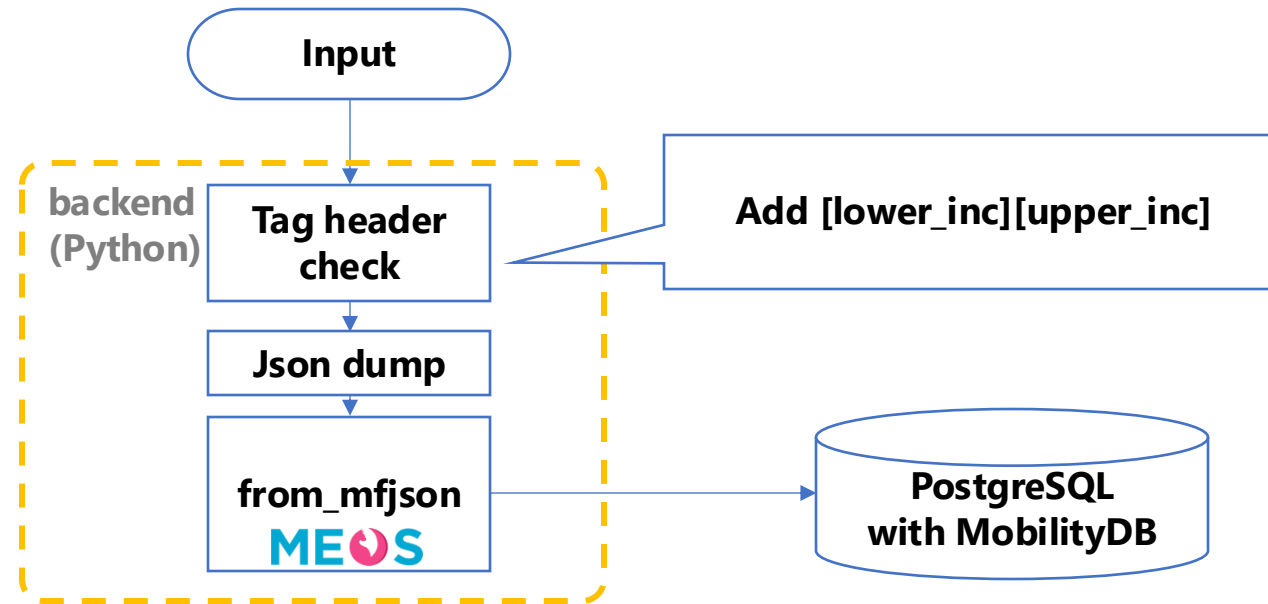
time here
anshin_ex
mobility

les
collection
mfeature
Columns

- collection_id (uuid)
- mfeature_id (uuid)
- mf_geometry (geometry)
- mf_property (jsonb)
- lifespan (period)

	collection_id	mfeature_id	mf_geometry	mf_property
1	7513cba0-14d3-4a45-a481-ce1246711ed9	6b8ab3ed-04ba-4a11-a319-6193af8cc378	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
2	7513cba0-14d3-4a45-a481-ce1246711ed9	646ced18-cc74-4b58-b773-b08c311a4f2a	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
3	86f99c78-0aa4-413d-8870-bbf502ab5c80	90466a88-383f-45f3-9800-dc5252e179c4	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
4	86f99c78-0aa4-413d-8870-bbf502ab5c80	c5a703f8-c180-4d91-918b-f0cc5cc5287b	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
5	86f99c78-0aa4-413d-8870-bbf502ab5c80	a77b19c0-e082-4d3a-b0ab-d2887ba5dde8	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
6	86f99c78-0aa4-413d-8870-bbf502ab5c80	d317765f-0f2f-4df6-acab-986500d8a279	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
7	86f99c78-0aa4-413d-8870-bbf502ab5c80	d6ef3703-42b8-409a-8b9e-a05ea14aa6cf	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
8	86f99c78-0aa4-413d-8870-bbf502ab5c80	dce61f9b-27b2-4e43-934e-561dcc88b818	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
9	86f99c78-0aa4-413d-8870-bbf502ab5c80	1c8f8490-ef47-41a7-bf9c-dd0c8f27a28d	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
10	86f99c78-0aa4-413d-8870-bbf502ab5c80	11329643-4265-48cc-bba8-4a595162a4ff	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n
11	86f99c78-0aa4-413d-8870-bbf502ab5c80	18b004ed-bc4e-4d4a-934b-aa5dd20cb370	LINESTRING(139.757083 35.627701 0.5,139.757399 35.627	{"crs":{"type":"Name","properties":{"n

Process flow from TemporalGeometry to MobilityDB

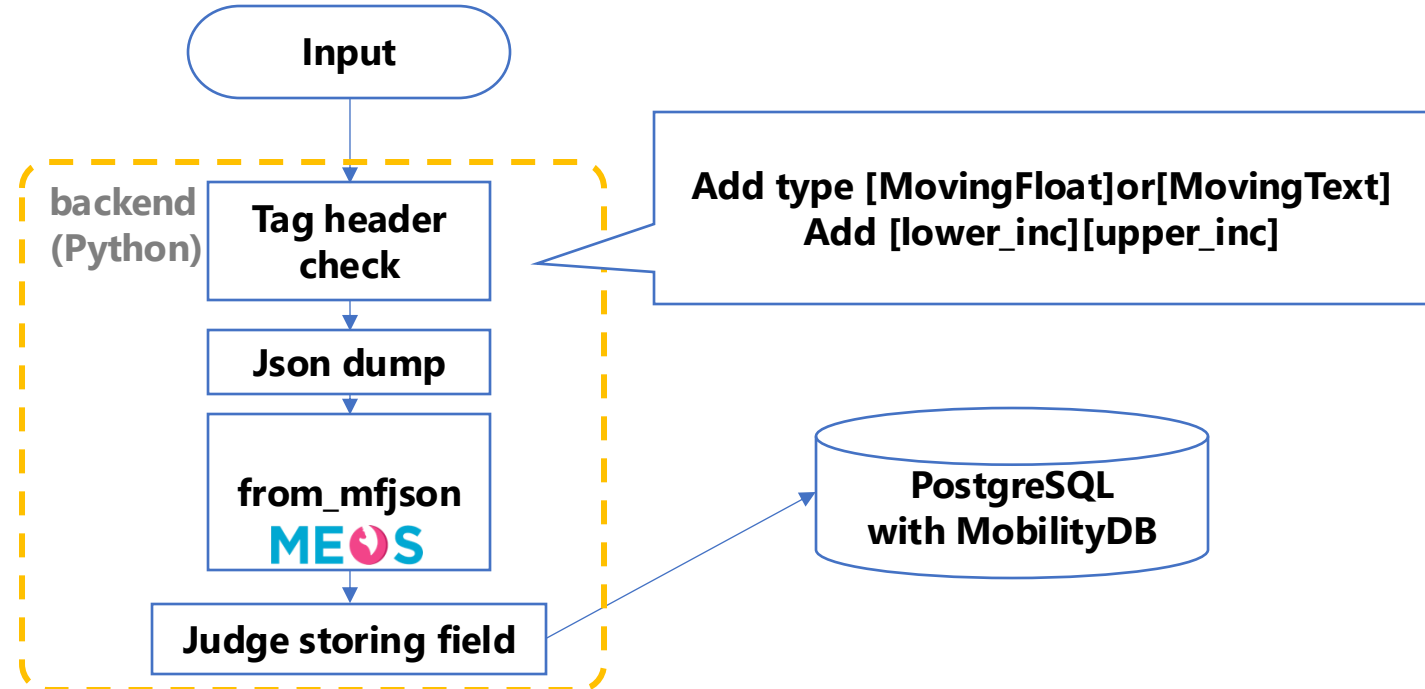


[tgeometry]

The screenshot shows a database management tool interface. On the left, a tree view displays the database structure, with the **tgeometry** table selected under the **public** schema. The table's columns are listed: **collection_id (uuid)**, **mfeature_id (uuid)**, **tgeometry_id (uuid)**, and **tgeometry_property (tgeompoint)**. The main window shows the **Data** tab for the **tgeometry** table, displaying a list of records with their respective IDs and properties. The table has columns: **collection_id**, **mfeature_id**, **tgeometry_id**, and **tgeometry_property**. The data is presented in a grid format with 14 rows visible.

	collection_id	mfeature_id	tgeometry_id	tgeometry_property
1	a01a5339-673a-415d-S	45b9cdb9-f369-4f59	935499cf-a9ee-4006-9ee3	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
2	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	cfce8354-8be7-4d00-95cf	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
3	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	d1199c75-457b-46e0-bf6	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
4	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	53b9db8c-e25d-4357-913	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
5	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	f17f1c60-c006-4c01-baba	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
6	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	99aa36fa-5f37-46a5-b701	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
7	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	d31bb228-6f2c-4fcf-b780	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
8	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	2e1091ba-f531-4c2b-ba9	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
9	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	5f4e8bc7-3838-4704-9c99	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
10	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	f5081e89-ea56-48ae-8945	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
11	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	31994404-f6af-4842-9e45	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
12	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	59d7bd34-d96b-46ee-b9	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
13	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	f66879a0-9009-4f0f-9fa9	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE
14	86f99c78-0aa4-413d-8;	90466a88-383f-45f3;	15f88bb9-9f0e-40bb-9af6	[010100008071AB20063A7861405055A18158D0414000000000000E03F@2011-07-14 22:01:01+09, 0101000080BDE

Process flow from TemporalProperties to MobilityDB



[tproperties]

Grid		collection_id	mfeature_id	length	datetime	tproperty	pvalue_float	pvalue_text
133		1f99f446-655a-442f-b989-c002f103d326	6afc6b9a-c5a3-431b-887	length	55	{"form": "http://v	[1@2010-11-24 13:06:00+09, 2.4@2010-11-2	[NULL]
134		1f99f446-655a-442f-b989-c002f103d326	6afc6b9a-c5a3-431b-887	length	56	{"form": "http://v	[1@2010-11-24 13:08:00+09, 2.4@2010-11-2	[NULL]
135		1f99f446-655a-442f-b989-c002f103d326	6afc6b9a-c5a3-431b-887	length	57	{"form": "http://v	[1@2010-11-24 13:10:00+09, 2.4@2010-11-2	[NULL]
136		1f99f446-655a-442f-b989-c002f103d326	6afc6b9a-c5a3-431b-887	length	58	{"form": "http://v	[1@2010-11-24 13:12:00+09, 2.4@2010-11-2	[NULL]
137		1f99f446-655a-442f-b989-c002f103d326	6afc6b9a-c5a3-431b-887	length	59	{"form": "http://v	[1@2010-11-24 13:14:00+09, 2.4@2010-11-2	[NULL]
138		1f99f446-655a-442f-b989-c002f103d326	6afc6b9a-c5a3-431b-887	length	60	{"form": "http://v	[1@2010-11-24 13:16:00+09, 2.4@2010-11-2	[NULL]
139		1f99f446-655a-442f-b989-c002f103d326	6afc6b9a-c5a3-431b-887	length	61	{"form": "http://v	[1@2010-11-24 13:18:00+09, 2.4@2010-11-2	[NULL]

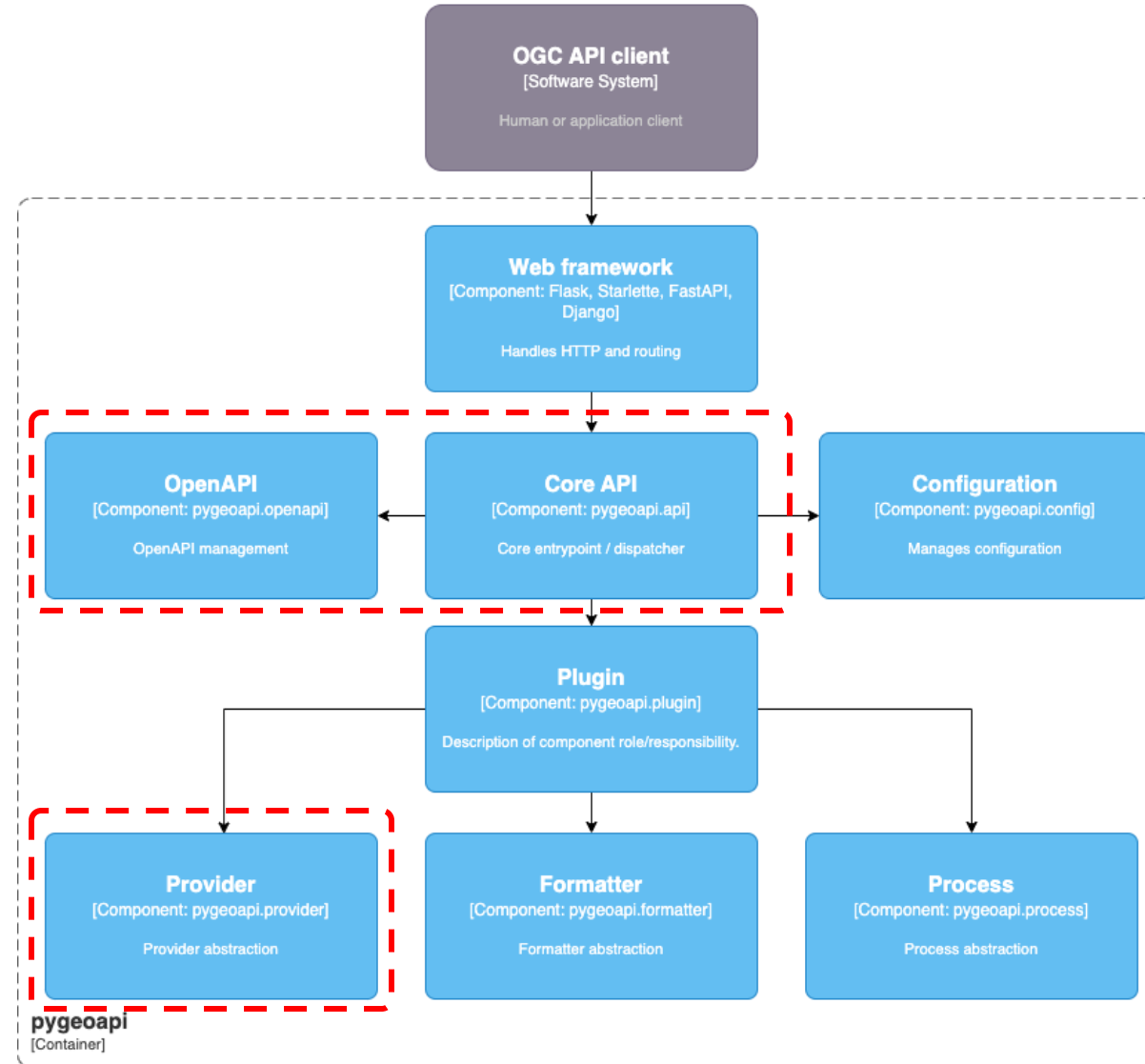
How to extend pygeoapi to support OGC API – Moving Features

1. Extension parts of pygeoapi
2. Process flow in pygeoapi
3. Used libraries for extension structure
4. PyMEOS in the process flow

Extension parts of pygeoapi

pygeoapi C4 Component diagram

 **Extension**

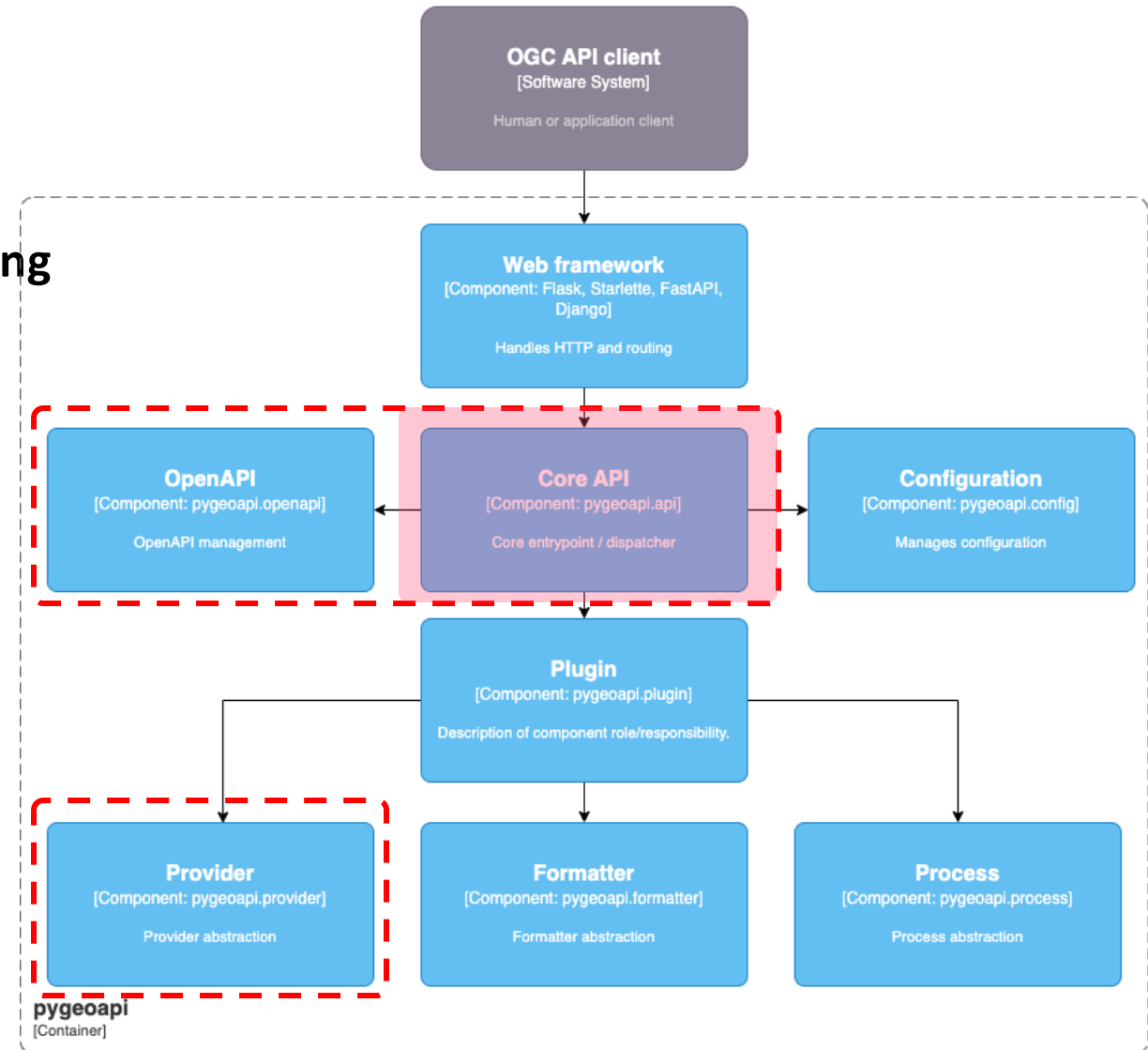


Extension parts of pygeoapi

- In Core API
 - pygeoapi/api/__init__.py
 - pygeoapi/api/movingfeature.py
 - **Parameter identification and response formatting**

 **Extension**

pygeoapi C4 Component diagram

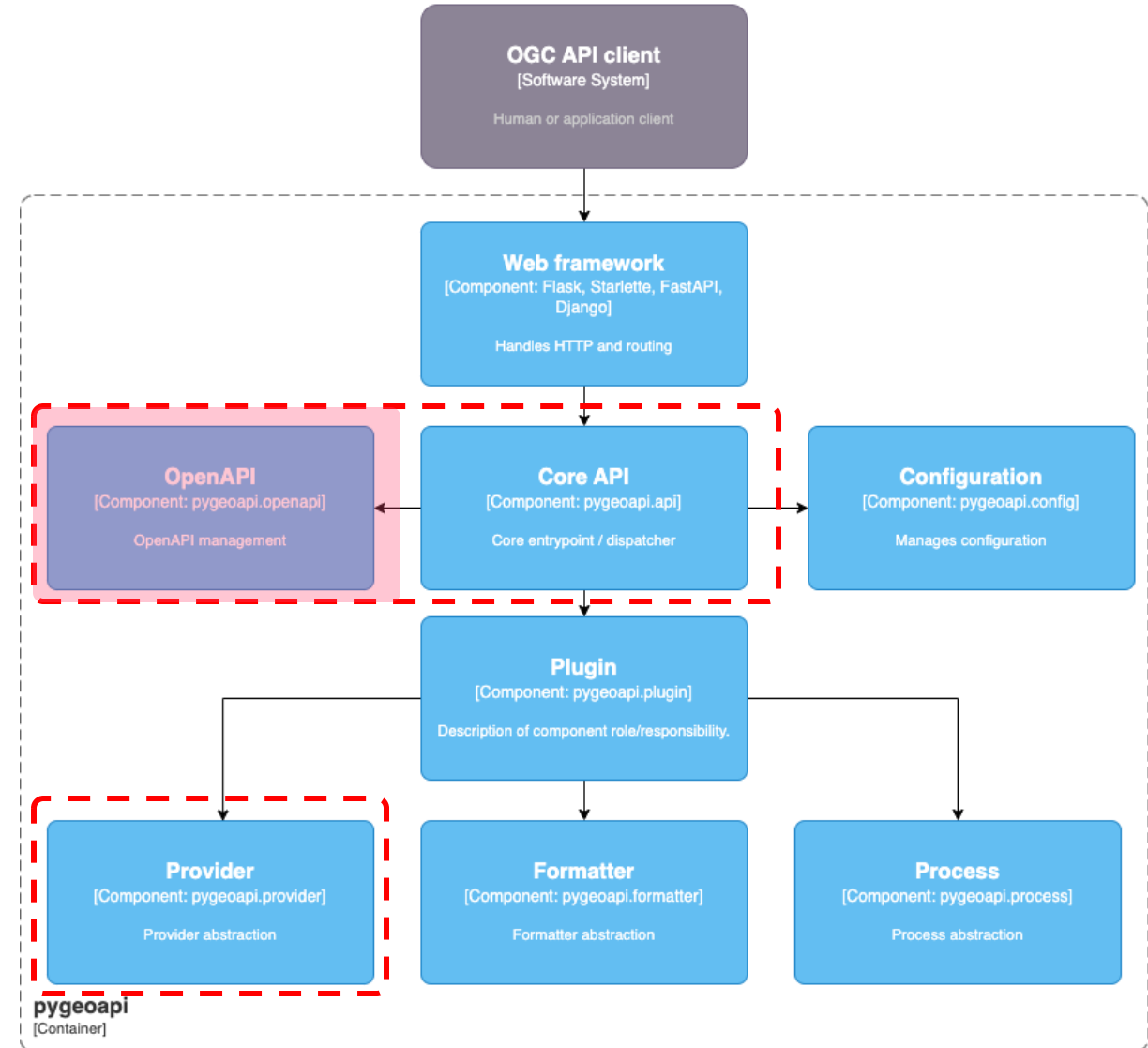


Extension parts of pygeoapi

- In OpenAPI
 - pygeoapi/flask_app.py
 - pygeoapi/openapi.py
 - **Determine processing from Swagger requests**

 **Extension**

pygeoapi C4 Component diagram

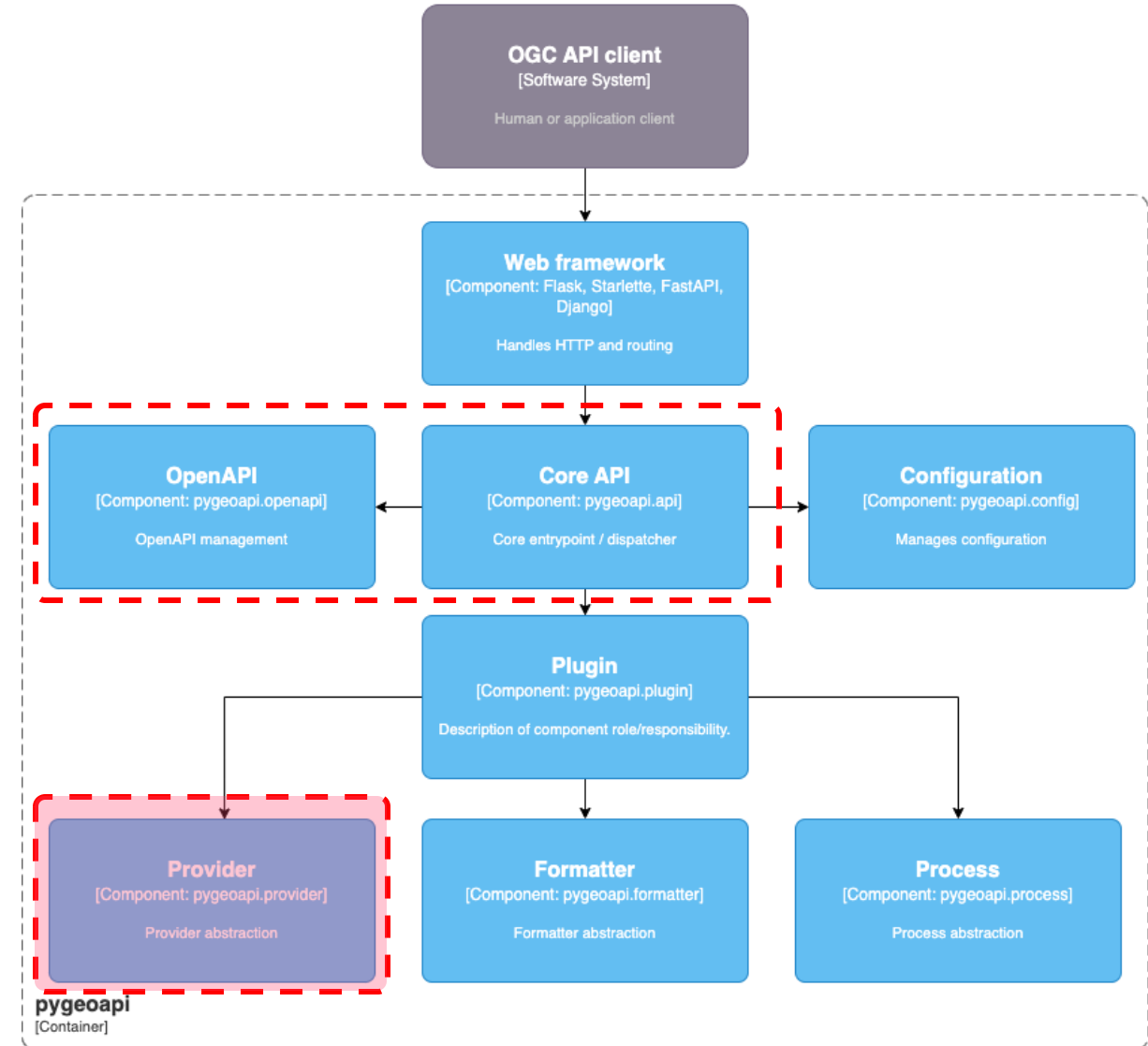


Extension parts of pygeoapi

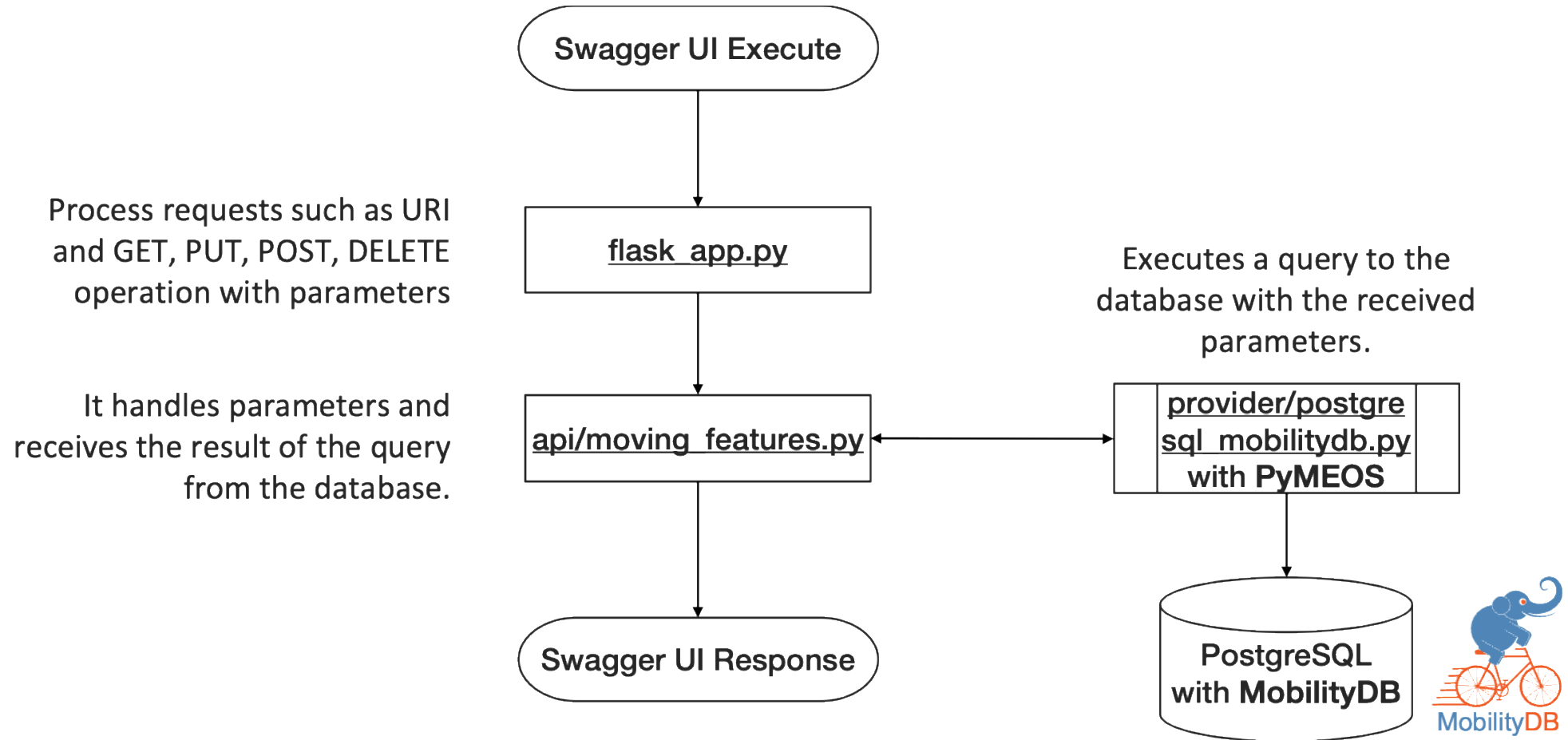
- In Provider
 - pygeoapi/provider/postgresql_mobilitydb.py
 - **Query Execution**
 - **SQL query generation from parameters**

 **Extension**

pygeoapi C4 Component diagram



Process flow in pygeoapi



Used libraries for extension structure

- GeoAlchemy2
 - To convert query parameters
 - **ST_MakeEnvelope, ST_3DMakeBox, ST_MakePoint**
- psycopg2
 - Postgres database adapter for python
- SQLAlchemy
 - Python SQL toolkit
- Postgres extension
 - uuid-osp: generating universally unique identifies (UUID)

[GeoAlchemy] <https://geoalchemy-2.readthedocs.io/en/latest/>

[psycopg2] <https://pypi.org/project/psycopg2>

[SQLAlchemy] <https://www.sqlalchemy.org/>

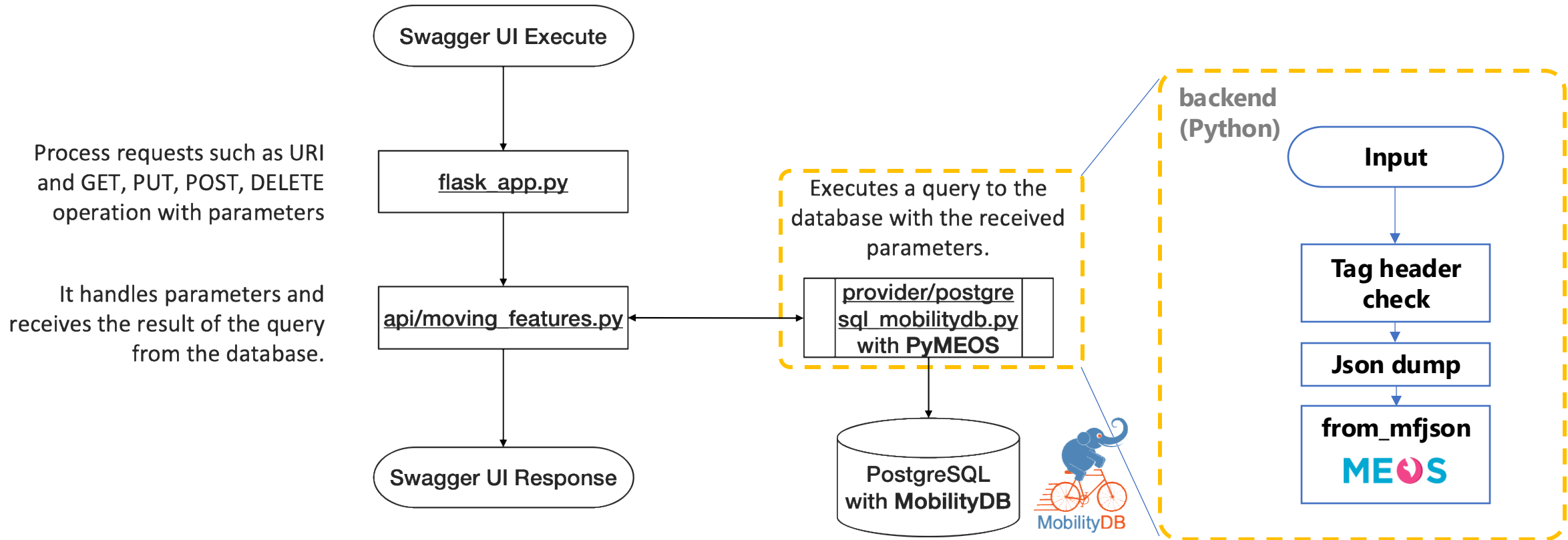
[uuid-osp] <https://www.postgresql.org/docs/current/uuid-osp.html>

Used libraries for extension structure

- PyMEOS (Mobility Engine, Open Source)
 - PyMEOS is a library built to top of MEOS that provides all its functionality wrapped in a set of Python class
 - MEOS
 - C library which enables the manipulation of temporal and spatio-temporal data based on MobilityDB's data types and functions



PyMEOS in the process flow



Verify that each API works properly using Swagger

1. Workshop materials
2. APIs about MovingFeatureCollection
3. APIs about MovingFeatures
4. APIs about TemporalGeometry
5. APIs about TemporalProperties
6. APIs about TemporalProperty
7. APIs about TemporalGeometryQuery

Workshop materials

- URL: https://github.com/opengeospatial/mf-swg/tree/foss4g_asia_2024
 - Sharing sample data with command for practicing

FOSS4G2024Workshop_How-to-implement-OGC-API

FOSS4G Asia 2024 Bangkok Half-day workshop > OGC API – MF, an introduction with MF-API Server based on pygeoapi and MobilityDB > How to implement OGC API – MF with pygeoapi and MobilityDB? Each section describes the commands and sample data used.

Recommended PC specifications

- ✓ HDD : At least 20GB free space
- ✓ memory >= 6GB
- ✓ Install Docker on local PC (<https://www.docker.com/get-started>)
- ✓ (optional) Database Viewer DBeaver (<https://dbeaver.io/>)

<5 mins> A brief explanation of pygeoapi (overall architecture, etc.) and install MF-API Server (using Docker)

Execute the following three commands in order at the command prompt

Step1

```
git clone https://github.com/aistairc/pygeoapi-mf-api
cd pygeoapi-mf-api
```

Step2

```
# For window / ubuntu
docker compose build
docker-compose up
```

Note

- If an issue occurs during the docker build process on a Mac

```
DOCKER_DEFAULT_PLATFORM=linux/amd64 docker-compose build
DOCKER_DEFAULT_PLATFORM=linux/amd64 docker-compose up
```

Step3

APIs about MovingFeatureCollection

POST /collections

No1

Try it out



Parameters

Request body (application/json)

Reference GitHub Page

```
{
  "title": "moving_feature_collection_sample1",
  "updateFrequency": 1000,
  "description": "FOSS4G2024 Asia Workshop",
  "itemType": "movingfeature"
}
```



Execute

APIs about MovingFeatureCollection

POST /collections

No1

Result

Server response

Code	Details
201	<div><p>Response headers</p><pre>access-control-allow-origin: http://localhost:8085 connection: close content-language: en-US content-length: 0 content-type: application/json date: Thu, 16 Nov 2023 07:02:19 GMT location: http://localhost:8085/collections/9fc1986e-1258-49e3-b130-c2d211326319 server: Werkzeug/2.3.6 Python/3.9.2 vary: Origin x-powered-by: pygeoapi 0.14.dev0</pre></div>

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

collectionId : 9fc1986e-1258-49e3-b130-c2d211326319

APIs about MovingFeatureCollection

GET /collections/{collectionId}

No2

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

The last part of `location` link
when POST response



Execute

APIs about MovingFeatureCollection

GET /collections/{collectionId}

Result

No2

Server response

Code

Details

200

Response body

```
{
  "collections": [
    {
      "title": "moving_feature_collection_sample1",
      "description": "FOSS4G2023 Seoul Workshop",
      "updateFrequency": 1000,
      "itemType": "movingfeature",
      "id": "9fc1986e-1258-49e3-b130-c2d211326319",
      "extent": {
        "spatial": {
          "bbox": [],
          "crs": "http://www.opengis.net/def/crs/OGC/1.3/CRS84"
        }
      },
      "temporal": {
        "interval": [],
        "trs": "http://www.opengis.net/def/uom/ISO-8601/0/Gregorian"
      },
      "links": [
        {
          "href": "http://localhost:8085/collections/9fc1986e-1258-49e3-b130-c2d211326319",
          "rel": "self",
          "type": "application/json"
        }
      ]
    }
  ],
  "links": [
```

Input parameters when POST

APIs about MovingFeatureCollection

DELETE /collections/{collectionId}

Skip the DELETE request for the next demonstration

DELETE /collections/{collectionId} Delete the collection

The collection catalog with id `collectionId` and including metadata and moving features SHOULD be deleted.

Parameters

Cancel

Name	Description
collectionId * required string (path)	local identifier of a collection <div>9fc1986e-1258-49e3-b130-c2d2113263</div>

If an id specify, the collection can delete

Execute

APIs about MovingFeatures

POST /collections/{collectionId}/items

No5

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

Request body(application/json)

```
{  
  "type": "Feature",  
  "properties": {  
    "name": "car1", ...  
  }  
}
```

Reference GitHub Page



Execute

APIs about MovingFeatures

POST /collections/{collectionId}/items

No5

Result

Server response

Code

Details

201

Response headers

```
access-control-allow-origin: http://localhost:8085
connection: close
content-language: en-US
content-length: 0
content-type: application/json
date: Fri, 17 Nov 2023 01:17:43 GMT
location: http://localhost:8085/collections/9fc1986e-1258-49e3-b130-c2d211326319/items/f7a5b599-389e-4fdf-8849-bae0221dbe0c
server: Werkzeug/2.3.6 Python/3.9.2
vary: Origin
x-powered-by: pygeoapi 0.14.dev0
```

mFeatureId

Responses

Code

Description

201

Successful create a set of moving features or a moving feature into a specific collection.

mFeatureId : f7a5b599-389e-4fdf-8849-bae0221dbe0c

APIs about MovingFeatures

POST /collections/{collectionId}/items

No5-2

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

Request body(application/json)

Reference GitHub Page

```
{  
  "type": "Feature",  
  "properties": {  
    "name": "car1", ...  
  }  
}
```



Execute

APIs about MovingFeatures

POST /collections/{collectionId}/items

No5-2

Result

Server response	
Code	Details
201	<div>Response headers</div> <div><pre>access-control-allow-origin: http://localhost:8085 connection: close content-language: en-US content-length: 0 content-type: application/json date: Fri, 24 Nov 2023 04:21:25 GMT location: http://localhost:8085/collections/f71c3c59-becd-4cb7-bd98-a93505e769c8/items/015b3091-2a77-4390-b473-2966b64a8cb8 server: Werkzeug/2.3.7 Python/3.9.2 vary: Origin x-powered-by: pygeoapi 0.14.dev0</pre></div> <div>mFeatureId</div> <div>015b3091-2a77-4390-b473-2966b64a8cb8</div>
Responses	
Code	Description
201	Successful create a set of moving features or a moving feature into a specific collection.

mFeatureId :015b3091-2a77-4390-b473-2966b64a8cb8

APIs about MovingFeatures

GET /collections/{collectionId}/items

No6

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

datetime

2011-07-14T22:20:00Z

limit

10

subTrajectory

--

Reference GitHub Page

Default Value

Default Value



Execute

APIs about MovingFeatures

GET /collections/{collectionId}/items

No6

Result

Server response	
Code	Details
200	<div>Response body<pre>{ "type": "FeatureCollection", "features": [{ "id": "f7a5b599-389e-4fdf-8849-bae0221dbe0c", "crs": { "type": "Name", "properties": { "name": "urn:ogc:def:crs:OGC:1.3:CRS84" } }, "trs": { "type": "Link", "properties": { "href": "http://www.opengis.net/def/uom/ISO-8601/0/Gregorian", "type": "ogcdef" } }, "type": "Feature", "properties": { "name": "car1", "state": "test1", "video": "http://.../example/video.mpeg" }, "geometry": { "type": "LineString", "coordinates": [</pre></div>

APIs about MovingFeatures

GET /collections/{collectionId}/items

No6-2

Try it out

Reference GitHub
Page

Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

datetime

2010-01-01T00:00:00Z/..

limit

10

subTrajectory

--

bbox

138.757083
34.627483
138.757716
34.627701

Reference GitHub Page

Default Value

Default Value

Execute

APIs about MovingFeatures

GET /collections/{collectionId}/items

No6-2

Result

Server response	
Code	Details
200	<div>Response body<pre>{ "type": "FeatureCollection", "features": [{ "id": "f7a5b599-389e-4fdf-8849-bae0221dbe0c", "crs": { "type": "Name", "properties": { "name": "urn:ogc:def:crs:OGC:1.3:CRS84" } }, "trs": { "type": "Link", "properties": { "href": "http://www.opengis.net/def/uom/ISO-8601/0/Gregorian", "type": "ogcdef" } }, "type": "Feature", "properties": { "name": "car1", "state": "test1", "video": "http://.../example/video.mpeg" }, "geometry": { "type": "LineString", "coordinates": [</pre></div>

APIs about MovingFeatures

GET /collections/{collectionId}/items

No6-3

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

datetime

2011-08-14T22:15:00Z/2011-08-14T22:55:00Z

limit

10

subTrajectory

true

Reference GitHub
Page

Default Value

Change Value



Execute

APIs about MovingFeatures

GET /collections/{collectionId}/items

No6-3

Result

Server response	
Code	Details
200	<div>Response body<pre>{ "type": "FeatureCollection", "features": [{ "id": "f7a5b599-389e-4fdf-8849-bae0221dbe0c", "crs": { "type": "Name", "properties": { "name": "urn:ogc:def:crs:OGC:1.3:CRS84" } }, "trs": { "type": "Link", "properties": { "href": "http://www.opengis.net/def/uom/ISO-8601/0/Gregorian", "type": "ogcdef" } }, "type": "Feature", "properties": { "name": "car1", "state": "test1", "video": "http://.../example/video.mpeg" }, "geometry": { "type": "LineString", "coordinates": [</pre></div>

APIs about MovingFeatures

GET /collections/{collectionId}/items/{mFeatureId}

No7

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c



Execute

APIs about MovingFeatures

GET /collections/{collectionId}/items/{mFeatureId}

No7

Result

Server response

Code

Details

200

Response body

```
{
  "id": "f7a5b599-389e-4fdf-8849-bae0221dbe0c",
  "crs": {
    "type": "Name",
    "properties": {
      "name": "urn:ogc:def:crs:OGC:1.3:CRS84"
    }
  },
  "trs": {
    "type": "Link",
    "properties": {
      "href": "http://www.opengis.net/def/uom/ISO-8601/0/Gregorian",
      "type": "ogcdef"
    }
  },
  "type": "Feature",
  "properties": {
    "name": "car1",
    "state": "test1",
    "video": "http://.../example/video.mpeg"
  },
  "geometry": {
    "type": "LineString",
    "coordinates": [
      [
        139.757083,
        35.627701,
        0.5
      ]
    ]
  }
}
```

APIs about MovingFeatures

DELETE /collections/{collectionId}/items/{mFeatureId}

Skip the DELETE request for the next demonstration

DELETE /collections/{collectionId}/items/{mFeatureId} Delete a single moving feature

The moving feature with id **mFeatureId** and including temporal geometries and properties SHOULD be deleted.

Parameters

Cancel

Name	Description
collectionId * required string (path)	local identifier of a collection 9fc1986e-1258-49e3-b130-c2d2113263
mFeatureId * required string (path)	local identifier of a moving feature f7a5b599-389e-4fdf-8849-bae0221dbe0

Execute

If an id specify,
the Moving Feature can delete

APIs about Temporal Geometry

POST /collections/{collectionId}/items/{mFeatureId}/tgsequence

No9

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c

Request body(application/json)

```
{  
  "id": "tg-1",  
  "type": "MovingPoint",...
```

Default Value



Execute

APIs about Temporal Geometry

POST /collections/{collectionId}/items/{mFeatureId}/tgsequence

No9

Result

Server response		
Code	Details	
201	<div>Response headers</div> <div><pre>access-control-allow-origin: http://localhost:8085 connection: close content-language: en-US content-length: 0 content-type: application/json date: Fri, 17 Nov 2023 01:47:16 GMT location: http://localhost:8085/collections/9fc1986e-1258-49e3-b130-c2d211326319/items/f7a5b599-389e-4fdf-8849-bae0221dbe0c/tGeometries/8602827f-6927-4c3c-9057-12c386889774 server: Werkzeug/2.3.6 Python/3.9.2 vary: Origin x-powered-by: pygeoapi 0.14.dev0</pre></div> <div>tGeometryId → 8602827f-6927-4c3c-9057-12c386889774</div>	
Responses		
Code	Description	Links
201	Successful add more movement data into a specified moving feature.	No links

tGeometryId : 8602827f-6927-4c3c-9057-12c386889774

APIs about TemporalGeometry

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence

No10

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c

leaf

2011-08-14T22:30:00Z

subTrajectory

--

limit

10

datetime

2010-01-01T00:00:00Z/..



Execute

APIs about Temporal Geometry

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence

No10

Result

Server response	
Code	Details
200	<div>Response body</div> <pre>139.757716, 35.627483, 4]], "datetimes": ["2011-07-14T22:01:06-09Z", "2011-07-14T22:01:07-09Z", "2011-07-14T22:01:08-09Z", "2011-07-14T22:01:09-09Z", "2011-07-14T22:01:10-09Z"], "interpolation": "Linear", "id": "8602827f-6927-4c3c-9057-12c386889774" }], "crs": { "type": "Name", "properties": "urn:ogc:def:crs:OGC:1.3:CRS84" }, "trs": { "type": "Name", "properties": "urn:ogc:data:time:iso8601" }, "links": [{ "href": "http://localhost:8085/collections/9fc1986e-1258-49e3-b130-c2d211326319/ite "rel": "self", "type": "application/json"</pre>

APIs about TemporalGeometry

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence

No10-2

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c

datetime

2011-08-14T22:15:00Z/2011-08-14T23:15:00Z

subTrajectory

true

limit

10

leaf,datetime

empty



Execute

APIs about Temporal Geometry

[30 mins] Verify that each API works properly using Swagger

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence

No10-2

Result

Server response	
Code	Details
200	<div>Response body</div> <pre>139.757716, 35.627483, 4]], "datetimes": ["2011-07-14T22:01:06-09Z", "2011-07-14T22:01:07-09Z", "2011-07-14T22:01:08-09Z", "2011-07-14T22:01:09-09Z", "2011-07-14T22:01:10-09Z"], "interpolation": "Linear", "id": "8602827f-6927-4c3c-9057-12c386889774" }], "crs": { "type": "Name", "properties": "urn:ogc:def:crs:OGC:1.3:CRS84" }, "trs": { "type": "Name", "properties": "urn:ogc:data:time:iso8601" }, "links": [{ "href": "http://localhost:8085/collections/9fc1986e-1258-49e3-b130-c2d211326319/ite "rel": "self", "type": "application/json"</pre>

APIs about Temporal Geometry

POST /collections/{collectionId}/items/{mFeatureId}/tproperties

No12

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c

Request body(application/json)

```
{  
  "temporalProperties": [  
    { ...  
  ]  
}
```

Reference GitHub
Page



Execute

APIs about TemporalGeometry

POST /collections/{collectionId}/items/{mFeatureId}/tproperties

No12

Result

Server response

Code

Details

201

Response headers

```
access-control-allow-origin: http://localhost:8085
connection: close
content-language: en-US
content-length: 0
content-type: application/json
date: Mon, 20 Nov 2023 04:16:19 GMT
location: http://localhost:8085/collections/8f7c2c94-82db-4cad-b3f2-27c13cae5c5/items/1be529cd-fb42-416f-ab2e-3ed1f8e26c6d/tProperties/labels
server: Werkzeug/2.3.7 Python/3.9.2
vary: Origin
x-powered-by: pygeoapi 0.14.dev0
```

Responses

Code

Description

APIs about TemporalProperties

GET /collections/{collectionId}/items/{mFeatureId}/tproperties

No13

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c

datetime

2011-08-14T22:15:00Z/2011-08-14T22:55:00Z

limit

10

subTemporalValue

true



Execute

APIs about TemporalProperty

GET /collections/{collectionId}/items/{mFeatureId}/tproperties

No13

Result

Server response	
Code	Details
200	<div>Response body</div> <pre>{ "temporalProperties": [{ "type": "Image", "name": "camera" }, { "form": "MQS", "type": "Measure", "name": "discharge" }, { "type": "Text", "name": "labels" }, { "form": "http://www.qudt.org/qudt/owl/1.0.0/quantity/Length", "type": "Measure", "description": "description1", "name": "length" }], "links": [{ "href": "http://localhost:8085/collections/9fc1986e-1258-49e3-b130-c2c", "rel": "self", "type": "application/json" }] }</pre>

APIs about TemporalProperty

GET /collections/{collectionId}/items/{mFeatureId}/tproperties/{tPropertyName}

No14

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c

tPropertyName

length

limit

10

subTemporalValue

--

datetime

2010-01-01T00:00:00Z/..



Execute

APIs about TemporalProperty

GET /collections/{collectionId}/items/{mFeatureId}/tproperties/{tPropertyName}

No14

Result

Server response

Code

Details

200

Response body

```
{
  "temporalProperties": [
    {
      "values": [
        1,
        2.4,
        1
      ],
      "datetimes": [
        "2011-07-14T22:01:01.45-09Z",
        "2011-07-14T23:01:01.45-09Z",
        "2011-07-15T00:01:01.45-09Z"
      ],
      "interpolation": "Linear"
    }
  ],
  "links": [
    {
      "href": "http://localhost:8085/collections/8f7c2c94-82db-4cad-b3f2-27c13ca1e5c5/items/1be529cd-fb42-416f-ab2e-3ed1f8e26c6d/tProperties/length?offset=0&limit=10",
      "rel": "self",
      "type": "application/json"
    }
  ],
  "timeStamp": "2023-11-20T04:17:45.377817Z",
  "numberMatched": 1,
  "numberReturned": 1
}
```

APIs about TemporalProperty

POST /collections/{collectionId}/items/{mFeatureId}/tproperties/{tPropertyName}

No15

Try it out



Parameters

collectionId

9fc1986e-1258-49e3-b130-c2d211326319

mFeatureId

f7a5b599-389e-4fdf-8849-bae0221dbe0c

tPropertyName

length

Request body(application/json)

```
{  
  "datetimes": [  

```

Reference GitHub
Page



Execute

APIs about TemporalProperty

POST /collections/{collectionId}/items/{mFeatureId}/tproperties/{tPropertyName}

No15

Result

Server response

Code	Details
201	<p>Response headers</p> <pre>access-control-allow-origin: http://localhost:8085 connection: close content-language: en-US content-length: 0 content-type: application/json date: Mon, 20 Nov 2023 04:19:15 GMT location: http://localhost:8085/collections/8f7c2c94-82db-4cad-b3f2-27c13ca1e5c5/items/1be529cd-fb42-416f-ab2e-3ed1f8e26c6d/tproperties/length/pvalue/0a59f0f1-2281-4133-811b-339b4863ce5c server: Werkzeug/2.3.7 Python/3.9.2 vary: Origin x-powered-by: pygeoapi 0.14.dev0</pre>

Responses

GET /collections/{collectionId}/items/{mFeatureId}/tproperties/{tPropertyName}

Server response

Code	Details
200	<p>Response body</p> <pre>{ "temporalProperties": [{ "values": [0, 20, 50], "datetimes": ["2011-07-15T08:00:00-09Z", "2011-07-15T08:00:01-09Z", "2011-07-15T08:00:02-09Z"], "interpolation": "Linear" }, { "values": [1, 2.4, 1], "datetimes": ["2011-07-14T22:01:45-09Z", "2011-07-14T23:01:45-09Z", "2011-07-15T00:01:45-09Z"], "interpolation": "Linear" }] }</pre>

confirm additions

APIs about TemporalProperty

DELETE /collections/{collectionId}/items/{mFeatureId}/tproperties/{tPropertyName}/{tValueId}

No16

Parameters

Cancel

Name	Description
collectionId * required string (path)	local identifier of a collection <div>cb76b757-9c83-439b-baa9-e67c1cf12d74</div>
mFeatureId * required string (path)	local identifier of a moving feature <div>71426252-f252-44cc-9d13-25eb1b93c31b</div>
tPropertyName * required string (path)	local identifier of a temporal property <div>label</div>
tValueId * required string (path)	local identifier of a temporal primitive value <div>d3b5b6a4-2415-4681-b5c1-dbdb397e6bc9</div>

APIs about TemporalGeometryQuery

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence/{tGeometryId}/acceleration

No17

Try it out

Parameters

collectionId

cb76b757-9c83-439b-baa9-e67c1cf12d74

mFeatureId

71426252-f252-44cc-9d13-25eb1b93c31b

mFeatureId

0a7ac9ae-bed8-4c8b-9290-251e6ce21db9

datetime

2011-08-14T22:15:00Z/2011-08-14T23:55:00Z

leaf

subTemporalValue

--

Execute

APIs about TemporalGeometryQuery

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence/{tGeometryId}/acceleration

No17

Result

Code

Details

200

Response body

```
{
  "form": "MTS",
  "name": "acceleration",
  "type": "TReal",
  "valueSequence": [
    {
      "datetimes": [
        "2011-08-14T22:20:00.000000Z",
        "2011-08-14T22:30:00.000000Z",
        "2011-08-14T22:40:00.000000Z",
        "2011-08-14T23:00:00.000000Z"
      ],
      "interpolation": "Step",
      "values": [
        0,
        0,
        0,
        0
      ]
    }
  ]
}
```

APIs about TemporalGeometryQuery

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence/{tGeometryId}/distance

No18

Try it out

Parameters

collectionId

cb76b757-9c83-439b-baa9-e67c1cf12d74

mFeatureId

71426252-f252-44cc-9d13-25eb1b93c31b

mFeatureId

0a7ac9ae-bed8-4c8b-9290-251e6ce21db9

datetime

2010-01-01T00:00:00Z/..

leaf

2011-08-14T22:30:00Z

subTemporalValue

--

Execute

APIs about TemporalGeometryQuery

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence/{tGeometryId}/distance

No18

Result

Code	Details
200	<div>Response body</div> <pre>{ "form": "MTR", "name": "distance", "type": "TReal", "valueSequence": [{ "datetimes": ["2011-08-14T22:10:00.000000Z", "2011-08-14T22:20:00.000000Z", "2011-08-14T22:30:00.000000Z", "2011-08-14T22:40:00.000000Z", "2011-08-14T23:00:00.000000Z"], "interpolation": "Linear", "values": [0, 1.500000033285333, 3.500000039411582, 3.500133005572702, 3.500263366609814] }] }</pre>

APIs about TemporalGeometryQuery

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence/{tGeometryId}/velocity

No19

Try it out



Parameters

collectionId

cb76b757-9c83-439b-baa9-e67c1cf12d74

mFeatureId

71426252-f252-44cc-9d13-25eb1b93c31b

mFeatureId

0a7ac9ae-bed8-4c8b-9290-251e6ce21db9

datetime

2011-08-14T22:15:00Z/2011-08-14T23:55:00Z

leaf

subTemporalValue

true



Execute

APIs about TemporalGeometryQuery

GET /collections/{collectionId}/items/{mFeatureId}/tgsequence/{tGeometryId}/velocity

No19

Result

Code

Details

200

Response body

```
{
  "form": "MTS",
  "name": "velocity",
  "type": "TReal",
  "valueSequence": [
    {
      "datetimes": [
        "2011-08-14T22:10:00.000000Z",
        "2011-08-14T22:20:00.000000Z",
        "2011-08-14T22:30:00.000000Z",
        "2011-08-14T22:40:00.000000Z",
        "2011-08-14T23:00:00.000000Z"
      ],
      "interpolation": "Step",
      "values": [
        0.002500000055476,
        0.003333333343544,
        2.21610269e-7,
        1.08634198e-7,
        1.08634198e-7
      ]
    }
  ]
}
```

Thank you