LEVERAGING MAPILLARY'S OBJECT DETECTION CAPABILITY TO UPDATE KEY DATASETS

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Introduction To Mapillary

"What if you could map the world with just your smartphone?"

- **What is Mapillary?**
  A global, crowdsourced platform turning street level imagery into actionable insights.

- **Why It Matters**:
  Streamlines mapping for urban planning, navigation, and infrastructure management by detecting features like traffic signs and crosswalks.

- **Key Details**:
  - Founded in 2013 in Malmö, Sweden.
  - Acquired by **Meta** (Facebook) in 2020.
  - **2+ billion** images from 190+ countries.

"Object detection on Mapillary (Image Source: Geo Week News)"

How Mapillary Works

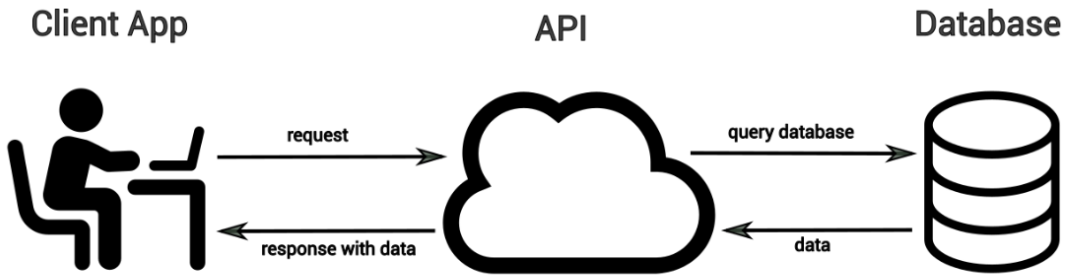
"From Photos to Actionable Data"

- **Crowdsourced Imagery Collection**:
  - Individuals/Organizations capture and upload geotagged street-level photos using devices like smartphones, dashcams, or action cameras.
- **3-D & Computer Vision Technology:**
  - **3-D Reconstruction:** Uses "SfM" (Surface from Motion) to map 3D locations by matching points across overlapping images.
  - **Semantic Segmentation**: Employs convolutional neural networks (CNNs) to analyze images at a pixel level and classify them.
  - **Object Detection**: Automatically identifies and maps infrastructure such as traffic signs, crosswalks, and hydrants for accurate mapping.
- **Data Validation and Quality Control:**
  - Ensures the accuracy of uploaded data using crowdsourced reviews. This process improves map reliability and reduces errors.

"Mapillary's end-to end workflow"

Unlocking Spatial Data with APIs

- An API (Application Programming Interface) acts as a bridge, enabling communication between systems and seamless data exchange.
- APIs enable users to connect to complex systems, retrieve data, and integrate it into their own applications.
- By leveraging APIs, Mapillary allows users to its extensive repository of spatial data.



"Illustration of API workflow (Image Source: Rob O'Leary)"

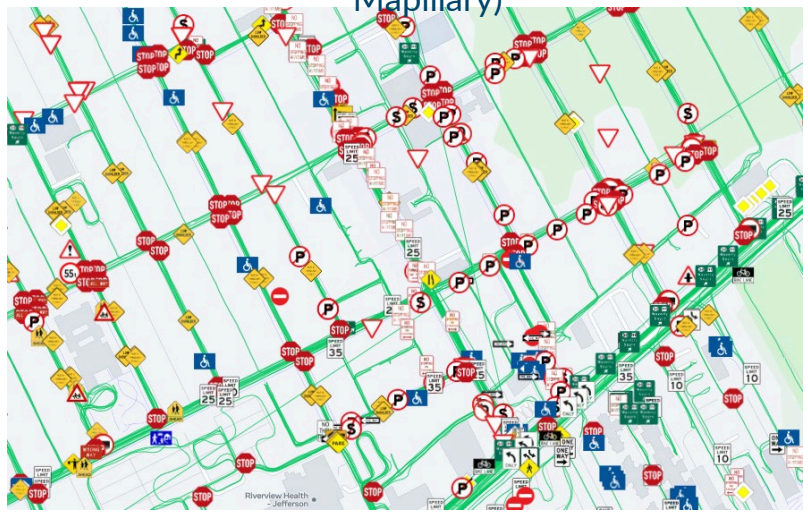
Utilizing the Mapillary API to Retrieve Spatial Data

Introduction to the Mapillary API

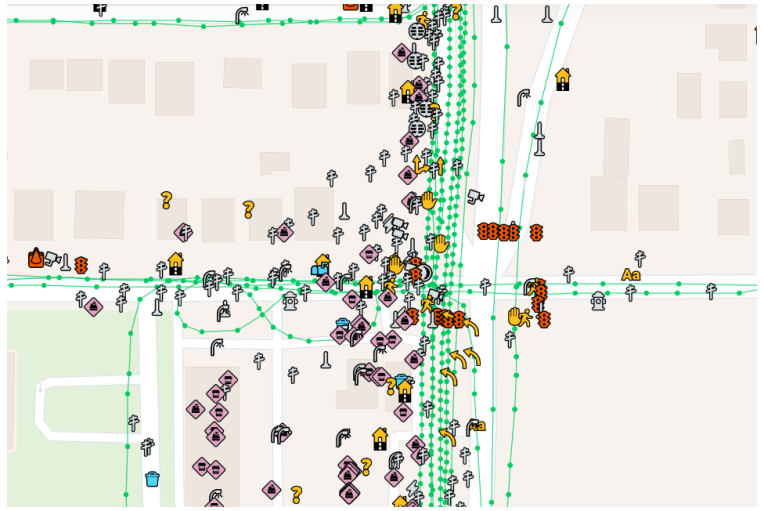
The Mapillary API allows for interaction with Mapillary data in two different forms:

- Vector Tiles – allow for geographic data
  - Coverage Tiles
  - Map Feature Tiles (1,500+ types)
- Entity Endpoints – interact with metadata and images
  - Image
  - Map feature
  - Detection
  - Organization
  - Sequence

Examples of Tile Traffic Signs (credit Mapillary)



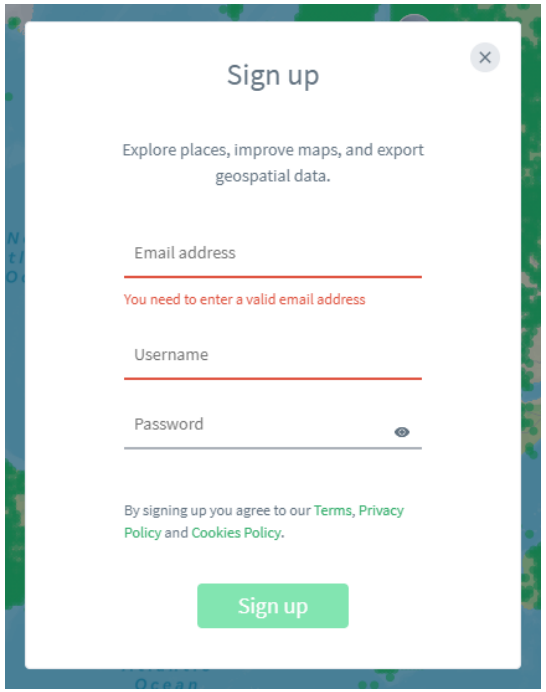
Examples of Tile Points (credit Mapillary)

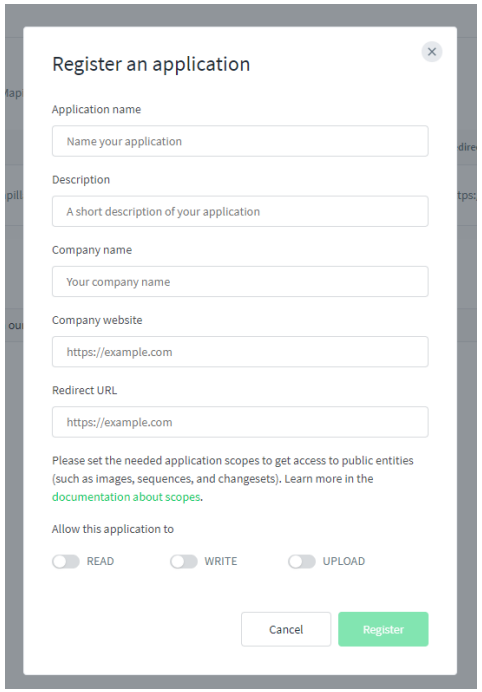


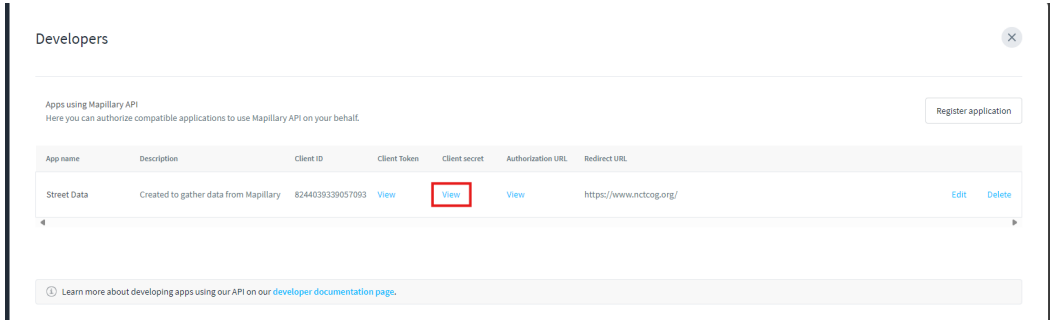
Getting Started with the Mapillary API

To begin using the Mapillary API:

- Sign up to create a new Mapillary account
- Once created, go to your profile settings and click “Developers”
- From there you can register an application with Mapillary that has Read/Write scopes enabled
- Once registered you will be able to view the access token by clicking “view” below “Client Token”
- This token will be used in the script as it allows for authorized requests to be made







Scripting with Mapillary

- Mapillary API scripts vary greatly in complexity, with the simplest ones requiring only the endpoint URL.
- Depending on the requested data type, a certain endpoint URL will be used to make the request.
  - Endpoint for metadata - https://graph.mapillary.com
  - Endpoint for vector tiles - https://tiles.mapillary.com
- Scripting for Mapillary in a python environment requires importing the “requests” and usually the “json”, “Mercantile”, and “mapbox_vector_tile” libraries.

https://tiles.mapillary.com/maps/vtp/{}/2/{}/{}/{}?access_token={}

https://tiles.mapillary.com/maps/vtp/mly_map_feature_traffic_sign/2/14/3729/6578?access_token=MLY|00000000000000000|9856ad9cc629a15337480e7344792d78

Example: Using Mapillary API to Gather All-Way Stop Locations

- Firstly, all relevant libraries are imported:
  - Mercantile – allows for retrieving more than 2,000 features when using a bounding box.
  - Mapbox_vector_tile – allows for the reading and interpretation of vector tiles.
- Then variables are created that will be used to complete the endpoint URL:
  - tile_traffic_signs
  - tile_layer
  - access_token
  - west, south, east, north
  - filter_values
- The mercantile library is then used to create a list of vector tiles that intersect with the search area.

```
import arcpy, requests, mercantile, mapbox_vector_tile, json
from vt2geojson.tools import vt_bytes_to_geojson

# define an empty geojson as output
output= { "type": "FeatureCollection", "features": [] }

# vector tile endpoints -- change this in the API request to reference the correct endpoint
tile_traffic_signs = 'mly_map_feature_traffic_sign'

# tile layer depends which vector tile endpoints:
# 1. if map features or traffic signs, it will be "point" or "traffic_sign" respectively
# 2. if looking for coverage, it will be "image" for points, "sequence" for lines, or "overview" for far zoom
tile_layer = "traffic_sign"

# Mapillary access token -- user should provide their own
access_token = 'MLY|0000000000000000000|9856ad9cc629a15337480e7344792d78'

# a bounding box in [west_lng,_south_lat,east_lng,north_lat] format
west, south, east, north = [-98.060889,32.051951,-95.862486,33.409515]

# list of values to filter for and keep -- update this if changing to traffic signs
filter_values = ['regulatory--all-way--g1']

# get the list of tiles with x and y coordinates which intersect our bounding box
# MUST be at zoom level 14 where the data is available, other zooms currently not supported
tiles = list(mercantile.tiles(west, south, east, north, 14))
```

Example Continued

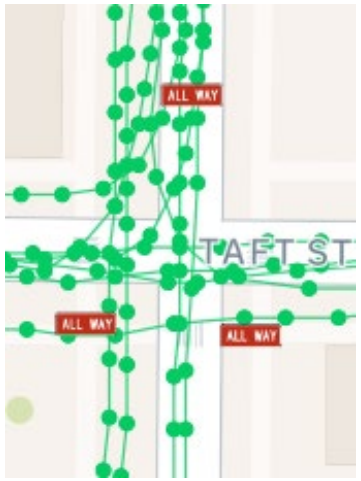
- Loop through all tiles that were previously selected using the variables to send a unique request for each tile
- The retrieved data is then added to “data” which is then filtered by values and geography.
- The filtered features are then appended to output and then saved locally as a geojson.

```
# loop through list of tiles to get tile z/x/y to plug in to Mapillary endpoints and make request
for tile in tiles:
    tile_url = r'https://tiles.mapillary.com/maps/vtp/{}/2/{}/{}/{}?access_token={}'.format(tile_traffic_signs,tile.z,tile.x,tile.y,access_token)
    print(tile_url)
    response = requests.get(tile_url, verify=False)
    data = vt_bytes_to_geojson(response.content, tile.x, tile.y, tile.z,layer=tile_layer)

    # filter for only features matching the values in filter list above
    filtered_data = [feature for feature in data['features'] if feature['properties']['value'] in filter_values]
    print(filtered_data)
    # check if features are inside bbox, and push to output geojson object if yes
    for feature in filtered_data:
        print(feature)
        if (west < feature['geometry']['coordinates'][0] < east) \
            and (south < feature['geometry']['coordinates'][1] < north):
            output['features'].append(feature)
# save a local geojson with the filtered data
with open(r'I:\GIS\GIS Project Assistance\2024\Mapillary API\MapillaryAPIOutput\mydata.geojson', 'w') as f:
    json.dump(output, f)
```

Uploading Data to ArcGIS Pro

- Take the exported geojson and run the tool “JSONToFeatures”
- Snapped multiples to an intersection generated from the TxDOT roadway inventory
- Dissolved to removed redundant duplicate features

```
geoJson = r'I:\GIS\GIS Project Assistance\2024\Mapillary API\MapillaryAPIOutput\mydata.geojson'
mapillaryFeatures = r"I:\GIS\GIS Project Assistance\2024\Mapillary API\mapillaryFeatures"
snappingIntersections = r"I:\GIS\GIS Project Assistance\2024\Mapillary API\MapillaryAPITask\MapillaryAPITask.gdb\TxDOT_Road_Intersections"
outputDissolved = r"I:\GIS\GIS Project Assistance\2024\Mapillary API\MapillaryAPITask\MapillaryAPITask.gdb\myDataDissolved"

arcpy.conversion.JSONToFeatures(geoJson, mapillaryFeatures, "POINT")
arcpy.edit.Snap(mapillaryFeatures, [(snappingIntersections, "END", "125 FEET")])
arcpy.management.Dissolve(mapillaryFeatures, outputDissolved,"", "", "SINGLE_PART")
```



(credit Mapillary)

Resources

- Mapillary
- API Documentation
- Getting Started with the new Mapillary API v4

Questions?

Is anyone else working with Mapillary or other similar resources to update their inventories?

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