Overture Maps Data Download

Applying DuckDB in R and Python

Pukar Bhandari

2024-05-22

Table of contents

# 1. Downloading Overture Maps Data with R and Python

Overture Maps Foundation provides a collaborative, open-source initiative to create the world’s most comprehensive and interoperable geospatial dataset. As transportation planners and data analysts, we often need access to high-quality geospatial data for buildings, transportation networks, places, and administrative boundaries. This post demonstrates how to efficiently download Overture Maps data using both R and Python with DuckDB’s powerful spatial capabilities.

## 1.1 What is Overture Maps?

Overture Maps is an open-source mapping initiative that provides global-scale geospatial data across four main themes:

* **Buildings**: Footprints and building parts
* **Transportation**: Road segments and connectors
* **Places**: Points of interest and place data
* **Admins**: Administrative boundaries and localities
* **Base**: Infrastructure, land use, land cover, and water features

The data is stored in cloud-optimized Parquet format on AWS S3, making it ideal for efficient querying and analysis.

## 1.2 Prerequisites

Before diving into the code, ensure you have the following dependencies installed:

#### R

# Install required packages  
install.packages(c("tidyverse", "sf", "tmap", "DBI", "duckdb", "arrow"))

#### Python

# Install required packages  
pip install duckdb matplotlib geopandas pandas shapely folium pathlib

## 1.3 Setting Up the Environment

First, we need to load our libraries and configure the environment for spatial data processing.

#### R

# Load required libraries  
library(tidyverse)  
library(sf)  
library(tmap)  
library(DBI)  
library(duckdb)  
library(arrow)  
  
# Set global options  
options(scipen = 999) # avoiding scientific notation  
tmap\_mode(mode = "view")

#### Python

import duckdb  
import geopandas as gpd  
import pandas as pd  
import shapely.wkb  
import matplotlib.pyplot as plt  
import folium  
from pathlib import Path

## 1.4 Data Type Mapping

Overture data is organized by themes, and we need to map specific data types to their corresponding themes for proper S3 path construction.

#### R

# Define the theme map  
map\_themes <- list(  
 "locality" = "admins",  
 "locality\_area" = "admins",  
 "administrative\_boundary" = "admins",  
 "building" = "buildings",  
 "building\_part" = "buildings",  
 "place" = "places",  
 "segment" = "transportation",  
 "connector" = "transportation",  
 "infrastructure" = "base",  
 "land" = "base",  
 "land\_use" = "base",  
 "water" = "base"  
)

#### Python

# Define theme mapping  
THEME\_MAP = {  
 "locality": "admins",  
 "locality\_area": "admins",  
 "administrative\_boundary": "admins",  
 "building": "buildings",  
 "building\_part": "buildings",  
 "place": "places",  
 "segment": "transportation",  
 "connector": "transportation",  
 "infrastructure": "base",  
 "land": "base",  
 "land\_use": "base",  
 "water": "base",  
}

## 1.5 Core Download Function

This function handles the DuckDB connection, S3 configuration, and spatial filtering to download only the data within your specified bounding box.

#### R

overture\_data <- function(bbox, overture\_type, dst\_parquet) {  
   
 # Validate overture\_type  
 if (!overture\_type %in% names(map\_themes)) {  
 stop(paste("Valid Overture types are:", paste(names(map\_themes), collapse = ", ")))  
 }  
   
 # Configure S3 path  
 s3\_region <- "us-west-2"  
 base\_url <- sprintf("s3://overturemaps-%s/release", s3\_region)  
 version <- "2024-04-16-beta.0"  
 theme <- map\_themes[[overture\_type]]  
 remote\_path <- sprintf("%s/%s/theme=%s/type=%s/\*", base\_url, version, theme, overture\_type)  
   
 # Connect to DuckDB and install extensions  
 conn <- dbConnect(duckdb::duckdb())  
 dbExecute(conn, "INSTALL httpfs;")  
 dbExecute(conn, "INSTALL spatial;")  
 dbExecute(conn, "LOAD httpfs;")  
 dbExecute(conn, "LOAD spatial;")  
 dbExecute(conn, sprintf("SET s3\_region='%s';", s3\_region))  
   
 # Create view and execute spatial query  
 read\_parquet <- sprintf("read\_parquet('%s', filename=TRUE, hive\_partitioning=1);", remote\_path)  
 dbExecute(conn, sprintf("CREATE OR REPLACE VIEW data\_view AS SELECT \* FROM %s", read\_parquet))  
   
 query <- sprintf("  
 SELECT data.\*  
 FROM data\_view AS data   
 WHERE data.bbox.xmin <= %f AND data.bbox.xmax >= %f  
 AND data.bbox.ymin <= %f AND data.bbox.ymax >= %f  
 ", bbox[3], bbox[1], bbox[4], bbox[2])  
   
 # Save results to Parquet file  
 file <- normalizePath(dst\_parquet, mustWork = FALSE)  
 dbExecute(conn, sprintf("COPY (%s) TO '%s' WITH (FORMAT 'parquet');", query, file))  
 dbDisconnect(conn, shutdown = TRUE)  
}

#### Python

def overture\_data(bbox, overture\_type, dst\_parquet):  
 """Query a subset of Overture's data and save it as a GeoParquet file.  
   
 Parameters  
 ----------  
 bbox : tuple  
 A tuple of floats representing the bounding box (xmin, ymin, xmax, ymax)   
 in EPSG:4326 coordinate reference system.  
 overture\_type : str  
 The type of Overture data to query  
 dst\_parquet : str or Path  
 The path to the output GeoParquet file.  
 """  
 if overture\_type not in THEME\_MAP:  
 raise ValueError(f"Valid Overture types are: {list(THEME\_MAP)}")  
   
 # Configure S3 connection  
 s3\_region = "us-west-2"  
 base\_url = f"s3://overturemaps-{s3\_region}/release"  
 version = "2024-04-16-beta.0"  
 theme = THEME\_MAP[overture\_type]  
 remote\_path = f"{base\_url}/{version}/theme={theme}/type={overture\_type}/\*"  
   
 # Setup DuckDB with spatial extensions  
 conn = duckdb.connect()  
 conn.execute("INSTALL httpfs;")  
 conn.execute("INSTALL spatial;")  
 conn.execute("LOAD httpfs;")  
 conn.execute("LOAD spatial;")  
 conn.execute(f"SET s3\_region='{s3\_region}';")  
   
 # Execute spatial query  
 read\_parquet = f"read\_parquet('{remote\_path}', filename=true, hive\_partitioning=1);"  
 conn.execute(f"CREATE OR REPLACE VIEW data\_view AS SELECT \* FROM {read\_parquet}")  
   
 query = f"""  
 SELECT data.\*  
 FROM data\_view AS data  
 WHERE data.bbox.xmin <= {bbox[2]} AND data.bbox.xmax >= {bbox[0]}  
 AND data.bbox.ymin <= {bbox[3]} AND data.bbox.ymax >= {bbox[1]}  
 """  
   
 file = str(Path(dst\_parquet).resolve())  
 conn.execute(f"COPY ({query}) TO '{file}' WITH (FORMAT PARQUET);")  
 conn.close()

## 1.6 Defining Your Study Area

For spatial analysis, you need to define a bounding box for your area of interest. This can come from existing boundary data or manual coordinates.

#### R

# Read existing boundary data (example: Albany, NY)  
albany\_boundary <- read\_sf(file.path(wd, project), layer = "City\_of\_Albany") |>  
 st\_transform(4326)  
  
# Extract bounding box coordinates (xmin, ymin, xmax, ymax)  
albany\_bbox <- albany\_boundary |>  
 st\_bbox() |>  
 as.vector()  
  
print(albany\_bbox)

#### Python

# Define study area bounding box manually  
# Manhattan example (xmin, ymin, xmax, ymax) in EPSG:4326  
bbox\_example = (-74.02169, 40.696423, -73.891338, 40.831263)  
  
# Alternative: extract from existing boundary data  
# boundary\_gdf = gpd.read\_file("your\_boundary.shp")  
# bbox\_example = boundary\_gdf.total\_bounds

## 1.7 Downloading the Data

Now we can download specific data types for our study area. The function handles all the cloud connectivity and spatial filtering automatically.

#### R

# Download places data for Albany  
overture\_data(albany\_bbox, "place", "albany\_places\_subset.parquet")  
  
# Download buildings data  
overture\_data(albany\_bbox, "building", "albany\_buildings\_subset.parquet")  
  
# Download transportation segments  
overture\_data(albany\_bbox, "segment", "albany\_roads\_subset.parquet")

#### Python

# Download buildings data for Manhattan  
overture\_data(bbox\_example, "building", "nyc\_buildings\_subset.parquet")  
  
# Download places data  
overture\_data(bbox\_example, "place", "nyc\_places\_subset.parquet")  
  
# Download transportation network  
overture\_data(bbox\_example, "segment", "nyc\_roads\_subset.parquet")

## 1.8 Processing Downloaded Data

After downloading, convert the Parquet files to spatial data formats for analysis and visualization.

#### R

# Read the downloaded Parquet file  
albany\_places <- read\_parquet("albany\_places\_subset.parquet")  
  
# Convert to sf object for spatial operations  
albany\_places\_sf <- st\_as\_sf(  
 albany\_places |> select(-sources),  
 geometry = albany\_places$geometry,  
 crs = 4326  
)  
  
# Basic data exploration  
print(paste("Downloaded", nrow(albany\_places\_sf), "places"))  
print(colnames(albany\_places\_sf))

#### Python

# Read the downloaded data  
manhattan = pd.read\_parquet("nyc\_buildings\_subset.parquet")  
  
# Convert to GeoDataFrame  
manhattan\_gdf = gpd.GeoDataFrame(  
 manhattan.drop(columns="geometry"),  
 geometry=shapely.wkb.loads(manhattan["geometry"]),  
 crs=4326,  
)  
  
# Basic exploration  
print(f"Downloaded {len(manhattan\_gdf)} buildings")  
print(manhattan\_gdf.columns.tolist())

## 1.9 Data Visualization

Create quick visualizations to explore your downloaded data and verify the results.

#### R

# Interactive map using tmap (equivalent to folium)  
albany\_places\_sf |>  
 select(names$primary, categories$main, confidence) |>  
 tm\_shape() +  
 tm\_dots(col = "categories$main", size = 0.5, alpha = 0.8) +  
 tm\_view(view.legend.position = c("left", "bottom"))  
  
# Simple quick visualization  
albany\_places\_sf |>  
 select(names$primary, categories$main, confidence) |>  
 qtm(dots.col = "categories$main")

#### Python

# Static plot using GeoPandas  
manhattan\_gdf.plot(figsize=(10, 10), alpha=0.7, column='categories', legend=True)  
plt.title("Manhattan Buildings from Overture Maps")  
plt.show()  
  
# Interactive map with folium (equivalent to tmap interactive)  
m = folium.Map(location=[40.7589, -73.9851], zoom\_start=12)  
folium.GeoJson(  
 manhattan\_gdf.head(100),  
 popup=folium.GeoJsonPopup(fields=['names', 'categories'])  
).add\_to(m)  
m

## 1.10 Available Data Types

Overture Maps provides the following data types organized by theme:

| Theme | Data Types | Description |
| --- | --- | --- |
| **Admins** | locality, locality\_area, administrative\_boundary | Administrative boundaries and place hierarchies |
| **Buildings** | building, building\_part | Building footprints and structural components |
| **Places** | place | Points of interest, businesses, and landmarks |
| **Transportation** | segment, connector | Road networks and transportation infrastructure |
| **Base** | infrastructure, land, land\_use, water | Base map features and land cover |

## 1.11 Transportation Planning Applications

This approach is particularly valuable for transportation planning workflows where you need to integrate multiple data sources for comprehensive analysis. The standardized schema and efficient spatial querying make it ideal for network analysis, land use integration, and multi-modal planning across different jurisdictions and scales.

## 1.12 Repository and Additional Resources

The complete code and examples are available in the [Overture Data Download repository](https://github.com/ar-puuk/overture-data-download/) on GitHub.

For more information about Overture Maps:

* [Official Documentation](https://docs.overturemaps.org/)
* [Data Schema Reference](https://docs.overturemaps.org/schema/)
* [Community Forum](https://github.com/OvertureMaps/data/discussions)