Spatial Thinking with Python

Sangarshanan

{{ ME_IRL }}

Sangarshanan

Recently graduated from VIT Vellore

Working at Grofers

Obsessed Memes and Astrophysics

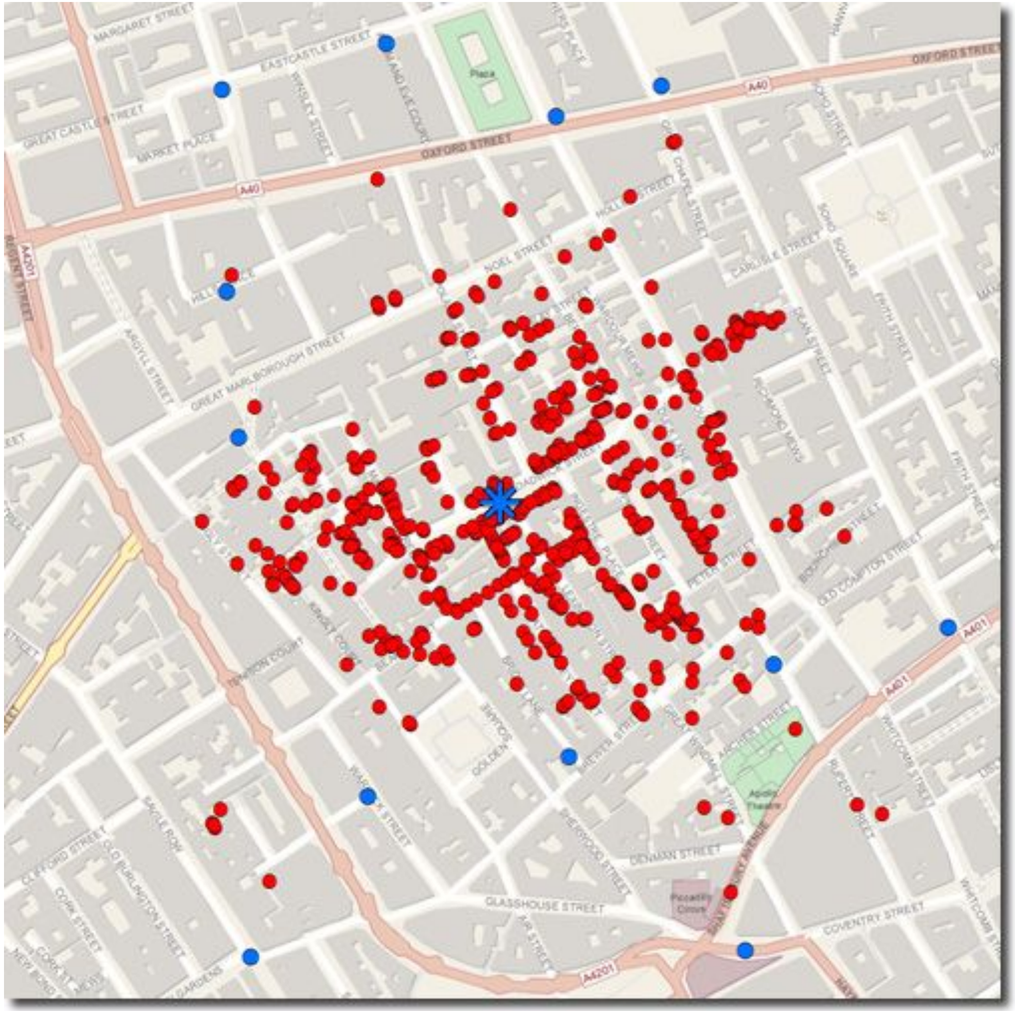
Github

Twitter


Me using memes in my presentation
Literally everyone
That one person who appreciates memes

The geostory begins

When you realize that John Snow was basically the first person to effectively make use of geospatial data


MARGARET STREET
EASTCASTLE STREET
GREAT CASTLE STREET
MARKET PLACE
OXFORD STREET
A40
Plaza
WINSLEY STREET
NOEL STREET
GREAT MARLBOROUGH STREET
ARGYLL STREET
A4201
CARLISLE STREET
SOHO SQUARE
DEAN STREET
FRITH STREET
OLD COMPTON STREET
A401
SAVILE ROW
OLD BURLINGTON STREET
CLIFFORD STREET
CORK STREET
DENMAN STREET
SHERWOOD STREET
GLASSHOUSE STREET
COVENTRY STREET
Piccadilly Circus
Apollo Theatre
RUPERT STREET
WHITCOMB STREET

Location Intelligence

Intelligence you acquire from spatial thinking

When you realize that spatial data doesn’t get the attention it deserves

WHAT IS GEOSPATIAL DATA ?

Geospatial data is any data with a geographic component that can be layered onto a map

Types of these geographic components ?

Vector

Points / Geometries /Shapes

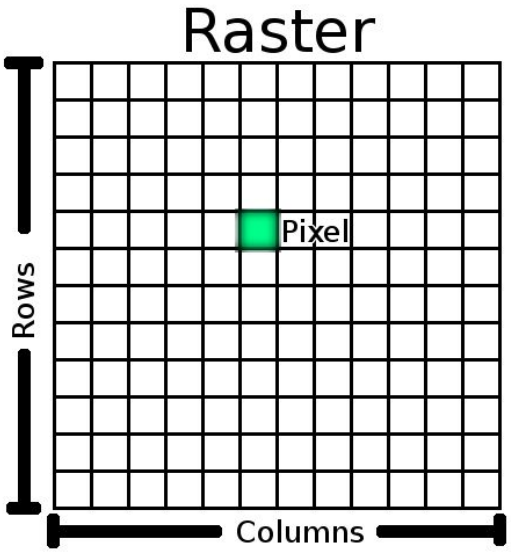
eg: Shapefiles, GEOJSON

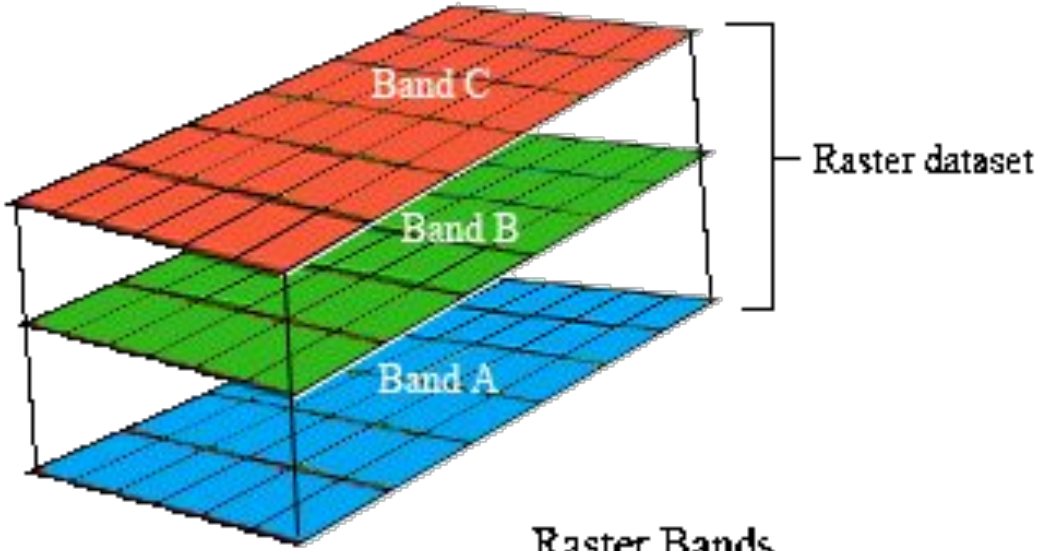
Raster

Pixels with or without spatial metadata

eg: GEOTIFF, TIFF

Raster Data





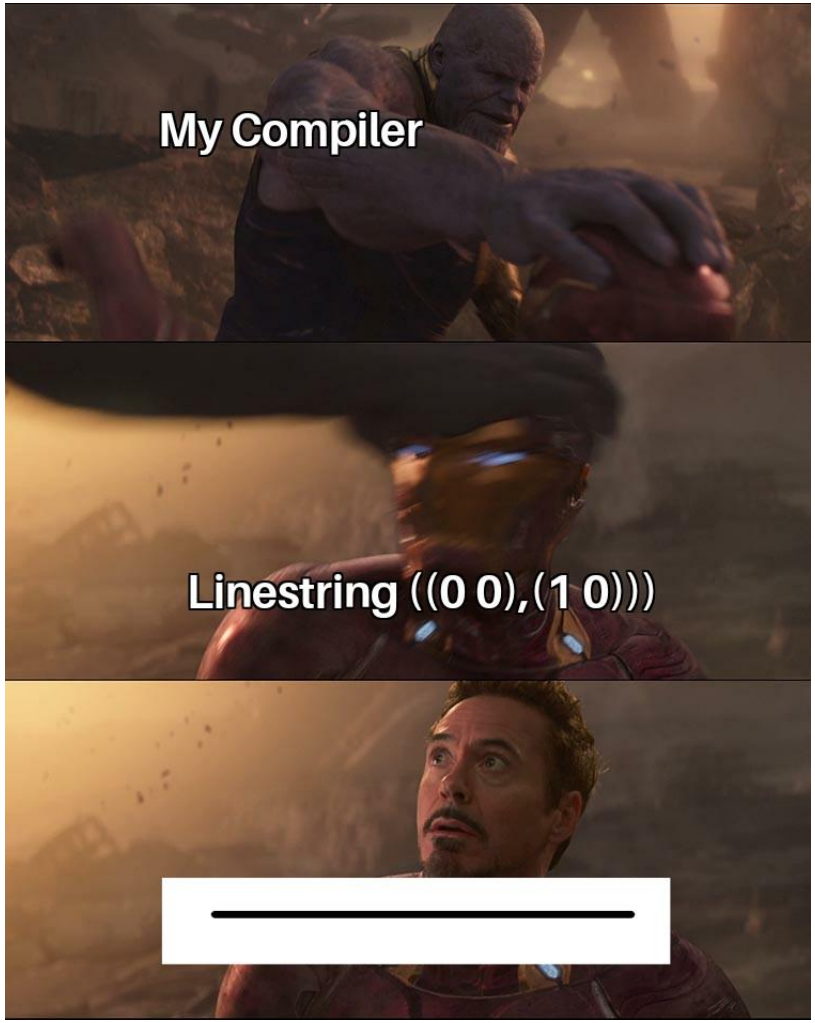
Raster Bands

We can get our Raster's degree now

We can get our Raster’s degree now

- Monitoring and predicting natural phenomena like Hurricanes, Forest fires etc
- Do tons of cool analysis over time like calculating the Affluence of the area, Extent of vegetation, Types of buildings, Road network, Population, Nightlights.

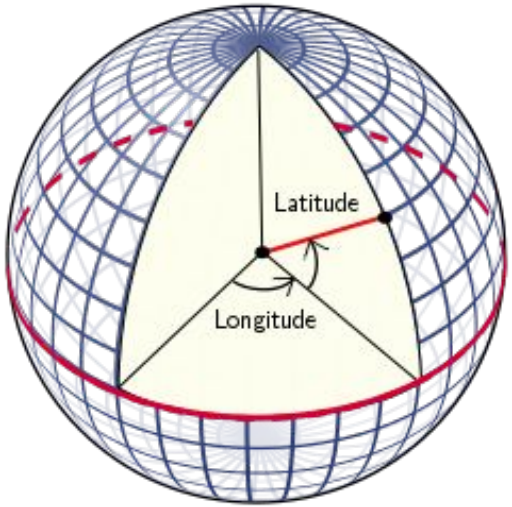
Well Known text



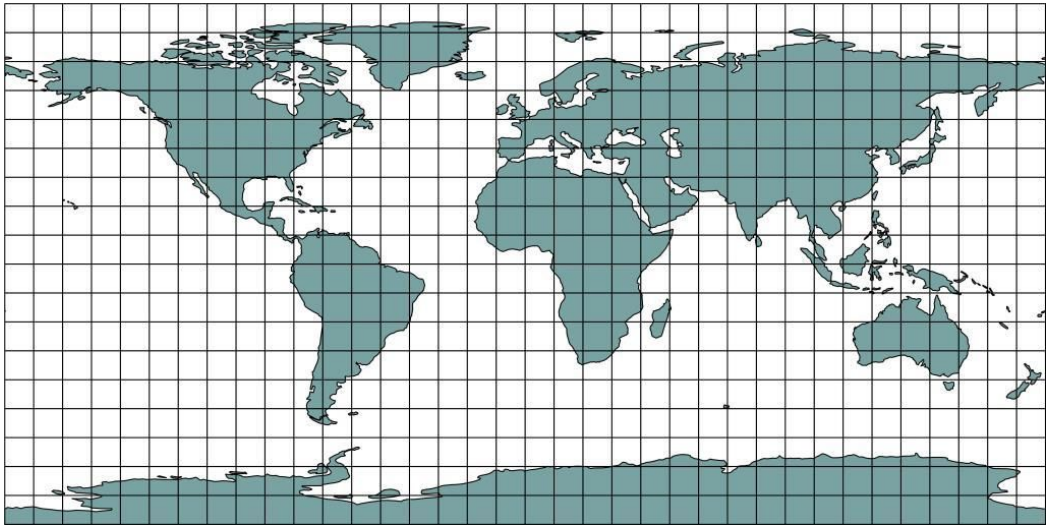
Well known binary

Spatial Reference System

Geographic coordinate systems



Projected coordinate systems



Sentinel 2

Geotiff

KMZ

KML

Carto

SHP

Geojson

SHP

KML

GPX

ESRI

GeoRSS

CSV

GSC

GML

Read/ Write/ Analyze

Number of geospatial python libraries jumping from 10 to 1000

GDAL / OGR

Geospatial Data Abstraction Library

YEAR 1998

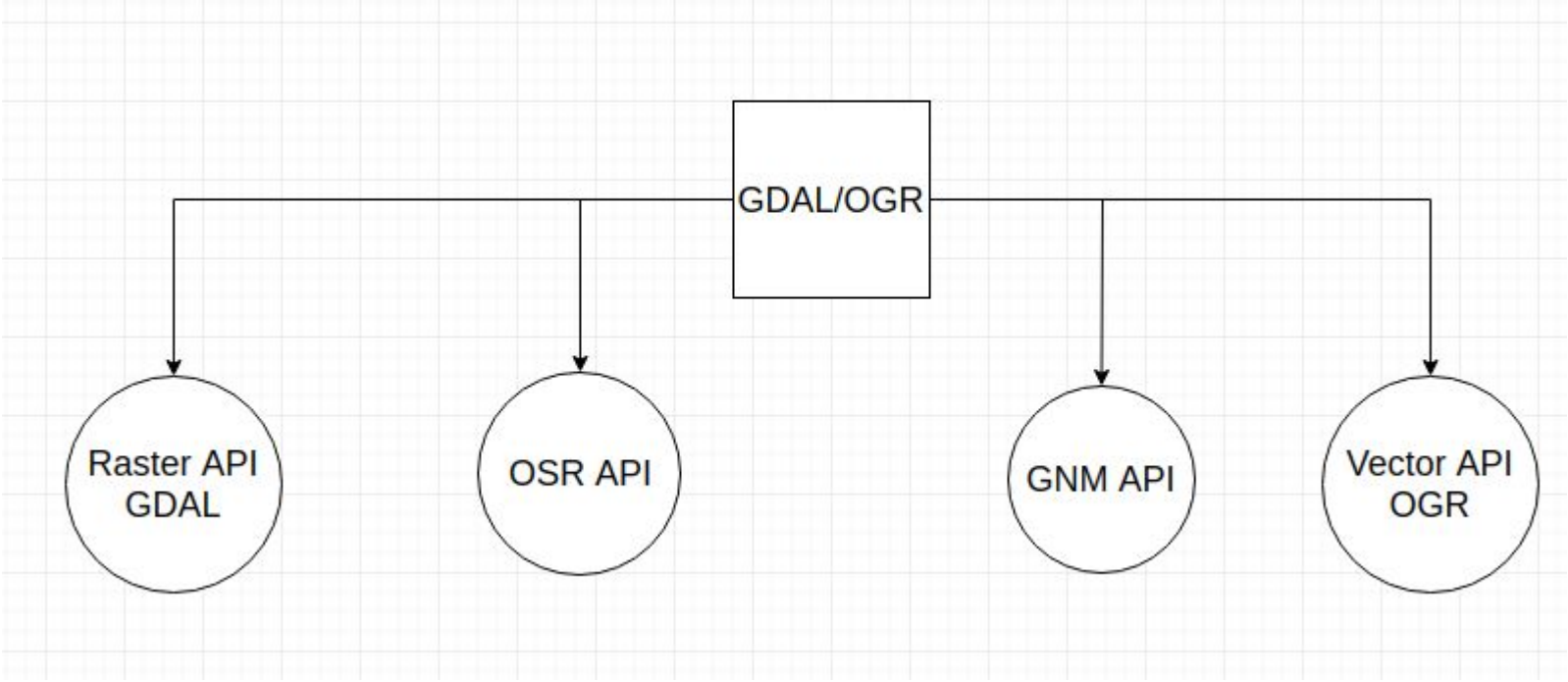
154 raster and 93 vector geospatial data formats

ogr2ogr can convert data in PostGIS to KML

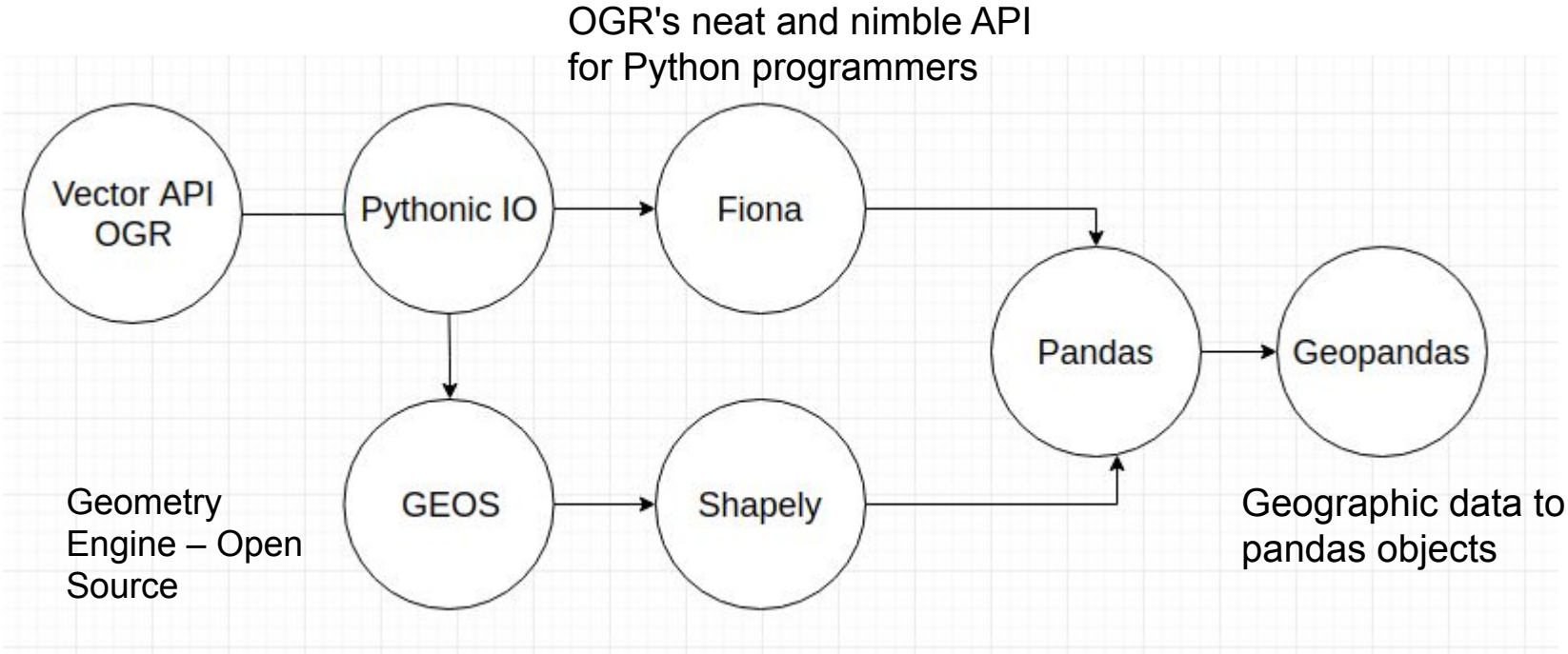
```
$ ogr2ogr -f "KML" \
neighborhoods.kml  \
PG:"host=myhost user=myloginname dbname=mydbname password=mypassword" \
-sql \
"select gid, name, the_geom from neighborhoods" \
```

ogrinfo lists information about the data

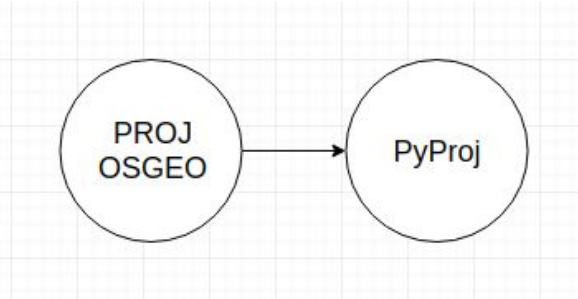
```
$ ogrinfo data/EXAMPLE.NTF
```

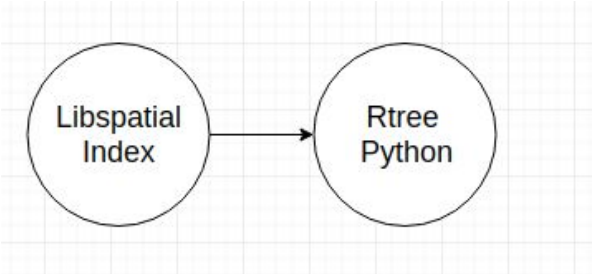

GDAL/OGR
Raster API
GDAL
OSR API
GNM API
Vector API
OGR

Vector Data


OGR's neat and nimble API
for Python programmers
Vector API
OGR
Pythonic IO
Fiona
Pandas
Geopandas
GEOS
Shapely
Geometry
Engine – Open
Source
Geographic data to
pandas objects

OSR Projections / Rtree





Pythonic cartographic projections and coordinate transformations library

Advanced spatial indexing features

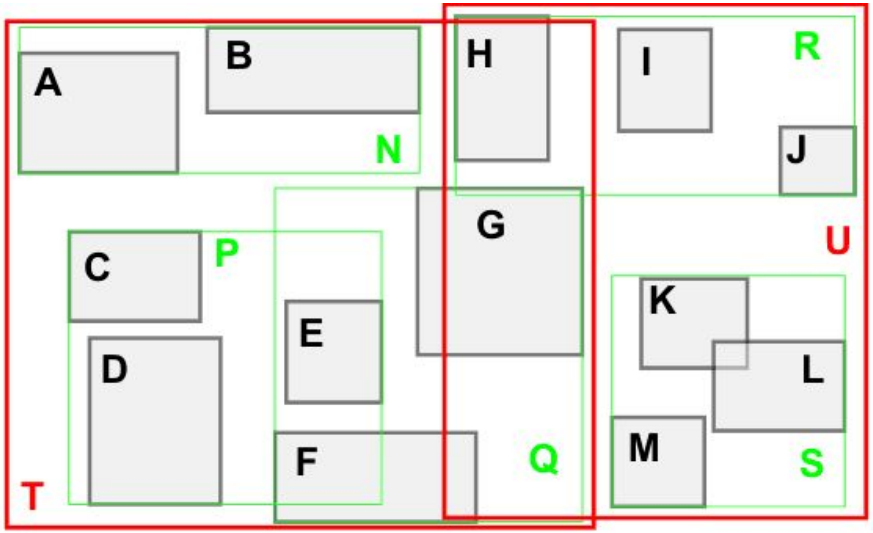
Fiona ,Shapely, Geopandas

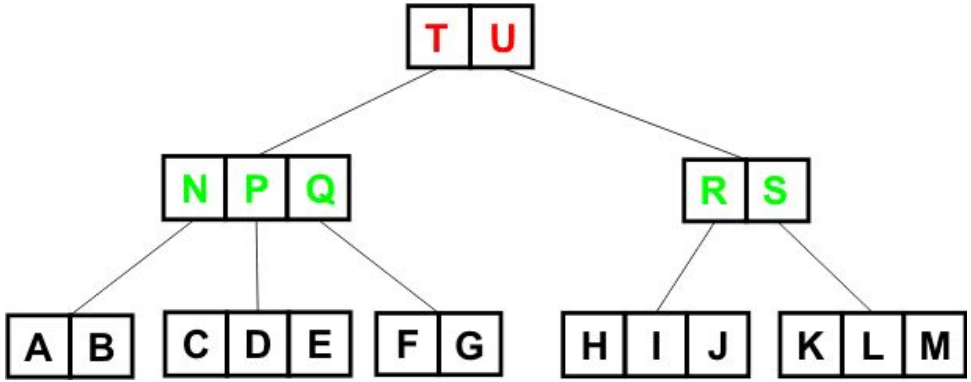
Indexing Geospatial Data

Suppose you want to find all the geospatial points in a given radius

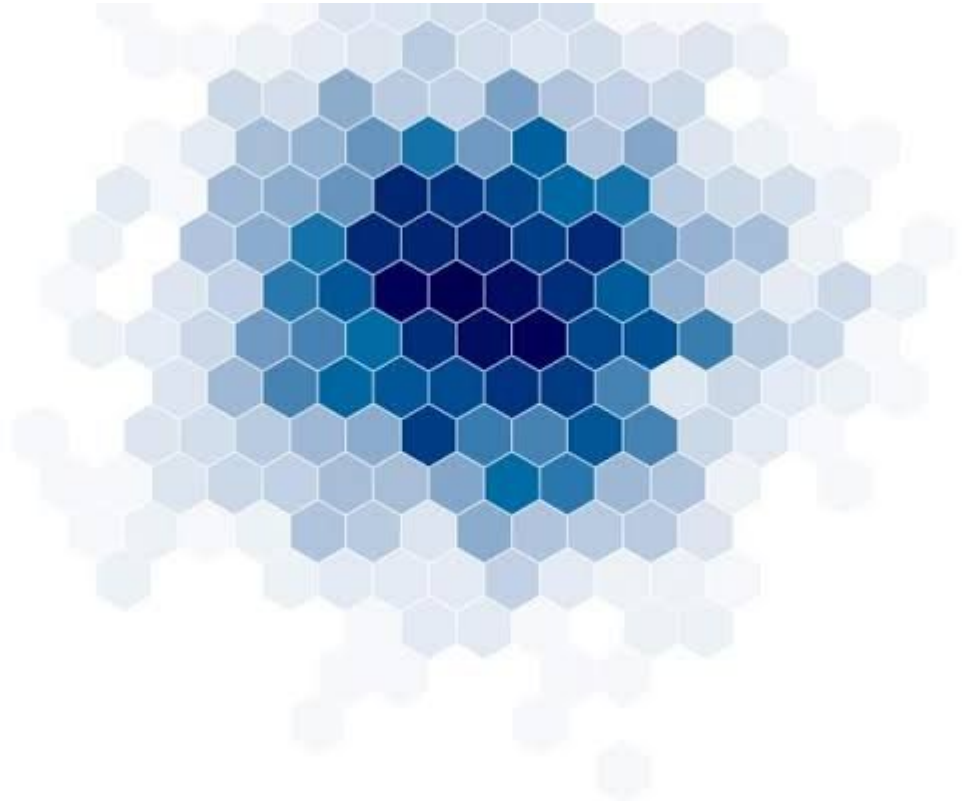
Are you gonna iterate ? HELL NAHHH

Use Spatial indices provided by the spatial extensions of traditional databases like postgres (Postgis uses Rtrees)


A
B
N
H
I
R
J
G
U
C
P
E
K
D
L
F
Q
M
S
T


T U
N P Q
R S
A B
C D E
F G
H I J
K L M

Hexagonal grid indexing (Uber H3)



```
SELECT superhero.name
FROM city, superhero
WHERE ST_Contains(city.geom, superhero.geom)
AND city.name = 'Gotham';
```

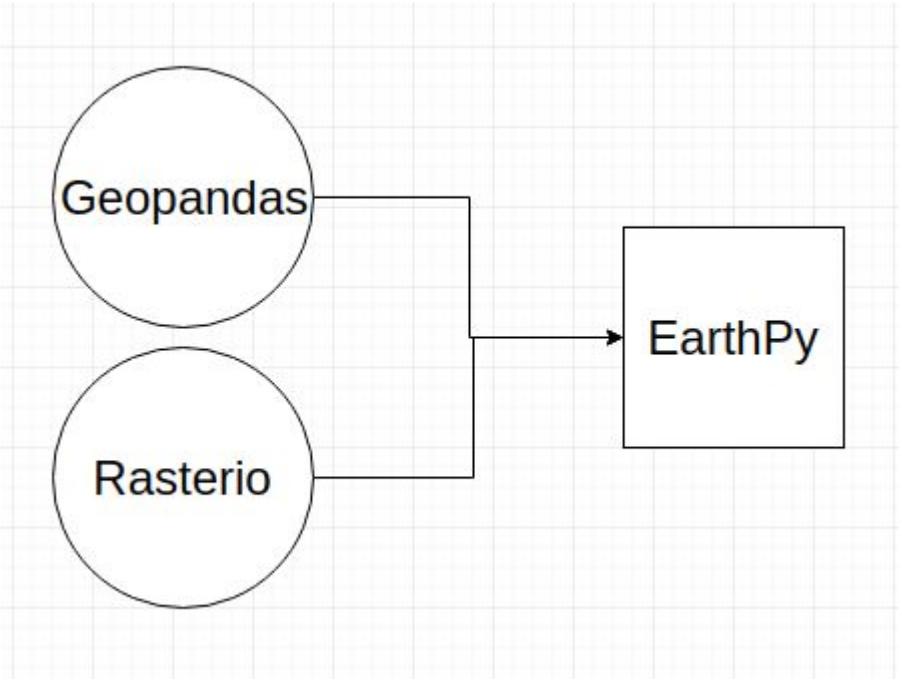
Raster Data

Rasterio reads and writes raster formats and provides a Python API based on N-D arrays.

There are also packages than combine these existing packages that are actually wrappers on already existing packages (like inception)

Vector data

Raster data



OSMNX (0SM + Networkx)

Work with road network data from osm using networkx

Analyze and visualize street networks, routing , travel times etc

Visualize

When you plot and visualize all your spatial layers on a basemap

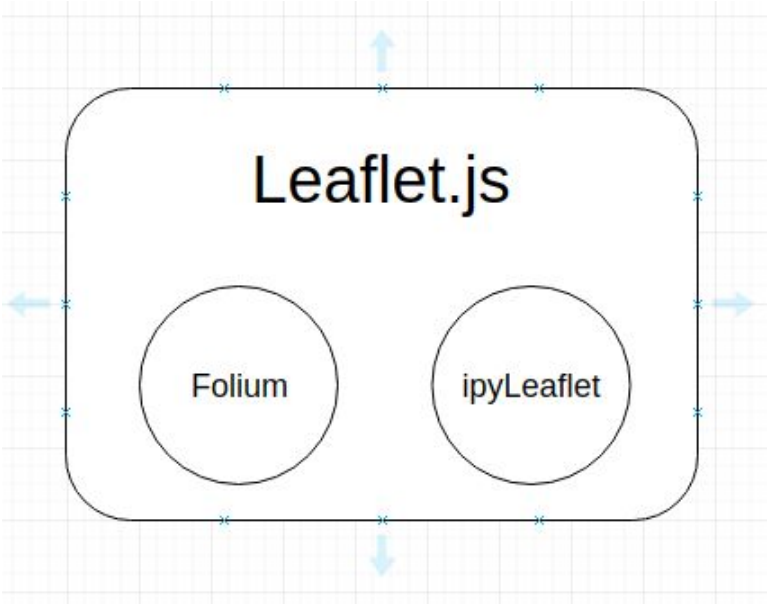
You need to know javascript to create such cool maps

Just Plot em

Matplotlib (for everything)

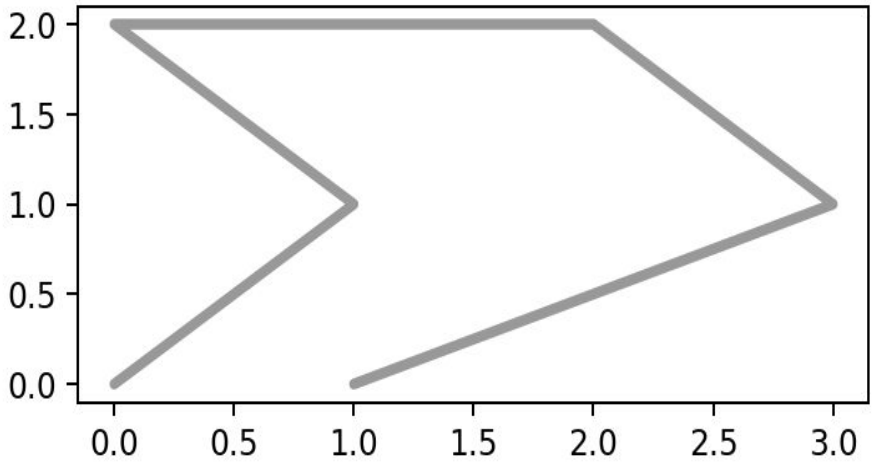
Leaflet / Openlayers / Mapbox

Plotly + Mapbox / Mapboxgl



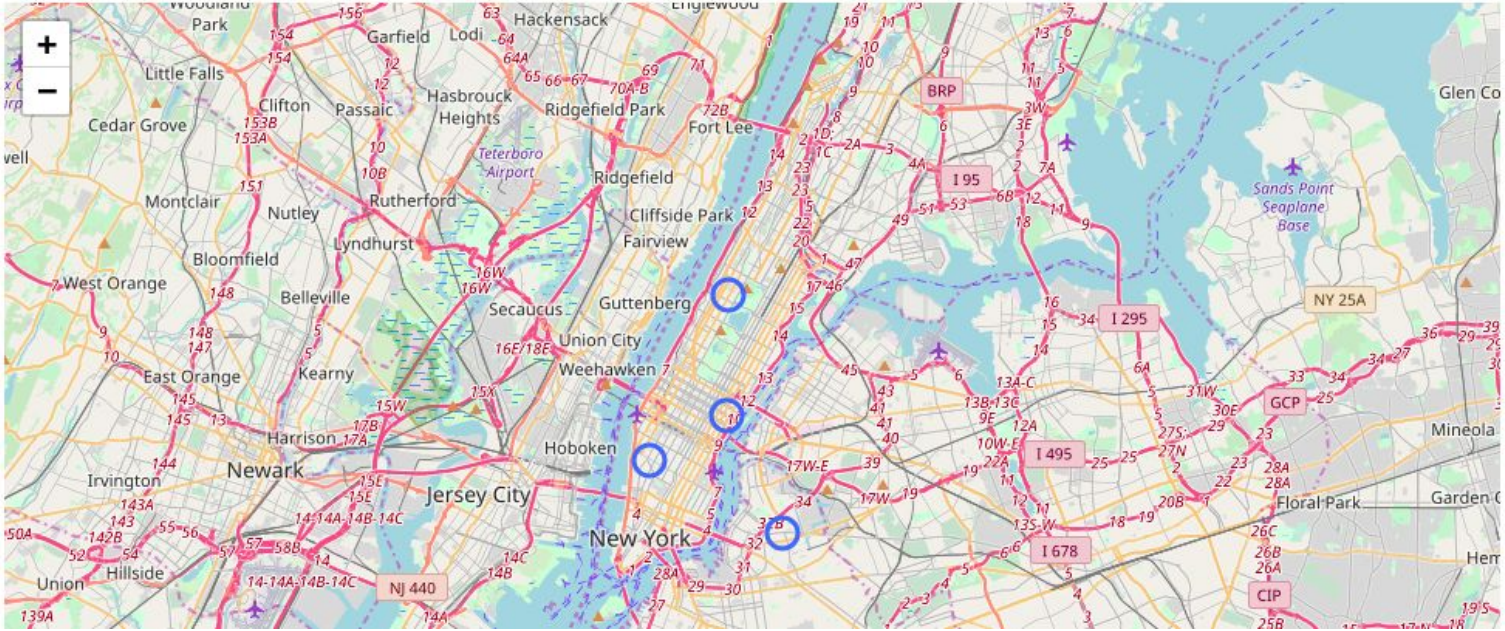
Geometry + Matplotlib = Descartes

Enables plotting of shapely geometries as matplotlib paths/ patches.

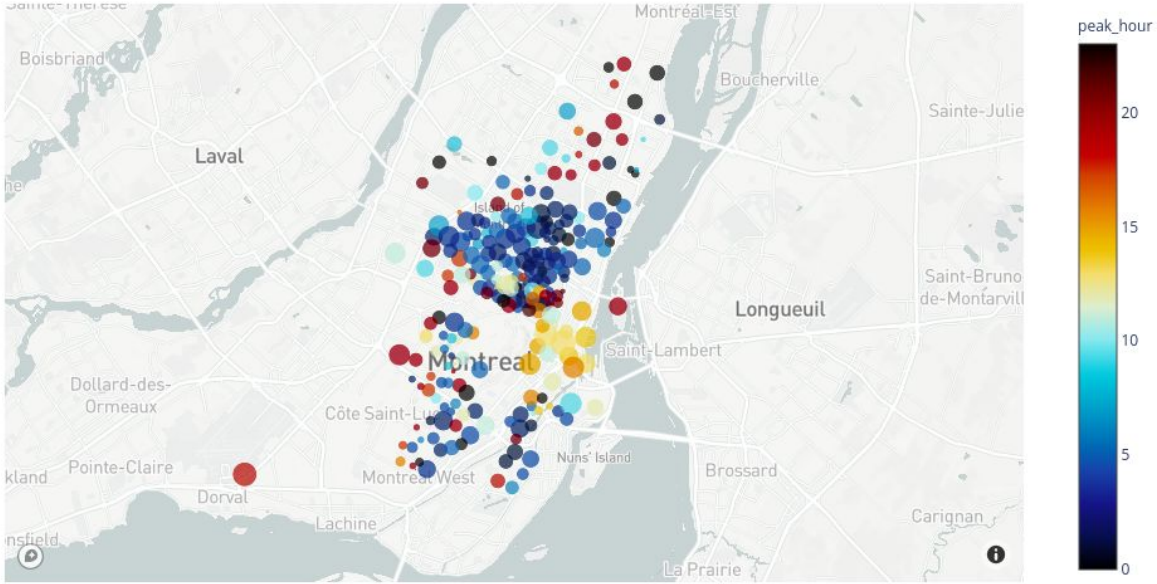


In [109]:
```
import folium
import pandas as pd

train_df = pd.DataFrame({'Latitude': [40.7145,40.7947,40.7388, 40.7539],
                         'Longitude':[ -73.9425 ,-73.9667 ,-74.0018 ,-73.9677 ]    })

map_osm = folium.Map(location=[40.742, -73.956], zoom_start=11)

train_df.apply(lambda row:folium.CircleMarker(location=[row["Latitude"], row["Longitude"]],
                                              radius=10)
                                             .add_to(map_osm), axis=1)

map_osm
```

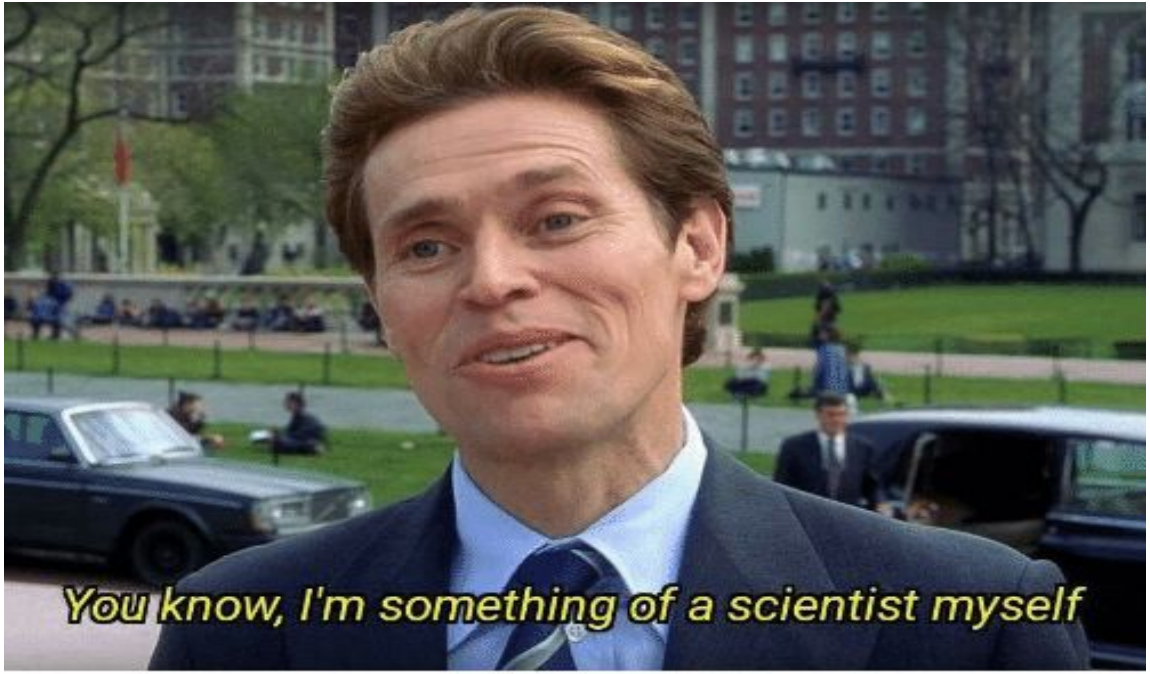
Out[109]:



```
import plotly.express as px
px.set_mapbox_access_token(open(".mapbox_token").read())
carshare = px.data.carshare()
fig = px.scatter_mapbox(carshare, lat="centroid_lat", lon="centroid_lon",     color="peak_hour", size="car_hours",
                        color_continuous_scale=px.colors.cyclical.IceFire, size_max=15, zoom=10)
fig.show()
```



Me after running
import tensorflow as tf



PySAL: Python Spatial Analysis Library

Spatially constrained Clustering

Spatio-temporal data analysis

Spatial regression and Statistical modeling


It’s Code Time

What’s the POINT(12.22,73.32) ?

Marketing

GEO - Marketing

Your Apps Know Where You Were Last Night, and They're Not Keeping It Secret

Dozens of companies use smartphone locations to help advertisers and even hedge funds. They say it's anonymous, but the data shows how personal it is.

By JENNIFER VALENTINO-DeVRIES, NATASHA SINGER, MICHAEL H. KELLER and AARON KROLIK DEC. 10, 2018

The millions of dots on the map trace highways, side streets and bike trails — each one following the path of an anonymous cellphone user.

One path tracks someone from a home outside Newark to a nearby Planned Parenthood, remaining there for more than an hour. Another represents a person who travels with the mayor of New York during the day and returns to Long Island at night.

PennyWISE Decision Making

GEO - Surge

That was UnUbercool

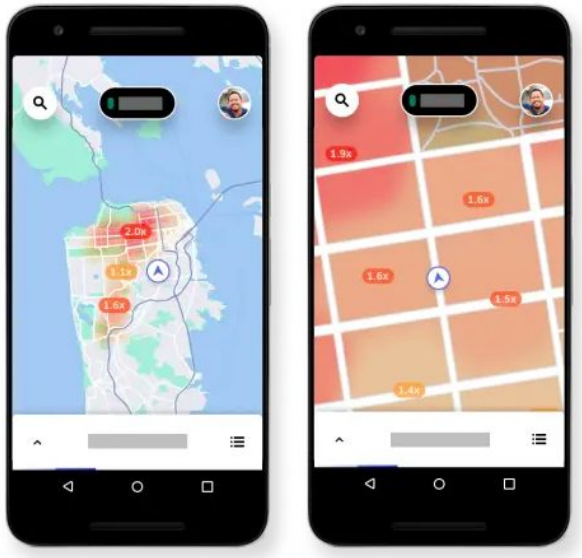
How to identify surge in the app

When demand increases in a specific area, that neighborhood will change color. You can zoom into colored areas of your app's city map to see current surge pricing.

The colored areas of the map will range from light orange to dark red. Light orange areas represent small multipliers while dark red areas indicate large multipliers.

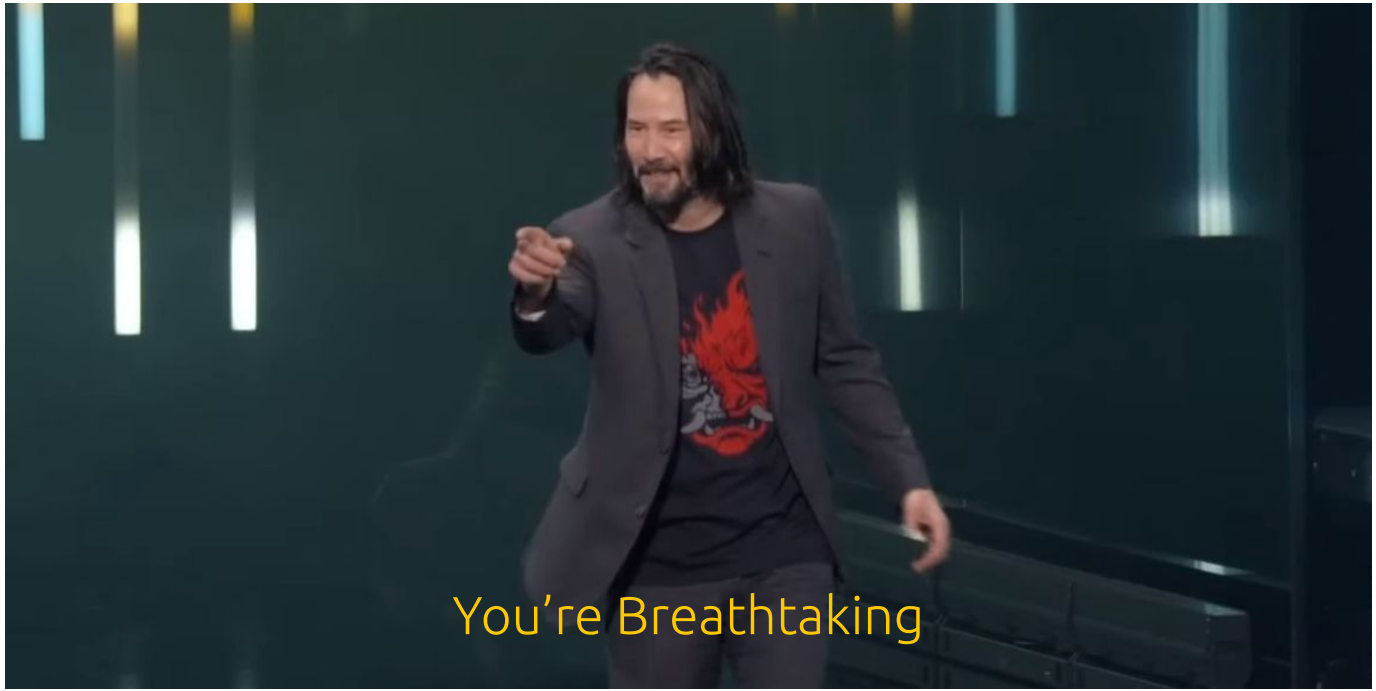
You can see the amount of surge pricing that will apply to a potential trip when you are deciding whether or not to accept a trip in the driver app.

How are surge prices calculated?




Airbnb
Starbucks
Uber
Mastercard

Hey You…. Yes you :)



Blogs I stole content from

- https://blog.mapbox.com/a-dive-into-spatial-search-algorithms-ebd0c5e39d2a
- https://github.com/pcjericks/py-gdalogr-cookbook
- https://medium.com/locale-ai
- https://geoffboeing.com/
- https://towardsdatascience.com/geospatial-indexing-with-ubers-h3-766399b690c
- https://medium.com/@chrieke/essential-geospatial-python-libraries-5d82fcc38731
- https://pysal.readthedocs.io/en/latest/