CARTO

2018

OSM in Location Science

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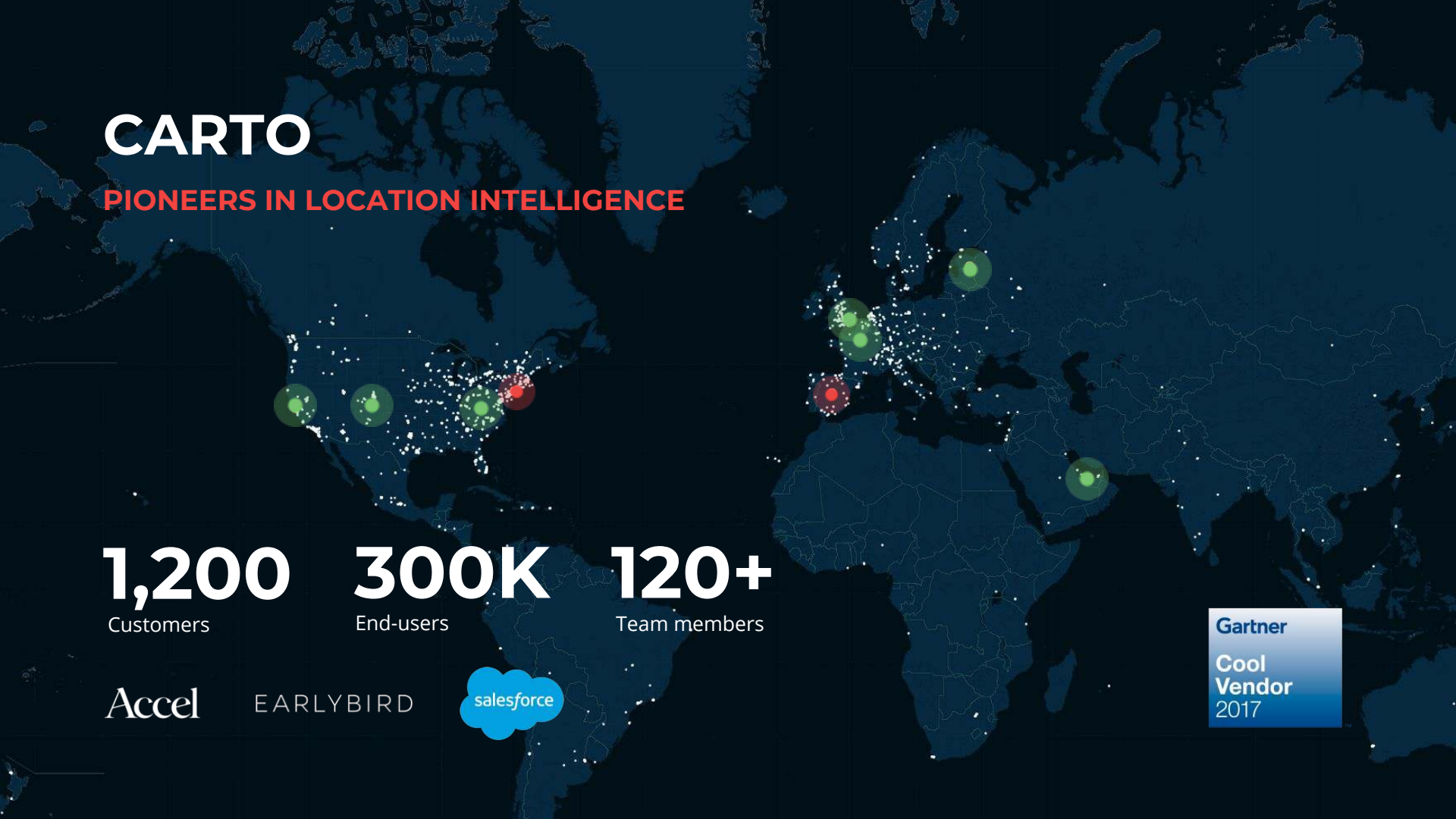
What is CARTO

CARTO

PIONEERS IN LOCATION INTELLIGENCE



1,200
Customers

300K
End-users

120+
Team members

Accel EARLYBIRD salesforce

Gartner
Cool Vendor
2017

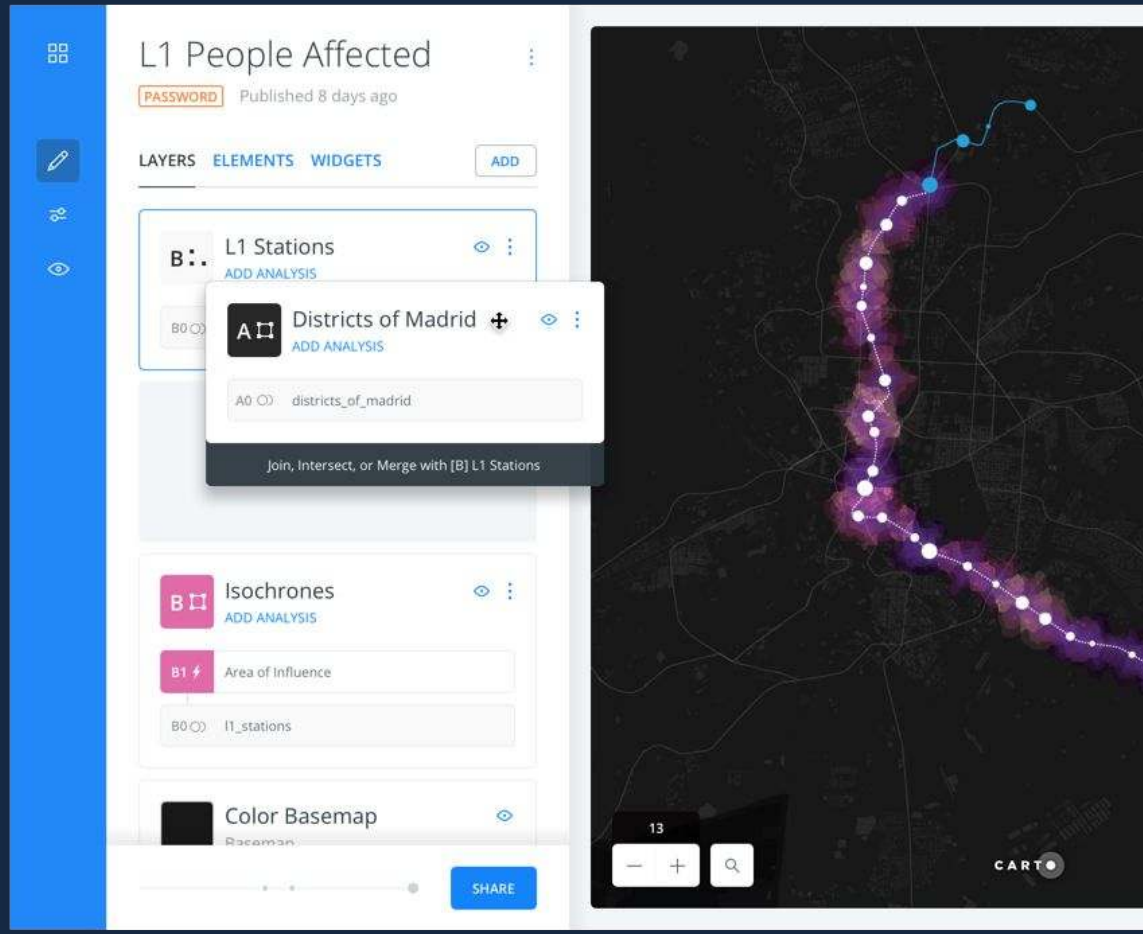
CARTO IS THE PLATFORM FOR TURNING LOCATION DATA INTO BUSINESS OUTCOMES

BUILDER

BRINGING LOCATION INTELLIGENCE TO THE MASSES

A self-service business user application for spatial analysis and visualization.

- Built in drag and drop analytics or custom functions
- Both in the cloud and on premise
- Auto-styling and Publishing
- Rapid application deployment
- Publish interactive dashboards that update analysis and filter live

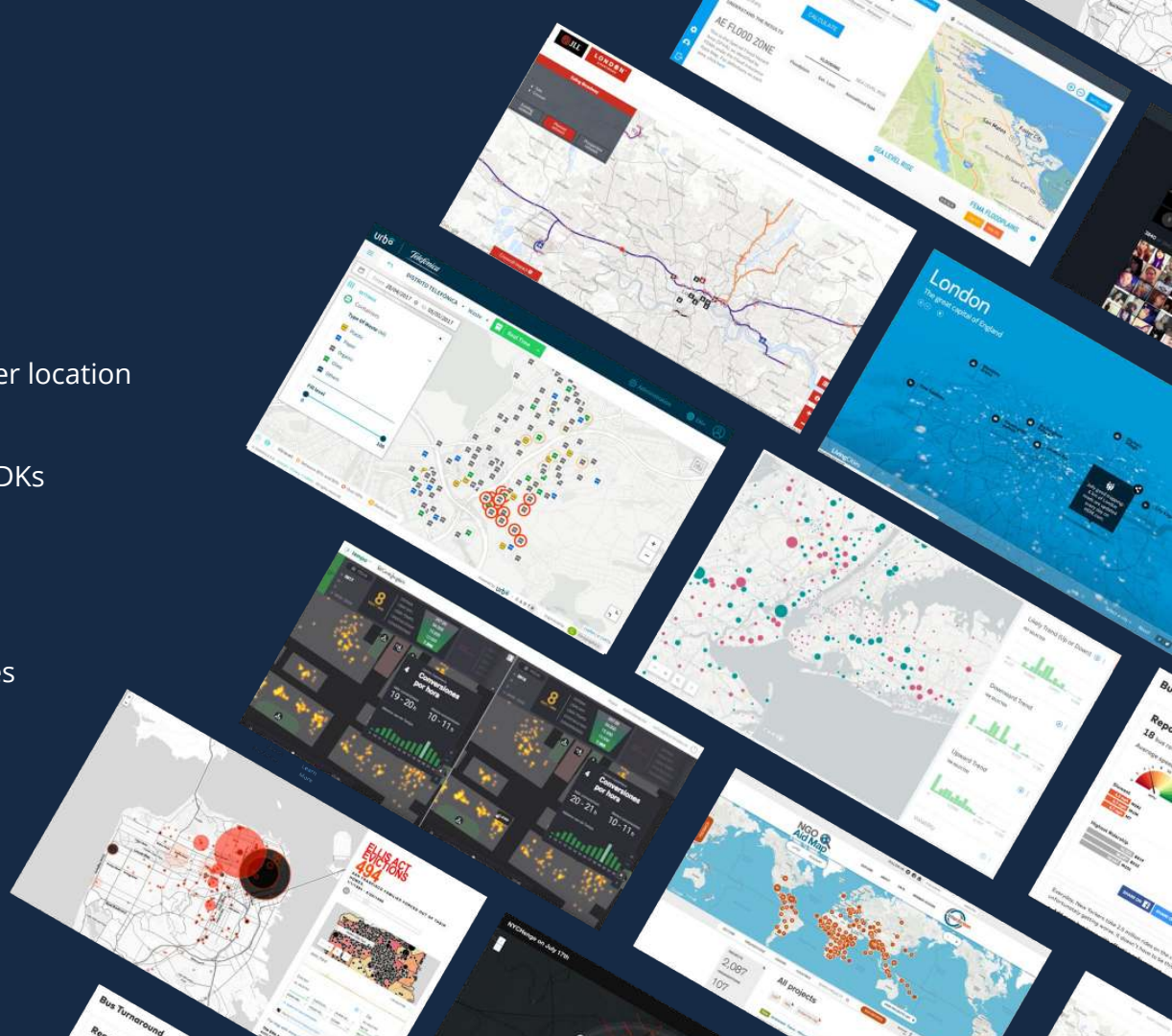


ENGINE

POWER YOUR APPS WITH LOCATION INTELLIGENCE

The one-stop shop for developers to power location applications in their organization.

- Easy-to-use, open source APIs & SDKs
- Location Data Services
- Built for developers and designers
- Native and custom analysis libraries



ENGINE APIs

Auth API

Create and manage credentials that grant specific permissions to data and access to APIs for different projects and apps.

SQL API

Interact with your tables and data inside CARTO, as if you were running SQL statements on your own database.

Maps API

Generate maps based on data hosted in your account and customize the SQL, CartoCSS, and other parameters.

Import API

Import files with different formats and manipulate them by using a set of HTTP commands.

Data Services API

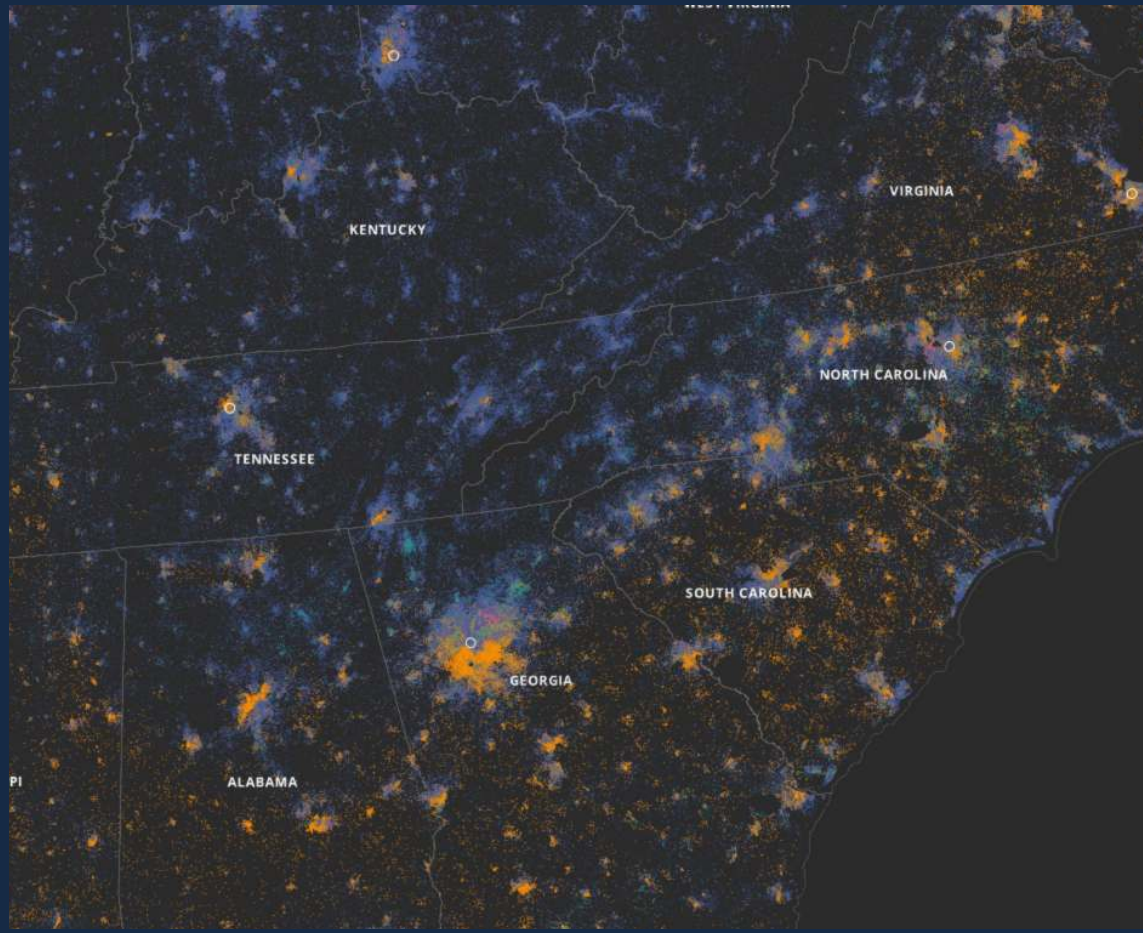
Geocode your data and perform other Location Intelligence analysis operations.

DATA OBSERVATORY

DON’T LET YOUR DATA LIMIT YOUR ANALYSIS

Augment your own data and broaden your analysis with thousands of datasets and measurements.

- Demographic segments
- Income, employment, and family datasets
- Real estate and financial data
- Many more…
- But : no OSM (yet) !



Location Science tools

Why Python?

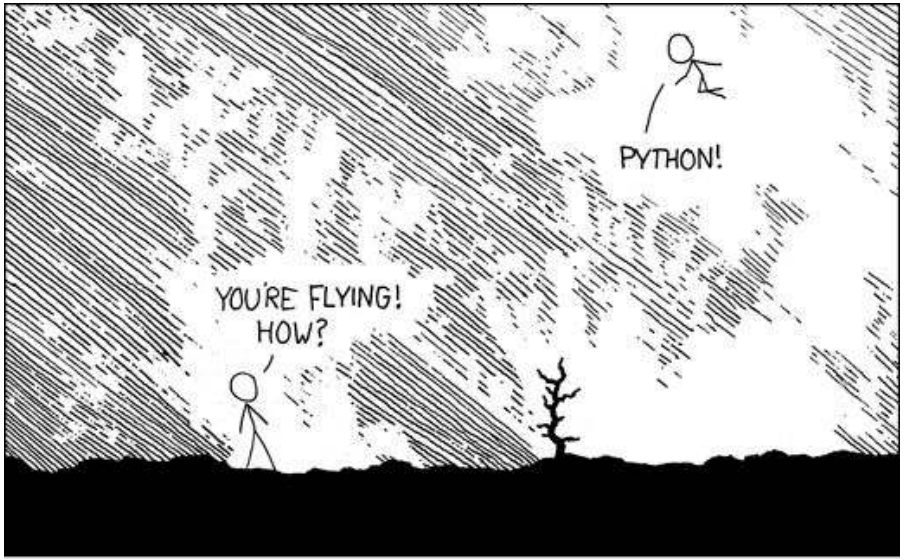


Image: xkcd.com/353

- Most popular language for data scientists
- Extremely flexible
- Huge + innovative community

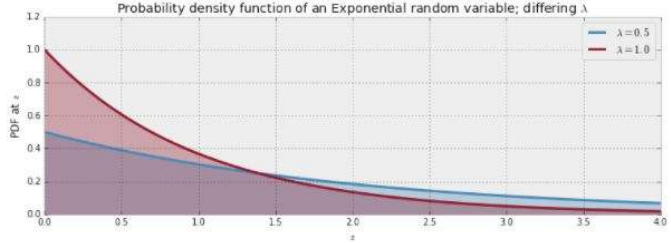
Jupyter

“open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text”

Given a specific λ, the expected value of an exponential random variable is equal to the inverse of λ, that is:

$$E[\, Z \mid \lambda \,] = \frac{1}{\lambda}$$

```
a = np.linspace(0, 4, 100)
expo = stats.expon
lambda_ = [0.5, 1]

for l, c in zip(lambda_, colours):
    plt.plot(a, expo.pdf(a, scale=1./l), lw=3,
             color=c, label="$\lambda = %.1f$" % l)
    plt.fill_between(a, expo.pdf(a, scale=1./l), color=c, alpha=.33)

plt.legend()
plt.ylabel("PDF at $z$")
plt.xlabel("$z$")
plt.ylim(0,1.2)
plt.title("Probability density function of an Exponential random variable;\
 differing $\lambda$");
```



But what is λ ?

This question is what motivates statistics. In the real world, λ is hidden from us. We see only Z, and must go backwards to try and determine λ. The problem is difficult because there is no one-to-one mapping from Z to λ. Many different methods have been created to solve the problem of estimating λ, but since λ is never actually observed, no one can say for certain which method is best!

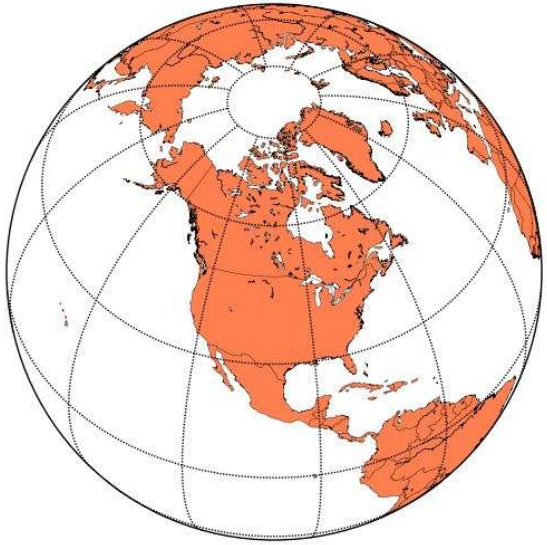
Image: [Bayesian Methods for Hackers]

Jupyter notebooks

- The de facto standard for communicating work
- Discovery environment of choice for many data scientists
- Clearly shows reproducible workflows

Geo python goodies

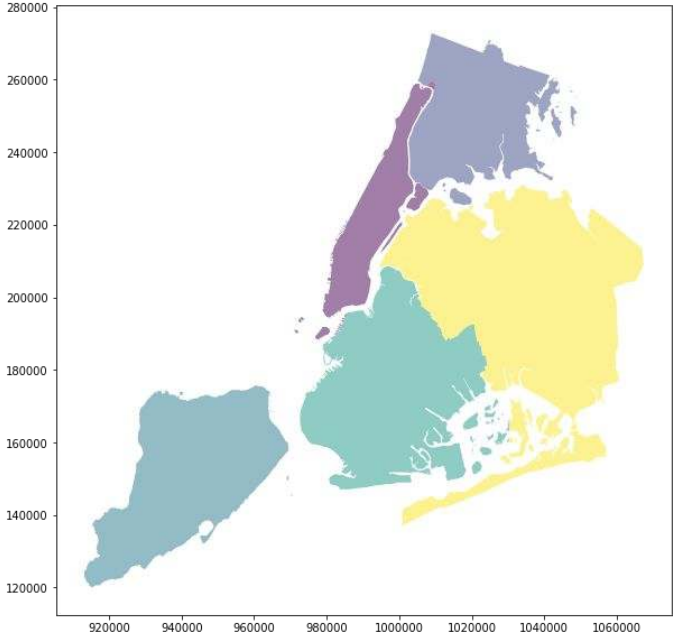
Matplotlib



```
from mpl_toolkits.basemap import Basemap
import matplotlib.pyplot as plt
import numpy as np

map = Basemap(projection='ortho',
              lat_0 = 50,
              lon_0 = -100,
              resolution = 'l',
              area_thresh = 1000.)
map.drawcoastlines()
map.drawcountries()
map.fillcontinents(color = 'coral')
map.drawmapboundary()
map.drawmeridians(np.arange(0, 360, 30))
map.drawparallels(np.arange(-90, 90, 30))
plt.show()
```

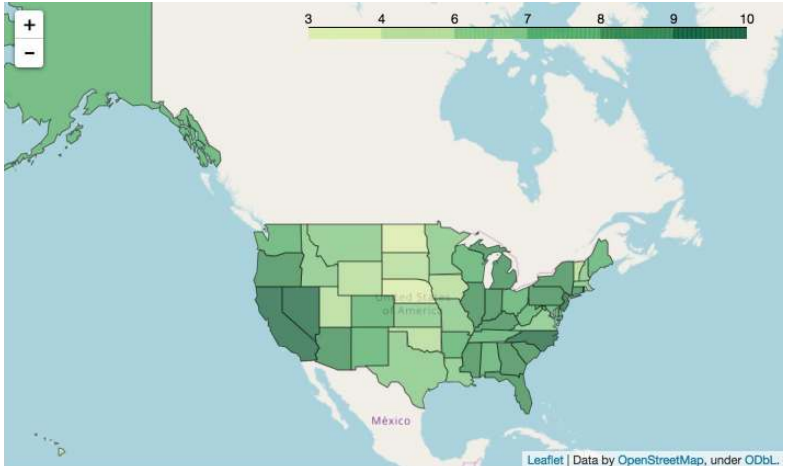
GeoPandas

```
import geopandas as gpd

boroughs = gpd.datasets.get_path('nybb')
df = gpd.read_file(boroughs)
df.plot(column='Shape_Area',
        figsize=(10, 10),
        alpha=0.5)
```



Folium

Leaflet and Python integrated




```
import folium
import pandas as pd

state_data = pd.read_csv('data.csv')
state_geo = 'us_states.geojson'
m = folium.Map(location=[48, -102])

m.choropleth(
    geo_data=state_geo,
    name='choropleth',
    data=state_data,
    columns=['State', 'Unemployment'],
    key_on='feature.id',
    fill_color='YlGn',
    fill_opacity=0.7,
    line_opacity=0.2,
    legend_name='Unemployment Rate (%)'
)
```

CARTOframes

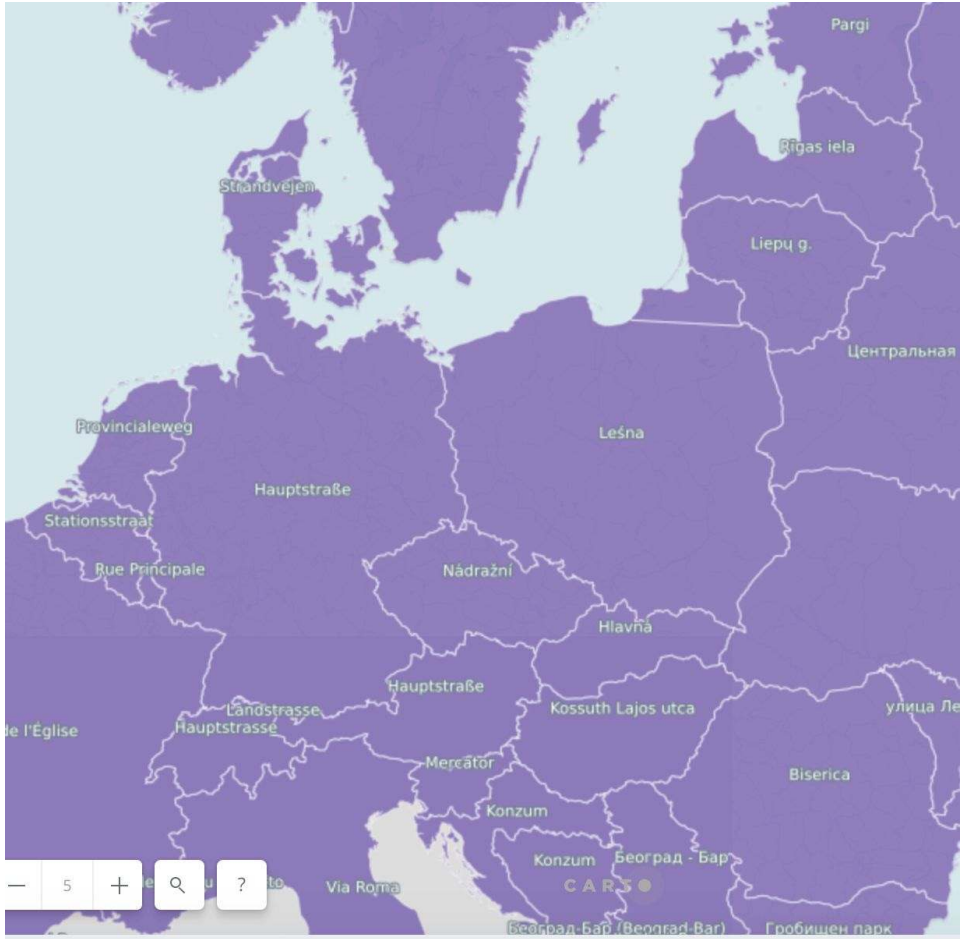
```
In [ ]: %matplotlib inline
        import cartoframes
        from cartoframes import Layer, styling, BaseMap

        cc = cartoframes.CartoContext()
        cc.map(layers=Layer('all_month_3'))
```

OSM in CartoFrames

Case study

What are the most popular names in different countries?

1. Extract data from OSM global database
2. Reduce data size, preprocess, filter, geocode
3. Do analysis with Python
4. Make a map!
5. Rinse, repeat



Data extract - the hard part

1. Planet → Imposm3 → **PostGIS** → SQL → result
   UPDATE osm_roads AS r SET admin2 = (SELECT a.name_iso FROM adm0 AS a WHERE r.geometry && a.geom LIMIT 1);

   SELECT admin2, name, count(*) FROM osm_roads GROUP BY name, admin2;

2. Overpass API. Can get names, even countries, but output format is tricky
   Hard to write queries, too big result

3. "Big Data" as a service providers.
   AWS has OSM Planet, weekly updated, queryable via **Athena SQL**. *No polygon query or custom functions*.
   Google BigQuery *does not have OSM* (yet). But it has user functions, can do point-in-polygon

Winning method

1. Download per-country packages from **Geofabrik**
2. **Osmconvert** to o5m
3. **Osmfilter** for key stats to CSV
4. Sort and head
5. Py: transpose data
6. Py: make a CartoFrames map

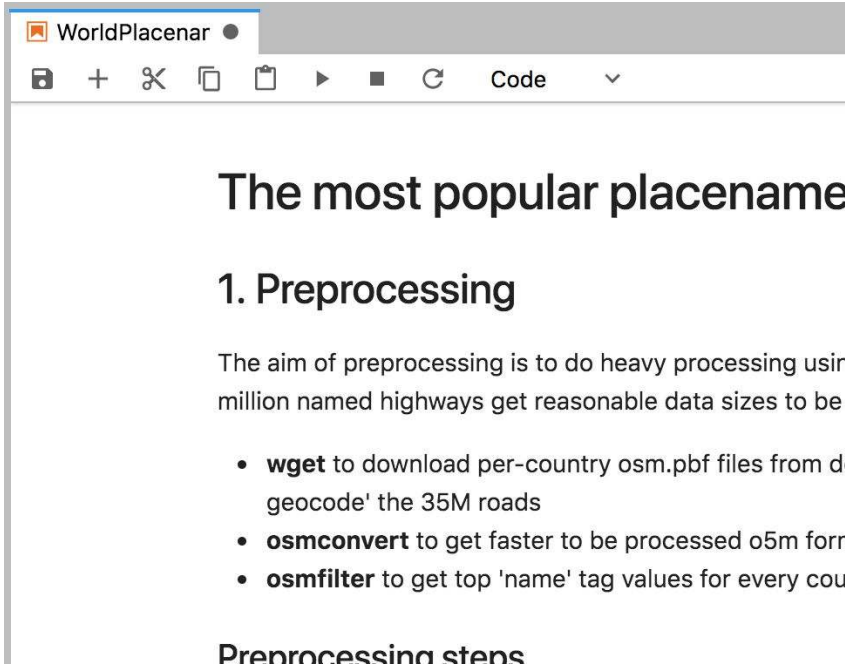
Fast! Convert: few seconds for small country, Italy (1.3G) ~1 minute. Filter: also ~1 minute

Notebook:

https://github.com/jaakla/osm-name-stats

Final map in CARTO:

https://cartomobile-team.carto.com/u/jaakl/builder/166ca721-7c3a-47d6-80d8-7d340e22b0ab/embed



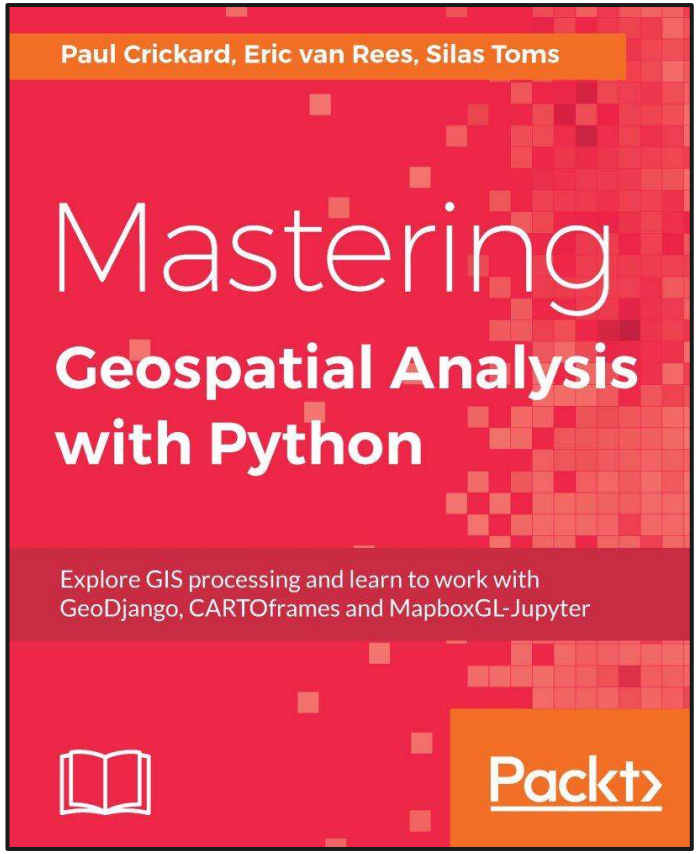
Key learnings

- Reduce big data to small
- Use preprocessed data
- Preprocess with proper tools
- There are no universal tools for big datasets
- Most tools are not ok for the Planet queries. E.g. PostGIS
- Use optimized formats
- Test with samples
- Some steps remain manual

Read about CARTOframes

Silas Toms, Eric van Rees, and Paul Crickard

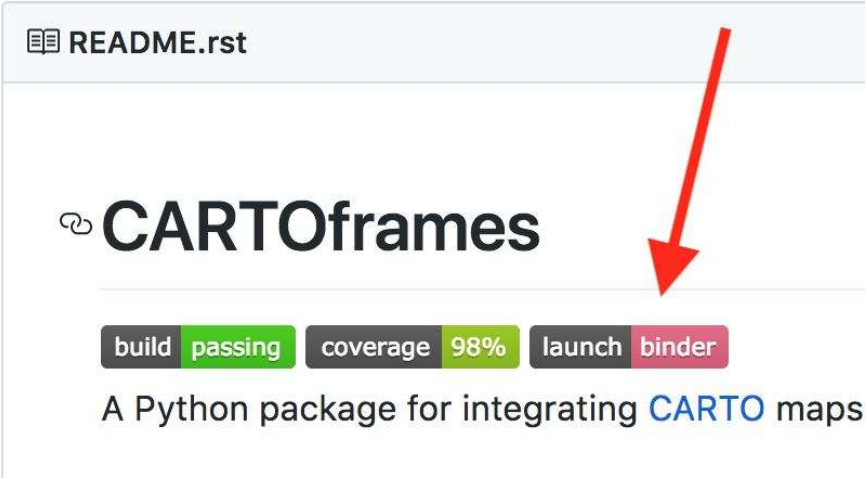
Includes a full chapter on CARTOframes



Try yourself

Visit
https://github.com/CartoDB/cartoframes

and click launch binder



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Thanks!

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