GeoData Processing in Python

Ramya Ragupathy
Soumya Ranjan

OpenStreetMap

www.openstreetmap.org


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OpenStreetMap (OSM) is the
“Wikipedia of Maps”
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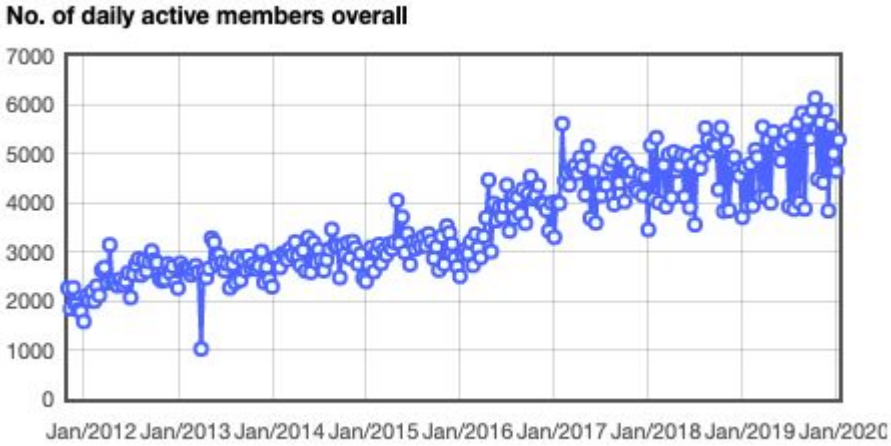
Geospatial World - https://www.youtube.com/watch?v=j4rtTzaA-VY

OpenStreetMap is an **open-source**, **global**, and **editable** geodata source that anyone can **use** and **improve**.

60M in Community



http://osmstats.neis-one.org/

https://flickr.com/photos/thomersch/48769513121/in/album-72157710997572098/lightbox/

Вторая пензенская картовечеринка // Second mapping party in Penza, Russia by Alexander Kachkaev, CC BY 2.0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Cooke Town
St Thomastown
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Banaswadi
Kalyan Nagar
Hennur
Rabindranath Tagore Nagar
Sulthanpalya
Deewanarapalya
Sadhashivanagar
Nandini Layout
Laggere
Kurubara Halli
Subrahmanya Nagar
Guttahalli
Ramachandra Pura
Kamakshipalya
Malagala
Govindaraj Nagara
Kasturibai Nagar
VV Puram
Byataranyapura
Jnana Bharathi
Pantarapalya
Banashankari 1st Stage
Banashankari 3rd Stage
Thyagaraja Nagar
Jayanagar East
Jayanagar
Someshwaranagar
Wilson Garden
Neelasandra
Adugodi
Ejipura
Koramangala
Halasuru
Murugeshpalaya
HAL Airport
Challaghatta
Yemaluru
Malleshpalya
Doddanekundi
Marathahalli
Munekolala
Kaadubeesanahalli
Panathur
Dooravaninagar
Ramamurthy Nagar
Shree Vinayaka Layout
Kowdenahalli
Post & Telegraph Layout
Parachute Regiment Training Centre - PRTC
Army Service Corps - ASC North
Army Service Corps - ASC South
Bellandur Lake
ORR
NH44
1 km
1 mi
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Edit feature

Park

Zoom to this

All fields

Name

Cubbon Park

Multilingual Name

Kannada

ಕಬ್ಬನ್ ಉದ್ಯಾನ

Operator

Unknown

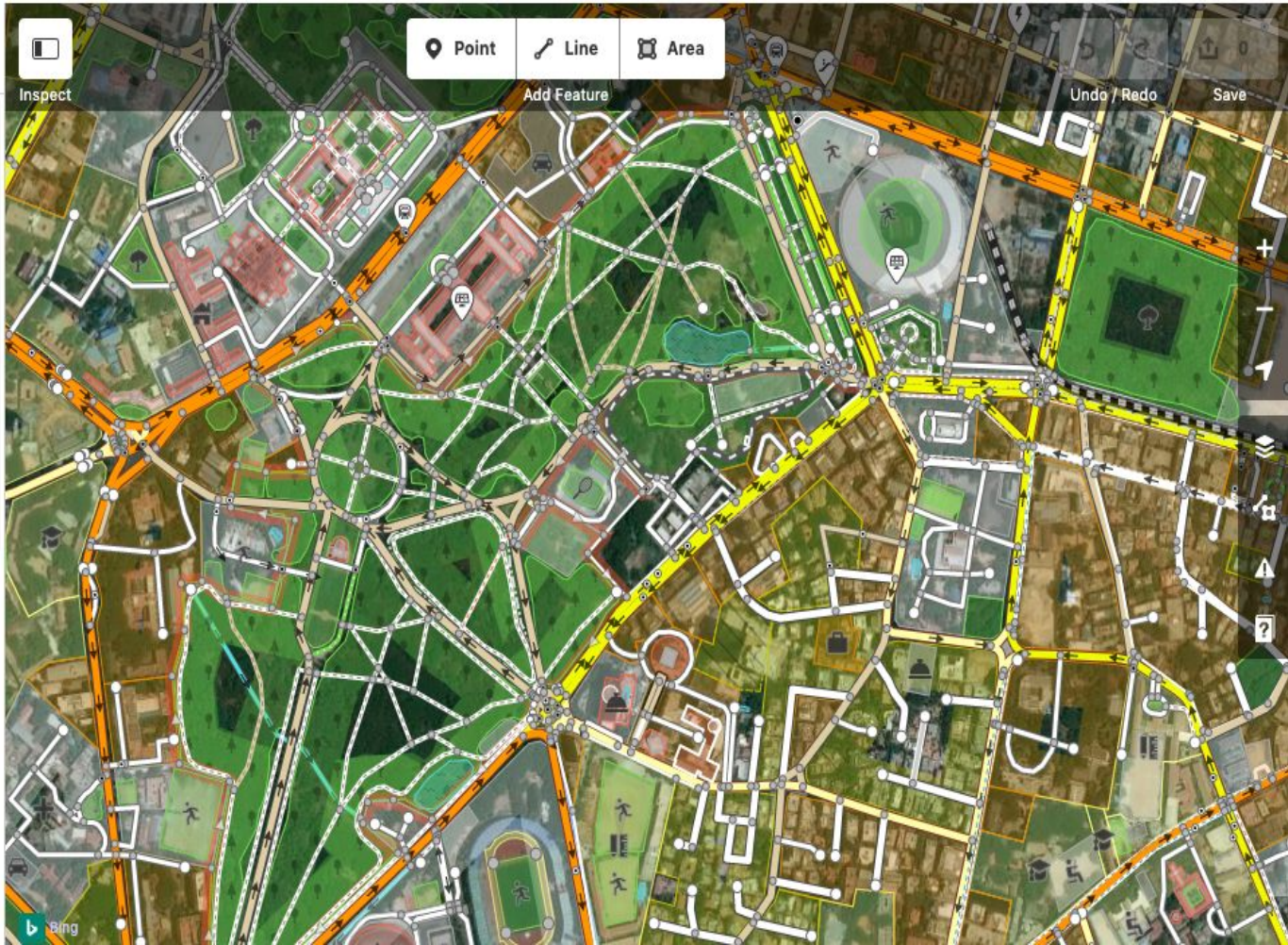
Address

123 Street

City Postcode

Hours

Unknown...

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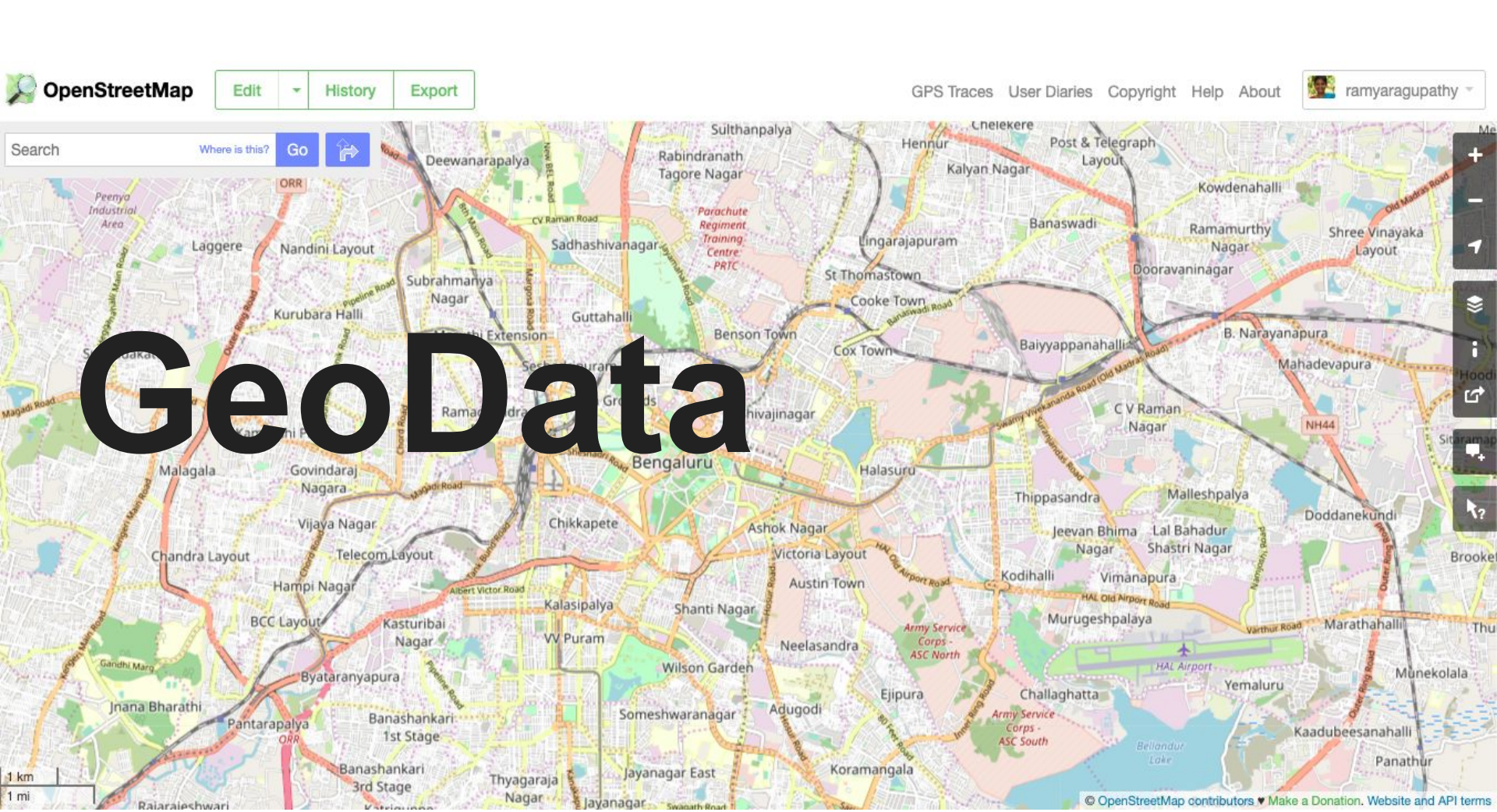
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Vijaya Nagar
Chandra Layout
Telecom Layout
Hampi Nagar
BCC Layout
Kasturibai Nagar
Byataranyapura
Jnana Bharathi
Pantarapalya
Banashankari 1st Stage
Banashankari 3rd Stage
Thyagaraja Nagar
Jayanagar East
Jayanagar
Koramangala
Someshwaranagar
Adugodi
Ejipura
Challaghatta
Yemaluru
Munekolala
Kaadubeesanahalli
Panathur
Bellandur Lake
Wilson Garden
Neelasandra
Shanti Nagar
VV Puram
Kalasipalya
Chikkapete
Ashok Nagar
Victoria Layout
Austin Town
Kodihalli
Vimanapura
Murugeshpalaya
Marathahalli
HAL Airport
Army Service Corps - ASC North
Army Service Corps - ASC South
Halasuru
Thippasandra
Malleshpalya
Doddanekundi
Jeevan Bhima Nagar
Lal Bahadur Shastri Nagar
C V Raman Nagar
Baiyyappanahalli
B. Narayanapura
Mahadevapura
Cooke Town
St Thomastown
Benson Town
Cox Town
Lingarajapuram
Banaswadi
Ramamurthy Nagar
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Nandini Layout
Laggere
Peenya Industrial Area
ORR
NH44
1 km
1 mi
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Geographic Data, or GeoData represents things that have a location.

This can include defined physical or abstract features like

- roads
- buildings
- census boundaries

It can also include temporal or ephemeral events, like

- Cloud cover
- Geo-located tweets

Geodata typically is stored and managed in one of two formats:

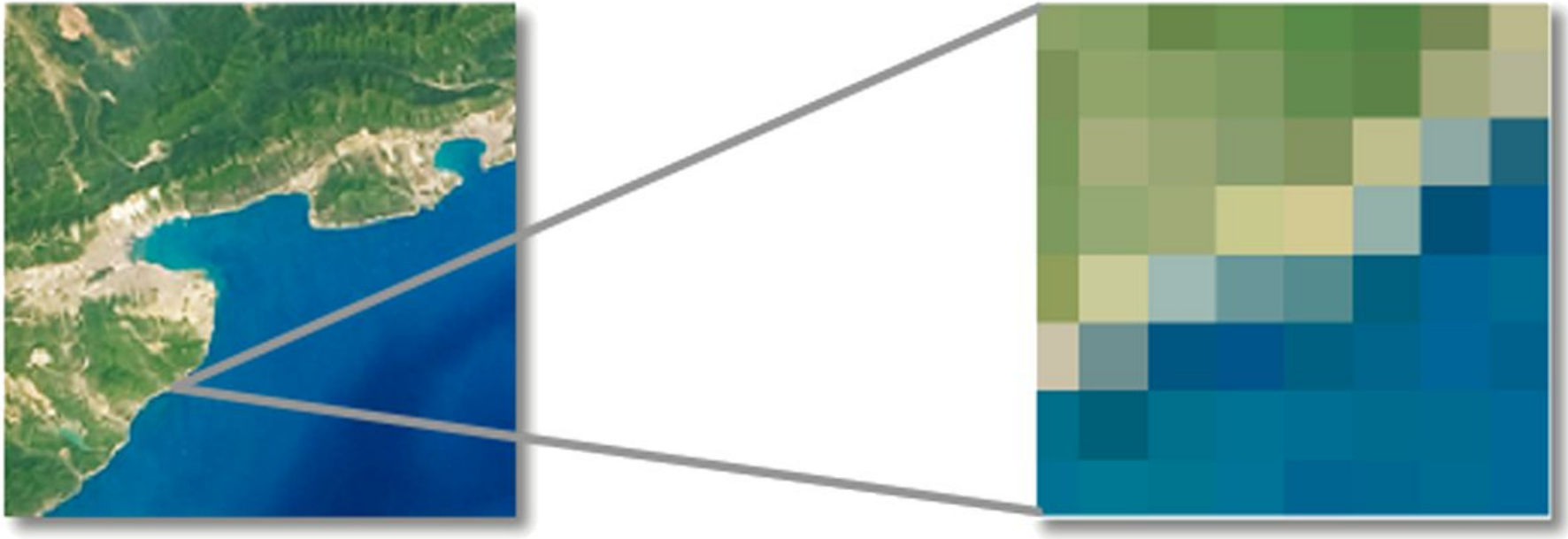
- raster data
- vector data


RASTER

Raster data stores its geographic information in pixels

Image

Pixels

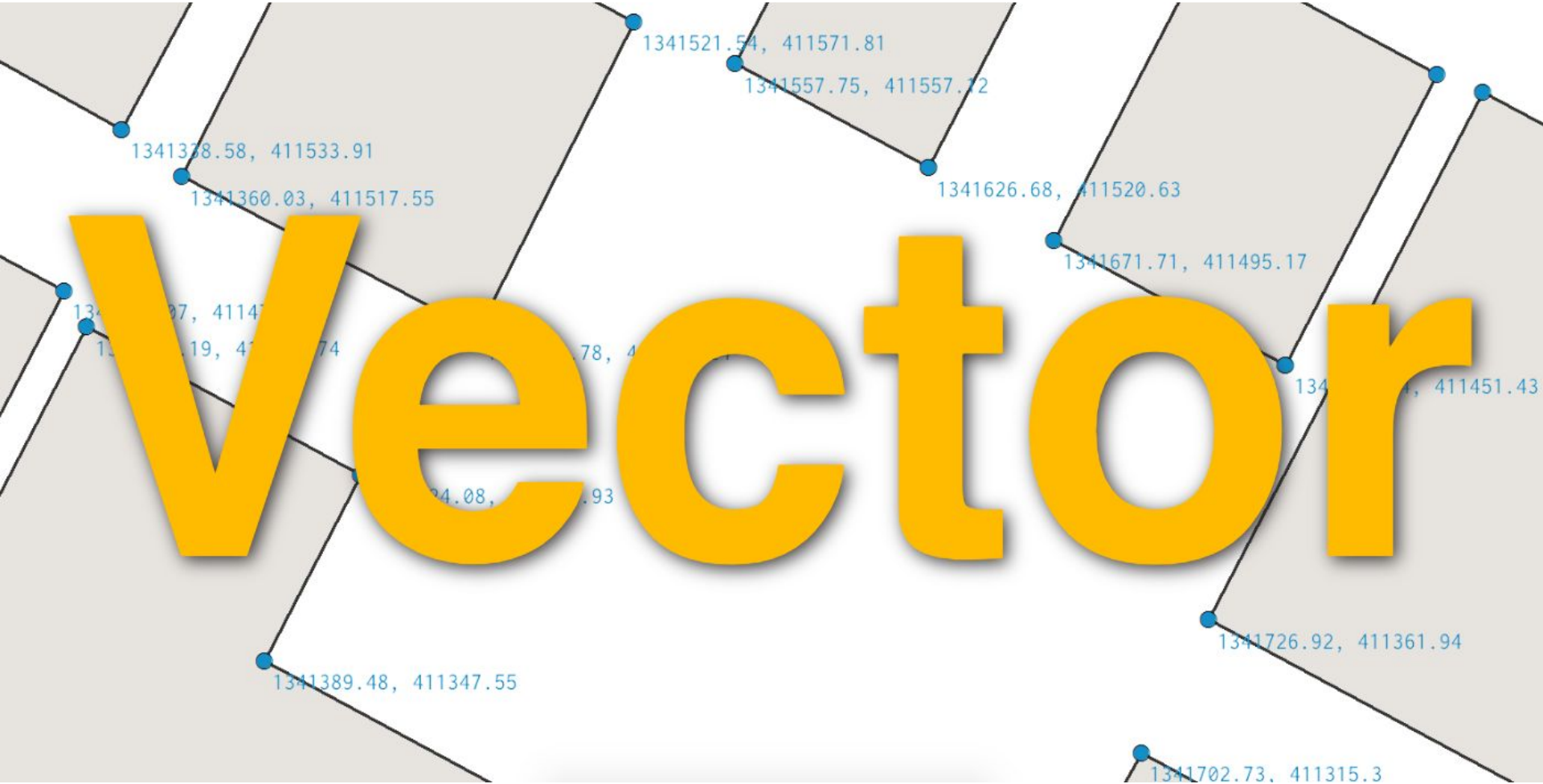


Pixels can represent color, height, slope, direction...and many other classifications or gradients.

Raster data is commonly encountered in:

- satellite imagery
- weather data
- digital elevation model

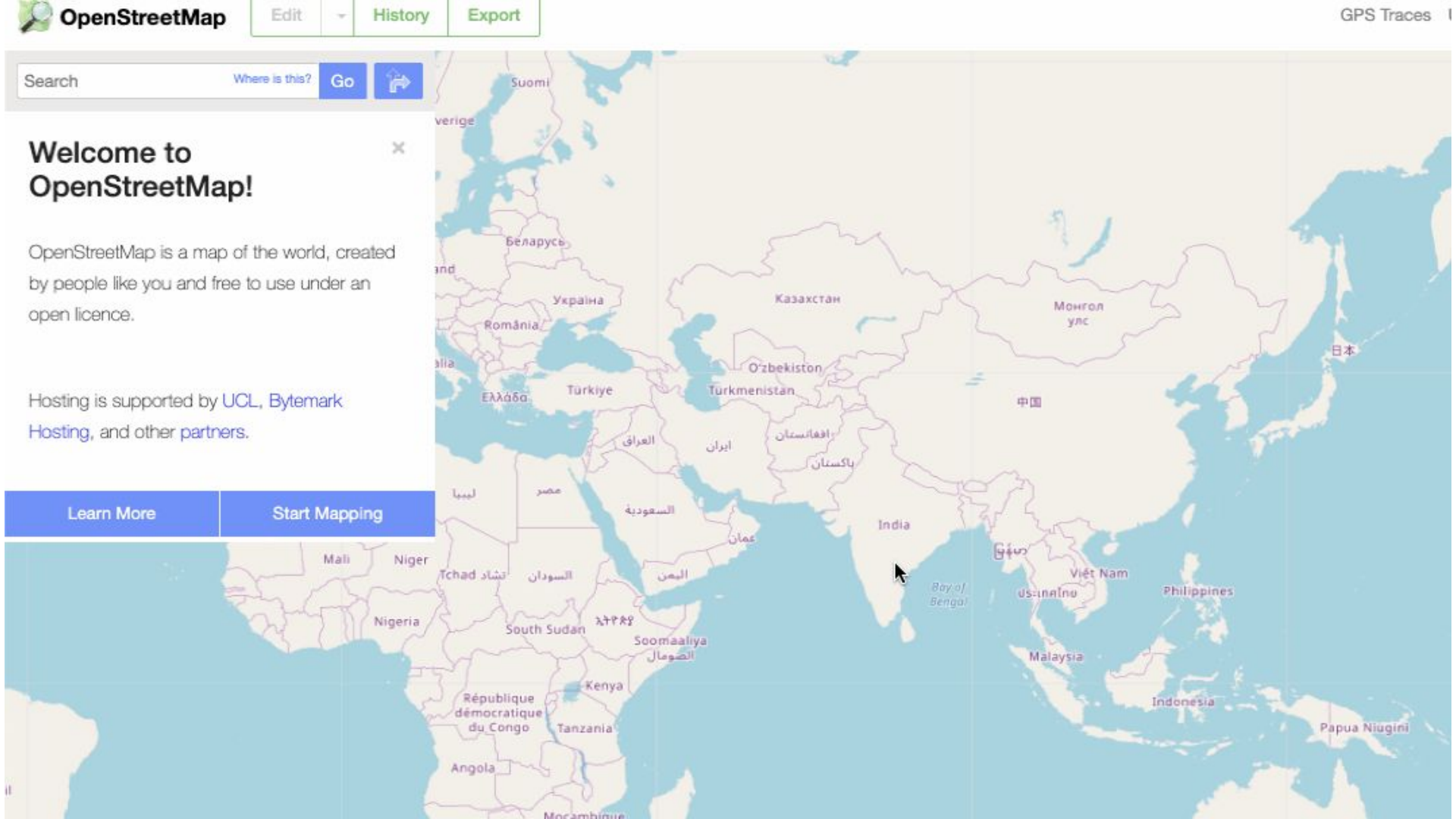
In OSM, raster data is provided in the form of satellite imagery.


1341521.54, 411571.81
1341557.75, 411557.72
1341626.68, 411520.63
1341671.71, 411495.17
1341360.03, 411517.55
1341726.92, 411361.94
1341389.48, 411347.55
1341702.73, 411315.3
Vector

Vector data stores **geometry**, **attribute**, and **location** information

No matter how much you 'zoom in', you won't see pixels.

Vector data is dynamically rendered.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Welcome to OpenStreetMap!
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中国
العراق
ایران
افغانستان
پاکستان
مصر
السعودية
عمان
India
Mali
Niger
Tchad
السودان
اليمن
Nigeria
South Sudan
Soomaaliya
Kenya
République démocratique du Congo
Tanzania
Angola
Mocambique
Bay of Bengal
Việt Nam
Philippines
Malaysia
Indonesia
Papua Niugini

Vector comes (primarily) in three geometric flavors:

Point

0, 0

Line

0, 0 1, 0

Polygon

0.5, 1

0, 0 1, 0

On OSM this translates to:

- point = node
- line = way/linestring
- polygon = area

Attributes are an important component of vector data.

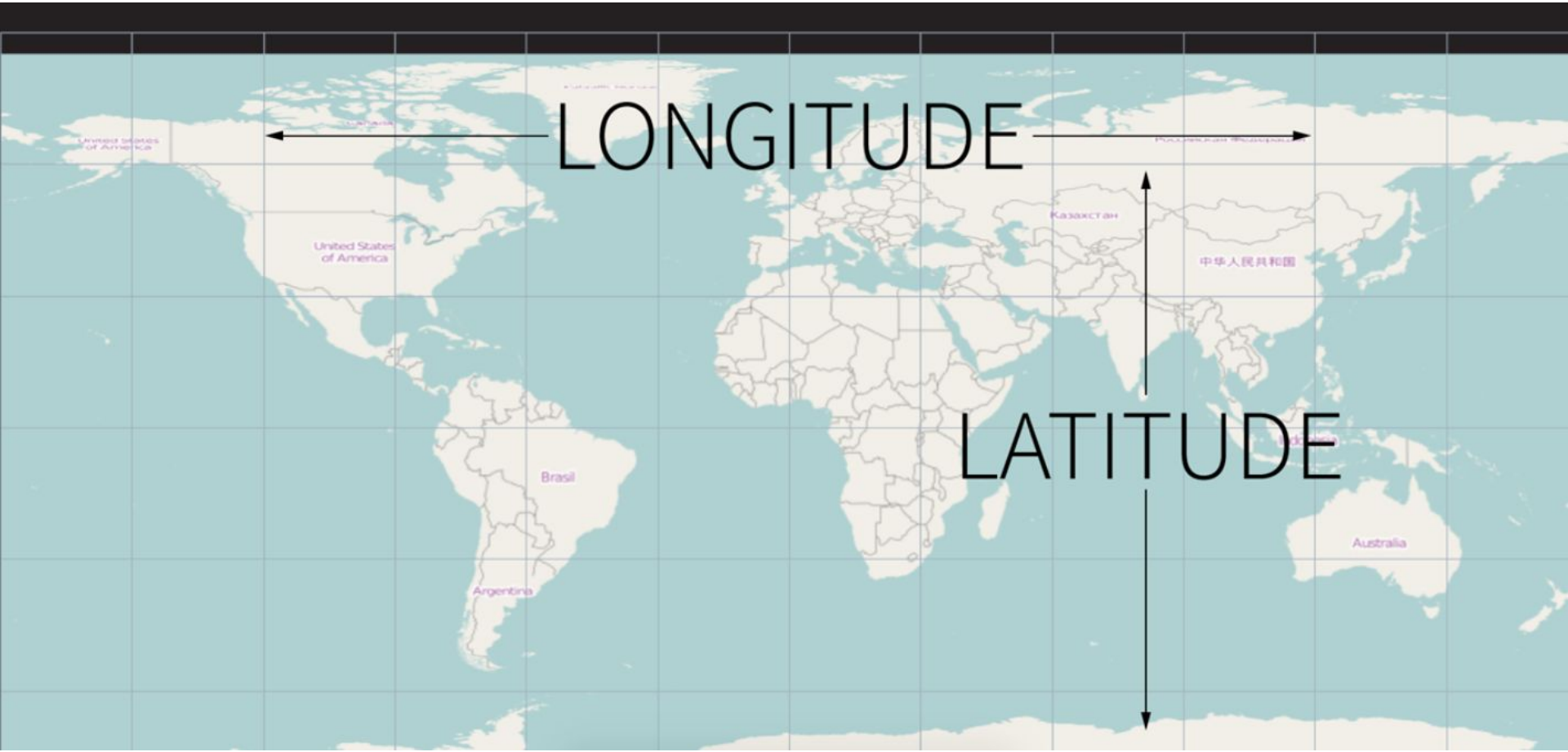
A vector dataset usually stores lots of individual features.

Each individual vector feature is like a row in a table. Each table column is an attribute.

You'll notice that if you have selected a building or street, you'll see on the map the feature is shown as series of of connected points and lines.


1341521.54, 411571.81
1341557.75, 411557.72
1341358.58, 411533.91
1341360.03, 411517.55
1341626.68, 411520.63
1341671.71, 411495.17
411477.43
Coordinates!
1341424.08, 411412.93
1341726.92, 411361.94
1341389.48, 411347.55

Locations are identified using latitude / longitude (lat/lon) decimal degrees.


LONGITUDE
LATITUDE
United States of America
Brasil
Argentina
Australia
Қазақстан
中华人民共和国

LATITUDE	north-south	horizontal lines, different circumferences	-90 to +90 decimal degrees
LONGITUDE	east-west	vertical lines, same circumferences	0 to 180 decimal degrees

You can access OSM data through:

- OSM API
- Overpass Turbo
- GeoFabrik extracts
- QA Tiles

File formats:

- GeoJSON
- Shape File
- KML
- PBF
- GeoPackage

Code & Data Repository

https://github.com/srm-soumya/intro-spatial-analysis

https://github.com/openbangalore/bangalore

Shapely

- Create a `Line` or `Polygon` from a `Collection` of `Point` -geometries
- Coordinate pairs are represented as `tuples`
- Calculate areas/length/bounds etc. of input geometries
- Conduct geometric operations based on the input geometries such as `Union`, `Difference`, `Distance` etc.
- Conduct spatial queries between geometries such as `Intersects`, `Touches`, `Crosses`, `Within` etc.

Geopandas

- combines the capabilities of the data analysis library `pandas` with other packages like `shapely`.
- Main data structures `GeoSeries` and `GeoDataFrame` extend the capabilities of `Series` and `DataFrames` from pandas.
- A `GeoDataFrame` should contain geometry which holds `Geoseries` data
- Possible to use all of the functionalities of the Shapely module when dealing with geometries in geopandas.
- `.plot()` -function from geopandas that creates a map based on the geometries of the data.

OSMnx

- Retrieve, construct, analyze, and visualize street networks, buildings and certain points of interest from OSM
- http://bit.ly/osmnx-example

Interactive Maps with mplleaflet and Folium

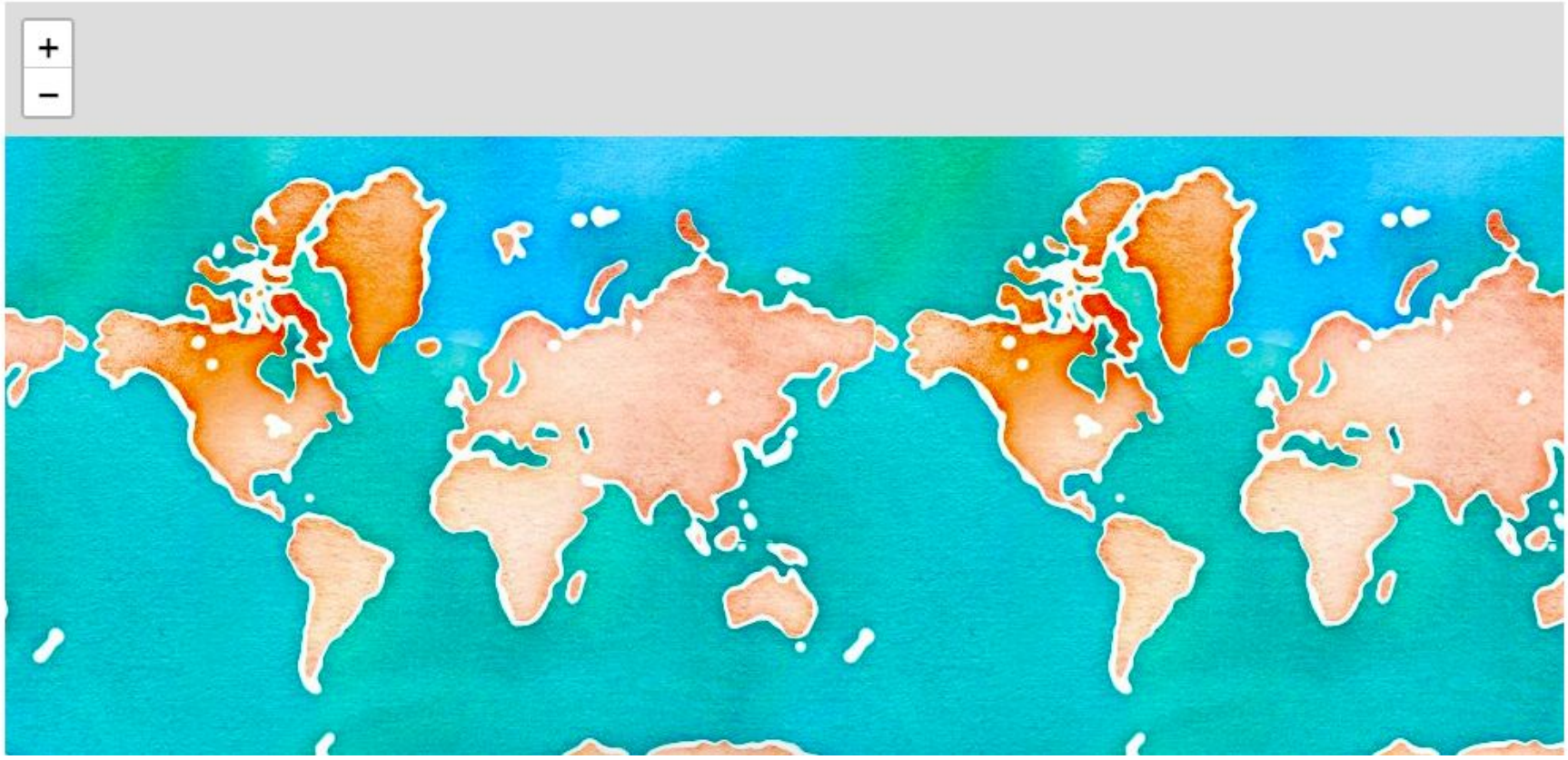
In [51]:
```
# 1. Plot data:
ax = points.plot(markersize = 50, color = "red")

# 2. Convert plot to a web map:
mplleaflet.display(fig=ax.figure, crs=points.crs)
```

```
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages/pyproj/crs.py:77: FutureWarning: '+init
=<authority>:<code>' syntax is deprecated. '<authority>:<code>' is the preferred initialization method.
  return _prepare_from_string(" ".join(pjargs))
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages/pyproj/crs.py:77: FutureWarning: '+init
=<authority>:<code>' syntax is deprecated. '<authority>:<code>' is the preferred initialization method.
  return _prepare_from_string(" ".join(pjargs))
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages/IPython/core/display.py:701: UserWarnin
g: Consider using IPython.display.IFrame instead
  warnings.warn("Consider using IPython.display.IFrame instead")
```

Out[51]:

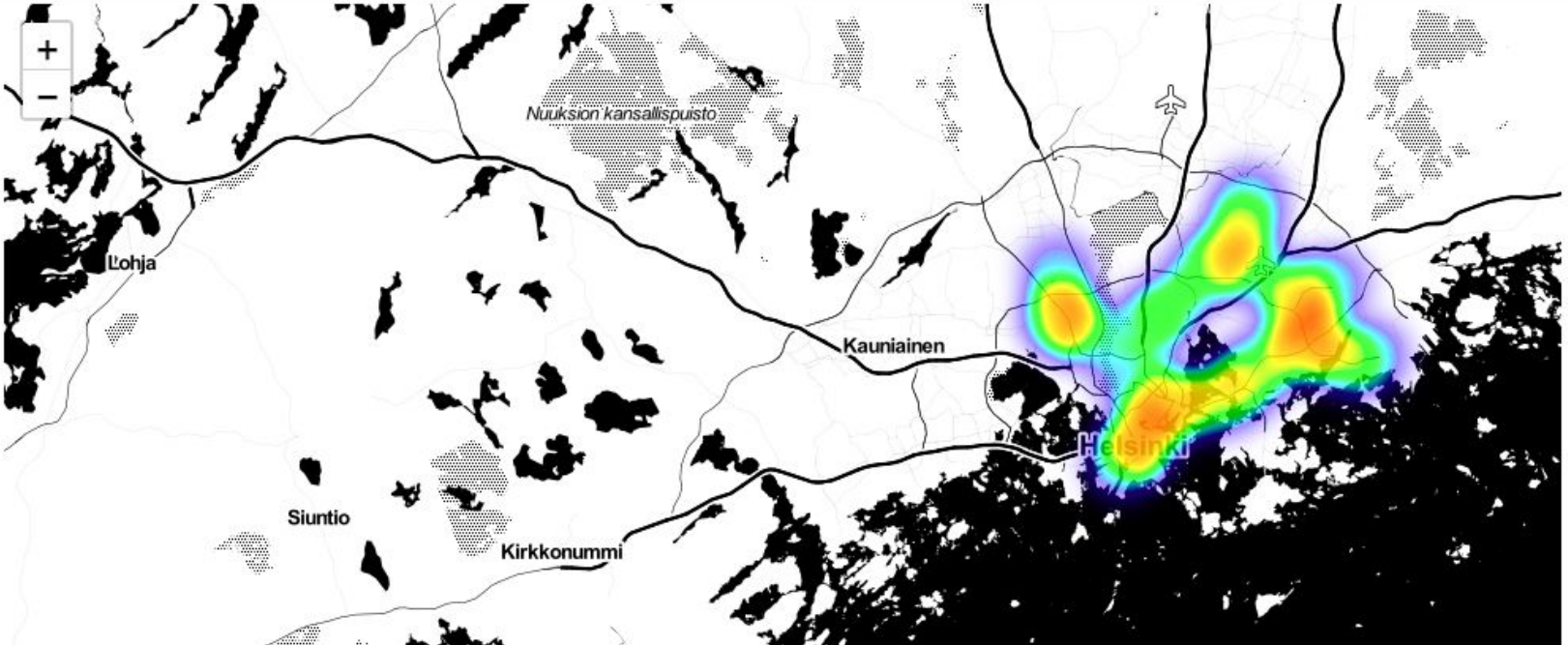
In [14]:
```
m = folium.Map(location=[40.730610, -73.935242], tiles='Stamen WaterColor',
               zoom_start=12, control_scale=True, prefer_canvas=True)
m
```

Out[14]:



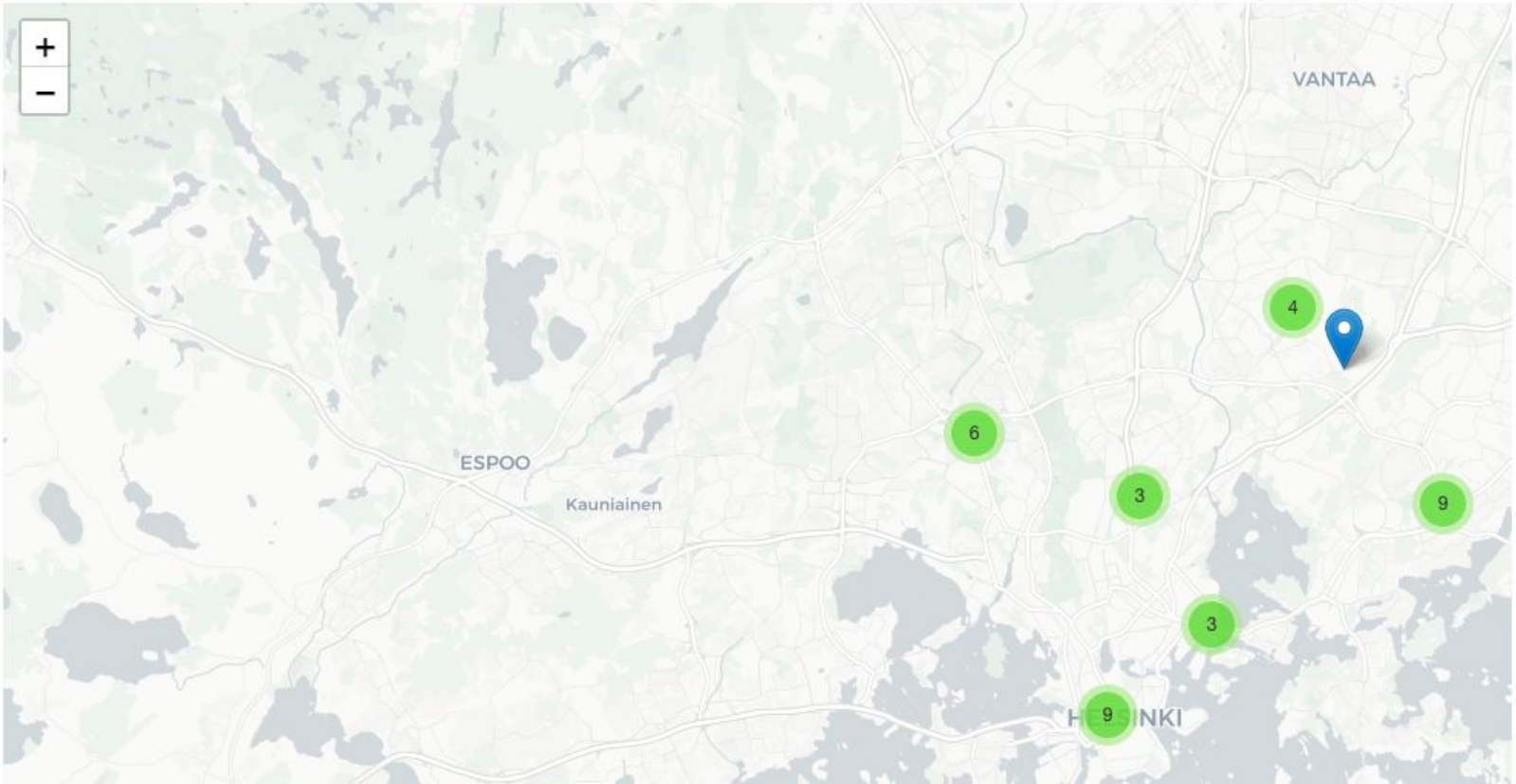
In [44]:
```
from folium.plugins import HeatMap

# Create a Map instance
m = folium.Map(location=[60.25, 24.8], tiles = 'stamentoner', zoom_start=10, control_scale=True)

# Add heatmap to map instance
# Available parameters: HeatMap(data, name=None, min_opacity=0.5, max_zoom=18, max_val=1.0, radius=25, blur=15, gradien
HeatMap(locations).add_to(m)

# Alternative syntax:
#m.add_child(HeatMap(points_array, radius=15))

# Show map
m
```

Out[44]:



In [48]:
```
# Create a folium marker cluster
marker_cluster = MarkerCluster(locations)

# Add marker cluster to map
marker_cluster.add_to(m)

# Show map
m
```

Out[48]:



GDAL , Geopandas , Shapely, OSMnx, Networkx

Fiona (alternative for geopandas).

Pyproj Performs cartographic transformations and geodetic computations

Rasterio –> Clean and fast and geospatial raster I/O for Python.

Pysal –> Library of spatial analysis functions written in Python.

Geopy –> Geocoding library: coordinates to address <-> address to coordinates.

Contextily –> Add background basemaps for your (static) map visualizations

GeoViews –> Interactive Maps for the web.

Geoplot –> High-level geospatial data visualization library for Python.

Cartopy –> Make drawing maps for data analysis and visualisation as easy as possible.

Scipy.spatial –> Spatial algorithms and data structures.

Rtree –> Spatial indexing for Python for quick spatial lookups.

RSGISLib –> Remote Sensing and GIS Software Library for Python.