

## • Geospatial Analytics and Visualization using FOLIUM



### • What is Folium ?

- **Folium** is a very powerful and enriched Python library which can be used for analyzing geospatial data with ease
  - **Geospatial data** refers to Location based data (data which is collected from different geographical locations)
    - For e.g., the pollution level in different states (locations) of India
- In almost every application sector today, analysis and visualization of geospatial data (location sensitive data) is becoming increasingly important.
- It has many useful features which can be used to create interactive maps
- Folium uses **Leaflet.js** module which is a leading open-source JavaScript library for plotting interactive maps.



### • What is Geospatial Analytics ?

- Geospatial Analytics uses location sensitive data gathered through GPS (Global Position System) based Location sensors, social media, mobile devices and other sources
- Data collected is then used for visualization purpose for better understanding of phenomena and finding trends in complex relationships between people and places
- Geospatial Analytics is used to analyse how the magnitude and trend of a certain quantity is varying with location

## Benefits of Geospatial Analytics

The visualization of spatial data makes it easier to see how things are changing with change in location and where the change is most pronounced.

### **Some of the benefits of Geospatial Analytics is as follows:**

1. **Engaging Insights** – Analysis and visualisation of location based data through interactive maps makes it easier to understand how a particular quantity or a phenomena is changing with location
2. **Accurate Prediction of Future Trends** – Careful observation ,analysis and visualisation of spatial data through interactive maps can help an organizations (companies) to understand current trends in different locations. On the basis of that accurate prediction for the future can be made which can help organizations (companies) to improve and provide better services to the customer.
3. **Targeted solutions** – Seeing location-based data helps organizations understand why some locations and countries are more successful for business than others.



## **Application Sectors of Geospatial Analytics**

### **1. Telecommunication Sector**

- Geospatial data is collected by mobile network providers and telecommunication companies to provide better mobile network services to the customer.
- They use geospatial data to quickly visualize call detail records and network logs so that they can fix network issues rapidly and efficiently
- Since network signal strength fluctuates with location, geospatial analytics helps telecommunications companies understand where network strength is weak and then resolve it.

### **2. Weather Monitoring**

- Geospatial Analytics becomes very useful for analysing how the weather is changing across a certain geographical location
- It can further be used to predict the possibility of a natural disaster such as hurricanes, tsunami, unexpected rainfall and other extreme weather conditions

### **3. Urban Planning/Development**

- Geospatial analytics is very important for analysing the status of crime, public health, education and housing/real estate in different states(locations) of a country.
- It helps Urban Planning commission to access the growing infrastructural and energy requirements of a state

### **4. Military**

- Geospatial predictive analytics helps the military optimize placement of resources while using predictive analytics to assess infrastructure, anticipate maintenance needs and meet deadlines.

## 5. Natural Resource Exploration

- Geospatial analytics greatly helps in analysing the availability of natural resources in different states of a country

## ◦ Installing Folium

```
pip install folium
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: folium in /usr/local/lib/python3.10/dist-packages (0.14.0)
Requirement already satisfied: branca>=0.6.0 in /usr/local/lib/python3.10/dist-packages (from folium) (0.6.0)
Requirement already satisfied: jinja2>=2.9 in /usr/local/lib/python3.10/dist-packages (from folium) (3.1.2)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from folium) (1.22.4)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from folium) (2.27.1)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packages (from jinja2>=2.9->
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from request
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests->
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.10/dist-packages (from req
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests->folium
```

## ◦ Importing Folium Library

```
import folium
```

## ◦ 1. Creating MAP object

- using **folium.Map( )** to display MAP

```
import folium
import matplotlib.pyplot as plt

plt.figure(figsize=(4,4))
WorldMap=folium.Map( )

WorldMap
```



## ‐ 2. Creating a MAP object

(centered around a certain desired location)

- using **location** attribute to center the map at the desired location
- using **width** and **height** parameter to set the size of the MAP object
- Latitude and Longitude coordinates of some cities:

DELHI => 28.7041° N, 77.1025° E

MUMBAI => 19.0760° N, 72.8777° E

KOLKATA => 22.5726° N, 88.3639° E

```
import folium  
  
WorldMap=folium.Map(location=[28.7041, 77.1025],width=500, height=300)  
  
WorldMap
```



## ‐ 3. Adjusting Zoom controls of MAP object

(centered around the desired location)

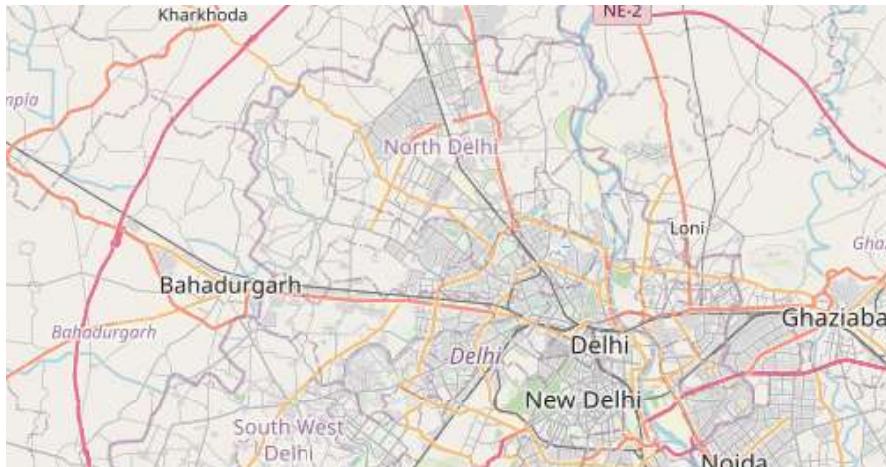
- **zoom\_start**
  - used to set initial zoom level
  - default value: 10
  - can be varied from 1 to 18
- **zoom\_control**
  - To Switch ON and OFF automatic zoom feature in the MAP object
  - zoom\_control= True (by default)
- **min\_zoom and max\_zoom**
  - For setting MAXIMUM and MINIMUM zoom level
  - Value can given in the range from 1 to 18
- **Saving MAP object using .save( )**

```
import folium

WorldMap=folium.Map(location=[28.7041, 77.1025],
                     zoom_start = 10, zoom_control=False,
                     min_zoom=9, max_zoom = 11,
                     width=500, height=300)

display(WorldMap)

WorldMap.save('Delhi.html')
```



## ▼ 5. Using different background MAP Tiles

Folium offers different **map tiles** which can be used to change or improve the look of a map

Some of the inbuilt MAP tiles include:

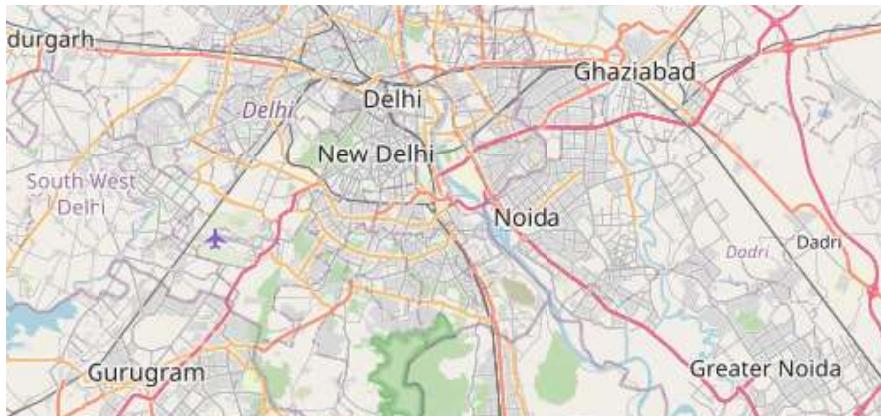
- Open Street Map (default)
- Stamen Terrain
- Stamen Toner
- CartoDB Positron
- CartoDB Dark Matter

## ▼ Background Tile Type 1 (Default style): Open street map

```
import folium

WorldMap=folium.Map(location=[28.5354, 77.2639],zoom_start = 10,
                     zoom_control=False, min_zoom=10, max_zoom=11,
                     tiles = 'Open street map',width=500, height=300)

display(WorldMap)
```



## • Background Tile Type 2: Stamen Terrain

```
import folium

WorldMap=folium.Map(location=[28.5354, 77.2639],zoom_start = 5,
                     zoom_control=False,
                     min_zoom=5, max_zoom=13,
                     tiles = 'Stamen Terrain',width=500, height=300)

display(WorldMap)
```

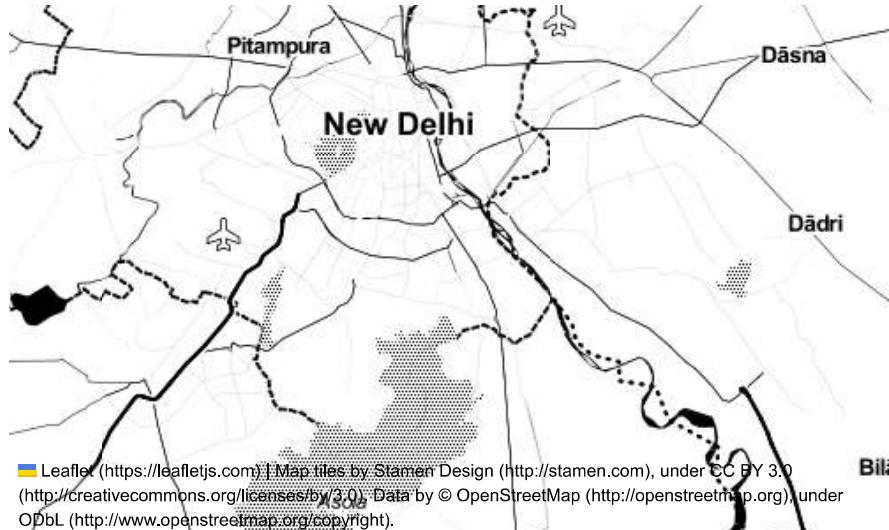


## • Background Tile Type 3: Stamen Toner

```
import folium

WorldMap=folium.Map(location=[28.5354, 77.2639],zoom_start = 10, zoom_control=False, min_zoom=10, max_zoom=11,
                     tiles = 'Stamen Toner',width=500, height=300)

display(WorldMap)
```



## ▼ Background Tile Type 4: CartoDB Positron

```
import folium

WorldMap=folium.Map(location=[28.5354, 77.2639],zoom_start = 10, zoom_control=False, min_zoom=10, max_zoom=11,
                     tiles = 'CartoDB Positron',width=500, height=300)

display(WorldMap)
```



## ▼ Background Tile Type 5: CartoDB Dark Matter

```
import folium

WorldMap=folium.Map(location=[28.5354, 77.2639],zoom_start = 10,
                     zoom_control=False, min_zoom=10, max_zoom=11,
                     tiles = 'Cartodbdark_matter',width=500, height=300)

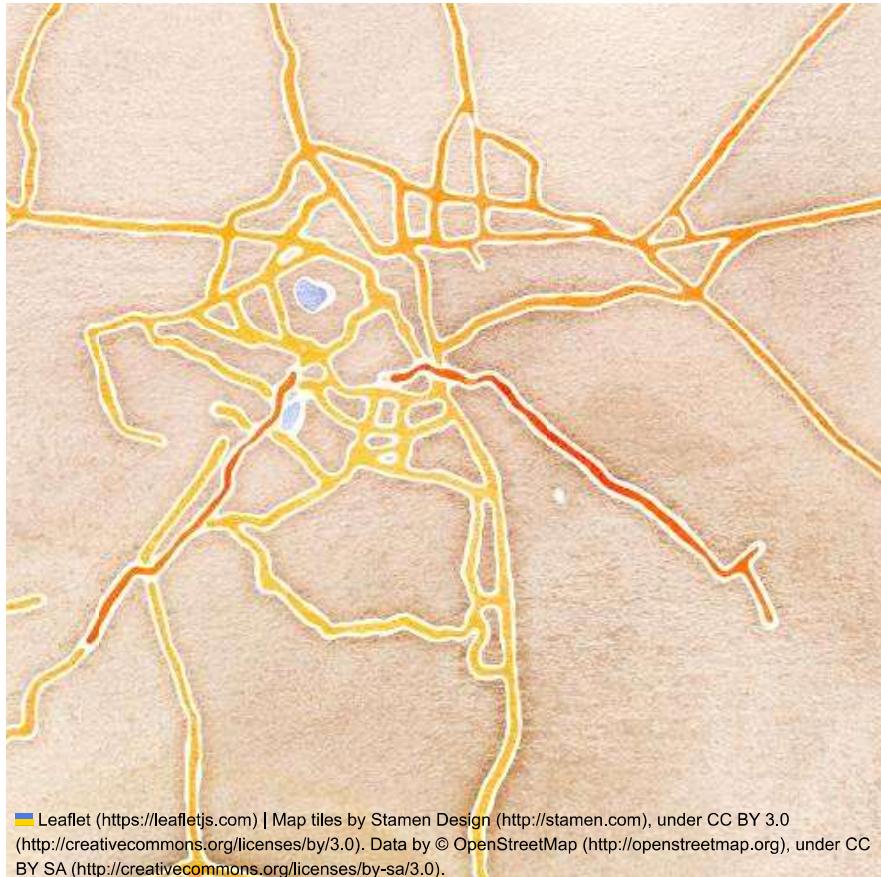
display(WorldMap)
```

## Background Tile Type 6: Stamen Watercolor

```
import folium

WorldMap=folium.Map(location=[28.5354, 77.2639],zoom_start = 10, zoom_control=False, min_zoom=4, max_zoom=13,
                     tiles = 'Stamen Watercolor',width=500, height=500)

display(WorldMap)
```



## 6. Creating Multiple Layers of Background Tiles and Switching between different Tile backgrounds

- Adding LAYER Control button to hide/display layers: **folium.LayerControl( ).add\_to()**
- Adding different LAYERS of backgrounds: **folium.TileLayer( ).add\_to()**

```
import folium

WorldMap=folium.Map(location=[28.7041, 77.1025], zoom_start = 10, zoom_control=False,
                     width=500, height=300)

folium.TileLayer('Open Street Map', attr = 'Open Street Map',name='Layer 1').add_to(WorldMap)
folium.TileLayer('Stamen Terrain', attr = 'Stamen Terrain',name='Layer 2').add_to(WorldMap)
```

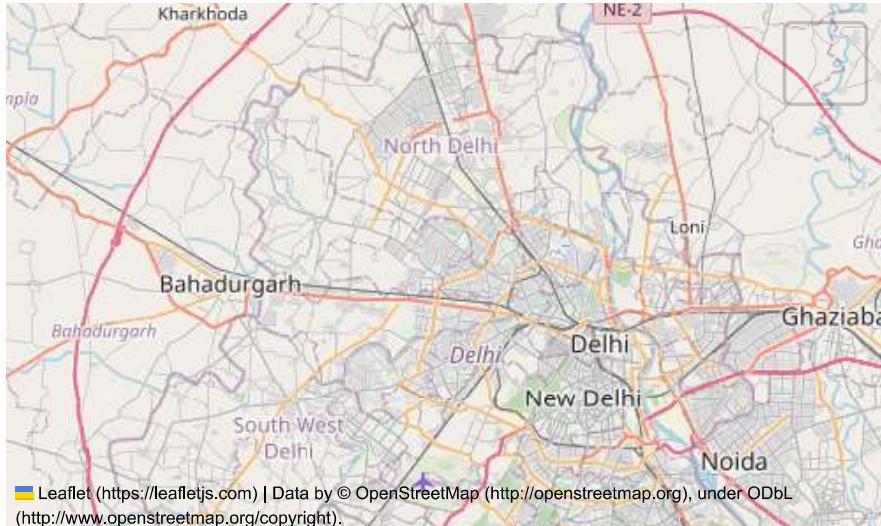
```

folium.TileLayer('Stamen Toner', attr = 'Stamen Toner',name='Layer 3').add_to(WorldMap)
folium.TileLayer('Stamen Water Color', attr = 'Stamen Water Color',name='Layer 4').add_to(WorldMap)
folium.TileLayer('CartoDB Positron',attr ='CartoDB Positron',name='Layer 5').add_to(WorldMap)
folium.TileLayer('cartodbdark_matter',attr ='CartoDB Dark matter',name='Layer 6',opacity=0.6).add_to(WorldMap)

folium.LayerControl().add_to(WorldMap)

display(WorldMap)

```



## • 7. Adding CIRCLE MARKERS to highlight certain locations

`folium.CircleMarker( )`

```

import folium

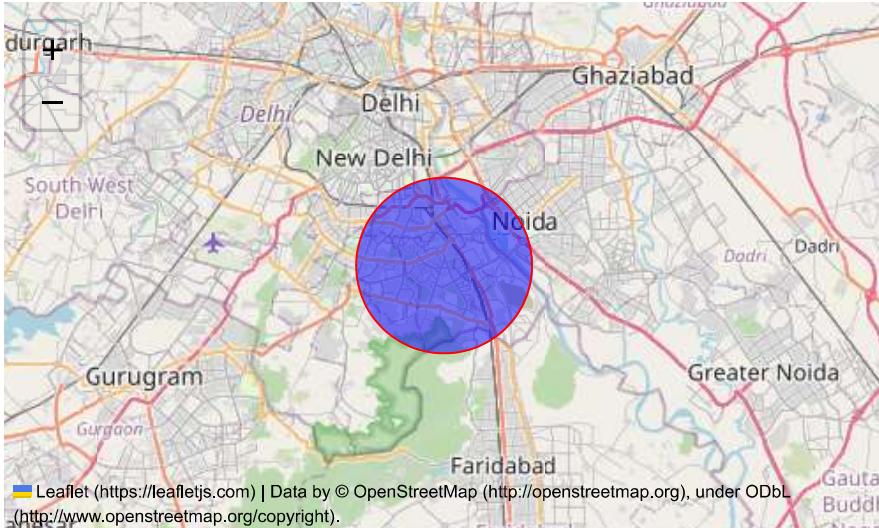
WorldMap=folium.Map(location=[28.5393, 77.264],zoom_start = 10,
                     min_zoom=10, max_zoom=17,
                     tiles = 'Open street map',width=500, height=300)

folium.CircleMarker(location=[28.5393, 77.264], radius=50,color='red',
                     weight=1, fill=True, fill_color='blue',
                     fill_opacity=0.5,
                     popup = 'Acharya Narendra Dev College, Govindpuri, Kalkaji, New Delhi-110019',
                     tooltip=' ACCREDITED A GRADE BY NAAC WITH SCORE OF 3.31,DBT STAR COLLEGE').add_to(WorldMap)

'''location=[28.5393, 77.264]: adds a circle marker at 'Acharya Narendra Dev College' Location
radius: radius of the circle marker

```

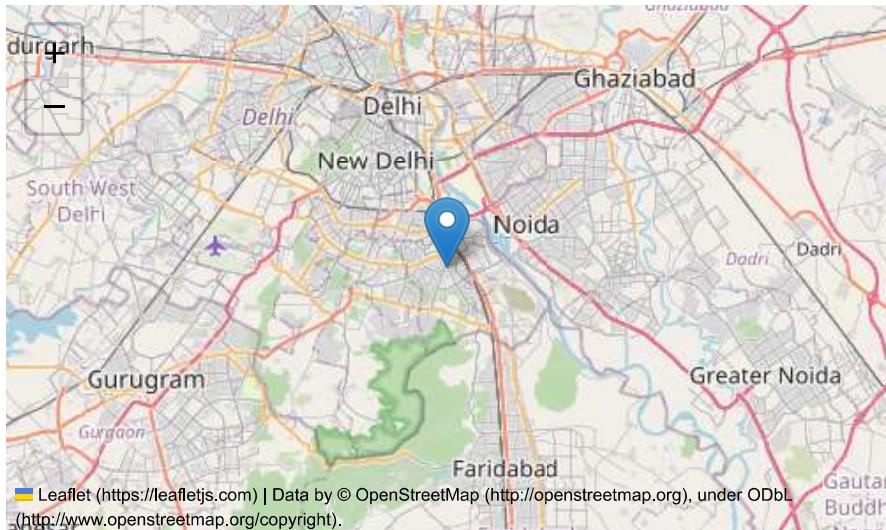
```
color: border color of the circle marker  
weight: border width of the circle marker  
fill =True: fills circle marker with a desired color  
fill_color: to specify fill color  
fill_opacity: adjusting opacity of fill color  
popup: To display a message when the marker is clicked  
...  
display(WorldMap)
```



## ▼ 8. Adding Location Markers to Folium Map

`folium.Marker( )`

```
import folium  
  
WorldMap=folium.Map(location=[28.5393, 77.264],zoom_start = 10,  
                     min_zoom=10, max_zoom=17,  
                     tiles = 'Open street map',width=500, height=300)  
folium.Marker(location=[28.5393, 77.264],  
              popup = 'Acharya Narendra Dev College',  
              tooltip = 'It is an amazing college').add_to(WorldMap)  
display(WorldMap)
```



## ▼ 8. Formatting Location Markers

using **icon** parameter

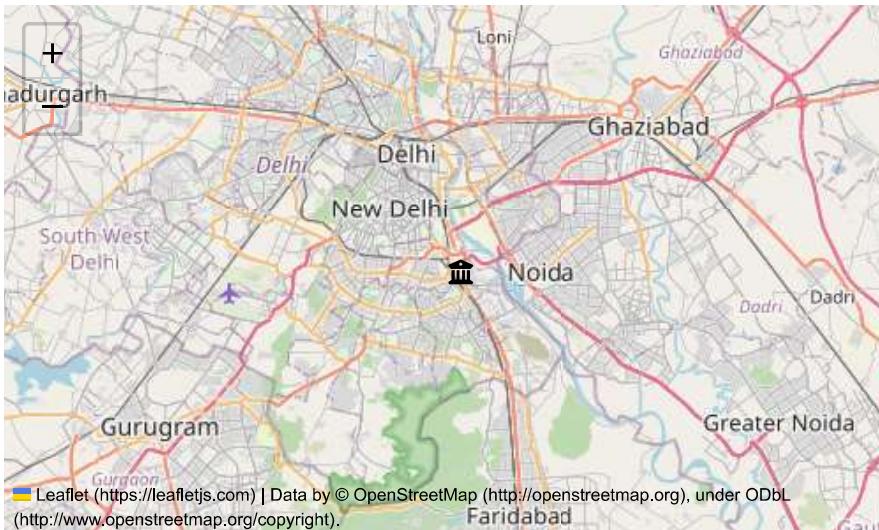
Full list of icons are given here: <https://fontawesome.com/icons?d=gallery> use with: prefix='fa'

or the glyphicon icons of Bootstrap that are built-in and standard, thus without prefix needed.

<https://getbootstrap.com/docs/3.3/components/>

```
import folium

WorldMap=folium.Map(location=[28.5393, 77.264],zoom_start = 10,
                     min_zoom=10, max_zoom=17,
                     tiles = 'Open street map',width=500, height=300)
folium.Marker(location=[28.5393, 77.264],
              popup = 'Acharya Narendra Dev College',
              tooltip = 'It is an amazing college',
              icon=folium.Icon(color='red', icon_color='white',icon='university',prefix='fa')).add_to(WorldMap)
display(WorldMap)
```



## 9. Adding Multiple Location Markers

```
import folium

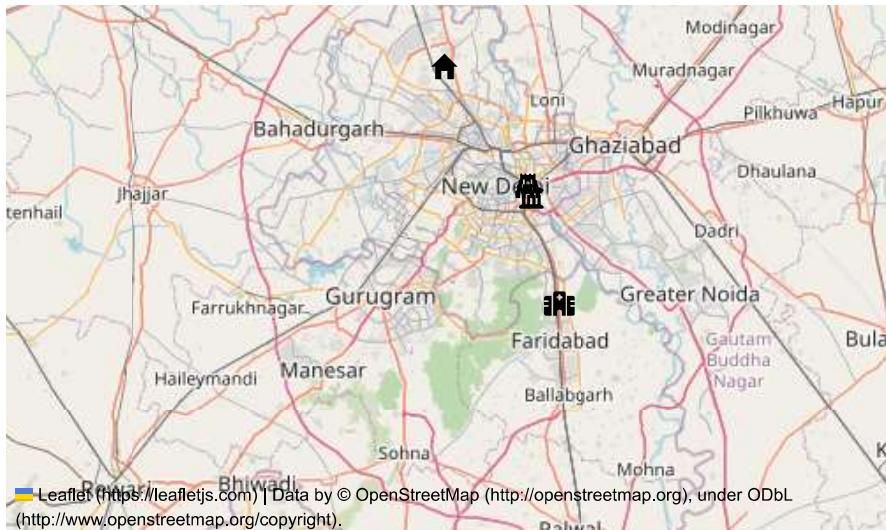
WorldMap=folium.Map(location=[28.5393, 77.264],zoom_start = 6, zoom_control=False, min_zoom=6, max_zoom=18,
                     tiles = 'Open street map',width=500, height=300)
folium.Marker(location=[28.5393, 77.264],popup = 'Acharya Narendra Dev College',tooltip = 'It is an amazing college',
             icon = folium.Icon(color='red', icon_color='white',icon='university',prefix='fa')).add_to(WorldMap)

folium.Marker(location=[28.7225, 77.1278],
              popup = 'Rohini, Sector-13',
              tooltip = 'Rohini, Sector-13',
              icon=folium.Icon(color='blue', icon_color='white',icon='home')).add_to(WorldMap)

folium.Marker(location=[28.5535, 77.2588],
              popup = 'Lotus Temple',
              tooltip = 'Lotus Temple',
              icon=folium.Icon(color='orange', icon_color='white',icon='gopuram',prefix='fa')).add_to(WorldMap)

folium.Marker(location=[28.391445, 77.306973],
              popup = 'Escorts Hospital. Delhi',
              tooltip = 'Escorts Hospital. Delhi',
              icon=folium.Icon(color='green', icon_color='white',icon='hospital',prefix='fa')).add_to(WorldMap)

WorldMap
```



## ▼ 9. Drawing straight-line paths between Multiple Location Markers

Displaying '**Distance**' between two locations

```
import folium
from geopy.distance import distance

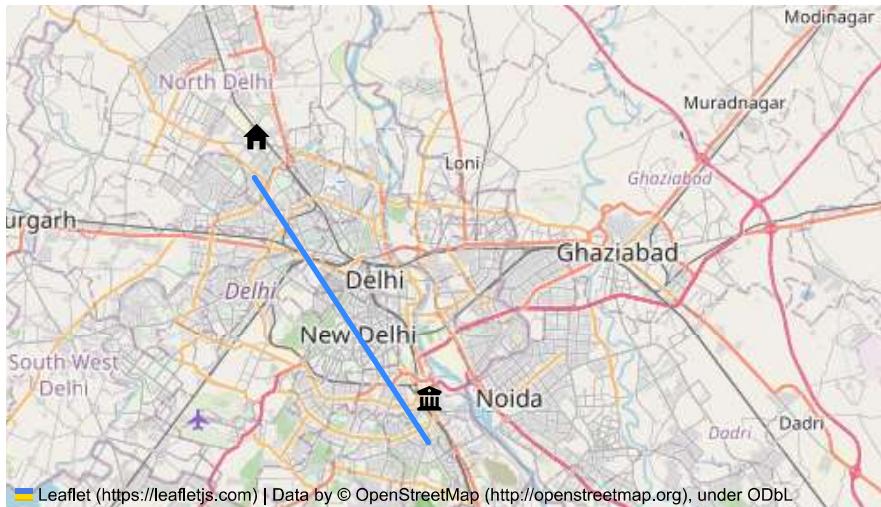
WorldMap=folium.Map(location=[28.5393, 77.264],zoom_start = 6, zoom_control=False, min_zoom=6, max_zoom=17,
                     tiles = 'Open street map',width=500, height=300)
folium.Marker(location=[28.5393, 77.264],popup = 'Acharya Narendra Dev College',tooltip = 'It is an amazing college',
             icon = folium.Icon(color='red', icon_color='white',icon='university',prefix='fa'),prefix='fa').add_to( WorldMap)

folium.Marker(location=[28.7225, 77.1278],
              popup = 'Rohini, Sector-13',
              tooltip = 'Rohini, Sector-13',
              icon=folium.Icon(color='blue', icon_color='white',icon='home')).add_to( WorldMap)

D=distance([28.5393, 77.264],[28.7225, 77.1278])

folium.PolyLine([[28.5393, 77.264],[28.7225, 77.1278]],tooltip=D).add_to( WorldMap)

display( WorldMap)
```



## ▼ CHOROPLETH MAPS



```

import json
import pandas as pd
import plotly.express as px

INDIA_MAP=json.load(open('/content/states_india.geojson','r'))

display(INDIA_MAP[ 'features'][0])

```

```
{'type': 'Feature',
 'geometry': {'type': 'MultiPolygon',
 'coordinates': [[[ [78.34088, 19.883615],
 [78.351327, 19.88184],
 [78.370422, 19.883346],
 [78.379149, 19.879733],
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 [78.57869, 19.814543],
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 [78.608696, 19.818273],
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 [78.624399, 19.809511],
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 [78.701092, 19.790606],
 [78.706982, 19.78649],
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 [78.721678, 19.767761],
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 [78.737084, 19.773814],
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 [78.862815, 19.720906],
 [78.867081, 19.707098],
 [78.868905, 19.697974],
 [78.869422, 19.687921],
 [78.868641, 19.680728],
 [78.864552, 19.670156],
 [78.864228, 19.657568].
```

```
[1]: , ,  
[2]: 10.650011
```

```
import json  
import pandas as pd  
import plotly.express as px  
  
INDIA_MAP=json.load(open('/content/states_india.geojson','r'))  
  
display(INDIA_MAP['features'][0]['properties'])
```

```
{'cartodb_id': 1, 'state_code': 0, 'st_nm': 'Telangana'}  
[ 78.968443, 19.61854],
```

```
import json  
import pandas as pd  
import plotly.express as px  
  
INDIA_MAP=json.load(open('/content/states_india.geojson','r'))  
  
INDIA_DATA=pd.read_csv('India-Population.csv')  
  
display(INDIA_DATA['Population'])
```

```
0      199812341  
1      112374333  
2      104099452  
3      91276115  
4      84580777  
5      72626809  
6      72147030  
7      68548437  
8      61095297  
9      60439692  
10     41974218  
11     33406061  
12     32988134  
13     31205576  
14     27743338  
15     25545198  
16     25351462  
17     16787941  
18     12541302  
19     10086292  
20     6864602  
21     3673917  
22     2966889  
23     2855794  
24     1978502  
25     1458545  
26     1383727  
27     1247953  
28     1097206  
29     1055450  
30     610577  
31     380581  
32     343709  
33     243247  
34     64473  
Name: Population, dtype: int64
```

```
[79.256049, 19.57949],
```

```
import json  
import pandas as pd  
import plotly.express as px
```

```

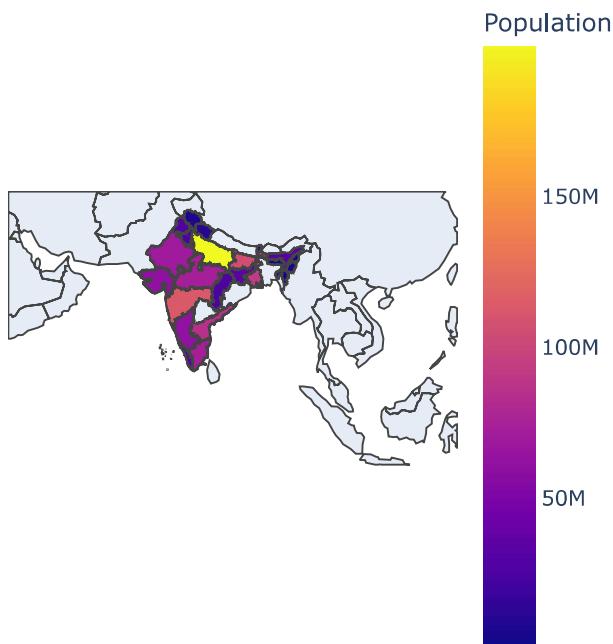
INDIA_MAP=json.load(open('/content/states_india.geojson','r'))

INDIA_DATA=pd.read_csv('India-Population.csv')

MAP=px.choropleth(INDIA_DATA,geojson=INDIA_MAP,
                  locations='State',
                  featureidkey="properties.st_nm",
                  color='Population',scope='asia',fitbounds='locations')

MAP.show()

```



```

[79.000000, 19.520000],
[79.613572, 19.541733],
[79.617268, 19.551439],
[79.622176, 19.560879],
[79.627763, 19.567353],
[79.646103, 19.577255],
[79.659015, 19.578958],
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[79.684435, 19.578861],
[79.691214, 19.581465],
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[79.792831, 19.592051],
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[79.811771, 19.579209],
[79.817657, 19.576299].

```

[79.823154, 19.571483],  
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[79.877975, 19.125971],  
[79.869893, 19.119096],  
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