

In [2]:

```

try:
    print("Importing libraries...\n")
    from progressbar import ProgressBar
    from bs4 import BeautifulSoup as bts # Library for web scraping
    import numpy as np # Library to handle data in a vectorized manner
    import pandas as pd # Library for data analysis
    from pandas.io.json import json_normalize
    import matplotlib.cm as cm
    import matplotlib.colors as colors
    import requests # Library to handle requests
    from geopy.geocoders import Nominatim # convert an address into latitude and longitude values
    import matplotlib as mp # Library for visualization
    from sklearn.cluster import KMeans # import k-means from clustering stage
    from geopy.geocoders import Nominatim # convert an address into latitude and longitude values
    import folium # map rendering library
    import lxml
    import re
    from time import sleep

    from matplotlib import pyplot as plt
    from matplotlib.pyplot import figure

    import datetime
    import dateutil
    print("All libraries imported successfully!\n")
except:
    print("ERROR: Could not import all libraries!\n")

%matplotlib inline

Importing libraries...
All libraries imported successfully!

```

## Mapping London

In [2]:

```

address = 'London'

geolocator = Nominatim(user_agent="ldn_explorer")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('The geographical coordinate of London are {}, {}'.format(latitude, longitude))

```

The geographical coordinate of London are 51.5073219, -0.1276474.

### 1. Boroughs

London can be subdivided into boroughs. This is available as an geojson overlay 'london\_boroughs\_proper.geojson' Much of the data provided at the London data store is at a borough level.

In [11]:

```

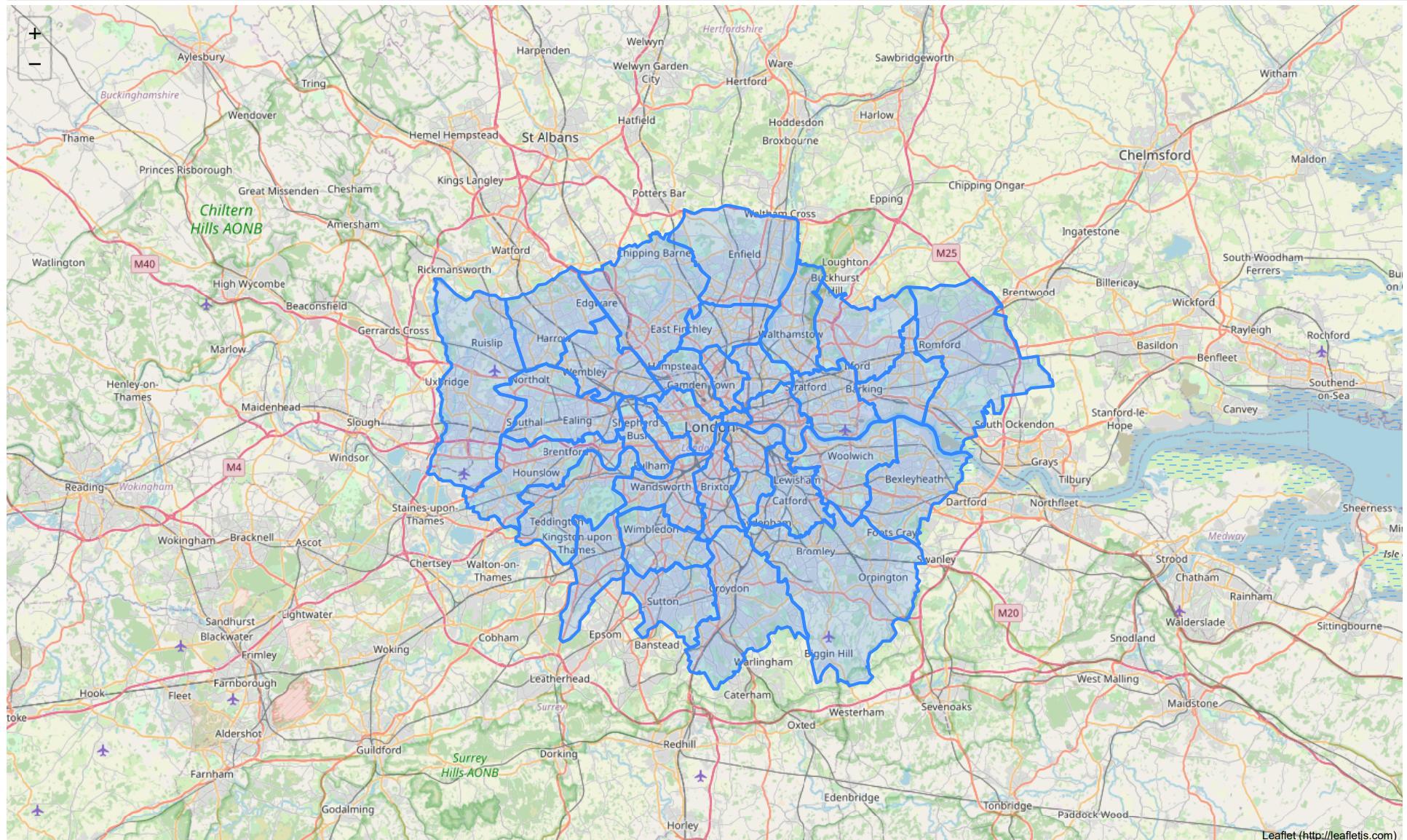
# create map
lnd_geo = r'london_boroughs_proper.geojson'
lnd_map = folium.Map(location = [latitude, longitude], zoom_start = 10)

folium.GeoJson(lnd_geo, name="geojson").add_to(lnd_map)

lnd_map

```

Out[11]:



In [ ]:

## 2. Wards

In [ ]:

```
In [12]: # create map
lnd_ward_geo = r'london-wards-2014.geojson'
lnd_map = folium.Map(location = [latitude, longitude], zoom_start = 10)

#London_merged['Borough Label']= London_merged.index

folium.GeoJson(lnd_ward_geo, name="geojson").add_to(lnd_map)
lnd_map
```

Out[12]:

The figure is a map of the London area, centered around Greater London. A large blue polygon covers most of the central and southern parts of the city, extending from Hertfordshire in the north to Kent in the south. This blue area represents a spatial distribution or coverage area. The map also shows the Chiltern Hills AONB and Surrey Hills AONB in green. Major roads are indicated by red lines, including the M25, M40, M4, and M20. Rivers are shown in blue. Numerous towns and cities are labeled, such as Aylesbury, Tring, Hemel Hempstead, St Albans, Watford, Rickmansworth, Gerrards Cross, Beaconsfield, Marlow, Henley-on-Thames, Maidenhead, Slough, Windsor, Reading, Wokingham, Bracknell, Ascot, Sandhurst, Blackwater, Farnborough, Aldershot, Guildford, Dorking, Godalming, Horley, Redhill, Caterham, Warlingham, Epsom, Banstead, Leatherhead, Cobham, Walton-on-Thames, Staines-upon-Thames, Chertsey, Croydon, Bromley, Elgin Hill, Orpington, Greenhithe, Dartford, Northfleet, Grays, Tilbury, Basildon, Brentwood, Chipping Ongar, Epping, Hoddesdon, Broxbourne, Harlow, Sawbridgeworth, Chelmsford, Maldon, South Woodham Ferrers, Rayleigh, Benfleet, Stanford-le-Hope, Canvey, Sheerness, Medway, Strood, Chatham, Rainham, Walderslade, Snodland, West Malling, Maidstone, Tonbridge, Paddock Wood, Sevenoaks, Oxted, Westerham, Edenbridge, and Tonbridge. Airports are marked with purple icons.

### 3. Neighbourhoods

Rather than modern political divisions, London communities centre around neighbourhoods, often based on old parishes and manor houses, often predating the expansion of London.

No official data on these neighbourhoods sourced, but a list located on Wikipedia. Many of these neighbourhoods are geocodable, so the wikipedia list can be webscraped and geolocator used to obtain coordinates.

Scrape the table of neighbourhoods from wikipedia using beautiful soup

```
In [4]: london_source = requests.get('https://en.wikipedia.org/wiki/List_of_areas_of_London').text
london_soup = bts(london_source, 'lxml')
london_table = london_soup.findAll('table', class_="wikitable sortable")
wiki_df = pd.read_html(str(london_table))
wiki_df = pd.concat(wiki_df)
wiki_df.head()
```

Out[4]:

	Location	London borough	Post town	Postcode district	Dial code	OS grid ref
0	Abbey Wood	Bexley, Greenwich [7]	LONDON	SE2	020	TQ465785
1	Acton	Ealing, Hammersmith and Fulham[8]	LONDON	W3, W4	020	TQ205805
2	Addington	Croydon[8]	CROYDON	CR0	020	TQ375645
3	Addiscombe	Croydon[8]	CROYDON	CR0	020	TQ345665
4	Albany Park	Bexley	BEXLEY, SIDCUP	DA5, DA14	020	TQ478728
5	Aldborough Hatch	Redbridge[9]	ILFORD	IG2	020	TQ455895
6	Aldgate	City[10]	LONDON	EC3	020	TQ334813
7	Aldwych	Westminster[10]	LONDON	WC2	020	TQ307810
8	Alperton	Brent[11]	WEMBLEY	HA0	020	TQ185835
9	Anerley	Bromley[11]	LONDON	SE20	020	TQ345695

**Observation:** Neighbourhoods can cross London boroughs

```
In [28]: print('The list contains {} London Neighbourhoods'.format(len(wiki_df['Location'].unique())))
```

The list contains 524 London Neighbourhoods

#### Clean neighbourhood data

Check whether any locations contain characters other than letters and spaces

```
In [18]: wiki_df[wiki_df['Location'].str.replace(" ", "").str.isalpha() == False]
```

Out[18]:

	Location	London borough	Post town	Postcode district	Dial code	OS grid ref
25	Barnet (also Chipping Barnet, High Barnet)	Barnet[16]	BARNET	EN5	020	TQ245955
44	Bexley (also Old Bexley, Bexley Village)	Bexley[25]	BEXLEY	DA5	020	TQ465755
45	Bexleyheath (also Bexley New Town)	Bexley[26]	BEXLEYHEATH, LONDON	DA6, DA7, SE2	020	TQ485755
66	Bromley (also Bromley-by-Bow)	Tower Hamlets[36]	LONDON	E3	020	TQ375825

	Location	London borough	Post town	Postcode district	Dial code	OS grid ref
73	Burroughs, The	Barnet[39]	LONDON	NW4	020	TQ227891
229	Havering-atte-Bower	Havering	ROMFORD	RM4	01708	TQ515935
268	King's Cross	Camden, Islington	LONDON	WC1	020	TQ301834
301	Marylebone (also St Marylebone)	Westminster	LONDON	W1	020	TQ285815
371	Pratt's Bottom	Bromley	ORPINGTON	BR6	01689	TQ471622
376	Queen's Park	Brent	LONDON	NW6	020	TQ246832
399	Shepherd's Bush	Hammersmith and Fulham	LONDON	W12	020	TQ235798
401	Shooter's Hill	Greenwich	LONDON	SE18	020	TQ435765
427	St James's	Westminster	LONDON	SW1	020	TQ295805
431	St John's Wood	Westminster	LONDON	NW8	020	TQ265835
432	St Luke's	Islington	LONDON	EC1	020	TQ324824
435	St Paul's Cray	Bromley	ORPINGTON	BR5	01689	TQ466688
452	Sydenham (also Lower Sydenham, Upper Sydenham)	Lewisham, Bromley	LONDON	SE26	020	TQ352714
515	Widmore (also Widmore Green)	Bromley	BROMLEY	BR1	020	TQ411691

Clean the data in the location column - remove notes in brackets and additional spaces

In [29]:

```
# remove (...) from Location
wiki_df['Location'] = wiki_df['Location'].str.replace(r"\(.*\)", "")
#remove trailing/Leading spaces
wiki_df['Location'] = wiki_df['Location'].str.strip()

wiki_df[wiki_df['Location'].str.replace(" ", "").str.isalpha() == False] #check the cleaned values to confirm brackets have been removed
```

<ipython-input-29-94dd556bbc2b>:2: FutureWarning: The default value of regex will change from True to False in a future version.  
wiki\_df['Location'] = wiki\_df['Location'].str.replace(r"\(.\*\)", "")

Out[29]:

	Location	London borough	Post town	Postcode district	Dial code	OS grid ref
73	Burroughs, The	Barnet[39]	LONDON	NW4	020	TQ227891
229	Havering-atte-Bower	Havering	ROMFORD	RM4	01708	TQ515935
268	King's Cross	Camden, Islington	LONDON	WC1	020	TQ301834
371	Pratt's Bottom	Bromley	ORPINGTON	BR6	01689	TQ471622
376	Queen's Park	Brent	LONDON	NW6	020	TQ246832
399	Shepherd's Bush	Hammersmith and Fulham	LONDON	W12	020	TQ235798
401	Shooter's Hill	Greenwich	LONDON	SE18	020	TQ435765
427	St James's	Westminster	LONDON	SW1	020	TQ295805
431	St John's Wood	Westminster	LONDON	NW8	020	TQ265835
432	St Luke's	Islington	LONDON	EC1	020	TQ324824
435	St Paul's Cray	Bromley	ORPINGTON	BR5	01689	TQ466688

Obtain coordinates for each neighbourhood. This is done using geolocator. Due to timeout issues, not all coordinates have been retrieved first pass, so this code has been designed to be rerunable to retry locations where data is absent

```
In [ ]: wiki_df['latitude'] = np.nan # add Latitude column, set to not a number, this can then be used to test whether a neighbourhood has had co-ordinates added
```

```
In [21]: ##Rerunable if geolacter errors.

for idx,ref, place, lat in zip(wiki_df.index, wiki_df['OS grid ref'], wiki_df['Location'], wiki_df['latitude']):
    if np.isnan(wiki_df.loc[idx, 'latitude'])==True: #If no Latitude value recorded for the location
        geolocator = Nominatim(user_agent="ldn_explorer")
        try:
            location = geolocator.geocode(place + ", London, United Kingdom")
        except:
            print('Geocoder error ' + place) # This error indicates issue accessing geolocator

        try:
            wiki_df.loc[idx, 'latitude'] = location.latitude
            wiki_df.loc[idx, 'longitude'] = location.longitude
            print('The geographical coordinate of {} is {}, {}'.format(place,location.latitude, location.longitude))
        except:
            print("Error " + place) #This indicates geolocator returned a response, but it was not coordinates - ie the neighbourhood was not geocodable
    else:
        print(place + ' already has latitude ' + str(lat))
```

Abbey Wood already has latitude 51.487621  
 Acton already has latitude 51.5081402  
 Addington already has latitude 51.3586365  
 Addiscombe already has latitude 51.3796916  
 Albany Park already has latitude 51.4353837  
 Error Aldborough Hatch  
 Aldgate already has latitude 51.5142477  
 Aldwych already has latitude 51.513103  
 Alperton already has latitude 51.5408036  
 Anerley already has latitude 51.4075993  
 Angel already has latitude 51.5318417  
 Aperfield already has latitude 51.3166288  
 Archway already has latitude 51.5654371  
 Ardleigh Green already has latitude 51.5841911  
 Arkley already has latitude 51.6455827  
 Arnos Grove already has latitude 51.6164024  
 Balham already has latitude 51.4447487  
 Bankside already has latitude 51.5074991  
 Barbican already has latitude 51.5201501  
 Barking already has latitude 51.5389922  
 Barkingside already has latitude 51.5858181  
 Barnehurst already has latitude 51.4650212  
 Barnes already has latitude 51.4718962  
 Barnes Cray already has latitude 51.4536058  
 Barnet Gate already has latitude 51.6418265  
 Barnet already has latitude 51.65309  
 Barnsbury already has latitude 51.5389351  
 Battersea already has latitude 51.4707933  
 Bayswater already has latitude 51.5122764  
 Beckenham already has latitude 51.4070938  
 Beckton already has latitude 51.5160797  
 Becontree already has latitude 51.5403111  
 Becontree Heath already has latitude 51.5610299  
 Beddington already has latitude 51.3719875  
 Bedford Park already has latitude 51.498020100000005  
 Belgravia already has latitude 51.4982128

Bellingham already has latitude 51.4311004  
Belmont already has latitude 51.3437847  
Belmont already has latitude 51.3437847  
Belsize Park already has latitude 51.5473926  
Belvedere already has latitude 51.4894735  
Bermondsey already has latitude 51.4970125  
Berrylands already has latitude 51.3937811  
Bethnal Green already has latitude 51.5303456  
Bexley already has latitude 51.4416793  
Bexleyheath already has latitude 51.4634854  
Bickley already has latitude 51.4017399  
Biggin Hill already has latitude 51.33202045  
Blackfen already has latitude 51.4505408  
Blackfriars already has latitude 51.5115854  
Blackheath already has latitude 51.4663175  
Blackheath Royal Standard already has latitude 51.4783917  
Blackwall already has latitude 51.5079378  
Blendon already has latitude 51.4482606  
Bloomsbury already has latitude 51.523126  
Botany Bay already has latitude 51.6765805  
Bounds Green already has latitude 51.607376  
Bow already has latitude 51.5309383  
Bowes Park already has latitude 51.6071861  
Brentford already has latitude 51.4863958  
Brent Cross already has latitude 51.5767595  
Brent Park already has latitude 51.5639957  
Brimsdown already has latitude 51.6555713  
Brixton already has latitude 51.4568044  
Brockley already has latitude 51.4578328  
Bromley already has latitude 51.4028046  
Bromley already has latitude 51.4028046  
Bromley Common already has latitude 51.3758752  
Brompton already has latitude 51.4918222  
Brondesbury already has latitude 51.5450493  
Brunswick Park already has latitude 51.6262191  
Bulls Cross already has latitude 51.6784103  
Burnt Oak already has latitude 51.6028082  
Burroughs, The already has latitude 51.5883045  
Camberwell already has latitude 51.4745706  
Cambridge Heath already has latitude 51.5319544  
Camden Town already has latitude 51.5423045  
Canary Wharf already has latitude 51.5048954  
Cann Hall already has latitude 51.55743685  
Canning Town already has latitude 51.5139887  
Canonbury already has latitude 51.5438298  
Carshalton already has latitude 51.3657883  
Castelnau already has latitude 51.485688  
Castle Green already has latitude 51.5334036  
Catford already has latitude 51.4453215  
Chadwell Heath already has latitude 51.5700474  
Chalk Farm already has latitude 51.5441141  
Charing Cross already has latitude 51.5074975  
Charlton already has latitude 51.4826053  
Chase Cross already has latitude 51.6038969  
Cheam already has latitude 51.3576155  
Chelsea already has latitude 51.4875167  
Chelsfield already has latitude 51.3579434  
Chessington already has latitude 51.358336  
Childs Hill already has latitude 51.5629822  
Chinatown already has latitude 51.511624499999996  
Chinbrook already has latitude 51.4294489  
Chingford already has latitude 51.630887  
Chislehurst already has latitude 51.4115718  
Chiswick already has latitude 51.4923137  
Church End already has latitude 51.6011117  
Church End already has latitude 51.6011117  
Clapham already has latitude 51.4622924  
Clerkenwell already has latitude 51.5237268

Cockfosters already has latitude 51.651366  
Colindale already has latitude 51.5954091  
Collier Row already has latitude 51.599912  
Colliers Wood already has latitude 51.4182747  
Colney Hatch already has latitude 51.6025172  
Colyers already has latitude 51.36834025  
Coney Hall already has latitude 51.3703786  
Coombe already has latitude 51.4194499  
Coombe already has latitude 51.4194499  
Coulson already has latitude 51.3199716  
Covent Garden already has latitude 51.512873600000006  
Cowley already has latitude 51.5279334  
Cranford already has latitude 51.4806709  
Cranham already has latitude 51.5614882  
Crayford already has latitude 51.4481946  
Creekmouth already has latitude 51.5163939  
Crews Hill already has latitude 51.6847476  
Cricklewood already has latitude 51.5566986  
Crofton Park already has latitude 51.4552107  
Crook Log already has latitude 51.4596374  
Crossness already has latitude 51.5019164  
Crouch End already has latitude 51.5787402  
Croydon already has latitude 51.3713049  
Crystal Palace already has latitude 51.4193664  
Cubitt Town already has latitude 51.4936677  
Cudham already has latitude 51.3163662  
Custom House already has latitude 51.5095972  
Dagenham already has latitude 51.5413271  
Dalston already has latitude 51.543212  
De Beauvoir Town already has latitude 51.5405639  
Denmark Hill already has latitude 51.468043  
Deptford already has latitude 51.4758453  
Derry Downs already has latitude 51.38431755  
Dollis Hill already has latitude 51.5519625  
Downe already has latitude 51.336978450000004  
Downham already has latitude 51.426111  
Dulwich already has latitude 51.4418786  
Ealing already has latitude 51.5126553  
Earls Court already has latitude 51.4916123  
Earlsfield already has latitude 51.4464482  
East Barnet already has latitude 51.6416813  
East Bedfont already has latitude 51.4490841  
East Dulwich already has latitude 51.4585222  
East Finchley already has latitude 51.5871881  
East Ham already has latitude 51.5329628  
East Sheen already has latitude 51.4623706  
East Wickham already has latitude 51.3758036  
Eastcote already has latitude 51.5795418  
Eden Park already has latitude 51.3901801  
Edgware already has latitude 51.6136623  
Edmonton already has latitude 51.6267968  
Eel Pie Island already has latitude 51.445126450000004  
Elephant and Castle already has latitude 51.4948884  
Elm Park already has latitude 51.549579  
Elmers End already has latitude 51.3994675  
Elmstead already has latitude 51.4181888  
Eltham already has latitude 51.4505687  
Emerson Park already has latitude 51.5686007  
Enfield Highway already has latitude 51.6570215  
Enfield Lock already has latitude 51.6708872  
Enfield Town already has latitude 51.6517156  
Enfield Wash already has latitude 51.6676487  
Erith already has latitude 51.4775613  
Falconwood already has latitude 51.4592305  
Farringdon already has latitude 51.5201241  
Feltham already has latitude 51.4442232  
Finchley already has latitude 51.5973246  
Finsbury already has latitude 51.521798

Finsbury Park already has latitude 51.5648345  
Fitzrovia already has latitude 51.5187642  
Foots Cray already has latitude 51.4186732  
Forest Gate already has latitude 51.5495236  
Forest Hill already has latitude 51.439108  
Forestdale already has latitude 51.3513283  
Fortis Green already has latitude 51.5910863  
Freezywater already has latitude 51.675772  
Friern Barnet already has latitude 51.6128792  
Frognal already has latitude 51.5549471  
Fulham already has latitude 51.4744221  
Fulwell already has latitude 51.4337482  
Gallows Corner already has latitude 51.5925799  
Gants Hill already has latitude 51.5765744  
Gidea Park already has latitude 51.5811818  
Gipsy Hill already has latitude 51.4245334  
Goddington already has latitude 51.3690444  
Golders Green already has latitude 51.5718315  
Goodmayes already has latitude 51.565803  
Gospel Oak already has latitude 51.5554865  
Grahame Park already has latitude 51.6028898  
Grange Park already has latitude 51.6433292  
Greenford already has latitude 51.5422492  
Greenwich already has latitude 51.4820845  
Grove Park already has latitude 51.4318969  
Grove Park already has latitude 51.4318969  
Gunnersbury already has latitude 51.4913757  
Hackney already has latitude 51.5432402  
Hackney Central already has latitude 51.5470605  
Hackney Marshes already has latitude 51.55649645  
Hackney Wick already has latitude 51.543433  
Hadley Wood already has latitude 51.6686277  
Haggerston already has latitude 51.5385184  
Hainault already has latitude 51.6033138  
The Hale already has latitude 51.5893574  
Ham already has latitude 51.4347641  
Hammersmith already has latitude 51.4920377  
Hampstead already has latitude 51.5580835  
Hampstead Garden Suburb already has latitude 51.5805081  
Hampton already has latitude 51.4150272  
Hampton Hill already has latitude 51.4278442  
Hampton Wick already has latitude 51.4144519  
Hanwell already has latitude 51.5089838  
Hanworth already has latitude 51.4348478  
Harefield already has latitude 51.6041828  
Harlesden already has latitude 51.5363567  
Harlington already has latitude 51.4884891  
Harmondsworth already has latitude 51.4889317  
Harold Hill already has latitude 51.6049  
Harold Park already has latitude 51.5936326  
Harold Wood already has latitude 51.5936326  
Harringay already has latitude 51.582382  
Harrow already has latitude 51.596827149999996  
Harrow on the Hill already has latitude 51.5792702  
Harrow Weald already has latitude 51.6047861  
Hatch End already has latitude 51.6095781  
Hatton already has latitude 51.4658301  
Havering-atte-Bower already has latitude 51.6191842  
Hayes already has latitude 51.5077154  
Hayes already has latitude 51.5077154  
Hazelwood already has latitude 51.3333728  
Hendon already has latitude 51.5897442  
Herne Hill already has latitude 51.4534691  
Heston already has latitude 51.4854573  
Highams Park already has latitude 51.6080662  
Highbury already has latitude 51.5457996  
Highgate already has latitude 51.5744322  
Hillingdon already has latitude 51.54251929999995

Hither Green already has latitude 51.4515872  
Holborn already has latitude 51.5195982  
Holland Park already has latitude 51.5030085  
Holloway already has latitude 51.5572453  
Homerton already has latitude 51.5470789  
Honor Oak already has latitude 51.45129  
Hook already has latitude 51.3678984  
Hornchurch already has latitude 51.5613235  
Horn Park already has latitude 51.4472867  
Hornsey already has latitude 51.5873645  
Hounslow already has latitude 51.4686132  
Hoxton already has latitude 51.5323935  
The Hyde already has latitude 51.5840727  
Ickenham already has latitude 51.5615698  
Ilford already has latitude 51.5582734  
Isle of Dogs already has latitude 51.4978447  
Isleworth already has latitude 51.4683558  
Islington already has latitude 51.5384287  
Kenley already has latitude 51.3227524  
Kennington already has latitude 51.4882861  
Kensal Green already has latitude 51.5306063  
Kensington already has latitude 51.4989948  
Kentish Town already has latitude 51.5500658  
Kenton already has latitude 51.5815255  
Keston already has latitude 51.3609685  
Kew already has latitude 51.4781044  
Kidbrooke already has latitude 51.4675731  
Kilburn already has latitude 51.541882  
King's Cross already has latitude 51.5323954  
Kingsbury already has latitude 51.5843174  
Kingston Vale already has latitude 51.43185  
Kingston upon Thames already has latitude 51.4096275  
Knightsbridge already has latitude 51.5008444  
Ladywell already has latitude 51.4560257  
Lambeth already has latitude 51.5013012  
Lamorbey already has latitude 51.4355092  
Lampton already has latitude 51.4776251  
Lea Bridge already has latitude 51.562141499999996  
Leamouth already has latitude 51.512158549999995  
Leaves Green already has latitude 51.33772965  
The geographical coordinate of Lee is 51.4565827, 0.0114959.  
The geographical coordinate of Lessness Heath is 51.484098, 0.14821.  
The geographical coordinate of Lewisham is 51.4624325, -0.0101331.  
The geographical coordinate of Leyton is 51.5696734, -0.015681.  
The geographical coordinate of Leytonstone is 51.5710783, 0.0064237.  
The geographical coordinate of Limehouse is 51.5128705, -0.0390456.  
The geographical coordinate of Lission Grove is 51.5224204, -0.1652763.  
The geographical coordinate of Little Ilford is 51.550298, 0.0625225.  
The geographical coordinate of Little Venice is 51.5211948, -0.1824045.  
The geographical coordinate of Locksbottom is 51.3670479, 0.0625805.  
The geographical coordinate of Longford is 51.4812266, -0.4908047.  
The geographical coordinate of Longlands is 51.4304854, 0.0841774.  
The geographical coordinate of Lower Clapton is 51.5546565, -0.0550912.  
The geographical coordinate of Lower Morden is 51.3897736, -0.2163635.  
The geographical coordinate of Loxford is 51.5481943, 0.084051.  
The geographical coordinate of Maida Vale is 51.527592, -0.1905916.  
The geographical coordinate of Malden Rusheatt is 51.3410523, -0.3190757.  
The geographical coordinate of Manor House is 51.5703208, -0.0963971.  
The geographical coordinate of Manor Park is 51.4269492, -0.1355069.  
The geographical coordinate of Marks Gate is 51.5863692, 0.1348482.  
The geographical coordinate of Maryland is 51.5460532, 0.0059223.  
The geographical coordinate of Marylebone is 51.5220589, -0.1504553.  
The geographical coordinate of Mayfair is 51.5110872, -0.147058.  
The geographical coordinate of Maze Hill is 51.482607, 0.0038458.  
The geographical coordinate of Merton Park is 51.4079938, -0.2019654.  
The geographical coordinate of Middle Park is 51.4453135, 0.0400849.  
The geographical coordinate of Mile End is 51.5253378, -0.033435.  
The geographical coordinate of Mill Hill is 51.6154423, -0.2330675.

The geographical coordinate of Millbank is 51.4926121, -0.1290435.  
The geographical coordinate of Millwall is 51.4933423, -0.0212187.  
The geographical coordinate of Mitcham is 51.4058006, -0.1640787.  
The geographical coordinate of Monken Hadley is 51.66121575, -0.19100962162691934.  
The geographical coordinate of Morden is 51.4027615, -0.1947552.  
The geographical coordinate of Morden Park is 51.3913369, -0.21066262224288523.  
The geographical coordinate of Mortlake is 51.4698873, -0.2685226.  
The geographical coordinate of Motspur Park is 51.3909852, -0.2488979.  
The geographical coordinate of Mottingham is 51.4339336, 0.0495702.  
The geographical coordinate of Muswell Hill is 51.5910395, -0.1420768.  
The geographical coordinate of Neasden is 51.5543358, -0.250749.  
The geographical coordinate of New Addington is 51.3425414, -0.0162924.  
The geographical coordinate of New Barnet is 51.6495724, -0.171006.  
The geographical coordinate of New Cross is 51.4763706, -0.0326237.  
The geographical coordinate of New Eltham is 51.4362297, 0.0685289.  
The geographical coordinate of New Malden is 51.4053347, -0.2634066.  
The geographical coordinate of New Southgate is 51.613804, -0.1428091.  
The geographical coordinate of Newbury Park is 51.5754985, 0.0899693.  
The geographical coordinate of Newington is 51.4852627, -0.10158303133535646.  
The geographical coordinate of Nine Elms is 51.4787433, -0.1362629.  
The geographical coordinate of Noah Hill is 51.6216658, 0.2271257.  
The geographical coordinate of Norbiton is 51.4099994, -0.2873963.  
The geographical coordinate of Norbury is 51.4110663, -0.1224869.  
The geographical coordinate of North Cray is 51.4251795, 0.1345992.  
The geographical coordinate of North End is 51.5678057, -0.1819396.  
The geographical coordinate of North Finchley is 51.6124905, -0.1756922.  
The geographical coordinate of North Harrow is 51.5851618, -0.3631762.  
The geographical coordinate of North Kensington is 51.5196647, -0.2106959.  
The geographical coordinate of North Ockendon is 51.5457699, 0.2936981.  
The geographical coordinate of North Sheen is 51.4653247, -0.2865821.  
The geographical coordinate of North Woolwich is 51.5004071, 0.064154.  
The geographical coordinate of Northolt is 51.5465937, -0.369565.  
The geographical coordinate of Northumberland Heath is 51.473075, 0.1624116.  
The geographical coordinate of Northwood is 51.6051713, -0.4205812.  
The geographical coordinate of Norwood Green is 51.4966058, -0.3693772.  
The geographical coordinate of Notting Hill is 51.5109995, -0.2055267.  
The geographical coordinate of Nunhead is 51.4615309, -0.0535056.  
The geographical coordinate of Oakleigh Park is 51.6376675, -0.1662251.  
The geographical coordinate of Old Coulsdon is 51.307089, -0.119647.  
The geographical coordinate of Old Ford is 51.5341124, -0.0268215.  
The geographical coordinate of Old Malden is 51.382484, -0.2590897.  
The geographical coordinate of Old Oak Common is 51.5279486, -0.2470894.  
The geographical coordinate of Orpington is 51.3805351, 0.1062656.  
The geographical coordinate of Osidge is 51.6349223, -0.13703584913350678.  
The geographical coordinate of Osterley is 51.4812336, -0.3521981.  
The geographical coordinate of Oval is 51.48375215, -0.11496182711601476.  
The geographical coordinate of Paddington is 51.5170856, -0.1775422.  
The geographical coordinate of Palmers Green is 51.6222544, -0.1127378.  
The geographical coordinate of Park Royal is 51.5264341, -0.2839348.  
The geographical coordinate of Parsons Green is 51.4750837, -0.201549.  
The geographical coordinate of Peckham is 51.4734122, -0.0699321.  
The geographical coordinate of Penge is 51.4146841, -0.0534213.  
The geographical coordinate of Pentonville is 51.5321048, -0.1148938.  
The geographical coordinate of Perivale is 51.5364952, -0.3225887.  
The geographical coordinate of Petersham is 51.4436913, -0.3052934.  
The geographical coordinate of Petts Wood is 51.3909147, 0.0771282.  
The geographical coordinate of Pimlico is 51.4889993, -0.1398817.  
The geographical coordinate of Pinner is 51.5968712, -0.3770142.  
The geographical coordinate of Plaistow is 51.5311544, 0.0166833.  
The geographical coordinate of Plaistow is 51.5311544, 0.0166833.  
The geographical coordinate of Plumstead is 51.4804635, 0.0924286.  
The geographical coordinate of Ponders End is 51.6428463, -0.0347837.  
The geographical coordinate of Poplar is 51.5110713, -0.0144629.  
The geographical coordinate of Pratt's Bottom is 51.3408843, 0.1114591.  
The geographical coordinate of Preston is 51.5762155, -0.2915108.  
The geographical coordinate of Primrose Hill is 51.5390165, -0.16193786284392453.  
The geographical coordinate of Purley is 51.3385156, -0.115893.  
The geographical coordinate of Putney is 51.4625524, -0.2167462.

The geographical coordinate of Queen's Park is 51.533873, -0.2054958.  
The geographical coordinate of Queensbury is 51.5941903, -0.286181.  
The geographical coordinate of Rainham is 51.5167284, 0.1996559.  
The geographical coordinate of Ratcliff is 51.5115396, -0.0442364.  
The geographical coordinate of Rayners Lane is 51.5752109, -0.3714658.  
The geographical coordinate of Raynes Park is 51.408966, -0.23054.  
The geographical coordinate of Redbridge is 51.5763203, 0.0454097.  
The geographical coordinate of Richmond is 51.4613531, -0.3032767.  
The geographical coordinate of Riddlesdown is 51.3329352, -0.0997037.  
The geographical coordinate of Roehampton is 51.4498773, -0.2412672.  
The geographical coordinate of Romford is 51.5760462, 0.1822646.  
The geographical coordinate of Rotherhithe is 51.5002908, -0.0436321.  
The geographical coordinate of Ruislip is 51.5714026, -0.4213375.  
The geographical coordinate of Rush Green is 51.5663201, 0.170001.  
The geographical coordinate of Ruxley is 51.4143345, 0.1326256.  
The geographical coordinate of Sanderstead is 51.3340837, -0.0767435.  
The geographical coordinate of Sands End is 51.4725454, -0.1871122.  
The geographical coordinate of Selhurst is 51.3922136, -0.0886537.  
The geographical coordinate of Selsdon is 51.3443067, -0.0607688.  
The geographical coordinate of Seven Kings is 51.5657811, 0.0951492.  
The geographical coordinate of Seven Sisters is 51.5824738, -0.0749325.  
The geographical coordinate of Shacklewell is 51.5523761, -0.0701582.  
The geographical coordinate of Shadwell is 51.51125, -0.0569241.  
The geographical coordinate of Shepherd's Bush is 51.5053155, -0.2229856.  
The geographical coordinate of Shirley is 51.3749243, -0.0466335.  
The geographical coordinate of Shooter's Hill is 51.4692255, 0.066306.  
The geographical coordinate of Shoreditch is 51.5266694, -0.0798926.  
The geographical coordinate of Sidcup is 51.4264002, 0.101044.  
The geographical coordinate of Silvertown is 51.5013626, 0.0385185.  
The geographical coordinate of Sipson is 51.489419, -0.4562064.  
The geographical coordinate of Slade Green is 51.4676731, 0.1903098.  
The geographical coordinate of Snaresbrook is 51.5809967, 0.0215251.  
The geographical coordinate of Soho is 51.5131628, -0.1311754.  
Error Somerstown  
The geographical coordinate of South Croydon is 51.3629173, -0.0933556.  
The geographical coordinate of South Hackney is 51.54888185, -0.047669054262764424.  
The geographical coordinate of South Harrow is 51.5646517, -0.3522211.  
The geographical coordinate of South Hornchurch is 51.5330916, 0.1912727.  
The geographical coordinate of South Kensington is 51.4940494, -0.1730439.  
The geographical coordinate of South Norwood is 51.3980951, -0.0768216.  
The geographical coordinate of South Ruislip is 51.5569909, -0.3990635.  
The geographical coordinate of South Wimbledon is 51.4151759, -0.1926457.  
The geographical coordinate of South Woodford is 51.5917798, 0.0274276.  
The geographical coordinate of South Tottenham is 51.5804433, -0.0717169.  
The geographical coordinate of Southend is 51.5952065, 0.0134128.  
The geographical coordinate of Southall is 51.511461, -0.3755169.  
The geographical coordinate of Southborough is 51.3899151, 0.0446175.  
The geographical coordinate of Southfields is 51.4457751, -0.2066142.  
The geographical coordinate of Southgate is 51.6281547, -0.123596.  
The geographical coordinate of Spitalfields is 51.5195274, -0.0751701.  
The geographical coordinate of St Helier is 51.3866947, -0.1800574.  
The geographical coordinate of St James's is 51.5079082, -0.1365727.  
The geographical coordinate of St Margarets is 51.4567091, -0.3224118.  
The geographical coordinate of St Giles is 51.5154723, -0.1284181.  
The geographical coordinate of St Johns is 51.4959801, -0.12699909770961582.  
The geographical coordinate of St John's Wood is 51.531726, -0.1741901.  
The geographical coordinate of St Luke's is 51.4896338, -0.16943919617052464.  
The geographical coordinate of St Mary Cray is 51.3954765, 0.1138557.  
The geographical coordinate of St Pancras is 51.5259149, -0.1290973.  
The geographical coordinate of St Paul's Cray is 51.4031797, 0.1183273.  
The geographical coordinate of Stamford Hill is 51.5707092, -0.0690402.  
The geographical coordinate of Stanmore is 51.6188526, -0.3026271.  
The geographical coordinate of Stepney is 51.5174023, -0.0462189.  
The geographical coordinate of Stockwell is 51.472211, -0.1225014.  
The geographical coordinate of Stoke Newington is 51.5578698, -0.0822482.  
The geographical coordinate of Stonebridge is 51.5441099, -0.2762285.  
The geographical coordinate of Stratford is 51.541289, -0.0035472.  
The geographical coordinate of Strawberry Hill is 51.4385925, -0.3399367.

The geographical coordinate of Streatham is 51.429769, -0.1311105.  
The geographical coordinate of Stroud Green is 51.5716864, -0.1114972.  
The geographical coordinate of Sudbury is 51.5143613, 0.0640345.  
The geographical coordinate of Sundridge is 51.4198856, 0.0202065.  
The geographical coordinate of Surbiton is 51.3937557, -0.3033105.  
The geographical coordinate of Surrey Quays is 51.4934207, -0.0478319.  
The geographical coordinate of Sutton is 51.357464449999995, -0.17362689496950337.  
The geographical coordinate of Swiss Cottage is 51.543722, -0.174982.  
The geographical coordinate of Sydenham is 51.4267658, -0.0523877.  
The geographical coordinate of Sydenham Hill is 51.4326038, -0.072322.  
The geographical coordinate of Teddington is 51.4277844, -0.333653.  
The geographical coordinate of Temple is 51.5109659, -0.1143345.  
The geographical coordinate of Temple Fortune is 51.5819126, -0.1990538.  
The geographical coordinate of Thamesmead is 51.4989335, 0.1148486.  
The geographical coordinate of Thornton Heath is 51.3988709, -0.099602.  
The geographical coordinate of Tokyngton is 51.55059635, -0.28489908276928966.  
The geographical coordinate of Tolworth is 51.3788758, -0.2828604.  
The geographical coordinate of Tooting is 51.4278214, -0.1679667.  
The geographical coordinate of Tooting Bec is 51.4356228, -0.1597188.  
The geographical coordinate of Tottenham is 51.5976955, -0.0672892.  
The geographical coordinate of Tottenham Green is 51.58775405, -0.07147608181567411.  
The geographical coordinate of Tottenham Hale is 51.5881223, -0.0599366.  
The geographical coordinate of Totteridge is 51.633156, -0.2008716.  
The geographical coordinate of Tower Hill is 51.5098481, -0.0766986.  
The geographical coordinate of Tufnell Park is 51.5568005, -0.138457.  
The geographical coordinate of Tulse Hill is 51.4412109, -0.1020591.  
The geographical coordinate of Turnpike Lane is 51.5886709, -0.1112342.  
The geographical coordinate of Twickenham is 51.4467444, -0.3281887.  
The geographical coordinate of Upminster is 51.5589708, 0.2516815.  
The geographical coordinate of Upminster Bridge is 51.5582655, 0.2347689.  
The geographical coordinate of Upper Clapton is 51.5668384, -0.0605697.  
The geographical coordinate of Upper Holloway is 51.5644891, -0.1338683.  
The geographical coordinate of Upper Norwood is 51.4164053, -0.0940347.  
The geographical coordinate of Upper Ruxley is 51.4102386, 0.1436717.  
The geographical coordinate of Upper Walthamstow is 51.5857628, 0.0007567.  
The geographical coordinate of Upton is 51.4524572, 0.1275711.  
The geographical coordinate of Upton Park is 51.5351062, 0.0339842.  
The geographical coordinate of Uxbridge is 51.5449509, -0.4816672.  
The geographical coordinate of Vauxhall is 51.4874834, -0.1229297.  
The geographical coordinate of Waddon is 51.3673338, -0.1174351.  
The geographical coordinate of Wallington is 51.357945, -0.1495621.  
The geographical coordinate of Walthamstow is 51.5844701, -0.0188186.  
The geographical coordinate of Walthamstow Village is 51.5836835, -0.0121451.  
The geographical coordinate of Walworth is 51.4901142, -0.0906603.  
The geographical coordinate of Wandsworth is 51.4570271, -0.1932607.  
The geographical coordinate of Wanstead is 51.5756739, 0.0277989.  
The geographical coordinate of Wapping is 51.5054363, -0.0587291.  
The geographical coordinate of Wealdstone is 51.5936353, -0.3294758.  
The geographical coordinate of Well Hall is 51.4574683, 0.0501437.  
The geographical coordinate of Welling is 51.46529, 0.1059038.  
The geographical coordinate of Wembley is 51.5531547, -0.2957562.  
The geographical coordinate of Wembley Park is 51.5636297, -0.2800532.  
The geographical coordinate of Wennington is 51.5043496, 0.2205249.  
The geographical coordinate of West Brompton is 51.4869765, -0.1951854.  
The geographical coordinate of West Drayton is 51.503513, -0.4662704.  
The geographical coordinate of West Ealing is 51.5135365, -0.3206893.  
The geographical coordinate of West Green is 51.5868063, -0.0898489.  
The geographical coordinate of West Hackney is 51.5608595, -0.0691322.  
The geographical coordinate of West Ham is 51.5280966, 0.0045685.  
The geographical coordinate of West Hampstead is 51.5468194, -0.1899646.  
The geographical coordinate of West Harrow is 51.5795852, -0.3530692.  
The geographical coordinate of West Heath is 51.4808745, 0.1273574.  
The geographical coordinate of West Hendon is 51.578213, -0.2403793.  
The geographical coordinate of West Kensington is 51.4907023, -0.2059442.  
The geographical coordinate of West Norwood is 51.4346192, -0.1036917.  
The geographical coordinate of West Wickham is 51.3758036, -0.0146843.  
The geographical coordinate of Westcombe Park is 51.4842137, 0.0188049.  
The geographical coordinate of Westminster is 51.5004439, -0.1265398.

The geographical coordinate of Whetstone is 51.6301762, -0.1748844.  
The geographical coordinate of White City is 51.5119347, -0.2242361.  
The geographical coordinate of Whitechapel is 51.5186227, -0.0620807.  
The geographical coordinate of Widmore is 51.4023963, 0.0351602.  
The geographical coordinate of Whitton is 51.4511693, -0.3579759.  
The geographical coordinate of Willesden is 51.5466216, -0.2358661.  
The geographical coordinate of Wimbledon is 51.4214787, -0.2064027.  
The geographical coordinate of Winchmore Hill is 51.6333948, -0.1033617.  
The geographical coordinate of Wood Green is 51.5972054, -0.1099585.  
The geographical coordinate of Woodford is 51.6068063, 0.0340272.  
The geographical coordinate of Woodford Green is 51.6118469, 0.02407962103878284.  
The geographical coordinate of Woodlands is 51.4721654, -0.3374321.  
The geographical coordinate of Woodside is 51.3870773, -0.0653308.  
The geographical coordinate of Woodside Park is 51.6179483, -0.1855794.  
The geographical coordinate of Woolwich is 51.4826696, 0.0623335.  
The geographical coordinate of Worcester Park is 51.3785033, -0.2416597.  
The geographical coordinate of Wormwood Scrubs is 51.5213926, -0.2405535260233359.  
The geographical coordinate of Yeading is 51.527239, -0.3992705.  
The geographical coordinate of Yiewsley is 51.5128661, -0.4741522.

**Observation:** Two neighbourhoods Somerstown and Aldborough Hatch are not geocodable. Coordinates have been obtained for the other neighbourhoods.

**Data Validation:** A sense check has been applied to validate this data, all latitudes truncate to 51, all longitudes are around 0. This indicates geolocator has correctly decoded the neighbourhoods.

In [22]: `wiki_df.tail()`

	Location	London borough	Post town	Postcode district	Dial code	OS grid ref	latitude	longitude
526	Woolwich	Greenwich	LONDON	SE18	020	TQ435795	51.482670	0.062334
527	Worcester Park	Sutton, Kingston upon Thames	WORCESTER PARK	KT4	020	TQ225655	51.378503	-0.241660
528	Wormwood Scrubs	Hammersmith and Fulham	LONDON	W12	020	TQ225815	51.521393	-0.240554
529	Yeading	Hillingdon	HAYES	UB4	020	TQ115825	51.527239	-0.399270
530	Yiewsley	Hillingdon	WEST DRAYTON	UB7	020	TQ063804	51.512866	-0.474152

Remove the two neighbourhoods which were not geocodable (ie have no latitude data)

In [31]: `wiki_df.dropna(axis=0, inplace=True)`

Save scraped Neighbourhood list and obtained coordinates for use in later analysis

In [69]: `#HACK save/reload data to avoid unnecessary API calls and enable analysis off line  
wiki_df.to_csv('london_neighbourhoods.csv')  
#wiki_df=pd.read_csv('London_neighbourhoods.csv')`

## Neighbourhoods in relation to wards

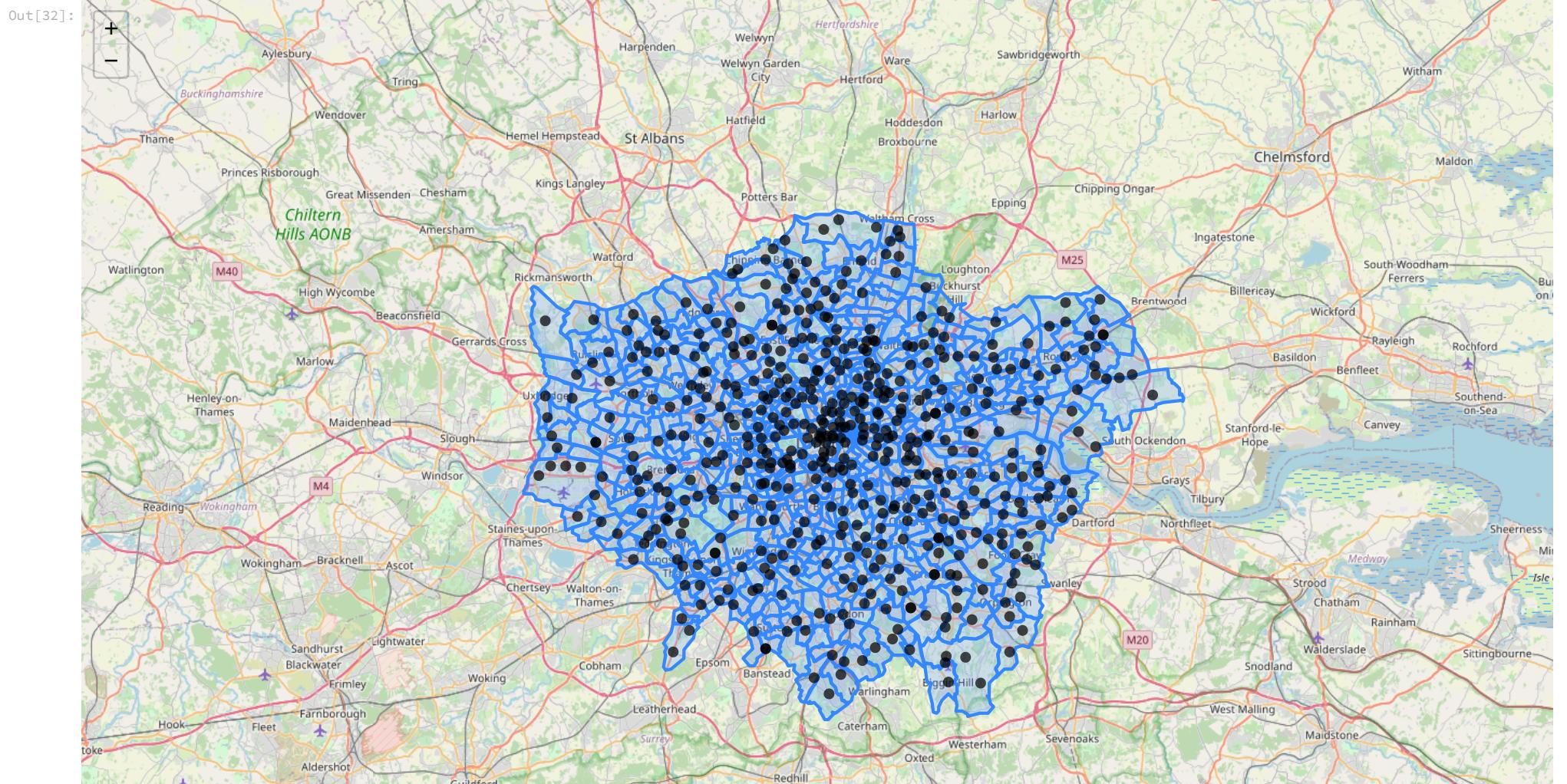
The neighbourhoods can be plotted with the ward boundaries superimposed

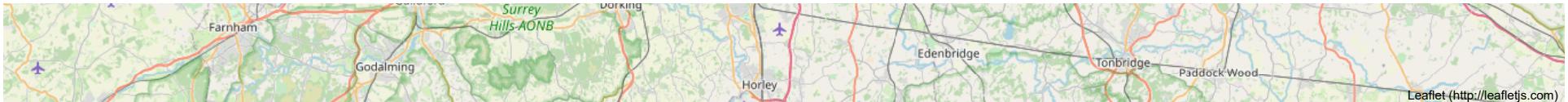
In [32]: `lnd_ward_geo = r'london-wards-2014.geojson'  
lnd_map = folium.Map(location = [latitude, longitude], zoom_start = 10)  
#London_merged['Borough Label']= London_merged.index`

```
folium.GeoJson(lnd_ward_geo, name="geojson").add_to(lnd_map)

# add markers to the map
markers_colors = []
for lat, lon, name in zip(wiki_df['latitude'], wiki_df['longitude'], wiki_df['Location']):
    label = folium.Popup(name, parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=5,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)
```

lnd\_map





**Observation:** Both ward and neighbourhoods provide a reasonable granular coverage of London. Ward data is comprehensive, covering all of London, whereas the neighbourhoods provide a good sample across London.

**Conclusion:** A visualisation of ward level data compared with neighbourhood data, may have potential for providing meaningful insights

## Obtaining Foursquare data

### Introduction to Foursquare API

The Foursquare API returns venues in a location based on either a location coordinate or a geocodable place name. The explore endpoint prioritises recommended locations.

In [33]:

```
CLIENT_ID = 'LHONXSF1T2PNUTZN2Q1S0RQNLFWUB1HJPLNCLUFKI52SKHLN' # Foursquare ID
CLIENT_SECRET = 'R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE' # Foursquare Secret (note this will be manually reset after uploading to GITHUB)
```

In [34]:

```
VERSION = '20180605' # Foursquare API version
LIMIT = 150 # A default Foursquare API limit value
```

### 1. Borough

An assessment of the best method of obtaining London borough level venue data from Foursquare API

#### Using Borough Coordinates with Foursquare API

A point within each London borough can be located, and venues returned within a radius around this point. To use this approach suitable coordinates should be identified.

#### Borough Coordinates obtained from Geolocator

First obtain a list of London Boroughs, sourcing this from the UK government London datastore. Also retrieving population data for use in data exploration

In [3]:

```
#London borough list
file ='https://data.london.gov.uk/download/london-borough-profiles/c1693b82-68b1-44ee-beb2-3decf17dc1f8/london-borough-profiles.csv'
boroughsData= pd.read_csv(file, encoding='latin1')
#lots of interesting data, but for this just want list of London boroughs
boroughs=pd.DataFrame(columns= ['Borough'])
boroughs['Borough']=boroughsData['Area_name']
boroughs['Population']=boroughsData['GLA_Population_Estimate_2017']
boroughs.set_index('Borough', inplace=True)
boroughs.head()
```

Out[3]:

Population

Borough	Population
City of London	8800
Barking and Dagenham	209000

Population	
Borough	
Barnet	389600
Bexley	244300
Brent	332100

The Borough list also contains summary statistics, remove these rows.

```
In [ ]: boroughs.drop(index=['Inner London', 'Outer London', 'London', 'England', 'United Kingdom'], axis = 0, inplace=True)
```

Add longitude and latitude columns to the borough list, and loop through using geolocator to obtain co-ordinates. Note that "City of London is not technically a London borough so is geocoded differently.

```
In [ ]: boroughs['longitude']=0
boroughs['latitude']=0
```

```
In [35]: for borough in boroughs.index:
    geolocator = Nominatim(user_agent="ldn_explorer")
    if borough != 'City of London':
        location = geolocator.geocode("The London Borough of " + borough + ", London")
    else:
        location = geolocator.geocode(borough + ", London")
    boroughs.loc[borough, 'latitude'] = location.latitude
    boroughs.loc[borough, 'longitude'] = location.longitude
    print('The geographical coordinate of {} is {}, {}'.format(borough, location.latitude, location.longitude))
```

The geographical coordinate of City of London is 51.5156177, -0.0919983.  
The geographical coordinate of Barking and Dagenham is 51.5541171, 0.15050434261994267.  
The geographical coordinate of Barnet is 51.61252299999996, -0.21144427132963145.  
The geographical coordinate of Bexley is 51.46196875, 0.14569856715068022.  
The geographical coordinate of Brent is 51.5639957, -0.27590641378489267.  
The geographical coordinate of Bromley is 51.36685695, 0.061709076090816765.  
The geographical coordinate of Camden is 51.5428548, -0.16252590365221342.  
The geographical coordinate of Croydon is 51.3550556, -0.0643103753173489.  
The geographical coordinate of Ealing is 51.5250846, -0.3142935008138148.  
The geographical coordinate of Enfield is 51.64874005, -0.08097999953626095.  
The geographical coordinate of Greenwich is 51.4686295, 0.0488382866312719.  
The geographical coordinate of Hackney is 51.54888185, -0.047669054262764424.  
The geographical coordinate of Hammersmith and Fulham is 51.49831419999996, -0.22787818358222445.  
The geographical coordinate of Haringey is 51.58792984999995, -0.10541010599099046.  
The geographical coordinate of Harrow is 51.59682714999996, -0.3373046180437286.  
The geographical coordinate of Havering is 51.55792615, 0.24981280474568598.  
The geographical coordinate of Hillingdon is 51.54251929999995, -0.44833493117949663.  
The geographical coordinate of Hounslow is 51.46173345, -0.38013097749520874.  
The geographical coordinate of Islington is 51.54703495, -0.10165844952259628.  
The geographical coordinate of Kensington and Chelsea is 51.4938742, -0.1861991.  
The geographical coordinate of Kingston upon Thames is 51.37584475, -0.2806821604495977.  
The geographical coordinate of Lambeth is 51.46046624999996, -0.12131281431701332.  
The geographical coordinate of Lewisham is 51.45343165, -0.012510531510678023.  
The geographical coordinate of Merton is 51.41086985, -0.18809708858824303.  
The geographical coordinate of Newham is 51.52999955, 0.02931796029382208.  
The geographical coordinate of Redbridge is 51.5863662, 0.06975911636956193.  
The geographical coordinate of Richmond upon Thames is 51.4405529, -0.3076394377337949.  
The geographical coordinate of Southwark is 51.4652783, -0.06903783020807258.  
The geographical coordinate of Sutton is 51.35746444999995, -0.17362689496950337.  
The geographical coordinate of Tower Hamlets is 51.51456185, -0.03501226201922958.

The geographical coordinate of Waltham Forest is 51.59816935, -0.01783667461048707.

The geographical coordinate of Wandsworth is 51.45190115, -0.19950823955687028.

The geographical coordinate of Westminster is 51.50328025, -0.11968732228242385.

In [36]:

```
boroughs.head()
```

Out[36]:

Borough	Population	longitude	latitude
<b>City of London</b>	8800	-0.091998	51.515618
<b>Barking and Dagenham</b>	209000	0.150504	51.554117
<b>Barnet</b>	389600	-0.211444	51.612523
<b>Bexley</b>	244300	0.145699	51.461969
<b>Brent</b>	332100	-0.275906	51.563996

In [37]:

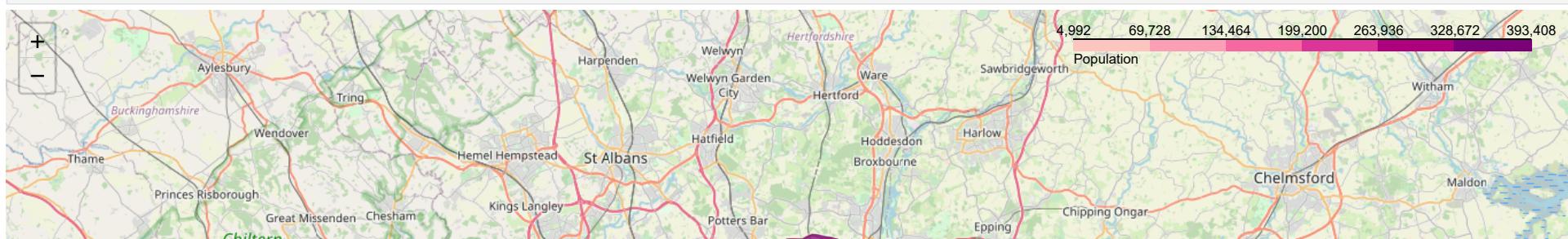
```
lnd_geo = r'London_Boroughs_Proper.geojson'
lnd_map = folium.Map(location = [latitude, longitude], zoom_start = 10)

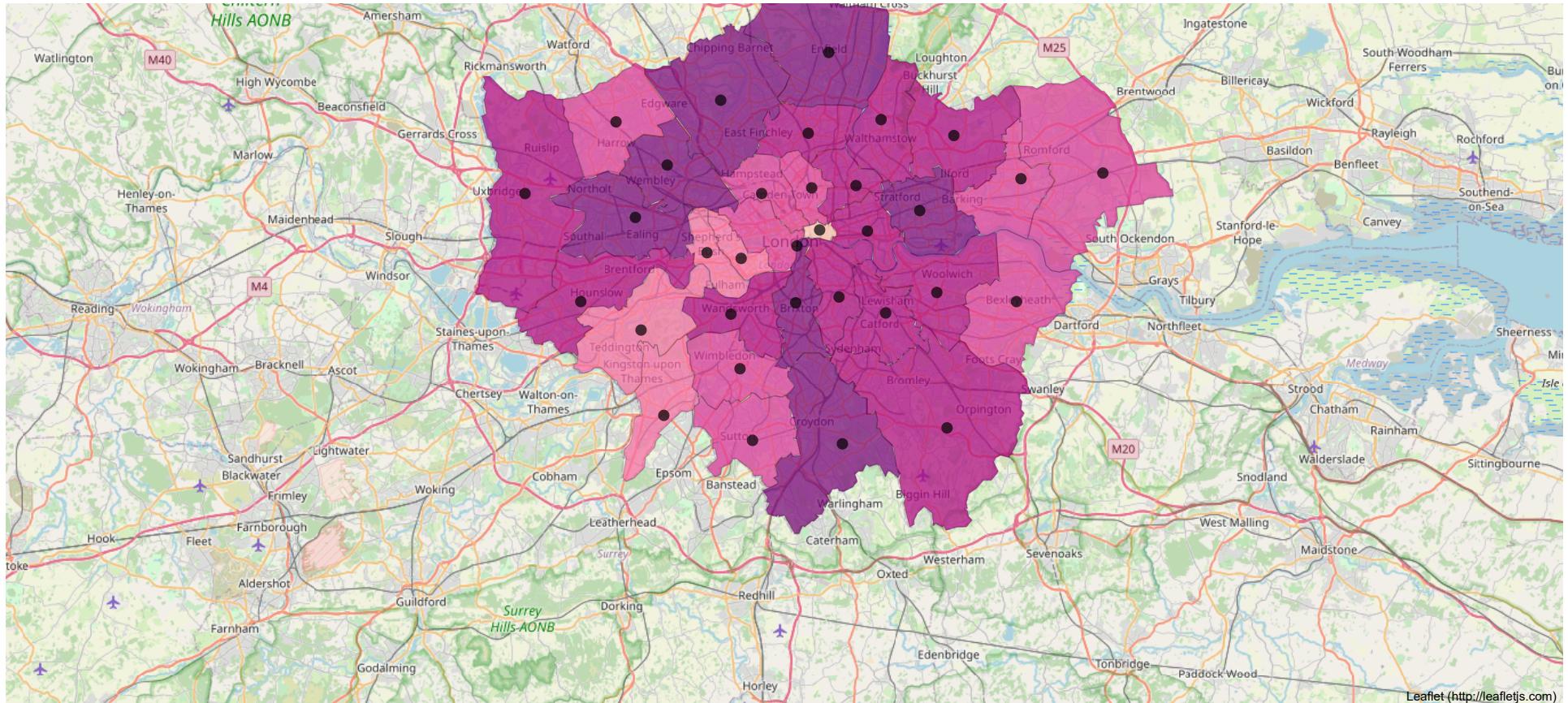
boroughs['Borough'] = boroughs.index.str.strip()

lnd_map.choropleth(
    geo_data=lnd_geo,
    data=boroughs,
    columns=['Borough', 'Population'],
    key_on='feature.properties.name',
    fill_color='RdPu',
    fill_opacity=0.7,
    line_opacity=0.2,
    legend_name='Population'
)
# add markers to the map
markers_colors = []
for lat, lon, poi in zip(boroughs['latitude'], boroughs['longitude'], boroughs.index):
    label = folium.Popup(str(poi), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=5,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)
```

```
lnd_map
```

Out[37]:





With the exception of Westminster the coordinates appear to be in the centre of each borough - based on the extremes. The Westminster location looks wrong - showing maybe tube station not centre of borough - this could be because it is commonly referred to as "The city of Westminster" rather than as a London borough.

Search for better Westminster coordinates and add to map

In [38]:

```
address = 'City of Westminster'

geolocator = Nominatim(user_agent="ldn_explorer")
wmlocation = geolocator.geocode(address)
wmlatitude = wmlocation.latitude
wmlongitude = wmlocation.longitude
print('The geographical coordinate of Westminster are {}, {}'.format(wmlatitude, wmlongitude))

boroughs.loc['Westminster', 'longitude']=wmlongitude
boroughs.loc['Westminster', 'latitude']=wmlatitude
```

The geographical coordinate of Westminster are 51.4973206, -0.137149.

In [39]:

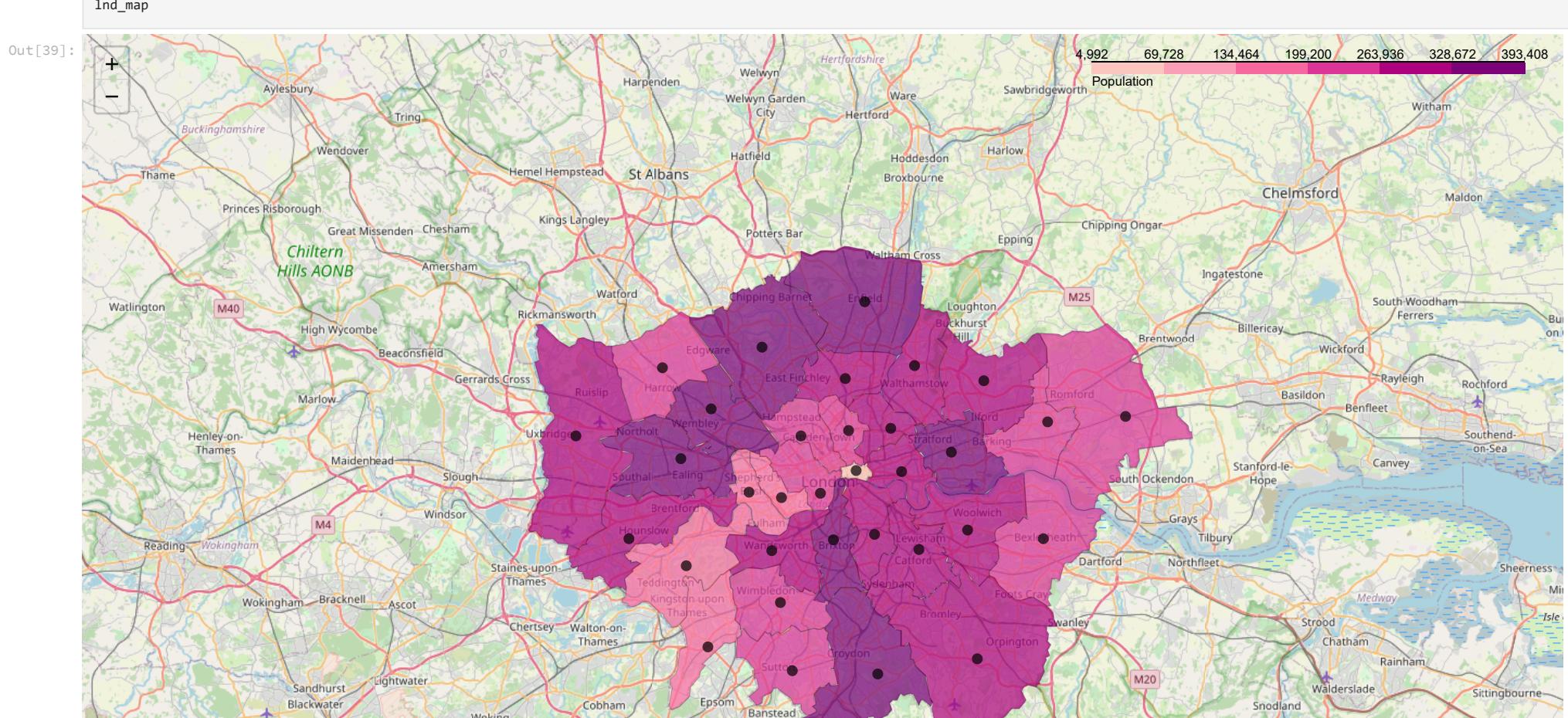
```
lnd_geo = r'london_boroughs_proper.geojson'
lnd_map = folium.Map(location = [latitude, longitude], zoom_start = 10)

lnd_map.choropleth(
```

```

geo_data=lnd_geo,
data=boroughs,
columns=['Borough','Population'],
key_on='feature.properties.name',
fill_color='RdPu',
fill_opacity=0.7,
line_opacity=0.2,
legend_name='Population'
)
# add markers to the map
markers_colors = []
for lat, lon, poi in zip(boroughs['latitude'], boroughs['longitude'], boroughs.index):
    label = folium.Popup(str(poi), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=5,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)
lnd_map

```





Westminster is now located more within the Borough.

**Observation:** These locations could be used for obtaining venue data (ie by searching for venues within a fixed radius around the borough), subject to the following challenges:

1. The centre of the borough may or may not be close to where venues are located, this is particularly relevant in larger outer London boroughs.
2. The slice of a borough taken by searching a radius around a central point may or may not be representative of the borough.
3. Due to the irregular shapes of London bororughs the centre points can be very close to borough boundaries, so venues returned are likely to be from other boroughs.
4. An apporiate radius of inner London boroughs (which are smaller, and may have venues more densely located) may not be appropriate for outer London boroughs

**Conclusion:** Given these limitations, the robustness of any analysis on the areas will be compromised, therefore a better approach is required

## Using Borough Name with Foursquare API

The Foursquare API recognises London Boroughs. This is a validation and exploration of the data returned

Define a function to obtain data per borough. Note that Forusquare does not recognise Westminster as a borough

In [40]:

```
def getLondonBoroughVenues(boroughs):

    venues_list=[]
    for borough in boroughs:
        print(borough)

        if borough == 'Westminster':
            search_borough = "City of Westminster, Greater London, United Kingdom"
        # elif borough == 'Lambeth':
        #     borough + ", London, Greater London, United Kingdom"
        else:
            search_borough = borough + ", Greater London, United Kingdom"

        search_borough =search_borough.replace(" ", "%20")
        # create the API request URL
        url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}&v={}&near={}&limit={}'.format(
            CLIENT_ID,
            CLIENT_SECRET,
            VERSION,
            search_borough,
            LIMIT)
        print(url)
        # make the GET request
        results = requests.get(url).json()["response"]["groups"][0]["items"]
        # print(results)
        # return only relevant information for each nearby venue
        venues_list.append([
            borough,
            v['venue']['name'],
            v['venue']['location']['lat'],
```

```
v['venue']['location']['lng'],
v['venue']['categories'][0]['name']) for v in results)

nearby_venues = pd.DataFrame([item for venue_list in venues_list for item in venue_list])
nearby_venues.columns = ['Borough',
                        'Venue',
                        'Venue Latitude',
                        'Venue Longitude',
                        'Venue Category']

return(nearby_venues)
```

Retrieve venues for each London borough

```
In [41]: borough_venues = getLondonBoroughVenues(boroughs=boroughs.index)
#London_venues = getLondonBoroughVenues(['City of London'])

print(borough_venues.shape)
borough_venues.head()
```

City of London  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=City%20f%20London,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=City%20f%20London,%20Greater%20London,%20United%20Kingdom&limit=150)

Barking and Dagenham  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Barking%20and%20Dagenham,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Barking%20and%20Dagenham,%20Greater%20London,%20United%20Kingdom&limit=150)

Barnet  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Barnet,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Barnet,%20Greater%20London,%20United%20Kingdom&limit=150)

Bexley  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Bexley,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Bexley,%20Greater%20London,%20United%20Kingdom&limit=150)

Brent  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Brent,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Brent,%20Greater%20London,%20United%20Kingdom&limit=150)

Bromley  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Bromley,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Bromley,%20Greater%20London,%20United%20Kingdom&limit=150)

Camden  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Camden,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Camden,%20Greater%20London,%20United%20Kingdom&limit=150)

Croydon  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Croydon,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Croydon,%20Greater%20London,%20United%20Kingdom&limit=150)

Ealing  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Ealing,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Ealing,%20Greater%20London,%20United%20Kingdom&limit=150)

Enfield  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Enfield,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Enfield,%20Greater%20London,%20United%20Kingdom&limit=150)

Greenwich  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Greenwich,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Greenwich,%20Greater%20London,%20United%20Kingdom&limit=150)

Hackney  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hackney,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hackney,%20Greater%20London,%20United%20Kingdom&limit=150)

Hammersmith and Fulham  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hammersmith%20and%20Fulham,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hammersmith%20and%20Fulham,%20Greater%20London,%20United%20Kingdom&limit=150)

Haringey  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Haringey,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Haringey,%20Greater%20London,%20United%20Kingdom&limit=150)

Harrow  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Harrow,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Harrow,%20Greater%20London,%20United%20Kingdom&limit=150)

0Greater%20London,%20United%20Kingdom&limit=150  
 Havering  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Havering,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Havering,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Hillingdon  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hillingdon,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hillingdon,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Hounslow  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hounslow,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Hounslow,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Islington  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Islington,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Islington,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Kensington and Chelsea  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=KensingtonandChelsea,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=KensingtonandChelsea,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Kingston upon Thames  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=KingstonuponThames,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=KingstonuponThames,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Lambeth  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Lambeth,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Lambeth,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Lewisham  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Lewisham,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Lewisham,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Merton  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Merton,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Merton,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Newham  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near>Newham,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near>Newham,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Redbridge  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Redbridge,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Redbridge,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Richmond upon Thames  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=RichmonduponThames,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=RichmonduponThames,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Southwark  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Southwark,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Southwark,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Sutton  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Sutton,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Sutton,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Tower Hamlets  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=TowerHamlets,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=TowerHamlets,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Waltham Forest  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=WalthamForest,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=WalthamForest,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Wandsworth  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Wandsworth,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Wandsworth,%20Greater%20London,%20United%20Kingdom&limit=150)  
 Westminster  
[https://api.foursquare.com/v2/venues/explore?&client\\_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client\\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=CityofWestminster,%20Greater%20London,%20United%20Kingdom&limit=150](https://api.foursquare.com/v2/venues/explore?&client_id=LHONXSF1T2PNUTZNQ1S0RQNLFWUB1HJPLNCLUFKI52SKHLD&client_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=CityofWestminster,%20Greater%20London,%20United%20Kingdom&limit=150)  
 (3007, 5)

Borough	Venue	Venue Latitude	Venue Longitude	Venue Category
0 City of London	Hampstead Heath	51.564436	-0.167363	Park
1 City of London	Regent's Park	51.530479	-0.153766	Park
2 City of London	Hyde Park	51.507188	-0.163731	Park
3 City of London	Greenwich Park	51.477521	0.000858	Park
4 City of London	Primrose Hill	51.539262	-0.161941	Park

**Observation:** Immediate inspection of this, applying local knowledge, shows an issue - the City of London results are from all over London, not just within the "City of London". This can be demonstrated by plotting on a map.

As the city of London is a unique case, a different coordinate approach could be used.

In [44]:

```
localBorough ="City of London"

localLng = boroughs.loc[localBorough, "longitude"]
localLat = boroughs.loc[localBorough, "latitude"]
local_venues = borough_venues.set_index('Borough').loc[[localBorough]]

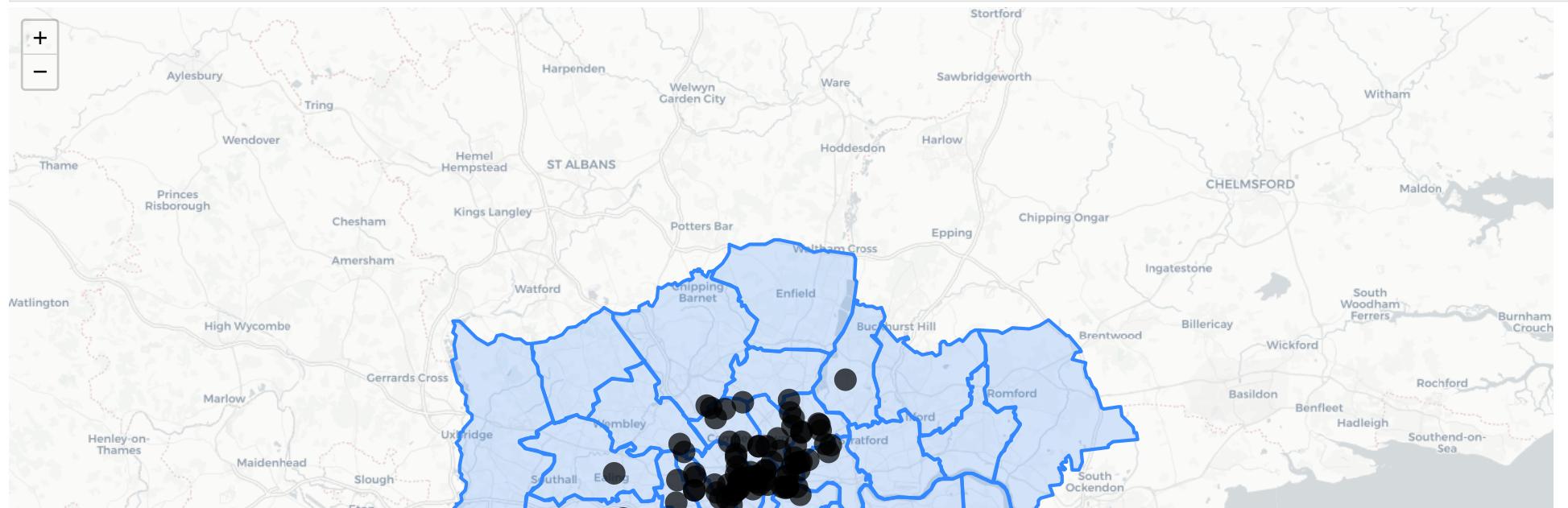
# create map
lnd_geo = r'London_Boroughs_Proper.geojson'
lnd_map = folium.Map(location = [localLat, localLng], zoom_start = 10, tiles="CartoDBPositron",)

folium.GeoJson(lnd_geo, name="geojson").add_to(lnd_map)

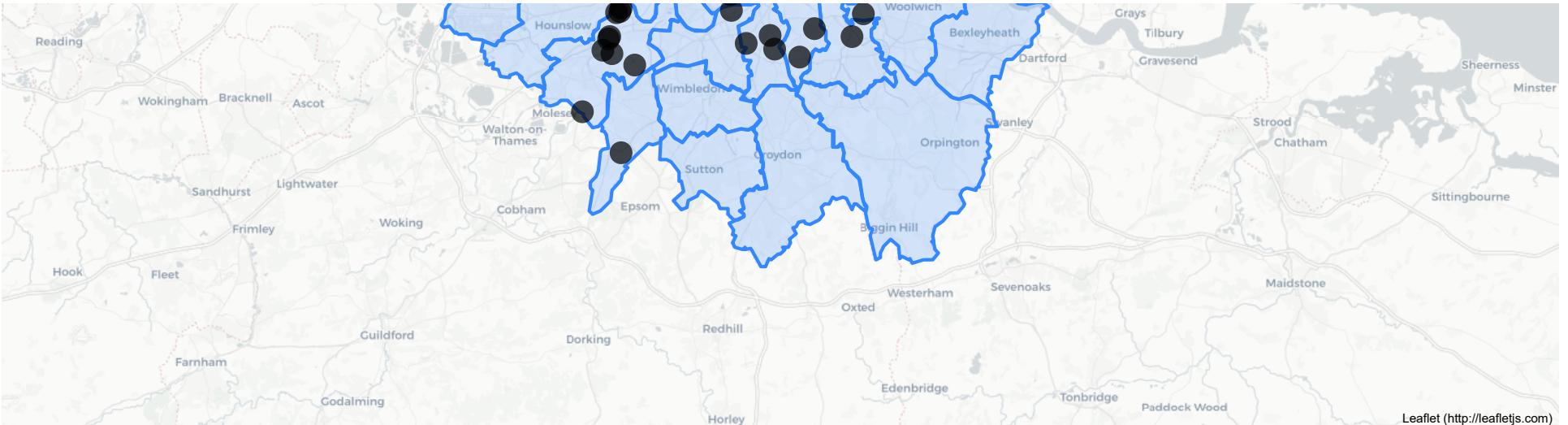
# add markers to the map
markers_colors = local_venues
for lat, lon, poi, venue in zip(local_venues['Venue Latitude'], local_venues['Venue Longitude'], local_venues.index, local_venues['Venue']):
    label = folium.Popup(str(venue), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=10,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)

lnd_map
```

Out[44]:



## 2 Data Exploration - London Mapping and Foursquare



```
In [24]: #London_venues.to_csv('borough_venues17Juneall.csv')
borough_venues = pd.read_csv('borough_venues17Juneall.csv')
```

Looking at the data returned

```
In [46]: print('There are {} uniques categories of venue.'.format(len(borough_venues['Venue Category'].unique())))
```

There are 271 uniques categories of venue.

```
In [47]: borough_venues.groupby('Borough').count()[ 'Venue']
```

```
Out[47]: Borough
Barking and Dagenham    82
Barnet                  28
Bexley                 100
Brent                  100
Bromley                 69
Camden                 100
City of London           100
Croydon                 100
Ealing                  100
Enfield                 66
Greenwich                100
Hackney                 100
Hammersmith and Fulham  100
Haringey                 100
Harrow                  37
Havering                 100
Hillingdon                100
Hounslow                 48
Islington                100
Kensington and Chelsea   100
Kingston upon Thames     100
Lambeth                  100
Lewisham                 77
Merton                  100
Newham                  100
Redbridge                 100
```

```

Richmond upon Thames    100
Southwark               100
Sutton                  100
Tower Hamlets           100
Waltham Forest           100
Wandsworth               100
Westminster              100
Name: Venue, dtype: int64

```

**Observation:** There is substantial variation in the amount of data available at borough level, many exceed the max Foursquare venue limit (100), whereas other have significantly less. Where the limit is exceeded, the results will be the most recommended venues, but may not represent the diversity of venue present.

Looking more closely at Newham results

In [48]:

```

localBorough = "Newham"

localLng = boroughs.loc[localBorough, "longitude"]
localLat = boroughs.loc[localBorough, "latitude"]
local_venues = borough_venues.set_index('Borough').loc[[localBorough]]

# create map
lnd_geo = r'London_Boroughs_Proper.geojson'
lnd_map = folium.Map(location = [localLat, localLng], zoom_start = 12, tiles="CartoDBPositron")

#London_merged['Borough Label']= London_merged.index

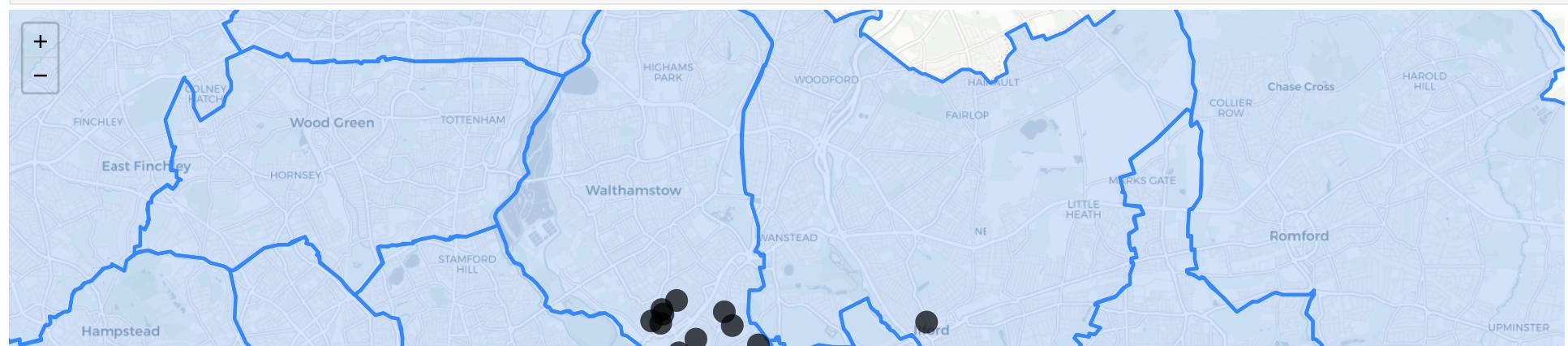
folium.GeoJson(lnd_geo, name="geojson").add_to(lnd_map)

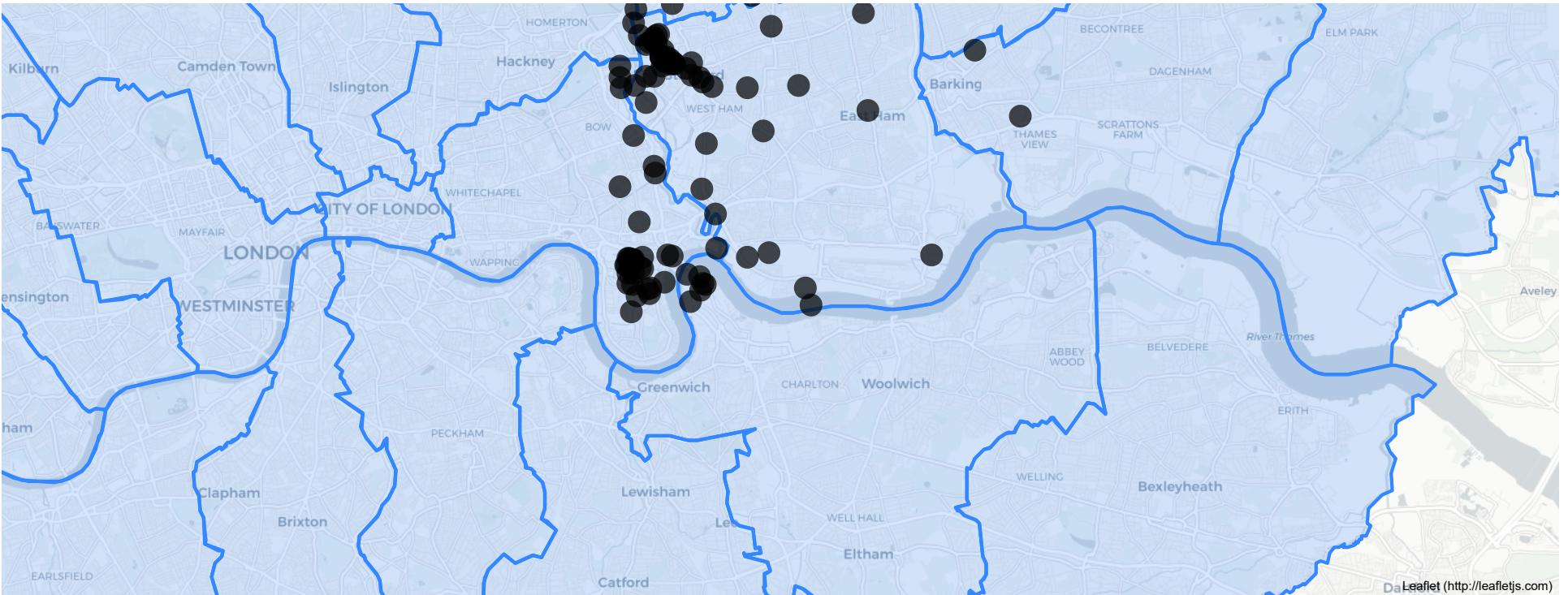
# add markers to the map
markers_colors = local_venues
for lat, lon, poi, venue in zip(local_venues['Venue Latitude'], local_venues['Venue Longitude'], local_venues.index, local_venues['Venue']):
    label = folium.Popup(str(venue), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=10,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)

```

lnd\_map

Out[48]:





Newham venues are not exclusively in Newham, including a sizeable cluster in Tower Hamlets. For those not familiar with London, Newham is the borough containing West Ham and Eastham. Tower Hamlets is the borough containing Bow and Whitechapel.

Looking more closely at Richmond upon Thames results

```
In [49]: localBorough ="Richmond upon Thames"

localLng = boroughs.loc[localBorough, "longitude"]
localLat = boroughs.loc[localBorough, "latitude"]
local_venues = borough_venues.set_index('Borough').loc[[localBorough]]

# create map
lnd_geo = r'./london_boroughs_proper.geojson'
lnd_map = folium.Map(location = [localLat, localLng], zoom_start = 12, tiles="cartodbpositron",)

#London_merged['Borough Label']= London_merged.index

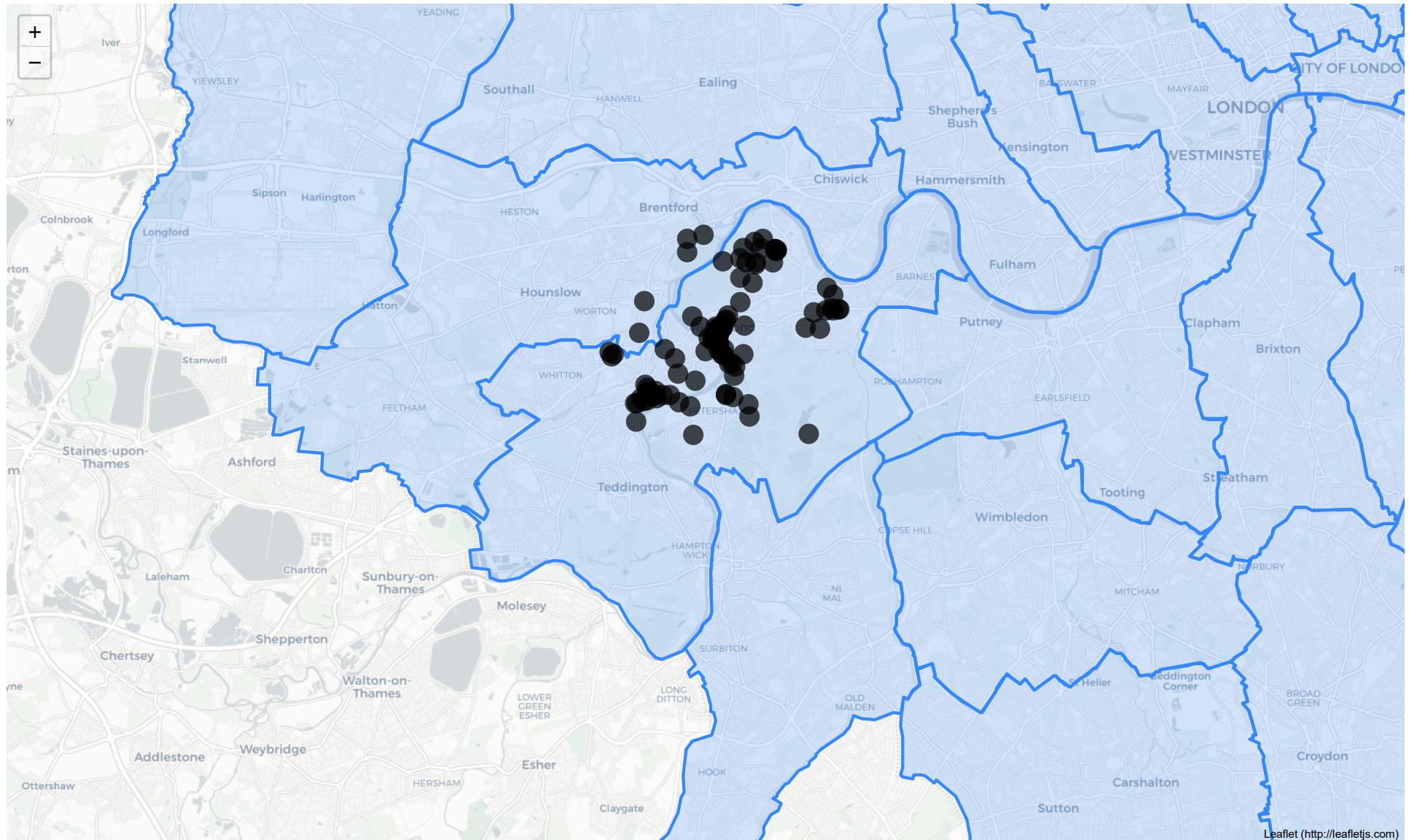
folium.GeoJson(lnd_geo, name="geojson").add_to(lnd_map)

# add markers to the map
markers_colors = local_venues
for lat, lon, poi, venue in zip(local_venues['Venue Latitude'], local_venues['Venue Longitude'], local_venues.index, local_venues['Venue']):
    label = folium.Popup(str(venue), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=10,
        popup=label,
```

```
color=1,  
fill=True,  
fill_color=1,  
fill_opacity=0.7).add_to(lnd_map)
```

```
lnd_map
```

```
Out[49]:
```



These venues are mainly in the borough (borough containing Teddington), but not exclusively, and do not seem to be taken from the entire borough.

Looking more closely at Hounslow results

In [50]: localBorough = "Hounslow"

```
localLng = boroughs.loc[localBorough, "longitude"]
localLat = boroughs.loc[localBorough, "latitude"]
local_venues = borough_venues.set_index('Borough').loc[[localBorough]]

# create map
lnd_geo = r'./london_boroughs_proper.geojson'
lnd_map = folium.Map(location = [localLat, localLng], zoom_start = 12, tiles="cartodbpositron",)

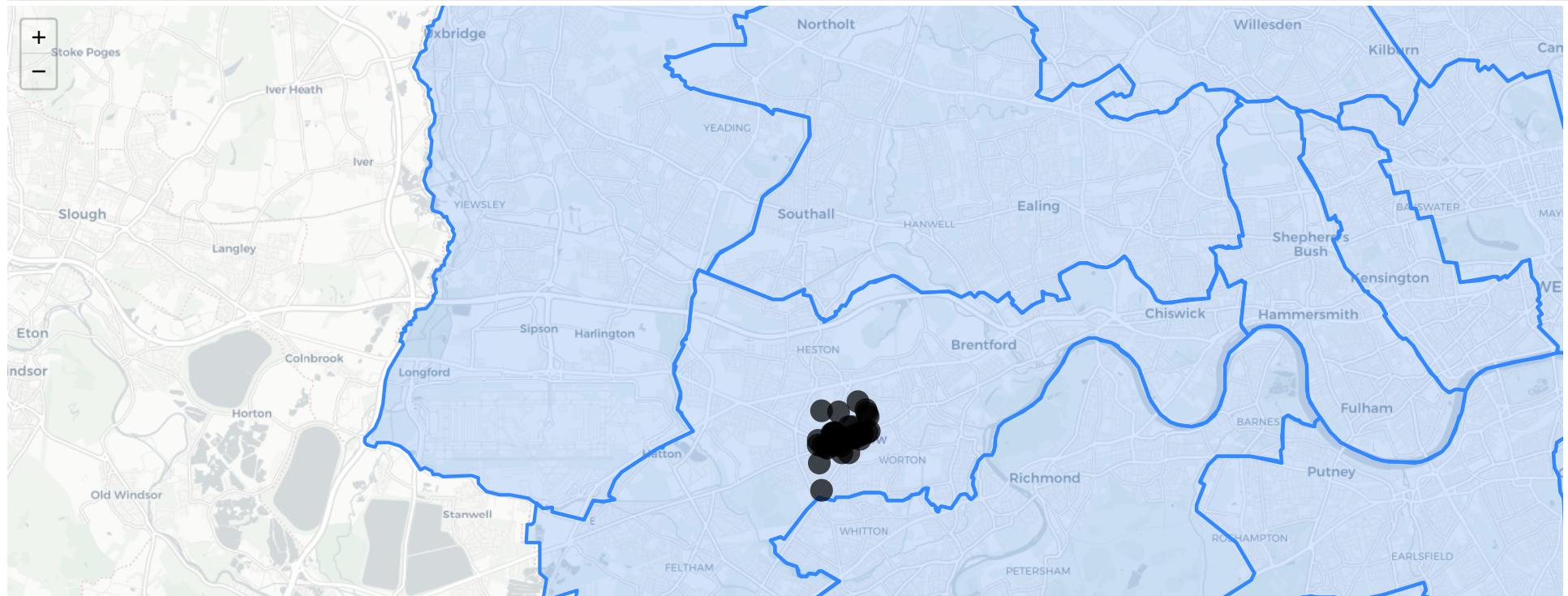
#London_merged['Borough Label']= London_merged.index

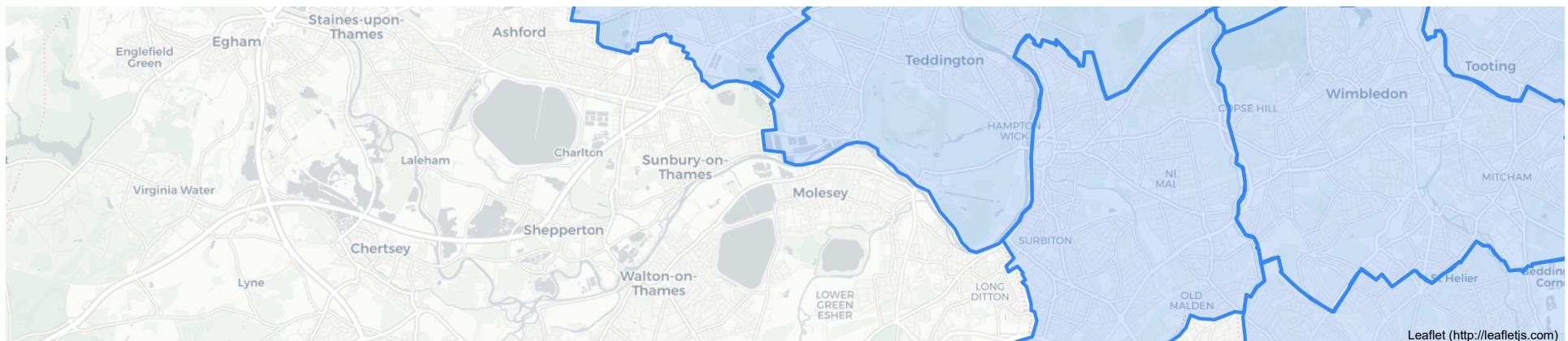
folium.GeoJson(lnd_geo, name="geojson").add_to(lnd_map)

# add markers to the map
markers_colors = local_venues
for lat, lon, poi, venue in zip(local_venues['Venue Latitude'], local_venues['Venue Longitude'], local_venues.index, local_venues['Venue']):
    label = folium.Popup(str(venue), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=10,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)
```

lnd\_map

Out[50]:



Leaflet (<http://leafletjs.com>)

**Observation:** The foursquare API is not returning comprehensive or exclusive results for each borough.

In some instances it appears to be using a simplified representation of a London borough, defined by just two coordinates, due to the highly irregular shapes of London boroughs this resulting in inaccurate responses.

In other instances results appear to be clustered around a location within the borough.

## Conclusion

Foursquares API is not suitable to obtain data at a borough level, for comparison with borough level crime data. However other datasources exist which indicate venues and industries present at a borough level. These can be used for further investigation.

## 2. Wards

Wards are not geocodable and no set of coordinates located for central points. Further they do not represent community centres, so may lack venues

## 3. Neighbourhoods

Define a function to obtain neighbourhood venues from foursquare. This takes the following parameters

Parameter	Usage
names	A list of neighbourhood names to search for. These will be presumed to be in London.
latitudes	The corresponding list of latitude coordinates, to be used if name search fails.
longitudes	The corresponding list of longitude coordinates, to be used if name search fails.
isLondons	The corresponding flag as to whether or not the neighbourhood has a London postal address. This will be used to determine search radius if coordinates used

In [41]:

```
def getNearbyVenues(names, latitudes, longitudes, isLondons):
    errCount = 0
    errTolerance=500 #allow a tolerance failed requests before exiting as there is probably a systematic issue with connection to investigate (for example exceed foursquare account limit)
    venues_list=[]
    # for name in names:
    for name, lat, lng, isLondon in zip(names, latitudes, longitudes, isLondons):

        neighbourhood = name + " London, United Kingdom"
        neighbourhood = neighbourhood.replace(' ', '%20')
        # create the API request URL, based on the neighbourhood name
```

```

url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}&v={}&near={}&limit={}'.format(
    CLIENT_ID,
    CLIENT_SECRET,
    VERSION,
    neighbourhood,
    LIMIT)

radius=0
# make the GET request
try:
    response = requests.get(url)
    results = response.json()["response"]["groups"][0]["items"]

    # return only relevant information for each nearby venue
    venues_list.append([
        name,
        lat,
        lng,
        v['venue']['name'],
        v['venue']['location']['lat'],
        v['venue']['location']['lng'],
        v['venue']['categories'][0]['name'],
        True) for v in results])
except:

    errType = response.json()["meta"]["errorType"]
    if errType =='failed_geocode':
        #if the neighbourhood wasn't recognised use central coordinate and radius - use a larger radius for neighbourhoods outside central London
        if isLondon ==True:
            radius = 600
        else:
            radius= 1200

    try:
        url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}&v={}&ll={},{}&radius={}&limit={}'.format(
            CLIENT_ID,
            CLIENT_SECRET,
            VERSION,
            lat,
            lng,
            radius,
            LIMIT)

        response = requests.get(url)
        results = response.json()["response"]["groups"][0]["items"]

        # return only relevant information for each nearby venue
        venues_list.append([
            name,
            lat,
            lng,
            v['venue']['name'],
            v['venue']['location']['lat'],
            v['venue']['location']['lng'],
            v['venue']['categories'][0]['name'],
            False) for v in results])

    except:
        errCount = errCount +1
        # if the request has failed continue with next item and provide url

```

```

        print('Error with coordinate request for ' + name + ' ' + url )
        print(str(response.json()["meta"]))
        if errCount>errTolerance:
            return(pd.DataFrame())
    else:
        errCount = errCount +1
    # if the request has failed continue with next item and provide url
    print('Error with neighbourhood request for ' + name + ' ' + url + ' ' + str(response.json()["response"]))
    print(str(response.json()["meta"]))

    if errCount>errTolerance:
        return(pd.DataFrame()) #This is only expected to happen with connection issues

nearby_venues = pd.DataFrame([item for venue_list in venues_list for item in venue_list])
nearby_venues.columns = ['Neighborhood',
                        'Neighborhood Latitude',
                        'Neighborhood Longitude',
                        'Venue',
                        'Venue Latitude',
                        'Venue Longitude',
                        'Venue Category',
                        'Neighborhood Geocodable']

return(nearby_venues)

```

Obtain venues for all neighbourhoods

In [42]:

```

neighbourhood_venues = getNearbyVenues(names=wiki_df['Location'],
                                         latitudes=wiki_df['latitude'],
                                         longitudes=wiki_df['longitude'],
                                         isLondons=wiki_df['Post town']=='LONDON'
                                         )

print(neighbourhood_venues.shape)
neighbourhood_venues.head()

```

Error with neighbourhood request for Gallows Corner https://api.foursquare.com/v2/venues/explore?&client\_id=LHONXSF1T2PNUTZN2Q1S0RQNLFWUB1HJPLNCLUFKI52SKHLN&client\_secret=R40DYYK4LQSB1MC1QHY0BP1CQJN2X00NP5BDZASI55KS4JPE&v=20180605&near=Gallows%20Corner%20London,%20United%20Kingdom&limit=150 {}  
{ 'code': 400, 'errorType': 'param\_error', 'errorDetail': 'Must provide parameters (ll and radius) or (sw and ne) or (near and radius) or (nearVenueId and ll) or (superVenueId) or (polygon)', 'requestId': '60d3ae1c453f00347e6c3c03' }  
(30114, 8)

Out[42]:

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	Neighborhood Geocodable
0	Abbey Wood	51.487621	0.11405	Lesnes Abbey	51.489526	0.125839	Historic Site	True
1	Abbey Wood	51.487621	0.11405	Dagenham Sunday Market	51.517026	0.111949	Flea Market	True
2	Abbey Wood	51.487621	0.11405	Morrisons	51.507276	0.105392	Supermarket	True
3	Abbey Wood	51.487621	0.11405	wilko	51.505596	0.103845	Furniture / Home Store	True
4	Abbey Wood	51.487621	0.11405	Lidl	51.496152	0.118417	Supermarket	True

The defined function distinguishes between neighbourhoods foursquare could and could not geocode. Radius search has been used where foursquare could not geocode

In [43]:

```

#summarise how many results from each request type (geocode/coords)

neighbourhood_venues.groupby(['Neighborhood Geocodable', 'Neighborhood']).count().groupby(['Neighborhood Geocodable']).count()['Venue']

```

```
Out[43]: Neighborhood Geocodable
False    188
True     330
Name: Venue, dtype: int64
```

Save venue data to csv for use in later analysis

```
In [72]: neighbourhood_venues.to_csv('london_venues.csv')
#neighbourhood_venues=pd.read_csv('London_venues.csv') #HACK if want to rerun without foursquare API
```

```
In [45]: print('There are {} uniques categories of venue.'.format(len(neighbourhood_venues['Venue Category'].unique())))
```

There are 438 uniques categories of venue.

remove any duplicates or rows with blank values

```
In [73]: neighbourhood_venues=neighbourhood_venues.dropna(axis=0)
neighbourhood_venues=neighbourhood_venues.drop_duplicates()
```

Look at what the most popular categories are (ie once where there are more than 100 such venues)

```
In [75]: category_count=neighbourhood_venues.groupby(['Venue Category']).size()
popular = category_count[category_count>100]
popular.sort_values(ascending=False)
```

Venue Category	
Pub	2529
Coffee Shop	2083
Grocery Store	1595
Café	1389
Park	1122
Hotel	969
Pizza Place	862
Italian Restaurant	860
Supermarket	793
Indian Restaurant	715
Gym / Fitness Center	633
Sandwich Place	555
Fast Food Restaurant	507
Restaurant	503
Bakery	459
Bar	362
Clothing Store	336
Pharmacy	324
Turkish Restaurant	286
Gastropub	282
Thai Restaurant	232
Portuguese Restaurant	228
French Restaurant	224
Chinese Restaurant	223
Bookstore	220
Train Station	213
Cocktail Bar	210
Bus Stop	210
Burger Joint	208
Newsagent	192
Gym	186

```
Furniture / Home Store      182
Garden                      181
Middle Eastern Restaurant   176
Mediterranean Restaurant    174
Sushi Restaurant             165
Japanese Restaurant          165
Fish & Chips Shop           164
Steakhouse                  154
Theater                     148
English Restaurant           144
Breakfast Spot               140
Golf Course                 131
Wine Bar                     124
Deli / Bodega                124
Ice Cream Shop               122
Platform                     121
Asian Restaurant              121
Convenience Store            118
Art Gallery                  118
Movie Theater                 116
Warehouse Store               116
Vietnamese Restaurant         113
Tapas Restaurant              111
Gas Station                   101
dtype: int64
```

**Observation:** Pubs, Coffee Shops, Grocery Stores, Cafés and Parks are the most popular. Noted that bus stops and petrol (gas) stations feature highly.

Perform a sense check on the data - consider a neighbourhood where venues are known and see if those returned make sense. Plot on map to visualise.

In [59]:

```
sense_check = neighbourhood_venues[neighbourhood_venues['Neighborhood']=='Leyton']
sense_check
```

Out[59]:

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	Neighborhood Geocodable
15991	Leyton	51.569673	-0.015681	Marmelo Kitchen	51.563913	-0.005926	Restaurant	True
15992	Leyton	51.569673	-0.015681	Yardarm	51.564402	-0.006960	Wine Bar	True
15993	Leyton	51.569673	-0.015681	Leyton Orient Supporters Club	51.559931	-0.013497	Sports Bar	True
15994	Leyton	51.569673	-0.015681	Michael's Fish Bar	51.569407	-0.003578	Fish & Chips Shop	True
15995	Leyton	51.569673	-0.015681	Deeney's Café	51.562088	-0.010269	Café	True
...	...	...	...	...	...	...	...	...
16056	Leyton	51.569673	-0.015681	TK Maxx	51.556548	-0.007183	Clothing Store	True
16057	Leyton	51.569673	-0.015681	Costa Coffee	51.555784	-0.008333	Coffee Shop	True
16058	Leyton	51.569673	-0.015681	Leyton Mills Retail Park	51.556145	-0.008739	Shopping Plaza	True
16059	Leyton	51.569673	-0.015681	Asda	51.555901	-0.009369	Supermarket	True
16060	Leyton	51.569673	-0.015681	Burger King	51.555484	-0.008305	Fast Food Restaurant	True

70 rows × 8 columns

In [60]:

```
neighborhoodLng=list(sense_check['Neighborhood Longitude'])[0]
neighborhoodLat=list(sense_check['Neighborhood Latitude'])[0]
# create map centre on the neighbourhood under examination
lnd_geo = r'london_boroughs_proper.geojson'
lnd_map = folium.Map(location = [neighborhoodLat, neighborhoodLng], zoom_start = 13)
```

```

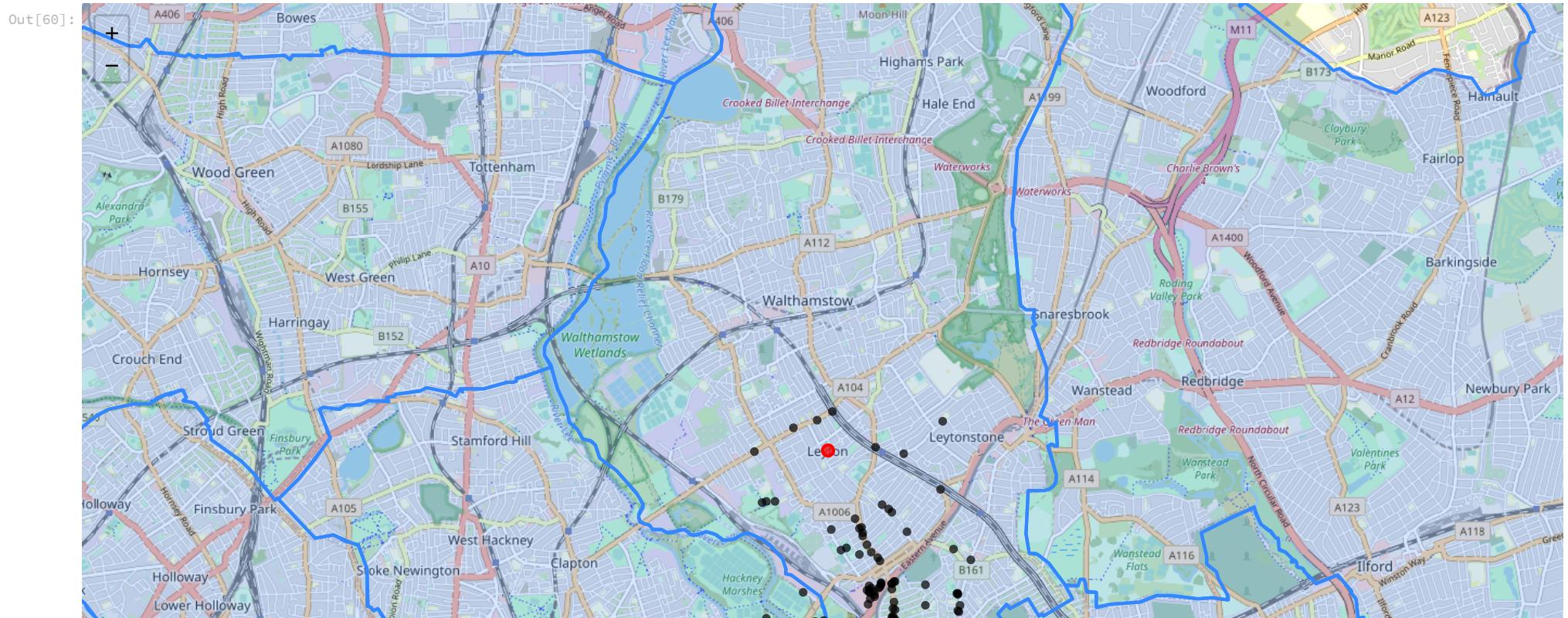
folium.GeoJson(lnd_geo, name="geojson").add_to(lnd_map)

# add markers to the map for venues

for lat, lon, poi, venue in zip(sense_check['Venue Latitude'], sense_check['Venue Longitude'], sense_check.index, sense_check['Venue']):
    label = folium.Popup(str(venue), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=4,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)

#add marker to map for neighbourhood coordinates
folium.CircleMarker(
    [neighborhoodLat, neighborhoodLng],
    radius=5,
    color="red",
    fill=True,
    fill_color="red",
    fill_opacity=0.7).add_to(lnd_map)
lnd_map

```





The red circle shows the geocoder coordinates for leyton, the black dots show the venues returned. Applying local knowledge with a couple of exceptions the venues are within what would be considered leyton.

Repeat for Forest Gate

```
In [76]: sense_check = neighbourhood_venues[neighbourhood_venues['Neighborhood']=='Forest Gate']
sense_check
```

	Unnamed: 0	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	Neighborhood Geocodable
9463	9463	Forest Gate	51.549524	0.024925	Forest Tavern	51.549786	0.024587	Pub	True
9464	9464	Forest Gate	51.549524	0.024925	The Wanstead Tap	51.555527	0.018714	Bar	True
9465	9465	Forest Gate	51.549524	0.024925	Leytonstone Tavern	51.559166	0.011072	Bar	True
9466	9466	Forest Gate	51.549524	0.024925	West Ham Park	51.538179	0.017574	Park	True
9467	9467	Forest Gate	51.549524	0.024925	Vijay's Chawalla	51.538650	0.032979	Indian Restaurant	True
9468	9468	Forest Gate	51.549524	0.024925	Wanstead Flats	51.558397	0.028238	Park	True
9469	9469	Forest Gate	51.549524	0.024925	Pie Republic	51.543949	0.026224	Comfort Food Restaurant	True
9470	9470	Forest Gate	51.549524	0.024925	Sainsbury's Local	51.543969	0.013036	Grocery Store	True
9471	9471	Forest Gate	51.549524	0.024925	Afters	51.541843	0.032354	Ice Cream Shop	True
9472	9472	Forest Gate	51.549524	0.024925	Co-op Food	51.549181	0.024500	Grocery Store	True
9473	9473	Forest Gate	51.549524	0.024925	The Holly Tree	51.555902	0.020552	Pub	True
9474	9474	Forest Gate	51.549524	0.024925	Tesco Express	51.547564	0.025497	Grocery Store	True
9475	9475	Forest Gate	51.549524	0.024925	Tesco Express	51.543216	0.011877	Grocery Store	True
9476	9476	Forest Gate	51.549524	0.024925	KFC	51.547764	0.025032	Fast Food Restaurant	True
9477	9477	Forest Gate	51.549524	0.024925	Tesco Express	51.540782	0.038752	Grocery Store	True
9478	9478	Forest Gate	51.549524	0.024925	Forest Gate Railway Station (FOG)	51.549323	0.023893	Train Station	True
9479	9479	Forest Gate	51.549524	0.024925	McDonald's	51.546368	0.027956	Fast Food Restaurant	True
9480	9480	Forest Gate	51.549524	0.024925	The Hudson Bay (Wetherspoon)	51.545903	0.026040	Pub	True
9481	9481	Forest Gate	51.549524	0.024925	Atherton Leisure Centre	51.544646	0.015263	Gym	True
9482	9482	Forest Gate	51.549524	0.024925	Morrisons Stratford Cafe	51.547243	0.016045	Café	True
9483	9483	Forest Gate	51.549524	0.024925	Old Spotted Dog	51.542190	0.022104	Soccer Stadium	True

Unnamed: 0	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	Neighborhood Geocodable	
9484	9484	Forest Gate	51.549524	0.024925	Arch Rivals	51.554790	0.019658	Restaurant	True
9485	9485	Forest Gate	51.549524	0.024925	Pretty Decent Brewery Tap	51.556713	0.017494	Brewery	True
9486	9486	Forest Gate	51.549524	0.024925	Forest Gate Saturday Market	51.550175	0.025514	Market	True
9487	9487	Forest Gate	51.549524	0.024925	Bereket Supermarket	51.551494	0.025175	Market	True
9488	9488	Forest Gate	51.549524	0.024925	McGrath Road bus stop	51.547443	0.012144	Bus Stop	True
9489	9489	Forest Gate	51.549524	0.024925	Forest View Hotel	51.545774	0.019146	Hotel	True
9490	9490	Forest Gate	51.549524	0.024925	Woodgrange Pharmacy	51.551022	0.025105	Pharmacy	True

In [77]:

```

neighborhoodLng=list(sense_check['Neighborhood Longitude'])[0]
neighborhoodLat=list(sense_check['Neighborhood Latitude'])[0]
# create map centred on neighbourhood
lnd_geo = r'london_boroughs_proper.geojson'
lnd_map = folium.Map(location = [neighborhoodLat, neighborhoodLng], zoom_start = 13)

folium.GeoJson(lnd_geo, name="geojson").add_to(lnd_map)

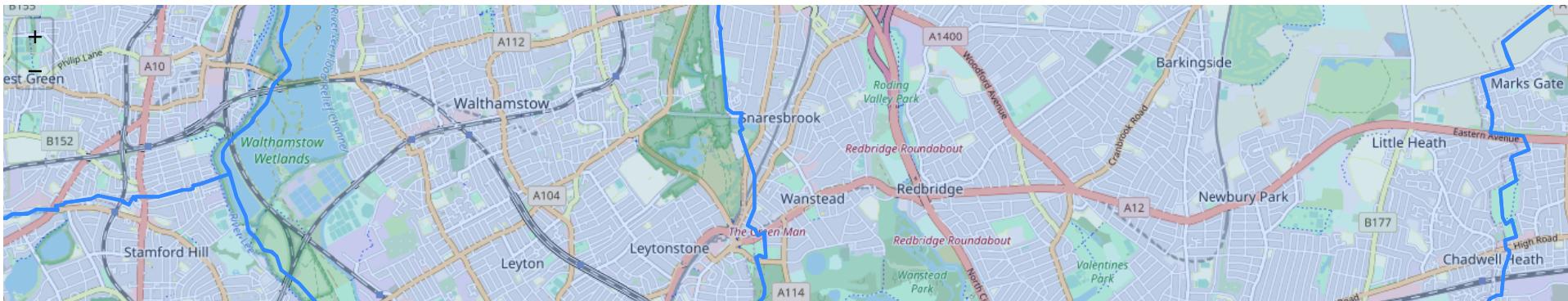
# add markers to the map for venues

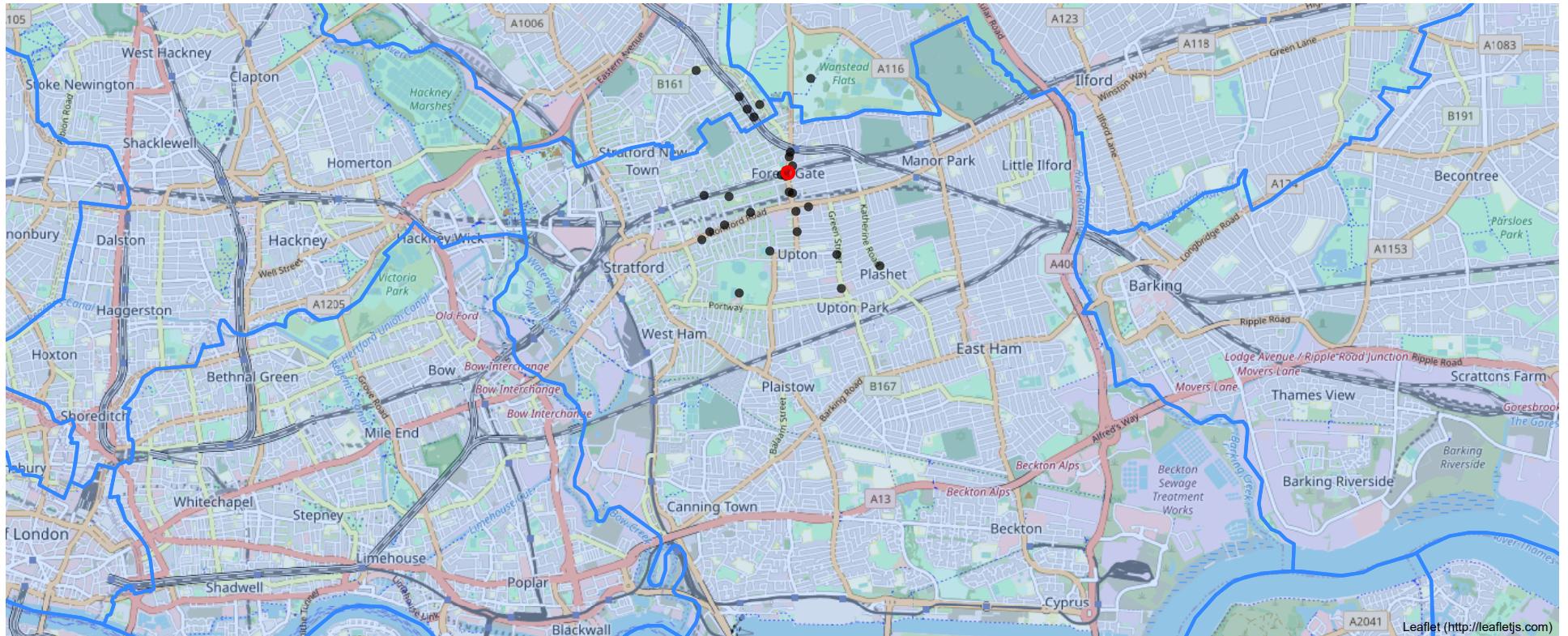
for lat, lon, poi, venue in zip(sense_check['Venue Latitude'], sense_check['Venue Longitude'], sense_check.index, sense_check['Venue']):
    label = folium.Popup(str(venue), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=4,
        popup=label,
        color=1,
        fill=True,
        fill_color=1,
        fill_opacity=0.7).add_to(lnd_map)

    folium.CircleMarker(
        [neighborhoodLat, neighborhoodLng],
        radius=5,
        color="red",
        fill=True,
        fill_color="red",
        fill_opacity=0.7).add_to(lnd_map)
lnd_map

```

Out[77]:





The venues follow a not unreasonable but quite generous definition of forest gate

**Remove neighbourhoods with less than 10 categories of venues retrieved, as there is insufficient data to conduct meaningful analysis**

```
In [61]: venue_count = neighbourhood_venues.groupby(['Neighborhood', 'Venue Category'])['Venue'].count()
venue_category_count=venue_count.groupby(['Neighborhood']).count()
limited_venues_categories = venue_category_count[venue_category_count<10]
limited_venues_categories
```

```
Out[61]: Neighborhood
Addiscombe          9
Albany Park         8
Aperfield           4
Arnos Grove         6
Barnehurst          8
Barnet Gate         4
Bellingham          9
Bickley             9
Blackfen             9
Blackheath Royal Standard 6
Botany Bay           3
Brimsdown           9
Brunswick Park      3
Cann Hall            8
```

```

Chase Cross          4
Childs Hill         8
Chinbrook           4
Colney Hatch        5
Colyers             3
Coombe              6
Crews Hill          7
Crossness            2
Derry Downs          5
Dollis Hill          6
Elmstead             6
Forestdale           8
Grahame Park        4
Grange Park          4
Hackney Marshes      3
Hampstead Garden Suburb 4
Harold Hill          7
Horn Park             4
Keston               6
Kingston Vale        6
Lea Bridge            7
Lessness Heath        6
Little Ilford         4
Marks Gate            9
Middle Park           5
Mortlake              8
New Addington         7
Noak Hill             8
North Cray            4
Oakleigh Park          5
Plumstead             8
Pratt's Bottom         6
Riddlesdown           5
South Hornchurch       8
South Tottenham         9
Southend               3
St Helier              8
Stonebridge             6
Sundridge              7
Sydenham Hill          5
Totteridge              4
Tulse Hill              8
Upper Ruxley            9
Wennington              6
Wormwood Scrubs         4
Name: Venue, dtype: int64

```

```
In [62]: venue_count = neighbourhood_venues.groupby(['Neighborhood'])['Venue'].count()
limited_venues = venue_count[venue_count<10]
limited_venues
```

```

Out[62]: Neighborhood
Albany Park          9
Aperfield             4
Arnos Grove           7
Barnet Gate            4
Bellingham             9
Blackheath Royal Standard 6
Botany Bay              3
Brunswick Park          5
Cann Hall              9
Chase Cross              4
Childs Hill             8
Chinbrook              5
Colney Hatch              5
Colyers                4

```

```

Coombe          6
Crossness       2
Derry Downs    5
Dollis Hill    6
Grahame Park   5
Grange Park    4
Hackney Marshes 3
Hampstead Garden Suburb 5
Harold Hill    7
Horn Park      4
Keston          7
Kingston Vale   6
Lea Bridge     8
Lessness Heath 7
Little Ilford   4
Middle Park    5
New Addington  9
Noak Hill      8
North Cray     4
Oakleigh Park   5
Pratt's Bottom  6
Riddlesdown    6
South Hornchurch 9
Southend        3
Stonebridge     6
Sundridge       7
Sydenham Hill   6
Totteridge     6
Tulse Hill      9
Upper Ruxley    9
Wennington      6
Wormwood Scrubs 4
Name: Venue, dtype: int64

```

Remove neighbourhoods with limited venue data

```
In [64]: #remove neighbourhoods with limited venue data
#insufficient categories
indexNames = neighbourhood_venues[neighbourhood_venues['Neighborhood'].isin(limited_venues_categories.index)].index
neighbourhood_venues_with_data=neighbourhood_venues.drop(indexNames)
```

```
In [79]: neighbourhood_venues_with_data.head()
```

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	Neighborhood Geocodable
0	Abbey Wood	51.487621	0.11405	Lesnes Abbey	51.489526	0.125839	Historic Site	True
1	Abbey Wood	51.487621	0.11405	Dagenham Sunday Market	51.517026	0.111949	Flea Market	True
2	Abbey Wood	51.487621	0.11405	Morrisons	51.507276	0.105392	Supermarket	True
3	Abbey Wood	51.487621	0.11405	wilko	51.505596	0.103845	Furniture / Home Store	True
4	Abbey Wood	51.487621	0.11405	Lidl	51.496152	0.118417	Supermarket	True

```
In [80]: neighbourhood_venues_with_data.to_csv('cleaned_neighborhood_venue.csv')
```

```
In [67]: full_neigbourhoods = neighbourhood_venues[neighbourhood_venues['Neighborhood Geocodable']==True]
full_neigbourhoods.groupby(['Neighborhood'])['Venue Category'].size()
```

```
Out[67]: Neighborhood
```

```
Abbey Wood      22
Acton          85
Addington      75
Aldgate        100
Aldwych        100
...
Woodside Park  100
Woolwich       50
Worcester Park 17
Yeading         100
Yiewsley        100
Name: Venue Category, Length: 330, dtype: int64
```

In [ ]: