

IBM Data Science Professional Certificate by IBM/Coursera

London - The Battle of Neighbors

Final project

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Introduction

London, city, capital of the United Kingdom is among the oldest of the world's great cities—its history spanning nearly two millennia - and one of the most cosmopolitan. By far Britain's largest metropolis, it is also the country's economic, transportation, and cultural center. London's continuous urban area extends beyond the borders of Greater London and was home to 9,787,426 people in 2011. According to Eurostat, London is the most populous city and metropolitan area of the European Union and the second most populous in Europe.

The coronavirus / COVID-19 pandemic, one of the biggest health crises of our time and the greatest challenges has affected every country in the world. Since its outbreak in January of 2020, our lives and lifestyles have changed greatly. One of the countries most affected by the virus is the UK and its capital London. Under current UK COVID-19 restrictions, the lockdown has been introduced, everyone in the UK must stay at home, travel is not possible, non-essential shops, leisure and entertainment venues closed, pubs and restaurants also, as well as schools. Additionally, households should not mix outdoors or indoors.

Due to current restrictions, London sees a boom in walking as pandemic changes lifestyles. Walking is the only form of exercise many can do but after a stressful day of working from home, and a walk can often improve the mood. The bans may be reduced soon, but there is a high possibility that they will not be lifted completely.

I've chosen **London** for my project and will explore **which boroughs in London offer the most places for walking, recreation, or any other useful entertainment or activity. At the same time, those venues should offer the possibility of social distancing** which is very crucial in these times. All these activities/venues represent some kind of fun, and that is the reason why I've named this project - Fun Battle of Neighborhoods.

The goal is to show which boroughs have the most venues answering these questions, how to cluster them, and show the data. The results could help residents to easily choose which boroughs to explore for their daily activities, but also possible relocation, or opening a small business in the future. When traveling is possible, results can be used by tourists interested in recreation, museums, landmarks, theaters, etc.

Data

Data sources







List of data sources that will be used for this project:

- The list of London boroughs on Wikipedia (https://en.wikipedia.org/wiki/List_of_London_boroughs#List_of_boroughs_and_local_authorities) to scrap the name, area, population, and headquarters for every borough in London.
- Foursquare API - to fetch venues that meet our requirements for every borough

Data cleaning and processing

Data used in the project is scraped from the Wikipedia: (https://en.wikipedia.org/wiki/List_of_London_boroughs#List_of_boroughs_and_local_authoritie) and combined into the table.

The data from Wikipedia was scraped using **Beautiful Soup Library**. The original table looked like this:

<title>List of London boroughs - Wikipedia</title>									
Borough	Inner	Status	Local authority	Political control	Headquarters	Area (sq mi)	Population (2019 est) ^[1]	Co-ordinates	N in map
Barking and Dagenham ^(town)			Barking and Dagenham London Borough Council	Labour	Town Hall, 1 Town Square	13.93	212,906	51°33′35″N 0°9′21″E﻿ / ﻿51.560°N 0.156°E﻿ / 51.560; 0.156	25
Barnet			Barnet London Borough Council	Conservative	Barnet House, 2 Bristol Avenue, Colindale	33.49	395,096	51°37′31″N 0°9′05″W﻿ / ﻿51.625°N 0.151°W﻿ / 51.625; -0.151	31
Bexley			Bexley London Borough Council	Conservative	Civic Offices, 2 Watling Street	23.38	248,287	51°27′10″N 0°9′32″E﻿ / ﻿51.454°N 0.156°E﻿ / 51.454; 0.156	23
Brent			Brent London Borough Council	Labour	Brent Civic Centre, Engineers Way	16.70	329,771	51°33′32″N 0°16′54″W﻿ / ﻿51.558°N 0.281°W﻿ / 51.558; -0.281	12
Bromley			Bromley London Borough Council	Conservative	Civic Centre, Stockwell Close	57.97	332,336	51°24′14″N 0°8′11″E﻿ / ﻿51.403°N 0.136°E﻿ / 51.403; 0.136	20
Camden 			Camden London Borough Council	Labour	Camden Town Hall, Judd Street	8.40	270,029	51°31′44″N 0°8′32″W﻿ / ﻿51.529°N 0.139°W﻿ / 51.529; -0.139	11
Croydon			Croydon London Borough Council	Labour	Bernard Weatherill House, Mint Walk	33.41	386,710	51°22′17″N 0°6′52″W﻿ / ﻿51.371°N 0.114°W﻿ / 51.371; -0.114	19
Ealing			Ealing London Borough Council	Labour	Perceval House, 14-16 Unbridge Road	21.44	341,806	51°30′47″N 0°18′32″W﻿ / ﻿51.513°N 0.309°W﻿ / 51.513; -0.309	13
Enfield			Enfield London Borough Council	Labour	Civic Centre, Silver Street	31.74	333,794	51°39′14″N 0°8′48″W﻿ / ﻿51.654°N 0.144°W﻿ / 51.654; -0.144	30
Greenwich ^(town)	^(town)	Royal	Greenwich London Borough Council	Labour	Woolwich Town Hall, Wellington Street	16.28	287,942	51°28′21″N 0°9′33″E﻿ / ﻿51.472°N 0.159°E﻿ / 51.472; 0.159	22
Hackney 			Hackney London Borough Council	Labour	Hackney Town Hall, Mare Street	7.36	281,120	51°32′42″N 0°8′19″W﻿ / ﻿51.545°N 0.138°W﻿ / 51.545; -0.138	9
Hammersmith and Fulham ^(town)			Hammersmith and Fulham London Borough Council	Labour	Town Hall, King Street	6.33	185,143	51°29′34″N 0°14′02″W﻿ / ﻿51.493°N 0.234°W﻿ / 51.493; -0.234	4
Haringey	^(town)		Haringey London Borough Council	Labour	Civic Centre, High Road	11.42	288,647	51°30′00″N 0°8′45″W﻿ / ﻿51.500°N 0.143°W﻿ / 51.500; -0.143	29
Harrow			Harrow London Borough Council	Labour	Civic Centre, Station Road	19.49	251,160	51°35′23″N 0°20′05″W﻿ / ﻿51.589°N 0.335°W﻿ / 51.589; -0.335	32
Havering			Havering London Borough Council	Conservative (council NOC)	Town Hall, Main Road	43.35	259,552	51°34′52″N 0°11′31″E﻿ / ﻿51.581°N 0.192°E﻿ / 51.581; 0.192	24
Hillingdon			Hillingdon London Borough Council	Conservative	Civic Centre, High Street	44.67	306,870	51°30′39″N 0°26′45″W﻿ / ﻿51.511°N 0.443°W﻿ / 51.511; -0.443	33
Hounslow			Hounslow London Borough Council	Labour	Hounslow House, 7 Bath Road	21.61	271,523	51°28′29″N 0°22′05″W﻿ / ﻿51.474°N 0.368°W﻿ / 51.474; -0.368	14
Islington 			Islington London Borough Council	Labour	Customer Centre, 222 Upper Street	5.74	242,467	51°32′30″N 0°8′08″W﻿ / ﻿51.541°N 0.136°W﻿ / 51.541; -0.136	10
Kensington and Chelsea 		Royal	Kensington and Chelsea London Borough Council	Conservative	The Town Hall, Horseman Street	4.68	156,129	51°30′07″N 0°8′11″W﻿ / ﻿51.502°N 0.136°W﻿ / 51.502; -0.136	3
Kingston upon Thames		Royal	Kingston upon Thames London Borough Council	Liberal Democrat	Guildhall, High Street	14.38	177,507	51°24′31″N 0°18′22″W﻿ / ﻿51.408°N 0.306°W﻿ / 51.408; -0.306	16
Lambeth 			Lambeth London Borough Council	Labour	Lambeth Town Hall, Brixton Hill	10.36	326,034	51°27′39″N 0°8′55″W﻿ / ﻿51.461°N 0.149°W﻿ / 51.461; -0.149	6
Lewisham 			Lewisham London Borough Council	Labour	Town Hall, 1 Catford Road	13.57	305,842	51°26′43″N 0°8′15″W﻿ / ﻿51.445°N 0.137°W﻿ / 51.445; -0.137	21
Merton			Merton London Borough Council	Labour	Civic Centre, London Road	14.52	206,548	51°24′05″N 0°11′45″W﻿ / ﻿51.401°N 0.193°W﻿ / 51.401; -0.193	17

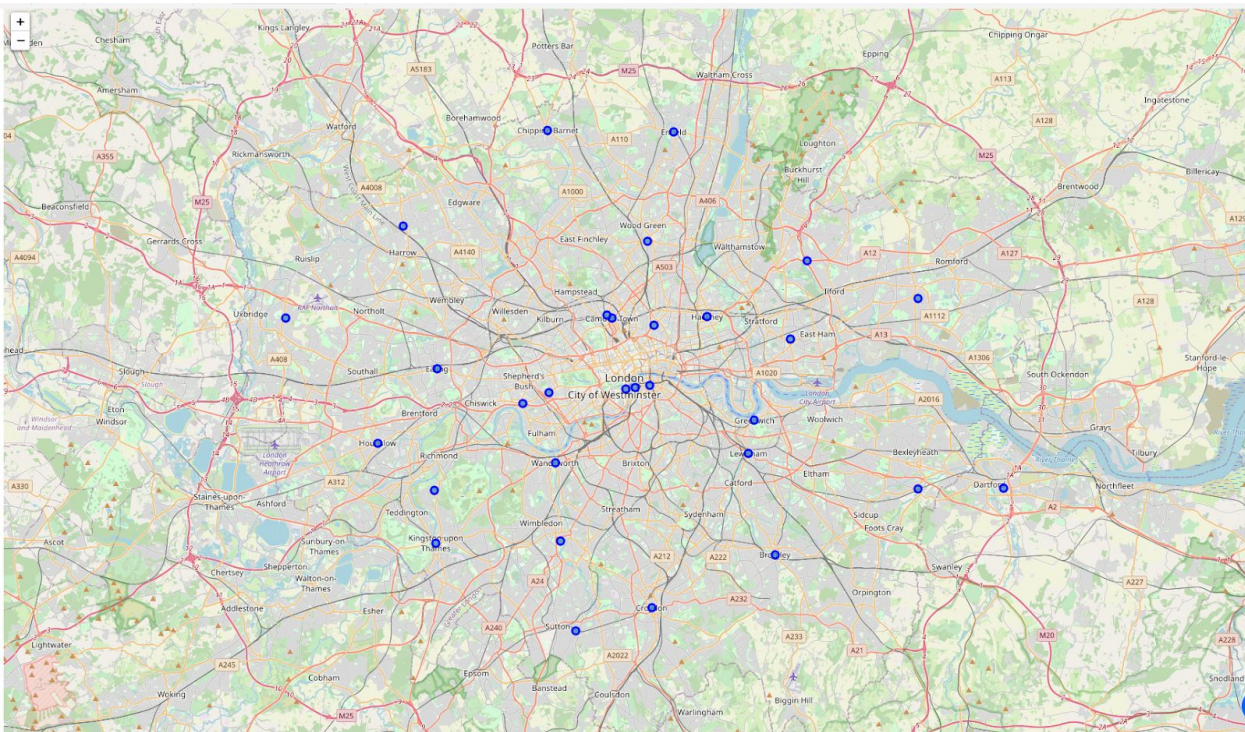
As you can see, after the data were scraped, it needed to be cleaned and prepared to use. There was a lot of unnecessary data that should be removed or edited. As a result, we got following data frame:

	Borough	Headquarters	Area	Population
0	Barking and Dagenham, UK	Town Hall, 1 Town Square	13.93	212906
1	Barnet, UK	Barnet House, 2 Bristol Avenue, Colindale	33.49	395896
2	Bexley, UK	Civic Offices, 2 Watling Street	23.38	248287
3	Brent, UK	Brent Civic Centre, Engineers Way	16.70	329771
4	Bromley, UK	Civic Centre, Stockwell Close	57.97	332336
5	Camden, UK	Camden Town Hall, Judd Street	8.40	270029
6	Croydon, UK	Bernard Weatherill House, Mint Walk	33.41	386710
7	Ealing, UK	Perceval House, 14-16 Uxbridge Road	21.44	341806
8	Enfield, UK	Civic Centre, Silver Street	31.74	333794
9	Greenwich, UK	Woolwich Town Hall, Wellington Street	18.28	287942
10	Hackney, UK	Hackney Town Hall, Mare Street	7.36	281120
11	Hammersmith and Fulham, UK	Town Hall, King Street	6.33	185143
12	Haringey, UK	Civic Centre, High Road	11.42	268647
13	Harrow, UK	Civic Centre, Station Road	19.49	251160
14	Havering, UK	Town Hall, Main Road	43.35	259552
15	Hillingdon, UK	Civic Centre, High Street	44.67	306870
16	Hounslow, UK	Hounslow House, 7 Bath Road	21.61	271523
17	Islington, UK	Customer Centre, 222 Upper Street	5.74	242467
18	Kensington and Chelsea, UK	The Town Hall, Hornton Street	4.68	156129
19	Kingston upon Thames, UK	Guildhall, High Street	14.38	177507
20	Lambeth, UK	Lambeth Town Hall, Brixton Hill	10.36	326034
21	Lewisham, UK	Town Hall, 1 Catford Road	13.57	305842
22	Merton, UK	Civic Centre, London Road	14.52	206548
23	Newham, UK	Newham Dockside, 1000 Dockside Road	13.98	353134
24	Redbridge, UK	Town Hall, 128-142 High Road	21.78	305222
25	Richmond upon Thames, UK	Civic Centre, 44 York Street	22.17	198019
26	Southwark, UK	160 Tooley Street	11.14	318830
27	Sutton, UK	Civic Offices, St Nicholas Way	16.93	206349
28	Tower Hamlets, UK	Town Hall, Mulberry Place, 5 Clove Crescent	7.63	324745
29	Waltham Forest, UK	Waltham Forest Town Hall, Forest Road	14.99	276983
30	Wandsworth, UK	The Town Hall, Wandsworth High Street	13.23	329677
31	Westminster, UK	Westminster City Hall, 64 Victoria Street	8.29	261317

In order to get the latitude and longitude values of boroughs in London, we've used **Geopy library**. We've added latitude and longitude values in our table as follows (showing first five rows):

	Borough	Headquarters	Area	Population	Latitude	Longitude
0	Barking and Dagenham	Town Hall, 1 Town Square	13.93	212906	51.554117	0.150504
1	Barnet	Barnet House, 2 Bristol Avenue, Colindale	33.49	395896	51.653090	-0.200226
2	Bexley	Civic Offices, 2 Watling Street	23.38	248287	51.441679	0.150488
3	Brent	Brent Civic Centre, Engineers Way	16.70	329771	51.442026	0.231523
4	Bromley	Civic Centre, Stockwell Close	57.97	332336	51.402805	0.014814

Using latitude and longitude values and the Folium library, I have managed to create map of London with boroughs superimposed on top.



Exploratory Analysis

Explore Boroughs in London

To do exploratory data analysis, it was necessary to define Foursquare credentials and version.

I have used the **Foursquare API** to explore the boroughs and segment them. I designed **the limit as 100 venues and the radius 750 meter for each borough from their given latitude and longitude information**. Here is a head of the list Venues name, category, latitude and longitude information from Foursquare API (showing the first 5 rows).

	Borough	Borough Latitude	Borough Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Barking and Dagenham	51.554117	0.150504	Iceland	51.560578	0.147685	Grocery Store
1	Barking and Dagenham	51.554117	0.150504	Shell	51.560415	0.148364	Gas Station
2	Barking and Dagenham	51.554117	0.150504	Tesco Express	51.551536	0.152784	Grocery Store
3	Barking and Dagenham	51.554117	0.150504	Connor Road Bus Stop	51.554345	0.147162	Bus Stop
4	Barking and Dagenham	51.554117	0.150504	Oglethorpe Road Bus Stop	51.555221	0.147136	Bus Stop

Since we were not interested in all the venues for this analysis, but only those venues that provide some type of fun, recreational and similar activity, it was necessary to filter the data and focus only on those that meet this criterion.

For this purpose, we've focused on the following venues: **Park, Museum, Historic Site, Monument, Gallery, Theater, Performing Arts, Golf, Soccer, Fun, Concert Hall, Music Venue, Opera House**. Those venues offer the possibility of social distance and meet our criterion.

Example of the code and its output:

```

Create the dataframe that focuses only on fun, recreational or similar activities

In [26]: searchfor = ['Park', 'Museum', 'Historic Site', 'Monument', 'Gallery', 'Theater', 'Performing Arts', 'Golf', 'Soccer', 'Fun', 'Concert Hall', 'Music Venue', 'Opera House']
london_venues_fun = london_venues[london_venues['Venue Category'].str.contains(''.join(searchfor))].reset_index(drop=True)
london_venues_fun.index = np.arange(1, len(london_venues_fun)+1)

In [27]: print(london_venues_fun['Venue Category'].value_counts())
Park                40
Theater             20
Art Gallery         9
Movie Theater       8
Historic Site       7
History Museum      7
Monument / Landmark 5
Indie Movie Theater 4
Art Museum          4
Concert Hall        4
Music Venue         3
Museum             3
Performing Arts Venue 3
Soccer Field        2
Theme Park Ride / Attraction 1
Golf Course         1
Opera House         1
Indie Theater       1
Soccer Stadium      1
Soccer Field        1
Name: Venue Category, dtype: int64

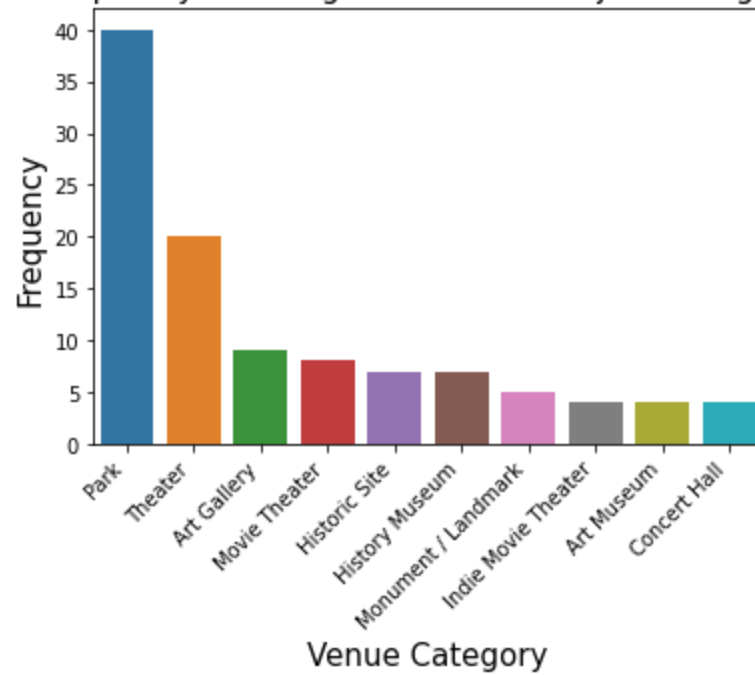
```

Additionally, we checked the unique categories, and there were 20 unique categories for this search.

We also did additional checks on which are the most common venues in our boroughs. We checked top 10 venues in the 32 boroughs and created a chart showing that data.

	Venue_Category	Frequency
0	Park	40
1	Theater	20
2	Art Gallery	9
3	Movie Theater	8
4	Historic Site	7
5	History Museum	7
6	Monument / Landmark	5
7	Indie Movie Theater	4
8	Art Museum	4
9	Concert Hall	4

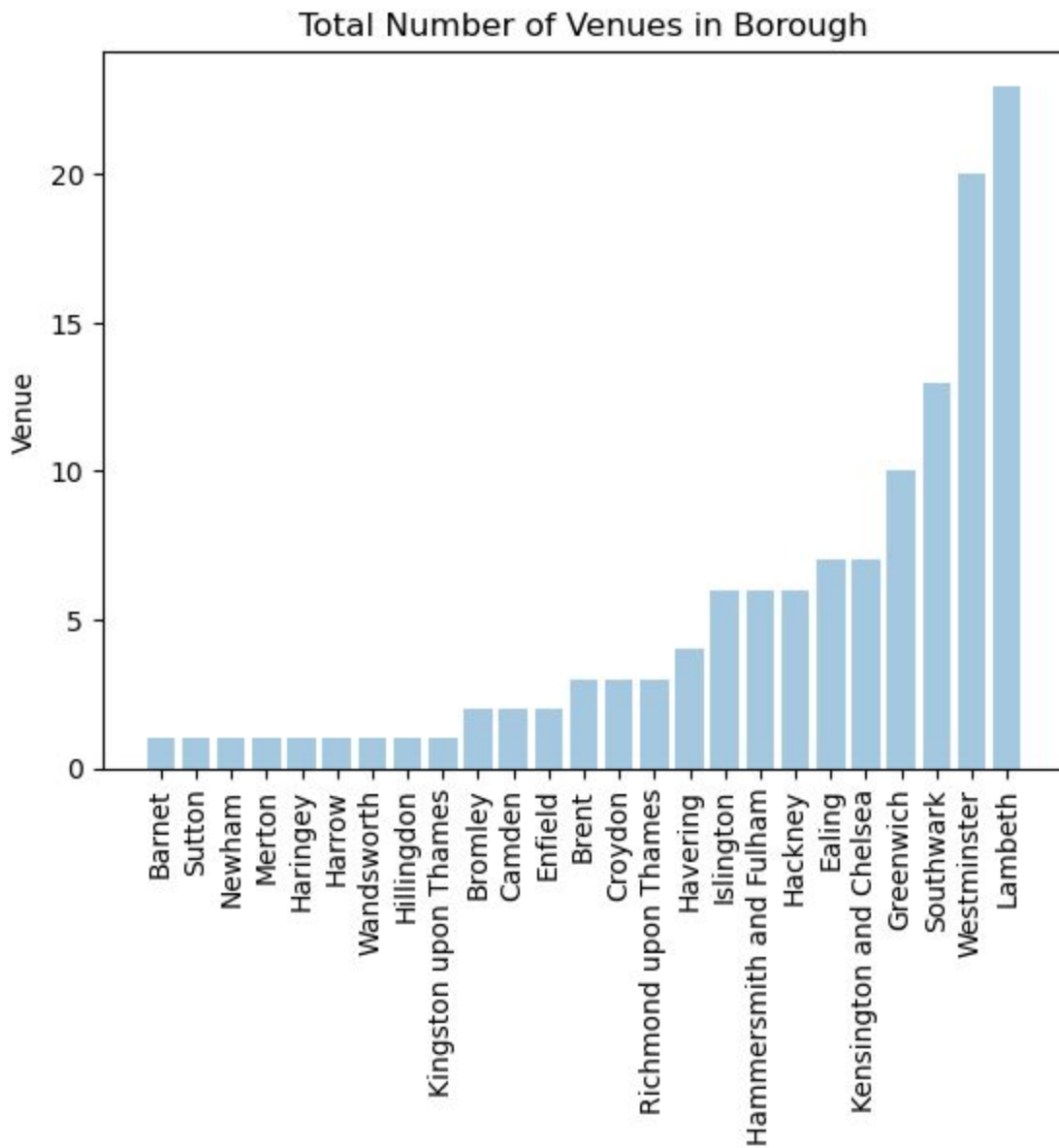
10 Most Frequently Occuring Venues in 32 Major Boroughs of London



As can be seen from the results, the Park is the most common venue in all 32 boroughs of London.

Analyzing Boroughs in London

Moreover, we checked how many venues were returned for each borough and sort them in count.



Lambeth and Westminster are leading boroughs in the total number of venues.

Afterwards, I created a table which shows a list of the top 10 venue categories for each borough in the below table.

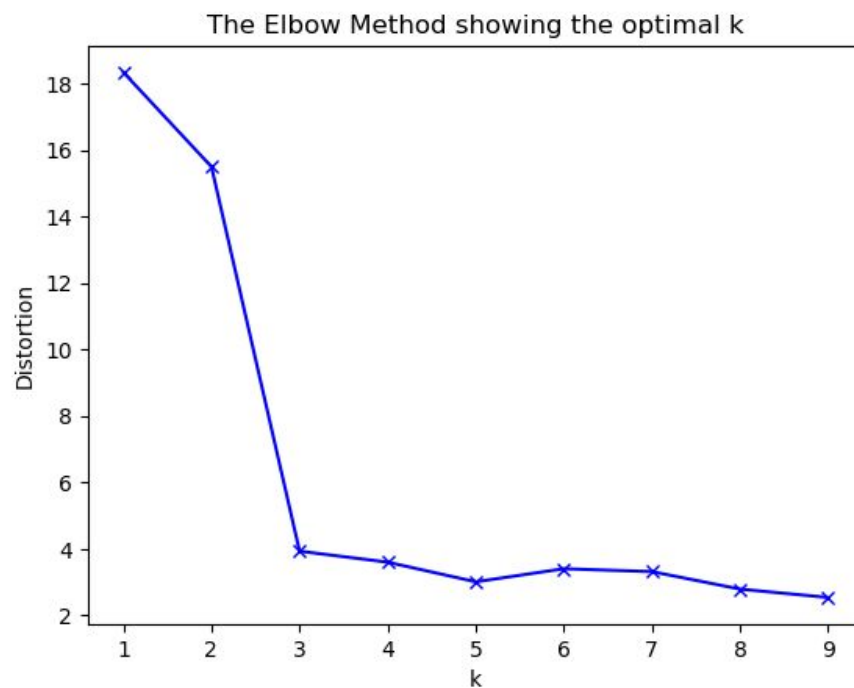
	Borough	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	Barnet	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
1	Brent	Soccer Stadium	Soccer Field	Park	Theme Park Ride / Attraction	Indie Theater	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum
2	Bromley	Movie Theater	Park	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
3	Camden	Park	Music Venue	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
4	Croydon	Park	Museum	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater

Clustering Boroughs

We have some common venue categories in boroughs. For this reason I used an unsupervised learning K-means algorithm to cluster the boroughs.

K-Means algorithm is one of the most common cluster methods of unsupervised learning.

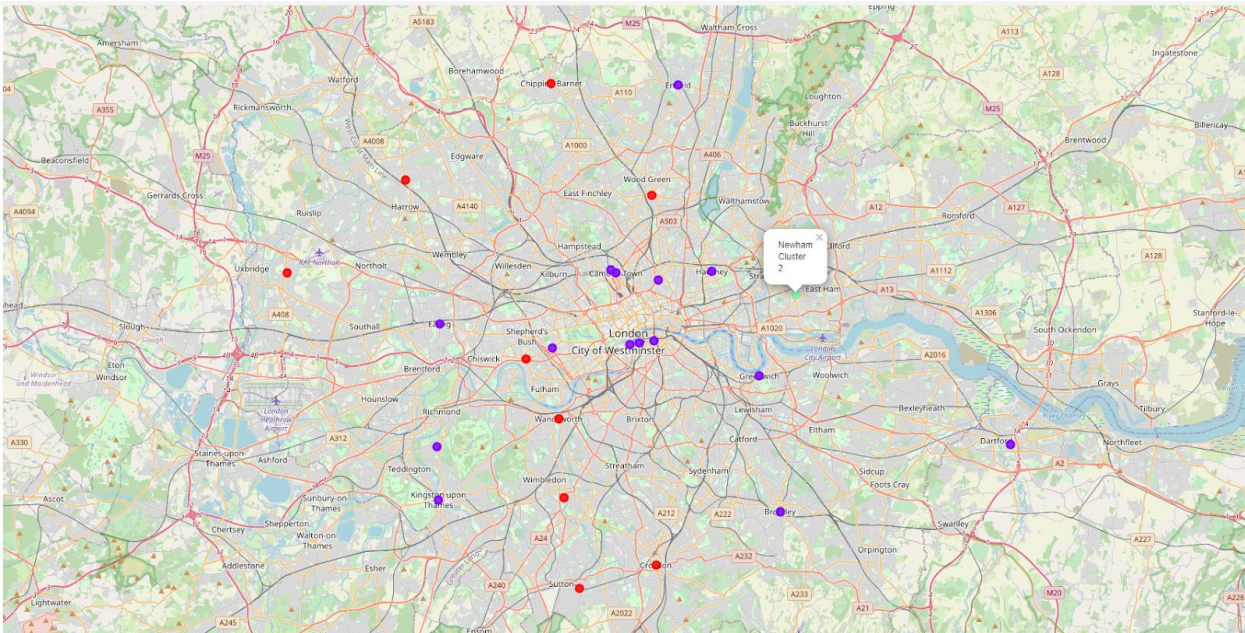
First, I will run K-Means to cluster the boroughs into 3 clusters because when I analyze the K-Means with elbow method it ensured me the 3 degree for optimum k of the K-Means.



I have created the new dataframe that includes the cluster as well as the top 10 venues for each civic neighborhood.

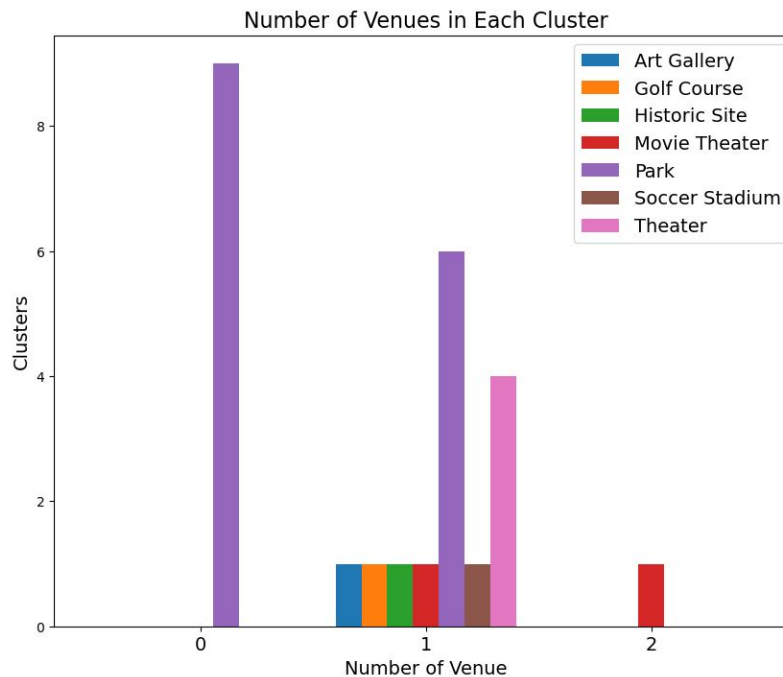
	Borough	Headquarters	Area	Population	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
1	Barnet	Barnet House, 2 Bristol Avenue, Colindale	33.49	395896	51.653060	-0.200226	0.0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
3	Brent	Brent Civic Centre, Engineers Way	16.70	329771	51.442026	0.231523	1.0	Soccer Stadium	Soccer Field	Park	Theme Park Ride / Attraction	Indie Theater	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum
4	Bromley	Civic Centre, Stockwell Close	57.97	332336	51.402805	0.014814	1.0	Movie Theater	Park	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
5	Camden	Camden Town Hall, Judd Street	8.40	270829	51.542305	-0.139560	1.0	Park	Music Venue	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
6	Croydon	Bernard Weatherill House, Mint Walk	33.41	386710	51.371305	-0.101957	0.0	Park	Museum	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
7	Ealing	Perceval House, 14-16 Uxbridge Road	21.44	341806	51.512855	-0.305195	1.0	Park	Art Gallery	Performing Arts Venue	Theater	Indie Theater	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum
8	Enfield	Civic Centre, Silver Street	31.74	333794	51.652085	-0.081018	1.0	Park	Theater	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
9	Greenwich	Woodwich Town Hall, Wellington Street	18.28	287842	51.482084	-0.004542	1.0	Historic Site	Park	History Museum	Art Gallery	Indie Movie Theater	Museum	Theater	Indie Theater	Art Museum	Concert Hall
10	Hackney	Hackney Town Hall, Mare Street	7.36	281120	51.543240	-0.049362	1.0	Park	Movie Theater	History Museum	Theater	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	Indie Movie Theater
11	Hammersmith and Fulham	Town Hall, King Street	6.33	185143	51.492038	-0.223640	0.0	Park	Concert Hall	Theater	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Golf Course	Historic Site	History Museum	Indie Movie Theater
12	Haringey	Civic Centre, High Road	11.42	268647	51.587930	-0.105410	0.0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
13	Harrow	Civic Centre, Station Road	19.49	251160	51.596827	-0.337316	0.0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
14	Havering	Town Hall, Main Road	43.35	259552	51.544365	-0.144307	1.0	Art Gallery	Park	Music Venue	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
15	Hillingdon	Civic Centre, High Street	44.67	306870	51.542519	-0.448335	0.0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
17	Islington	Customer Centre, 222 Upper Street	5.74	242467	51.538429	-0.099905	1.0	Theater	Movie Theater	Art Museum	Park	Music Venue	Indie Theater	Concert Hall	Golf Course	Historic Site	History Museum
18	Kensington and Chelsea	The Town Hall, Hornton Street	4.68	156129	51.496480	-0.190443	1.0	Park	History Museum	Art Gallery	Opera House	Museum	Indie Theater	Art Museum	Concert Hall	Golf Course	Historic Site
19	Kingston upon Thames	Guildhall, High Street	14.38	177507	51.409527	-0.306262	1.0	Theater	Theme Park Ride / Attraction	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater	Monument / Landmark
20	Lambeth	Lambeth Town Hall, Brixton Hill	10.36	326034	51.501301	-0.117287	1.0	Theater	Movie Theater	Concert Hall	Skate Park	Park	Indie Movie Theater	Historic Site	History Museum	Indie Theater	Monument / Landmark
22	Merton	Civic Centre, London Road	14.52	206548	51.410870	-0.188997	0.0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
23	Newham	Newham Dockside, 1000 Dockside Road	13.98	353134	51.530000	0.029318	2.0	Movie Theater	Theater	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater	Monument / Landmark
25	Richmond upon Thames	Civic Centre, 44 York Street	22.17	198019	51.440553	-0.307639	1.0	Golf Course	Historic Site	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	History Museum	Indie Movie Theater	Indie Theater
26	Southwark	160 Tooley Street	11.14	318830	51.502922	-0.103458	1.0	Theater	Art Museum	Park	Movie Theater	Music Venue	Art Gallery	Performing Arts Venue	Opera House	Skate Park	Museum
		Civic Offices, 48 Northcote							Theme Park Ride /	Monument /						Indie Movie	

Resulting clusters are visualized on the map.



Results

The number of 1st Most Common Venue in each cluster can also be estimated and shown via a bar chart to show as proper labels for each cluster.



When we examine above graph we can describe each cluster as follows:

- Cluster 0 : “Parks”
- Cluster 1 : “Multiple Fun Venues”
- Cluster 2 : “Theaters”

We have also examined results per cluster.

```
In [51]: london_merged.loc[london_merged['cluster_labels'] == 0, london_merged.columns[0] + list(range(3, london_merged.shape[1]))]
Out[51]:
```

	Borough	Population	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
1	Barnet	395586	51.653090	-0.200225	0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
6	Croydon	386710	51.371305	-0.101957	0	Park	Museum	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
11	Hammersmith and Fulham	185143	51.492038	-0.223640	0	Park	Concert Hall	Theater	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Golf Course	Historic Site	History Museum	Indie Movie Theater
12	Haringey	268647	51.587930	-0.105410	0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
13	Harrow	251160	51.596827	-0.337319	0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
15	Hillingdon	300670	51.542519	-0.448335	0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
22	Merton	206548	51.410670	-0.188097	0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
27	Sutton	200349	51.357454	-0.173627	0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
30	Wandsworth	329677	51.457027	-0.193261	0	Park	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater

As we can see in Cluster 0, we have Park as the most common value in all boroughs assigned to that cluster. Very interesting fact for Cluster 0 is that the second most common value is Theme Park / Attraction and third is Landmark/Monument. By looking at these venues, we can say that cluster 0 is mostly focused on the venues that provide outdoor activities and can be accessed during the Lockdown in London.

```
In [52]: london_merged.loc[london_merged['Cluster Labels'] == 1, london_merged.columns[[0] + list(range(3, london_merged.shape[1]))]]
```

Out[52]:

	Borough	Population	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
3	Brent	329771	51.442026	0.231523	1	Soccer Stadium	Soccer Field	Park	Theme Park Ride / Attraction	Indie Theater	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum
4	Bromley	332336	51.402805	0.014814	1	Movie Theater	Park	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater
5	Camden	270029	51.542305	-0.139560	1	Park	Music Venue	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
7	Ealing	341606	51.512655	-0.305195	1	Park	Art Gallery	Performing Arts Venue	Theater	Indie Theater	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum
8	Enfield	333794	51.652085	-0.081918	1	Park	Theater	Theme Park Ride / Attraction	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
9	Greenwich	287942	51.482084	-0.004542	1	Historic Site	Park	History Museum	Art Gallery	Indie Movie Theater	Museum	Theater	Indie Theater	Art Museum	Concert Hall
10	Hackney	281120	51.543240	-0.049352	1	Park	Movie Theater	History Museum	Theater	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	Indie Movie Theater
14	Havering	255552	51.544385	-0.144307	1	Art Gallery	Park	Music Venue	Monument / Landmark	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater
17	Islington	242467	51.538429	-0.099905	1	Theater	Movie Theater	Art Museum	Park	Music Venue	Indie Theater	Concert Hall	Golf Course	Historic Site	History Museum
18	Kensington and Chelsea	156129	51.488480	-0.199943	1	Park	History Museum	Art Gallery	Opera House	Museum	Indie Theater	Art Museum	Concert Hall	Golf Course	Historic Site
19	Kingston upon Thames	177507	51.409627	-0.306262	1	Theater	Theme Park Ride / Attraction	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater	Monument / Landmark

As we can see in Cluster 1, we have multiple venues as the most common venues in all boroughs assigned to that cluster. By looking at these venues, we can say that cluster 1 is focused on the venues that provide both outdoor and indoor activities.

```
In [53]: london_merged.loc[london_merged['Cluster Labels'] == 2, london_merged.columns[[0] + list(range(3, london_merged.shape[1]))]]
```

Out[53]:

	Borough	Population	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
23	Newham	353134	51.53	0.029318	2	Movie Theater	Theater	Art Museum	Concert Hall	Golf Course	Historic Site	History Museum	Indie Movie Theater	Indie Theater	Monument / Landmark

As we can see in Cluster 2, we have Movie Theaters and Theaters as the most common venues. Boroughs in this cluster are suitable for people interested in performing arts.

Discussion

As I mentioned before, London is a big city with a high population density, meaning that different approaches can be tried in clustering and classification studies. Moreover, it is obvious that not every classification method can yield the same high quality results.

I used the K Means algorithm as part of this clustering study. When I tested the Elbow method, I set the optimum k value to 3 and used 32 boroughs. However, I have not taken into account "City of London" since it is not stated as Borough and covers a rather small area in the administrative and geographical meaning. However, it could affect the provided results. Also, if we want more detailed results, we can drill down to the street or some specific areas.

Additionally, the venues filtered are decided by me based on what might be useful and appropriate for this type of analysis. E.g. For this project, I've focused on the following venues: Park, Museum, Historic Site, Monument, Gallery, Theater, Performing Arts, Golf, Soccer, Fun, Concert Hall, Music Venue, Opera House. However, this can be expanded.

Conclusion

As we could see from this analysis, even amidst the global pandemic and lockdown, London has a lot to offer to its citizens.

Parks have proven to be one of the most common venues in most of the boroughs. However, Landmarks/Monuments as well as Theme Parks/Attractions are also very common.

This research shows / offers data that can make it easier to choose boroughs for the next activity and adventure in the city, facilitate relocation, or provide tourist information for those interested in this type of activity in the future.