CAPSTONE PROJECT –
THE BATTLE OF NEIGHBORHOOD REPORT

- PRAVEEN JUYAL

1. INTRODUCTION

1.1 Background

The average American moves about eleven times in their lifetime. This brings us to the question: Do people move until they find a place to settle down where they truly feel happy,
or do our wants and needs change over time, prompting us to eventually leave a town we once called home for a new area that will bring us satisfaction? Or, do we too often move to a new area without knowing exactly what we're getting into, forcing us to turn tail and run at the first sign of discomfort?

To minimize the chances of this happening, we should always do proper research when planning our next move in life. Consider the following factors when picking a new place to live so you don't end up wasting your valuable time and money making a move you'll end up regretting. Safety is a top concern when moving to a new area. If you don't feel safe in your own home, you're not going to be able to enjoy living there.

1.2 Problem

The crime statistics dataset of London found on Kaggle has crimes in each Boroughs of London from 2008 to 2016. The year 2016 being the latest we will be considering the data of that year which is actually old information as of now. The crime rates in each borough may have changed over time.

This project aims to select the safest borough in London based on the total crimes, explore the neighborhoods of that borough to find the 10 most common venues in each neighborhood and finally cluster the neighborhoods using k-mean clustering.

1.3 Interest

Expats who are considering to relocate to London will be interested to identify the safest borough in London and explore its neighborhoods and common venues around each neighborhood.

2. Data Acquisition and Cleaning

2.1 Data Acquisition

The data acquired for this project is a combination of data from three sources. The first data source of the project uses a London crime data that shows the crime per borough in London. The dataset contains the following columns:

- lsoa_code : code for Lower Super Output Area in Greater London.
- borough : Common name for London borough.
- major_category : High level categorization of crime
- minor_category : Low level categorization of crime within major category.
- value : monthly reported count of categorical crime in given borough
- year : Year of reported counts, 2008-2016
- month : Month of reported counts, 1-12

The second source of data is scraped from a wikipedia page that contains the list of London boroughs . This page contains additional information about the boroughs, the following are the columns:

- **Borough** : The names of the 33 London boroughs.
- **Inner** : Categorizing the borough as an Inner London borough or an Outer London Borough.
- **Status** : Categorizing the borough as Royal, City or other borough.

- **Local authority** : The local authority assigned to the borough.
- **Political control** : The political party that control the borough.
- **Headquarters**: Headquarters of the Boroughs.
- **Area (sq mi)** : Area of the borough in square miles.
- **Population** (2013 est) : The population in the borough recorded during the year 2013.
- **Co-ordinates** : The latitude and longitude of the boroughs.
- **Nr. in map** : The number assigned to each borough to represent visually on a map.

The third data source is the list of Neighborhoods in the Royal Borough of Kingston upon Thames as found on a wikipedia page. This dataset is created from scratch using the list of neighborhood available on the site, the following are columns:

- **Neighborhood**: Name of the neighborhood in the Borough.
- **Borough**: Name of the Borough.
- **Latitude**: Latitude of the Borough.
- **Longitude**: Longitude of the Borough.

2.2 Data Cleaning

The data preparation for each of the three sources of data is done separately. From the London crime data, the crimes during the most recent year (2016) are only selected. The major categories of crime are pivoted to get the total crimes per the boroughs for each major category (see fig 2.1).

	Borough	Burglary	Criminal Damage	Drugs	Other Notifiable Offences	Robbery	Theft and Handling	Violence Against the Person	Total
0	Barking and Dagenham	1287	1949	919	378	534	5607	6067	16741
1	Barnet	3402	2183	906	499	464	9731	7499	24684
2	Bexley	1123	1673	646	294	209	4392	4503	12840
3	Brent	2631	2280	2096	536	919	9026	9205	26693
4	Bromley	2214	2202	728	417	369	7584	6650	20164

Fig 2.1 London crime data after preprocessing

The second data is scraped from a Wikipedia page using the Beautiful Soup library in python. Using this library we can extract the data in the tabular format as shown in the website. After the web scraping, string manipulation is required to get the names of the boroughs in the correct form (see fig 2.2). This is important because we will be merging the two datasets together using the Borough names.

	Borough	Inner	Status	Local authority	Political control	Headquarters	Area (sq mi)	Population (2013 est)[1]	Co-ordinates	Nr. in map
0	Barking and Dagenham	NaN	NaN	Barking and Dagenham London Borough Council	Labour	Town Hall, 1 Town Square	13.93	194352	51°33′39″N 0°09′21″E / 51.5607°N 0.1557°E /...	25
1	Barnet	NaN	NaN	Barnet London Borough Council	Conservative	North London Business Park, Oakleigh Road South	33.49	369088	51°37′31″N 0°09′06″W / 51.6252°N 0.1517°W /...	31
2	Bexley	NaN	NaN	Bexley London Borough Council	Conservative	Civic Offices, 2 Watling Street	23.38	236687	51°27′18″N 0°09′02″E / 51.4549°N 0.1505°E /...	23
3	Brent	NaN	NaN	Brent London Borough Council	Labour	Brent Civic Centre, Engineers Way	16.70	317264	51°33′32″N 0°16′54″W / 51.5588°N 0.2817°W /...	12
4	Bromley	NaN	NaN	Bromley London Borough Council	Conservative	Civic Centre, Stockwell Close	57.97	317899	51°24′14″N 0°01′11″E / 51.4039°N 0.0198°E /...	20

Fig 2.2 List of London Boroughs

The two datasets are merged on the Borough names to form a new dataset that combines the necessary information in one dataset (see fig 2.3). The purpose of this dataset is to visualize the crime rates in each borough and identify the borough with the least crimes recorded during the year 2016.

	Borough	Local authority	Political control	Headquarters	Area (sq mi)	Population (2013 est)[1]	Co-ordinates	Burglary	Criminal Damage	Drugs	Other Notifiable Offences	Robbery	Theft and Handling	Violence Against the Person	Total
0	Barking and Dagenham	Barking and Dagenham London Borough Council	Labour	Town Hall, 1 Town Square	13.93	194352	51°33′39″N 0°09′21″E / 51.5607°N 0.1557°E /...	1287	1949	919	378	534	5607	6067	16741
1	Barnet	Barnet London Borough Council	Conservative	North London Business Park, Oakleigh Road South	33.49	369088	51°37′31″N 0°09′06″W / 51.6252°N 0.1517°W /...	3402	2183	906	499	464	9731	7499	24684
2	Bexley	Bexley London Borough Council	Conservative	Civic Offices, 2 Watling Street	23.38	236687	51°27′18″N 0°09′02″E / 51.4549°N 0.1505°E /...	1123	1673	646	294	209	4392	4503	12840
3	Brent	Brent London Borough Council	Labour	Brent Civic Centre, Engineers Way	16.70	317264	51°33′32″N 0°16′54″W / 51.5588°N 0.2817°W /...	2631	2280	2096	536	919	9026	9205	26693
4	Bromley	Bromley London Borough Council	Conservative	Civic Centre, Stockwell Close	57.97	317899	51°24′14″N 0°01′11″E / 51.4039°N 0.0198°E /...	2214	2202	728	417	369	7584	6650	20164

Fig 2.3 London Borough Crime

After visualizing the crime in each borough we can find the borough with the lowest crime rate and hence tag that borough as the safest borough. The third source of data is acquired from the list of neighborhoods in the safest borough on Wikipedia. This dataset is created from scratch, the pandas data frame is created with the names of the neighborhoods and the name of the borough with the latitude and longitude left blank (see fig 2.4).

	Neighborhood	Borough	Latitude	Longitude
0	Berrylands	Kingston upon Thames		
1	Canbury	Kingston upon Thames		
2	Chessington	Kingston upon Thames		
3	Coombe	Kingston upon Thames		
4	Hook	Kingston upon Thames		

Fig 2.4 Neighborhoods of the safest borough

The coordinates of the neighborhoods is be obtained using Google Maps API geocoding to get the final dataset (See Fig 2.5).

	Neighborhood	Borough	Latitude	Longitude
0	Berrylands	Kingston upon Thames	51.393781	-0.284802
1	Canbury	Kingston upon Thames	51.417499	-0.305553
2	Chessington	Kingston upon Thames	51.358336	-0.298622
3	Coombe	Kingston upon Thames	51.419450	-0.265398
4	Hook	Kingston upon Thames	51.367898	-0.307145

Fig 2.5 Neighborhoods of the safest borough

The new dataset is used to generate the 10 most common venues for each neighborhood using the Foursquare API, finally using k means clustering algorithm to cluster similar neighborhoods together.

3. METHODOLOGY

3.1 Exploratory Data Analysis

3.1.1 Statistical summary of crimes

The describe function in python is used to get statistics of the London crime data, this returns the mean, standard deviation, minimum, maximum, 1st quartile (25%), 2nd quartile (50%), and the 3rd quartile (75%) for each of the major categories of crime (See fig 3.1.1).

	Burglary	Criminal Damage	Drugs	Other Notifiable Offences	Robbery	Theft and Handling	Violence Against the Person	Total
count	33.000000	33.000000	33.000000	33.000000	33.000000	33.000000	33.000000	33.000000
mean	2069.242424	1941.545455	1179.212121	479.060606	682.666667	8913.121212	7041.848485	22306.696970
std	737.448644	625.207070	586.406416	223.298698	441.425366	4620.565054	2513.601551	8828.228749
min	2.000000	2.000000	10.000000	6.000000	4.000000	129.000000	25.000000	178.000000
25%	1531.000000	1650.000000	743.000000	378.000000	377.000000	5919.000000	5936.000000	16903.000000
50%	2071.000000	1989.000000	1063.000000	490.000000	599.000000	8925.000000	7409.000000	22730.000000
75%	2631.000000	2351.000000	1617.000000	551.000000	936.000000	10789.000000	8832.000000	27174.000000
max	3402.000000	3219.000000	2738.000000	1305.000000	1822.000000	27520.000000	10834.000000	48330.000000

Fig 3.1.1 Statistical description of the London crimes

The count for each of the major categories of crime returns the value 33 which is the number of London boroughs. Theft and Handling' is the highest reported crime during the year 2016 followed by 'Violence against the person, Criminal damage.
The lowest recorded crimes are Drugs, Robbery and Other Notifiable offenses.

3.1.2 Boroughs with the highest crime rates

Comparing five boroughs with the highest crime rate during the year 2016 it is evident that Westminster has the highest crimes recorded followed by Lambeth, Southwark, Newham and Tower Hamlets. Westminster has a significantly higher crime rate than the other 4 boroughs (see fig 3.1.2).

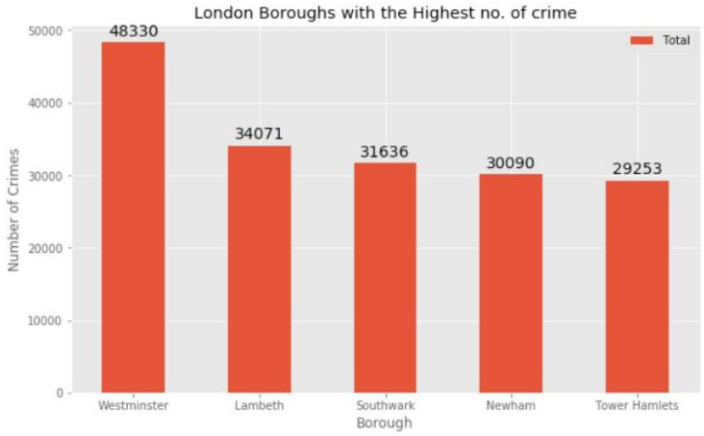


Fig 3.1.2 Boroughs with the highest crime rates

3.1.3 Boroughs with the lowest crime rates

Comparing five boroughs with the lowest crime rate during the year 2016, City of London has the lowest recorded crimes followed by Kingston upon Thames, Sutton, Richmond upon Thames and Merton (see fig 3.1.3).

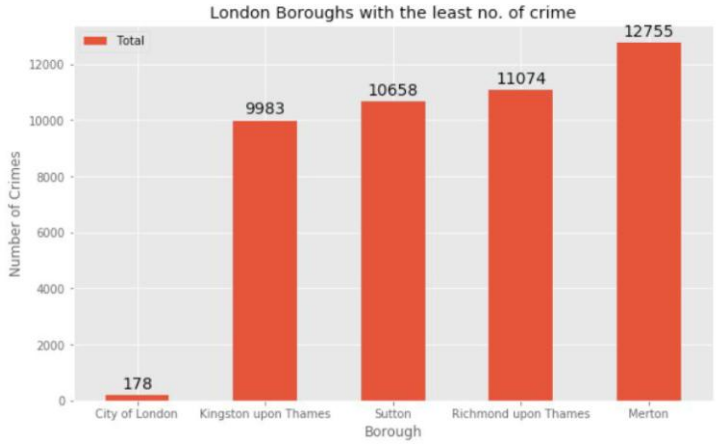


Fig 3.1.3 Boroughs with the lowest crime rates

City of London has a significantly lower crime rate because it i is the 33rd principal division of Greater London but it is not a London borough. It has an area of 1.12 square miles and a population of 7000 as of 2013 which suggests that it is a small area (see fig 3.1.3.1). Hence we will consider the next borough with the lowest crime rate as the safest borough in London which is Kingston upon Thames.

	Borough	Total	Area (sq mi)	Population (2013 est)[1]
6	City of London	178	1.12	7000

Fig 3.1.3.1 City of London

3.1.4 Neighborhoods in Kingston upon Thames

There are 15 neighborhoods in the royal borough of Kingston upon Thames, they are visualised on a map using folium on python (see fig 3.1.4).

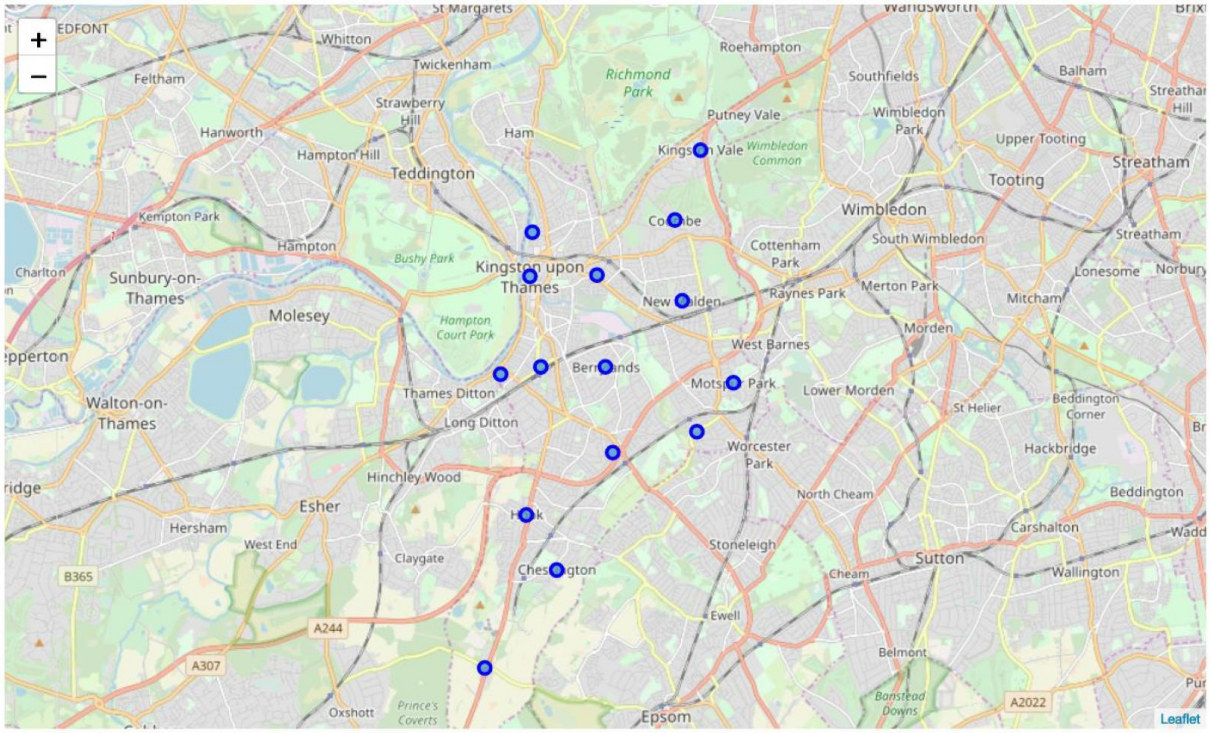


Fig 3.1.4 Neighborhoods in Kingston upon Thames

3.2 Modelling

Using the final dataset containing the neighborhoods in Kingston upon Thames along with the latitude and longitude, we can find all the venues within a 500 meter radius of each neighborhood by connecting to the Foursquare API. This returns a json file containing all the venues in each neighborhood which is converted to a pandas dataframe. This data frame contains all the venues along with their coordinates and category (see fig 3.2.1).

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Berrylands	51.393781	-0.284802	Surbiton Racket & Fitness Club	51.392676	-0.290224	Gym / Fitness Center
1	Berrylands	51.393781	-0.284802	Alexandra Park	51.394230	-0.281206	Park
2	Berrylands	51.393781	-0.284802	K2 Bus Stop	51.392302	-0.281534	Bus Stop
3	Canbury	51.417250	-0.305631	Canbury Gardens	51.417409	-0.305300	Park
4	Canbury	51.417250	-0.305631	The Boater's Inn	51.418546	-0.305915	Pub

Fig 3.2.1 Venue details of each Neighborhood

One hot encoding is done on the venues data. (One hot encoding is a process by which categorical variables are converted into a form that could be provided to ML algorithms to do a better job in prediction).

The Venues data is then grouped by the Neighborhood and the mean of the venues are calculated, finally the 10 common venues are calculated for each of the neighborhoods.

To help people find similar neighborhoods in the safest borough we will be clustering similar neighborhoods using K - means clustering which is a form of unsupervised machine learning algorithm that clusters data based on predefined cluster size. We will use a cluster size of 5 for this project that will cluster the 15 neighborhoods into 5 clusters.

The reason to conduct a K- means clustering is to cluster neighborhoods with similar venues together so that people can shortlist the area of their interests based on the venues/amenities around each neighborhood.

4. RESULTS

After running the K-means clustering we can access each cluster created to see which neighborhoods were assigned to each of the five clusters. Looking into the neighborhoods in the first cluster (see fig 4.1)

	Neighborhood	Borough	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
0	Berrylands	Kingston upon Thames	51.393781	-0.284802	0	Gym / Fitness Center	Park	Bus Stop	Train Station	Electronics Store	Cosmetics Shop	Deli / Bodega	Department Store	Dry Cleaner

Fig 4.1 Cluster 1

Upon close examination, we find that Cluster 1 comprises of one neighbourhood, which consists of venues such as Gym/Fitness Center and Parks as most common.

	Neighborhood	Borough	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
6	Kingston Vale	Kingston upon Thames	51.431850	-0.258138	1	Grocery Store	Bar	Soccer Field	Sandwich Place	Train Station	Farmers Market	Cosmetics Shop	Deli / Bodega
7	Malden Rushett	Kingston upon Thames	51.341052	-0.319076	1	Restaurant	Garden Center	Grocery Store	Pub	Train Station	Convenience Store	Cosmetics Shop	Deli / Bodega
14	Tolworth	Kingston upon Thames	51.378876	-0.282860	1	Grocery Store	Pharmacy	Restaurant	Hotel	Indian Restaurant	Coffee Shop	Pizza Place	Café

Fig 4.2 Cluster 2

Cluster 2 comprises of three neighbourhood, which consists of venues such as Grocery Store, Restaurant, Garden Center, Bar and Pharmacy as most common.

	Neighborhood	Borough	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
8	Motspur Park	Kingston upon Thames	51.390985	-0.248898	2	Park	Gym	Soccer Field	Construction & Landscaping	Train Station	Electronics Store	Cosmetics Shop	Deli / Bodega

Fig 4.3 Cluster 3

Cluster 3 comprises of one neighbourhood, which consists of venues such as Park and Gym as most common.

	Neighborhood	Borough	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
1	Canbury	Kingston upon Thames	51.417250	-0.305631	3	Pub	Café	Shop & Service	Japanese Restaurant	Indian Restaurant	Plaza	Hotel	Park
4	Hook	Kingston upon Thames	51.367898	-0.307145	3	Indian Restaurant	Bakery	Supermarket	Pub	Fish & Chips Shop	Train Station	Cosmetics Shop	Deli / Bodega
5	Kingston upon Thames	Kingston upon Thames	51.409627	-0.306262	3	Café	Burger Joint	Sushi Restaurant	Coffee Shop	Pub	German Restaurant	Gift Shop	Theater
9	New Malden	Kingston upon Thames	51.405335	-0.263407	3	Gastropub	Sushi Restaurant	Supermarket	Korean Restaurant	Bar	Gym	Indian Restaurant	Train Station
10	Norbiton	Kingston upon Thames	51.409999	-0.287396	3	Indian Restaurant	Food	Italian Restaurant	Pub	Auto Garage	Supermarket	Thai Restaurant	Athletics & Sports
12	Seething Wells	Kingston upon Thames	51.392642	-0.314366	3	Indian Restaurant	Coffee Shop	Pub	Fish & Chips Shop	Fast Food Restaurant	Gym	Gym / Fitness Center	Harbor / Marina
13	Surbiton	Kingston upon Thames	51.393756	-0.303310	3	Coffee Shop	Pub	Italian Restaurant	Pharmacy	Grocery Store	Train Station	Hotel	Deli / Bodega

Fig 4.4 Cluster 4

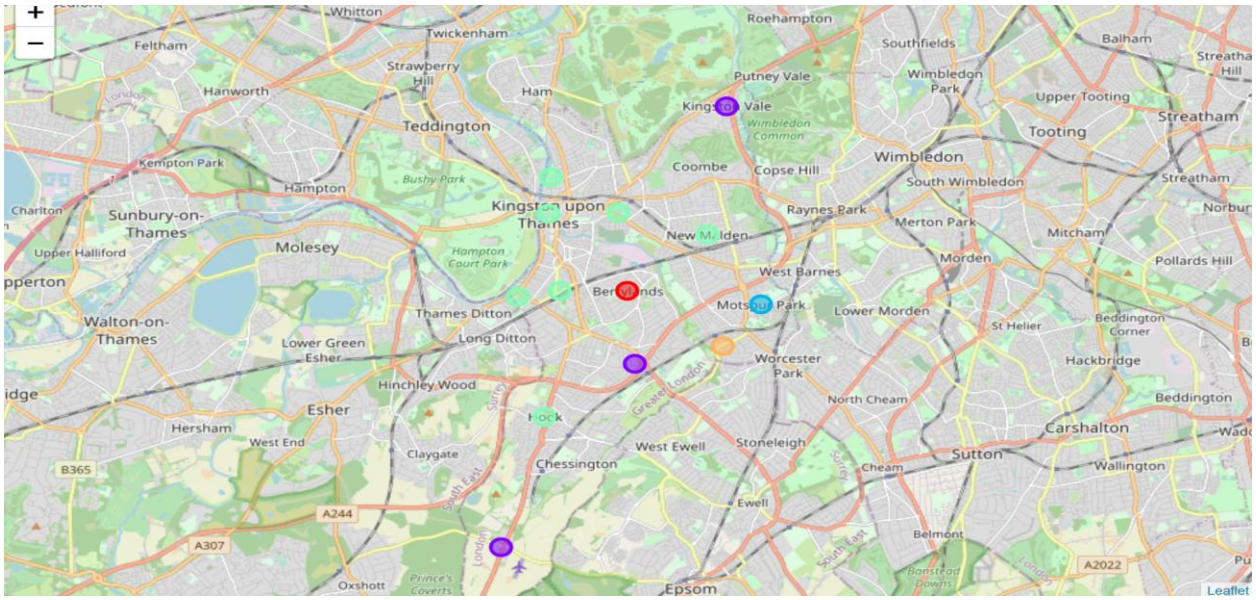
Cluster 4 comprises of seven neighbourhoods, which consists of venues such as Pub, Indian Restaurant, Cafe, Bakery as the most common.

	Neighborhood	Borough	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
11	Old Malden	Kingston upon Thames	51.382484	-0.25909	4	Train Station	Food	Pub	Construction & Landscaping	Fried Chicken Joint	French Restaurant	Garden Center	Fish & Chips Shop

Fig 4.5 Cluster 5

Cluster 5 comprises of one neighbourhood, which consists of venues such as Train Station, Food and Pubs as most common.

Visualising the clustered neighborhoods on a map using the folium library (see fig 4.6).



5. DISCUSSION

The aim of this project is to help people who want to relocate to the safest borough in London, expats can chose the neighborhoods to which they want to relocate based on the most common venues in it. For example if a person is looking for a neighborhood with good connectivity and public transportation we can see that Cluster 5 and 4 have Train station as the most common venue. If a person is looking for a neighborhood with stores and restaurants in a close proximity then the neighborhoods in the Fourth and the Second cluster is suitable. For a family I feel that the neighborhoods in Cluster First and Third are more suitable due to the common venues in that cluster, these neighborhoods have common venues such as Parks and Gym/Fitness centers which is ideal for a healthy family.

6. CONCLUSION

This project enables a person get a better understanding of the neighborhoods with respect to the most common venues in that neighborhood. It is always helpful to make use of technology to stay one step ahead i.e. finding out more about places before moving into a neighborhood. We have just taken safety as a primary concern to shortlist the borough of London. The future of this project includes taking other factors such as cost of living in the areas into consideration to shortlist the borough based on safety and a predefined budget.