

The Battle of Neighbourhoods: IBM Capstone Project

Introduction

As part of the course, we looked at location data for Toronto and New York, these cities had a lot of replies from the Foursquare API calls, so I decided to look at smaller cities that are expanding and test if a similar comparison can be done with them. The aim is to contribute to future interested parties for example data analysts, Tourists, location data managers, if there are limitations that might need to be resolved using a different API or collecting more data to feed into the requests etc.

In this project the comparison is between Toronto and London Ontario as I wanted to have a city which I had to start compiling the data as there was not much location data that was already compiled, but also a city near Toronto so that can also inform anyone wanting to explore further than Toronto example Tourists on other places of interest.

Toronto is a multicultural city in the Province of Ontario, it is the most populated city in Canada, it had a population of over 2.7 million in 2016 (Canadian census), also has the highest proportion of minority ethnic population in Canada. Its economy is diversified: Art, Design, Banking & Finance, Life Science, Technology, Aerospace, Fashion, Education, Tourism etc, thus an attractive location for many headquarters of multinational corporations, it welcomes many immigrants annually thus attracting an inflow of talent and opportunities for innovation and expansion as well as having influence on the neighbourhood demographics and tastes.

As urban centres grow some people move out to the suburbs to seek other job opportunities or choose to retire elsewhere, others move to be closer to friends and family, others seek a change etc. Where to relocate to depends on many factors for example, job opportunities in their industry, average wages, housing, public/community provisions, crime rates, access to amenities, warmer weather etc.

London is a city in Western Ontario which had a population of 383,822 in 2016 according to the Canadian census, it is about 120 miles from Toronto and Detroit. Strong industries are Healthcare with several hospitals located in the city, Education for example the University of Western Ontario (UWO), Insurance and Technology industries. London holds cultural events; Tourists can also explore the settlement changes that happened after the natural disasters and immigration influence over time since the early settlers, for example links to the UK with many similar names and systems.

I want to compare Toronto and London Ontario using location data from Foursquare API to look at the different neighbourhoods in these cities, to find the most popular venues in each.

Data

Location data: postcodes, neighbourhood, borough data for Toronto has been taken from a Wikipedia page "[List of postal codes of Canada: M - Wikipedia](#)" that was mentioned as part of the course. The data for London Ontario has been taken from another Wikipedia page "[List of postal codes of Canada: N - Wikipedia](#)". The Foursquare API will be used to gather data for the different venues to analyse these urban neighbourhoods in Toronto and London Ontario. Longitude and Latitude data for Toronto was provided in week 3 of the course "http://cocl.us/Geospatial_data" and London Ontario geographical coordinates data were gathered from "<https://www.geonames.org/>" also geolocator has been used.

Data scrapping and cleaning using python packages, on a Jupyter notebook hosted on IBM Cloud, and has been shared on GitHub. I will cluster the neighbourhoods and choose top 10 most popular venues in each and plot them on a map using Folium to help visualise and interpret the data.

Methodology:

Gathering Toronto data: For Toronto data provided in week 3 of the course, creating a python dataframe and then merged with the geo data, the final data will be used to send the API calls. The data needs to be cleaned to remove missing or duplicate data, in this case removing "Not assigned" Borough, then tidying the data so that can be merged on Postal Code, the index is set as Postal Code.

Geo data (Postcodes with Longitude and Latitude csv file) was provided for Toronto; the postal code is set as the index then will merge the two dataframes on Postal Code. The dataframes are now ready to be merged, this data will be used for the API calls.

```
#merge the dataframes
df_Toronto=pd.merge(df,postcodes,on=["Postal Code"])
df_Toronto.head()
```

8]:

	Postal Code	Borough	Neighbourhood	Latitude	Longitude
0	M3A	North York	Parkwoods	43.753259	-79.329656
1	M4A	North York	Victoria Village	43.725882	-79.315572
2	M5A	Downtown Toronto	Regent Park, Harbourfront	43.654260	-79.360636
3	M6A	North York	Lawrence Manor, Lawrence Heights	43.718518	-79.464763
4	M7A	Downtown Toronto	Queen's Park, Ontario Provincial Government	43.662301	-79.389494

Plotting this data using folium, to get map out neighbourhoods in Toronto where each neighbourhood has one geo coordinate, illustrates citywide coverage of data and that the centre of the city has several of neighbourhoods in closer proximity.

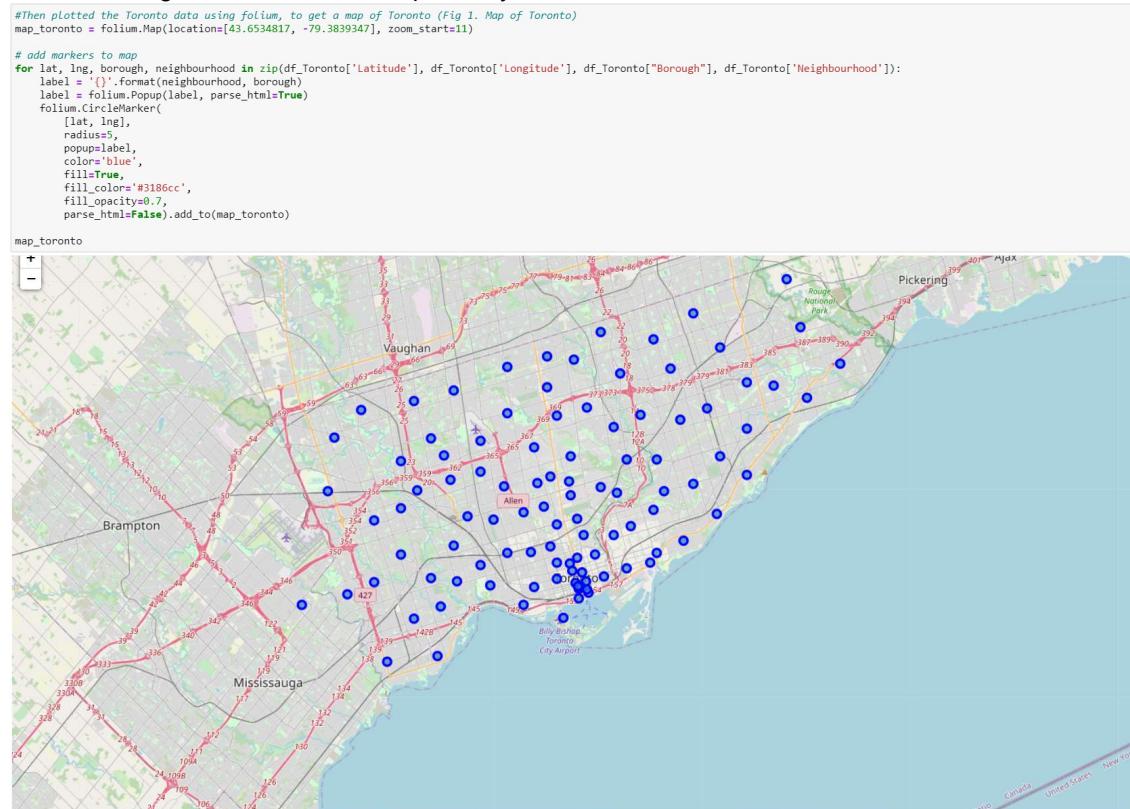


Fig 1 Map of Toronto Neighbourhoods

Gathering London Data: I searched without success for any prepared data, (Canada statistics, Ontario province & London City websites etc) to get the geographic boundaries or postcodes and geo data that can be populated to build the data frame like for Toronto that was used to plot the map above. London City website had information on planning districts and other information was gathered from; [GeoNames](#) for co-ordinates and neighbourhood data, [List of postal codes of Canada: N - Wikipedia](#) for postcodes and neighbourhood data and checking against [City Map Gallery \(london.ca\)](#).

```
df_W=pd.DataFrame(LondonOntario)
df_W
```

	Postal Code	Borough	Neighbourhood	Latitude	Longitude
0	N6B	London Central	London Central	42.984	-81.239
1	N5W	London East	London East	42.986	-81.182
2	N6A	London North	London North	42.998	-81.256
3	N6C	London South	London South	42.958	-81.238
4	N6H	London West	London West	42.991	-81.34
5	N6E	London	South White Oaks,Central Westminster,East Long...	42.918	-81.224
6	N6P	London	Talbot,Lambeth,West Tempo,South Sharon Creek	42.891	-81.324
7	N6N	London	South Highbury,Glanworth,East Brockley,SE West...	42.9	-81.159
8	N6M	London	Jackson,Old Victoria,Bradley,North Highbury	42.963	-81.139
9	N6L	London	East Tempo	42.872	-81.247
10	N6K	London	Riverbend,Woodhull,North Sharon Creek,Byron,We...	42.954	-81.342
11	N6J	London	Southcrest,East Westmount,West Highland	42.955	-81.273
12	N6G	London	Sunningdale,West Masonville,Medway,NE Hyde Par...	43.015	-81.305
13	N5V	London	YXU,North and East Argyle,East Huron Heights	43.023	-81.164
14	N5Z	London	Glen Cairn	42.966	-81.205
15	N5Y	London	West Huron Heights,Carling	43.012	-81.231
16	N5X	London	Fanshawe,Stoneybrook,Stoney Creek,Uplands,East...	43.044	-81.239

The map plotted with the data above shows the locations plotted are scattered across the city and this is expected as only one location data was plotted per neighbourhood postal code.

```
map_london = folium.Map(location=[42.9836747, -81.2496068], zoom_start=11)

# add markers to map
for lat, lng, borough, neighbourhood in zip(df_W['Latitude'], df_W['Longitude'], df_W["Borough"], df_W['Neighbourhood']):
    label = '{0}'.format(neighbourhood, borough)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='blue',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(map_london)

map_london
```

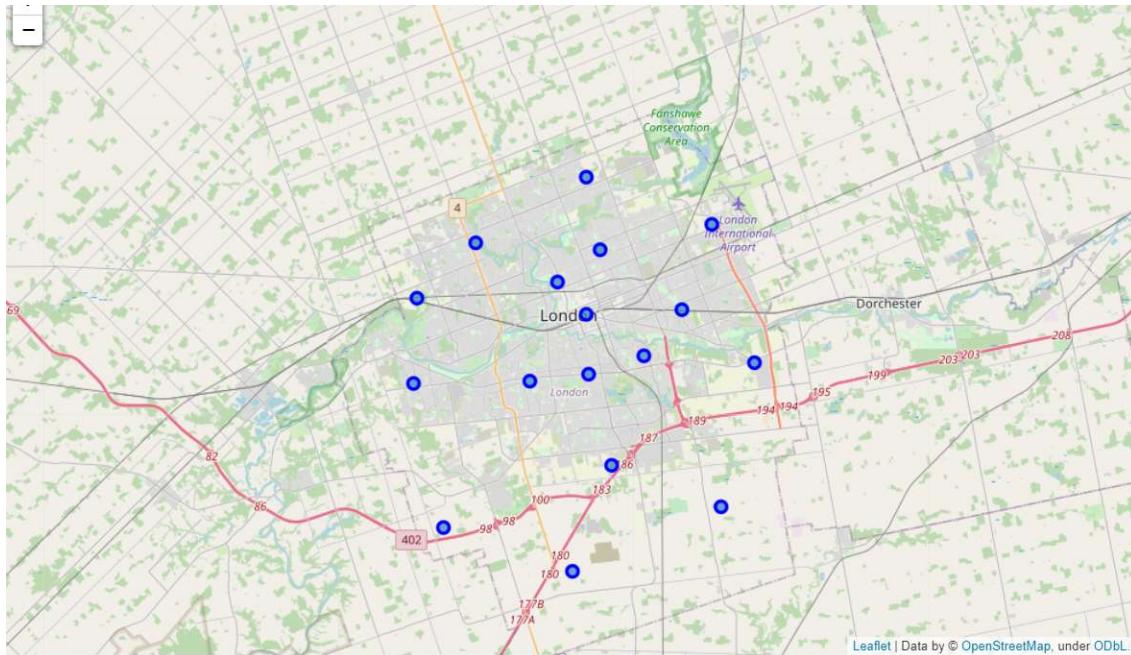


Fig 2. London Ontario

Venues Nearby Foursquare “explore” API call

Now that we have the geo data for Toronto and London we can gather the venues and sort the data.

```
def getNearbyVenues(names, latitudes, longitudes, radius=5000):
    venues_list = []
    for name, lat, lng in zip(names, latitudes, longitudes):
        print(name)

        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)

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

        venues_list.append([
            name,
            lat,
            lng,
            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 = ['Neighbourhood',
                            'Neighbourhood Latitude',
                            'Neighbourhood Longitude',
                            'Venue',
                            'Venue Latitude',
                            'Venue Longitude',
                            'Venue Category']

    return(nearby_venues)

#Toronto Venues from API call
Toronto_venues = getNearbyVenues(names=df_Toronto["Neighbourhood"],
                                  latitudes=df_Toronto["Latitude"],
                                  longitudes=df_Toronto["Longitude"])
)

print(Toronto_venues.shape)
Toronto_venues.head()

(10258, 7)

Neighbourhood Neighbourhood Latitude Neighbourhood Longitude Venue Venue Latitude Venue Longitude Venue Category
0 Parkwoods 43.753259 -79.329656 Alwyn's Bakery 43.759840 -79.324719 Caribbean Restaurant
1 Parkwoods 43.753259 -79.329656 Donalds Golf & Country Club 43.752816 -79.342741 Golf Course
2 Parkwoods 43.753259 -79.329656 Galleria Supermarket 43.753520 -79.349518 Supermarket
3 Parkwoods 43.753259 -79.329656 Tim Hortons 43.760668 -79.326368 Café
4 Parkwoods 43.753259 -79.329656 Island Foods 43.745866 -79.346035 Caribbean Restaurant
```

The API returned 10,258 venues across 255 categories; grouping the data by neighbourhood count illustrates the number of replies per neighbourhood, this checks that we have sufficient data to continue with the analysis. The venues are assigned against each neighbourhood so that we can calculate the mean value per venue to rank the popularity and to summarise the data, then a snapshot of the top 5 venues per neighbourhood is viewed.

Now we have can get the top 10 venues per neighbourhood.

```
def return_most_common_venues(row, num_top_venues):
    row_categories = row.iloc[1:]
    row_categories_sorted = row_categories.sort_values(ascending=False)

    return row_categories_sorted.index.values[0:num_top_venues]
```

The top 10 venues are then returned per neighbourhood, the geo data is added back to the data to be able to plot the neighbourhoods.

```
num_top_venues = 10

indicators = ['1st', 'nd', 'rd']

columns = ['Neighbourhood']
for ind in np.arange(num_top_venues):
    try:
        columns.append('{0} Most Common Venue'.format(ind+1, indicators[ind]))
    except:
        columns.append('{0}th Most Common Venue'.format(ind+1))

neighbourhoods_venues_sorted = pd.DataFrame(columns=columns)
neighbourhoods_venues_sorted['Neighbourhood'] = Toronto_grouped['Neighbourhood']

for ind in np.arange(Toronto_grouped.shape[0]):
    neighbourhoods_venues_sorted.iloc[ind, 1:] = return_most_common_venues(Toronto_grouped.iloc[ind, :], num_top_venues)

neighbourhoods_venues_sorted.head()
```

	Neighbourhood	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	Agincourt	Coffee Shop	Chinese Restaurant	Caribbean Restaurant	Noodle House	Park	Supermarket	Sushi Restaurant	Sandwich Place	Bakery	Pizza Place
1	Alderwood, Long Branch	Bakery	Coffee Shop	Pizza Place	Park	Liquor Store	Seafood Restaurant	Grocery Store	Burger Joint	Burrito Place	Brewery
2	Bathurst Manor, Wilson Heights, Downsview North	Coffee Shop	Middle Eastern Restaurant	Clothing Store	Korean Restaurant	Bubble Tea Shop	Grocery Store	Restaurant	Sushi Restaurant	Bakery	Japanese Restaurant
3	Bayview Village	Coffee Shop	Supermarket	Middle Eastern Restaurant	Bakery	Korean Restaurant	Japanese Restaurant	Thai Restaurant	Restaurant	Bagel Shop	Chinese Restaurant

We have the data of the 10 most common venues for Toronto neighbourhood, before we cluster this lets also follow the same process to get the 10 most common venues for London.

```
London_venues = getNearbyVenues(names=df_W["Neighbourhood"],
                                latitudes=df_W["Latitude"],
                                longitudes=df_W["Longitude"]
                               )
```

London Central
 London East
 London North
 London South
 London West
 South White Oaks,Central Westminster,East Longwoods,West Brockley
 Talbot,Lambeth,West Tempo,South Sharon Creek
 South Highbury,Glanworth,East Brockley,SE Westminster
 Jackson,Old Victoria,Bradley,North Highbury
 East Tempo
 Riverbend,Woodhull,North Sharon Creek,Byron,West Westmount
 Southcrest,East Westmount,West Highland
 Sunningdale,West Masonville,Medway,NE Hyde Park,East Fox Hollow
 YXU,North and East Argyle,East Huron Heights
 Glen Cairn
 West Huron Heights,Carling
 Fanshawe,Stoneybrook,Stoney Creek,Uplands,East Masonville

London venues using the “explore” Foursquare API call returned 1,214 venues, these are then sorted and grouped like was done with Toronto data.

```
print(London_venues.shape)
London_venues.head()

(1214, 7)
```

	Neighbourhood	Neighbourhood Latitude	Neighbourhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	London Central	42.984	-81.239	Edgar + Joe's Cafe	42.979983	-81.243563	Cafe
1	London Central	42.984	-81.239	The Morrissey House	42.985865	-81.241693	Pub
2	London Central	42.984	-81.239	TG's Addis Ababa Restaurant	42.987210	-81.237107	African Restaurant
3	London Central	42.984	-81.239	The Works Gourmet Burger Bistro	42.982151	-81.249710	Restaurant
4	London Central	42.984	-81.239	Abruzzii Ristorante	42.982105	-81.250735	Italian Restaurant

Only 1,214 London venues were returned, this is 11% of the Toronto API replies and this is not surprising as the population in London was about 14% of that of Toronto in 2014. Also the geo data used to send the request was not the same size as London is a smaller city, this also could explain why some neighbourhoods have only a few venues returned. Another reason could be more geodata

needs to be added or the location data needs to be updated.

Neighbourhood	Latitude	Neighbourhood	Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
East Tempo	4		4	4	4	4	4
Fanshawe,Stoneybrook,Stoney Creek,Uplands,East Masonville	81		81	81	81	81	81
Glen Cairn	100		100	100	100	100	100
Jackson,Old Victoria,Bradley,North Highbury	25		25	25	25	25	25
London Central	100		100	100	100	100	100
London East	100		100	100	100	100	100
London North	100		100	100	100	100	100
London South	100		100	100	100	100	100
London West	90		90	90	90	90	90
Riverbend,Woodhull,North Sharon Creek,Byron,West Westmount	56		56	56	56	56	56
Southcrest,East Westmount,West Highland	100		100	100	100	100	100
South Highbury,Glanworth,East Brockley,SE Westminster	13		13	13	13	13	13
South White Oaks,Central Westminster,East Longwoods,West Brockley	96		96	96	96	96	96
Sunningdale,West Masonville,Medway,NE Hyde Park,East Fox Hollow	100		100	100	100	100	100
Talbot,Lambeth,West Tempo,South Sharon Creek	10		10	10	10	10	10
West Huron Heights,Carling	100		100	100	100	100	100
YXU,North and East Argyle,East Huron Heights	39		39	39	39	39	39

```
print('There are {} uniques categories.'.format(len(London_venues['Venue Category'].unique())))
There are 129 uniques categories.
```

Like was done with the Toronto data, venues are then displayed by the type and then grouped by the mean, then the most common venues in each neighbourhood can be grouped together.

Neighbourhood	African Restaurant	American Restaurant	Arcade	Arts & Crafts Store	Asian Restaurant	Athletics & Sports	BBQ Joint	Bakery	Bank	Bar	Baseball Field	Baseball Stadium	Beer Store	Bistro	Bookstore	Bowling Alley	Breakfast Spot	Brewery	Bubble Tea Shop	Burger Joint	Burrito Place	Bus Station	Café
0 London Central	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1 London Central	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 London Central	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 London Central	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 London Central	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5																							

```
London_grouped = London_onehot.groupby('Neighbourhood').mean().reset_index()
London_grouped
```

Neighbourhood	African Restaurant	American Restaurant	Arcade	Arts & Crafts Store	Asian Restaurant	Athletics & Sports	BBQ Joint	Bakery	Bank	Bar	Baseball Field	Baseball Stadium	Beer Store	Bistro	Bookstore	Bowling Alley	Breakfast Spot	Brewery	Bubble Tea Shop	Burger Joint	Burrito Place	Bus Station	Café
0 East Tempo	0.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.250000	0.000000	0.000000	
1 Fanshawe,Stoneybrook,Stoney Creek,Uplands,East...	0.00	0.012346	0.012346	0.012346	0.024691	0.00	0.000000	0.000000	0.024691	0.00	0.012346	0.00	0.012346	0.00	0.012346	0.00	0.012346	0.00	0.012346	0.00	0.012346	0.00	0.024691
2 Glen Cairn	0.01	0.020000	0.000000	0.000000	0.010000	0.01	0.000000	0.000000	0.000000	0.02	0.000000	0.01	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000	0.00	0.000000
3 Jackson,Old Victoria,Bradley,North Highbury	0.00	0.040000	0.000000	0.000000	0.000000	0.00	0.000000	0.000000	0.000000	0.00	0.040000	0.00	0.040000	0.00	0.040000	0.00	0.040000	0.00	0.040000	0.00	0.040000	0.00	0.040000
4 London Central	0.01	0.010000	0.000000	0.000000	0.010000	0.01	0.000000	0.010000	0.01	0.000000	0.010000	0.01	0.000000	0.01	0.000000	0.01	0.000000	0.01	0.000000	0.01	0.000000	0.01	0.000000
5 London East	0.01	0.020000	0.000000	0.000000	0.010000	0.01	0.010000	0.020000	0.030000	0.01	0.000000	0.00	0.020000	0.00	0.000000	0.01	0.000000	0.00	0.000000	0.01	0.000000	0.01	0.010000

The Top 5 venues per neighbourhood (normalized by mean) are then gathered and then will be sorted by the most common venue.

num_top_venues = 5
for hood in London_grouped['Neighbourhood']:
print("----+hood----")
temp = London_grouped[London_grouped['Neighbourhood'] == hood].T.reset_index()
temp.columns = ['venue','freq']
temp = temp.iloc[1:]
temp['freq'] = temp['freq'].astype(float)
temp = temp.round({‘freq’: 2})
print(temp.sort_values(‘freq’, ascending=False).reset_index(drop=True).head(num_top_venues))
print("\n")
-----East Tempo-----
venue freq
0 Hotel 0.25
1 Italian Restaurant 0.25
2 Golf Course 0.25
3 Breakfast Spot 0.25
4 Irish Pub 0.00

The most common 10 venues in London per neighbourhood are then produced, this data will then be merged with the postcode/neighbourhood/geo data, then can be clustered and then plotted on a map.

```
num_top_venues = 10
indicators = ['st', 'nd', 'rd']

columns = ['Neighbourhood']
for ind in np.arange(num_top_venues):
    try:
        columns.append('{0} Most Common Venue'.format(ind+1, indicators[ind]))
    except:
        columns.append('{0}th Most Common Venue'.format(ind+1))

neighbourhoods_venues_sorted = pd.DataFrame(columns=columns)
neighbourhoods_venues_sorted['Neighbourhood'] = London_grouped['Neighbourhood']

for ind in np.arange(London_grouped.shape[0]):
    neighbourhoods_venues_sorted.iloc[ind, 1:] = return_most_common_venues(London_grouped.iloc[ind, :], num_top_venues)

neighbourhoods_venues_sorted.head()
```

	Neighbourhood	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	East Tempo	Hotel	Italian Restaurant	Golf Course	Breakfast Spot	Diner	Discount Store	Dog Run	Eastern European Restaurant	Dessert Shop	Electronics Store
1	Fanshawe, Stoneybrook, Stoney Creek, Uplands, East...	Restaurant	Coffee Shop	Pub	Grocery Store	Pharmacy	Breakfast Spot	Electronics Store	Bank	Ice Cream Shop	Liquor Store
2	Glen Cairn	Coffee Shop	Grocery Store	Liquor Store	Restaurant	Gym	Pizza Place	Diner	Italian Restaurant	Brewery	Café
3	Jackson, Old Victoria, Bradley, North Highbury	Coffee Shop	Supermarket	Gas Station	Pharmacy	Grocery Store	Intersection	Flower Shop	Fast Food Restaurant	Movie Theater	Dog Run
4	London Central	Coffee Shop	Pub	Café	Liquor Store	Park	Brewery	Gastropub	Pizza Place	Vegetarian / Vegan Restaurant	Italian Restaurant

Now that we have top 10 venues per neighbourhoods in both Toronto and London, next is to cluster these neighbourhoods.

Clustering the data with K means

The data was grouped into 6 clusters as it gave a better distribution, the geo data is added back to the data to be able to plot the neighbourhood clusters with folium on the Toronto map.

```
kclusters = 6
Toronto_grouped_clustering = Toronto_grouped.drop('Neighbourhood', 1)
kmeans = KMeans(n_clusters=kclusters, random_state=0).fit(Toronto_grouped_clustering)
kmeans.labels_[0:10]
```

3]: array([3, 3, 3, 3, 1, 2, 1, 4, 1, 2], dtype=int32)

The data was grouped into 6 clusters as it gave a better distribution, then the clusters are plotted with folium on the Toronto map.

```
#venue data and geodata is merged
neighbourhoods_venues_sorted.insert(0, 'Cluster Labels', kmeans.labels_)
Toronto_merged = df_Toronto

Toronto_merged = Toronto_merged.join(neighbourhoods_venues_sorted.set_index('Neighbourhood'), on='Neighbourhood')

Toronto_merged.head()
```

	Postal Code	Borough	Neighbourhood	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
0	M3A	North York	Parkwoods	43.753259	-79.329656	3	Middle Eastern Restaurant	Grocery Store	Caribbean Restaurant	Burger Joint	Supermarket	Japanese Restaurant	Italian Restaurant	Bakery	Liquor Store	Café
1	M4A	North York	Victoria Village	43.725882	-79.315572	3	Park	Supermarket	Burger Joint	Coffee Shop	Italian Restaurant	Grocery Store	Middle Eastern Restaurant	Liquor Store	Pizza Place	Restaurant
2	MSA	Downtown Toronto	Regent Park, Harbourfront	43.654260	-79.360636	2	Coffee Shop	Park	Café	Pizza Place	Plaza	French Restaurant	Hotel	Neighborhood	Farmers Market	Mediterranean Restaurant
3	M6A	North York	Lawrence Manor, Lawrence Heights	43.718518	-79.464763	1	Coffee Shop	Italian Restaurant	Vietnamese Restaurant	Café	Bakery	Park	Bank	Mediterranean Restaurant	Brazilian Restaurant	Burger Joint
4	M7A	Downtown Toronto	Queen's Park, Ontario Provincial Government	43.662301	-79.389494	2	Coffee Shop	Park	Café	Farmers Market	Bakery	Plaza	Sandwich Place	Neighborhood	Restaurant	Liquor Store

And for the London data.

```
kclusters = 6
London_grouped_clustering = London_grouped.drop('Neighbourhood', 1)
kmeans = KMeans(n_clusters=kclusters, random_state=0).fit(London_grouped_clustering)
kmeans.labels_[0:10]
0: array([2, 1, 4, 3, 4, 1, 4, 4, 1, 1], dtype=int32)
```

```
#London Venues data merged with geodata and clustered
London_merged = df_W
London_merged = London_merged.join(neighbourhoods_venues_sorted.set_index('Neighbourhood'), on='Neighbourhood')
London_merged.head()
```

	Postal Code	Borough	Neighbourhood	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
0	N6B	London Central	London Central	42.984	-81.239	1	Coffee Shop	Pub	Café	Liquor Store	Park	Brewery	Gastropub	Pizza Place	Vegetarian / Vegan Restaurant	Italian Restaurant
1	N5W	London East	London East	42.986	-81.182	1	Coffee Shop	Fast Food Restaurant	Gas Station	Pharmacy	Grocery Store	Gym	Restaurant	Liquor Store	Bank	Sandwich Place
2	N6A	London North	London North	42.998	-81.256	1	Pub	Coffee Shop	Park	Café	Italian Restaurant	Vegetarian / Vegan Restaurant	Pizza Place	Grocery Store	Restaurant	Indian Restaurant
3	N6C	London South	London South	42.958	-81.238	1	Coffee Shop	Restaurant	Café	Park	Italian Restaurant	Pizza Place	Liquor Store	Grocery Store	Pub	Middle Eastern Restaurant
4	N6H	London West	London West	42.991	-81.34	1	Coffee Shop	Grocery Store	Park	Fast Food Restaurant	Pizza Place	Golf Course	Gym	Pharmacy	Supermarket	Sandwich Place

Results

Toronto Cluster Map below shows most clusters fit per geographical area; these neighbourhoods have similar popular venues.

```
#map of Toronto clusters
map_cluster = folium.Map(location=[43.6532, -79.3832], zoom_start=11)

x = np.arange(kclusters)
ys = [i + x + (i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

markers_colors = []
for lat, lon, poi, cluster in zip(Toronto_merged['Latitude'], Toronto_merged['Longitude'], Toronto_merged['Neighbourhood'], Toronto_merged['Cluster Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=10,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_cluster)
map_cluster
```

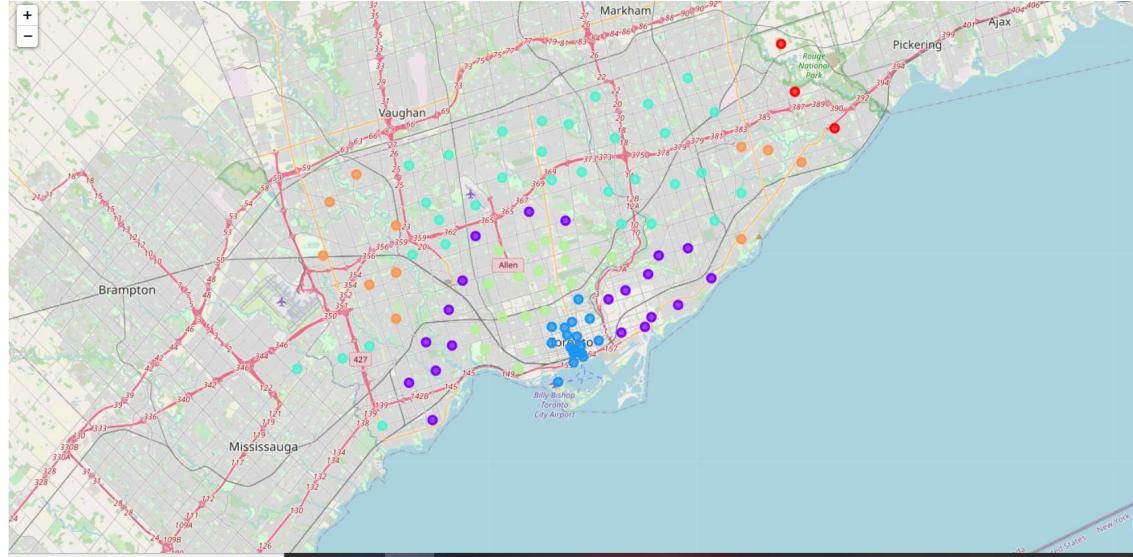


Fig 3. Toronto Cluster map

London Ontario cluster map, the clusters also fit per geographical area: Purple cluster is centrally and to the north where the Education and Healthcare industry is based. The other smaller clusters are in the south of the city.

```
#London Ontario Cluster Map
map_clusters = folium.Map(location=[42.9836747, -81.2496068], zoom_start=11)

x = np.arange(kclusters)
ys = [1 + x + (i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

markers_colors = []
for lat, lon, poi, cluster in zip(London_merged['Latitude'], London_merged['Longitude'], London_merged['Neighbourhood'], London_merged['Cluster Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=10,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters)
map_clusters
```

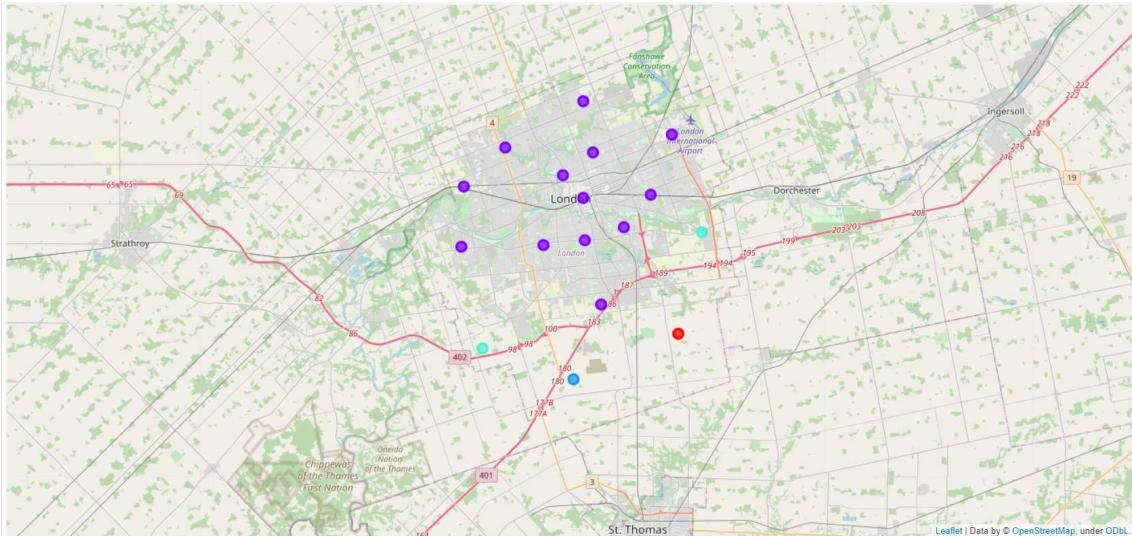


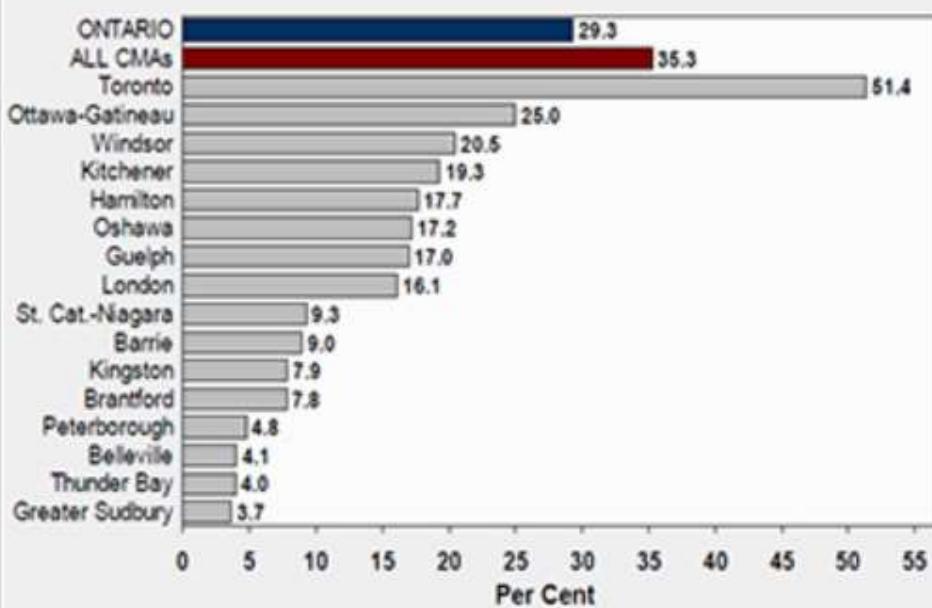
Fig 4. London Cluster map

Discussion

Demographics:

Ontario is Canada's most populous province and Toronto is the most populous city, Ottawa the capital city is in the province. As the datasets are of different size it is expected that London might not have all the clusters as Toronto, since its economy is not as diversified, it is a smaller city which also has different demographics. In 2016 census Toronto's population 51.14% were visible minorities, while London was at 16.1%, as per below from Canada Statistics the visible minority ethnicity population in the rest of Ontario province is much lower than Toronto. Visible minorities are defined "as persons who are non-Caucasian in race or non-white in colour and who do not report being Aboriginal" [2016 CENSUS HIGHLIGHTS: Factsheet 9 \(gov.on.ca\)](#)

Proportion of Visible Minorities, Ontario CMAs, 2016



Note: Ottawa-Gatineau (Ontario part). Kitchener = Kitchener-Cambridge-Waterloo.
Source: Statistics Canada

Fig 5. Proportion of visible minorities in Ontario (Statistics Canada as part of the 2016 Census)

Population demographics change over time and that influences changes in demands for different venues, looking at the last two census there was an increase in people identifying as Canadian, about 250 ethnic origins were declared in the last census. Understanding the different demographics helps to understand the popularity of the venues in Toronto versus London, but ethnicity is not the only influence on demand for a particular taste, as more people try out different cuisines there is an increase in demand. Also, venues with high ratings get more regular customers, the location of these venues would also factor into the demand.

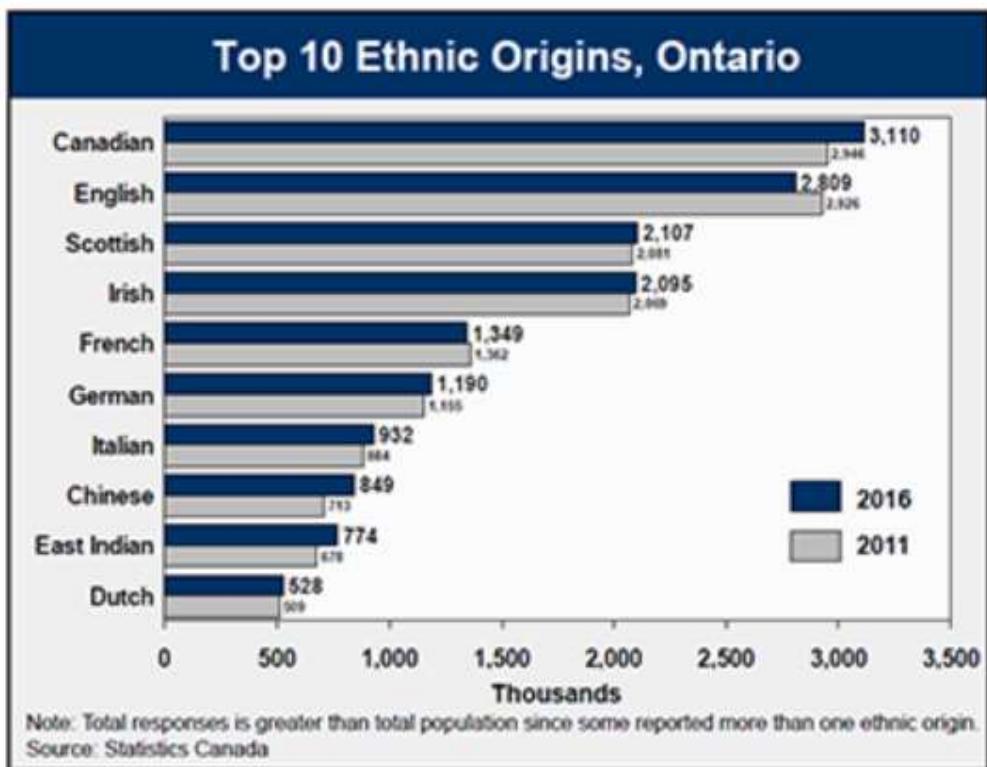


Fig 6. Top 10 Ethnic Origins Ontario (Statistics Canada)

Neighbourhoods are also shaped by government policy example disposable income and levels of employment will influence demand for the different venues. There are clusters of expensive neighbourhoods that continue to attract people to move and venues will open that cater to the demands, likewise where public provisions are located example schools can attract growth in population and the types of venues that are in the supply chain. Where big infrastructure investments e.g., the Airport, Universities, Hospitals are located they can support other businesses downstream on the supply chain, and people who work in those industries.

London Clusters: The three small clusters are in the south, there are leisure venues that can attract visitors from longer distances e.g Golf Course, Hotel, Gym, Movie Theater, but these neighbourhoods are mainly residential since it has popular retail venues that would be in residential areas: Pharmacy, Breakfast Spot, Grocery Store.

#Red Cluster	London_merged.loc[London_merged['Cluster Labels'] == 0, London_merged.columns[[2] + list(range(6, London_merged.shape[1]))]]																																	
3]:	<table border="1"> <thead> <tr> <th>Neighbourhood</th><th>1st Most Common Venue</th><th>2nd Most Common Venue</th><th>3rd Most Common Venue</th><th>4th Most Common Venue</th><th>5th Most Common Venue</th><th>6th Most Common Venue</th><th>7th Most Common Venue</th><th>8th Most Common Venue</th><th>9th Most Common Venue</th><th>10th Most Common Venue</th></tr> </thead> <tbody> <tr> <td>7 South Highbury,Glanworth,East Brockley,SE West...</td><td>Coffee Shop</td><td>Breakfast Spot</td><td>Sandwich Place</td><td>Waste Facility</td><td>Warehouse Store</td><td>Clothing Store</td><td>Thrift / Vintage Store</td><td>Motorcycle Shop</td><td>Fast Food Restaurant</td><td>Gas Station</td></tr> </tbody> </table>	Neighbourhood	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	7 South Highbury,Glanworth,East Brockley,SE West...	Coffee Shop	Breakfast Spot	Sandwich Place	Waste Facility	Warehouse Store	Clothing Store	Thrift / Vintage Store	Motorcycle Shop	Fast Food Restaurant	Gas Station											
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Most of London is in the purple cluster; it has some of the most desirable neighbourhoods example Riverbend, best known for the golf course. The most popular venue in this cluster is Coffee shops, which are usually located in places with higher footfall and they would be in areas where there are other businesses (for example offices), parks, leisure venues, natural environment attractions; Fanshawe conservation area and the River Thames.

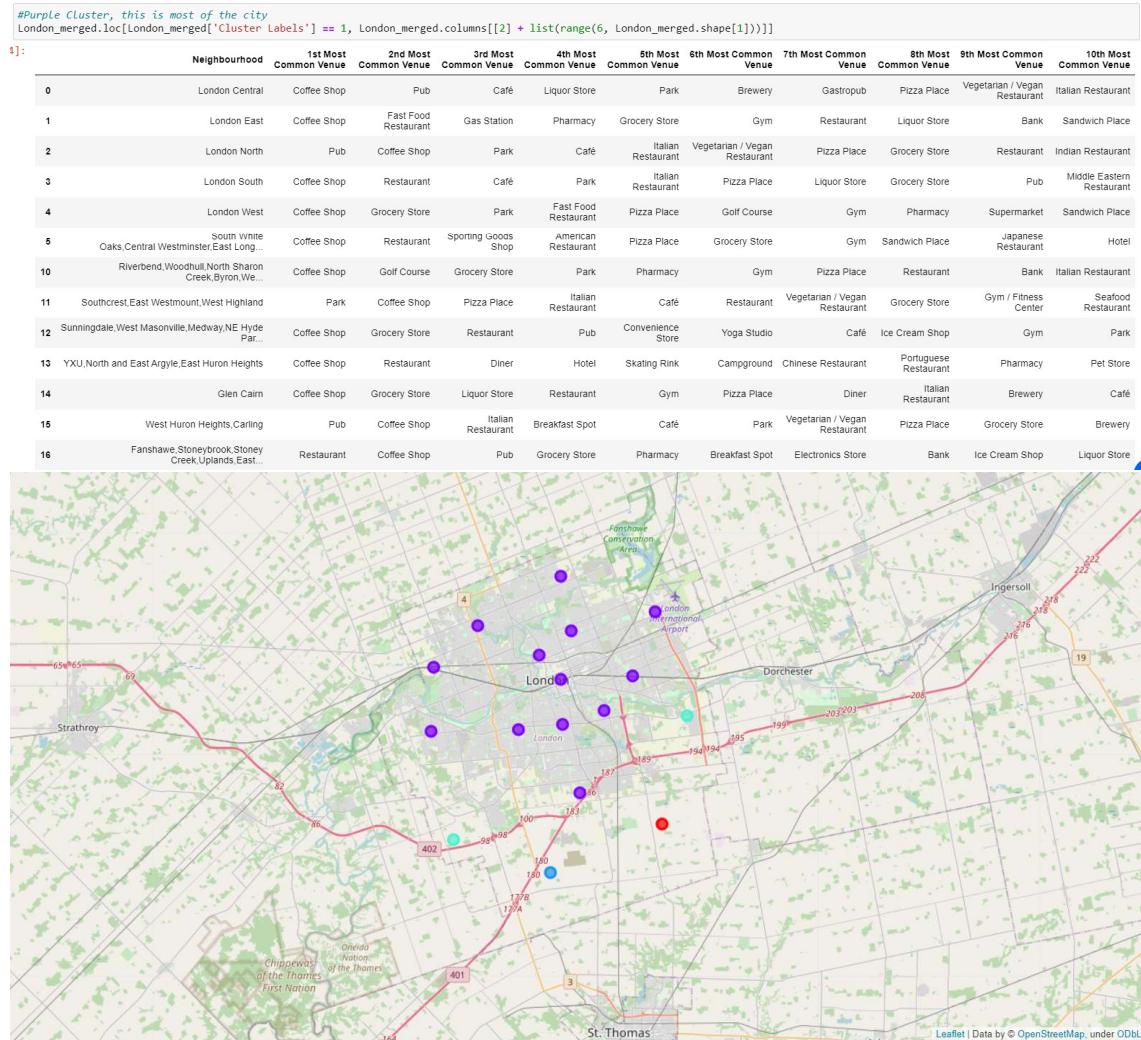


Fig 7. London cluster map

Toronto Clusters: Red cluster is in Scarborough these neighbourhoods are near Rouge National Park, thus will attract visitors, this is similar to Fanshawe Conservation area in London but they haven't been placed in the same cluster, could be due to lack of data for London or split the cluster.



Purple cluster is located across different boroughs to the north east of the city and across to the north west, the most popular venues are parks, coffee shop, brewery, Italian restaurant, bakery, farmers market etc. There are different restaurants (Italian, Thai, Middle Eastern, Japanese, Sushi, Greek,

Mediterranean, Indian, Deli/Bodega, Seafood) indicating the demands of the local community for different tastes. It also means there is high footfall and economic activity, this is the cluster that has most of London but it is more diverse in the different cuisines that are popular.

#Purple Cluster Toronto_merged.loc[Toronto_merged['Cluster Labels'] == 1, Toronto_merged.columns[[2] + list(range(6, Toronto_merged.shape[1]))]]											
1:	Neighbourhood	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	Lawrence Manor, Lawrence Heights	Coffee Shop	Italian Restaurant	Vietnamese Restaurant	Café	Bakery	Park	Bank	Mediterranean Restaurant	Brazilian Restaurant	Burger Joint
8	Parkview Hill, Woodbine Gardens	Park	Beach	Café	Bakery	BBQ Joint	Brewery	Grocery Store	Middle Eastern Restaurant	Coffee Shop	Thai Restaurant
14	Woodbine Heights	Coffee Shop	Brewery	Café	Park	Gastropub	BBQ Joint	Bakery	Farmers Market	Indian Restaurant	Beach
19	The Beaches	Park	Coffee Shop	Beach	Bakery	Brewery	Ice Cream Shop	Café	Breakfast Spot	Pub	Gastropub
35	East Toronto, Broadview North (Old East York)	Park	Coffee Shop	Brewery	Café	Bakery	BBQ Joint	Beach	Pizza Place	Gastropub	Farmers Market
41	The Danforth West, Riverdale	Park	Coffee Shop	Café	Brewery	Greek Restaurant	Bakery	Farmers Market	Gastropub	Historic Site	Ice Cream Shop
44	Golden Mile, Clairlea, Oakridge	Park	Beach	Coffee Shop	Grocery Store	Breakfast Spot	Sandwich Place	Burger Joint	Café	Pub	Middle Eastern Restaurant
47	India Bazaar, The Beaches west	Park	Coffee Shop	Brewery	Café	Beach	Bakery	BBQ Joint	Gastropub	Pizza Place	Ice Cream shop
54	Studio District	Coffee Shop	Park	Brewery	Café	Farmers Market	Beach	Bakery	Ice Cream Shop	Greek Restaurant	Hotel
55	Bedford Park, Lawrence Manor East	Coffee Shop	Café	Park	Grocery Store	Sushi Restaurant	Bakery	Japanese Restaurant	Liquor Store	Shopping Mall	Thai Restaurant
56	Del Ray, Mount Dennis, Keelsdale and Silverthorn	Café	Italian Restaurant	Brewery	Bakery	Coffee Shop	Bar	Restaurant	Furniture / Home Store	Liquor Store	Pizza Place
58	Birch Cliff, Cliffside West	Beach	Park	Bakery	Ice Cream Shop	Coffee Shop	Breakfast Spot	Pub	Liquor Store	Gastropub	BBQ Joint
61	Lawrence Park	Coffee Shop	Park	Italian Restaurant	Café	Bakery	Grocery Store	Sushi Restaurant	Bookstore	B&B Joint	Japanese Restaurant
63	Runnymede, The Junction North	Café	Italian Restaurant	Bakery	Brewery	Coffee Shop	Pizza Place	Bar	Park	Dessert Shop	Deli / Bodega
81	Runnymede, Swansea	Café	Bakery	Park	Coffee Shop	Brewery	Italian Restaurant	Ice Cream Shop	Bar	Scenic Lookout	Restaurant
88	New Toronto, Mimico South, Humber Bay Shores	Park	Coffee Shop	Italian Restaurant	Sushi Restaurant	Bakery	Thai Restaurant	Ice Cream Shop	Café	Pizza Place	Seafood Restaurant
98	The Kingsway, Montgomery Road, Old Mill North	Coffee Shop	Brewery	Bakery	Park	Café	Ice Cream Shop	Italian Restaurant	Liquor Store	Grocery Store	Dessert Shop
100	Business reply mail Processing Centre, South C...	Park	Coffee Shop	Brewery	Café	Beach	Pizza Place	Bakery	Gastropub	BBQ Joint	Sushi Restaurant

Blue cluster is Downtown Toronto, the most popular venues are coffee shop, park, farmers market, bakery, Plaza, Historic site, and a few other eating establishments. This cluster has similar venues to the purple cluster to the north east and green cluster to the north and north west. Downtown Toronto cluster has the most coffee shops/café and park as the top venues, which means high footfall traffic to support the demand but also and other leisure venues that support coffee shops example Farmers market, plaza, hotel, historic sites, and likely offices which would not appear on the API as popular venues unless they are also opened for public for example Libraries.

#Blue Cluster, all are in Downtown Toronto Toronto_merged.loc[Toronto_merged['Cluster Labels'] == 2, Toronto_merged.columns[[2] + list(range(6, Toronto_merged.shape[1]))]]											
2:	Neighbourhood	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
2	Regent Park, Harbourfront	Coffee Shop	Park	Café	Pizza Place	Plaza	French Restaurant	Hotel	Neighborhood	Farmers Market	Mediterranean Restaurant
4	Queen's Park, Ontario Provincial Government	Coffee Shop	Park	Café	Farmers Market	Bakery	Plaza	Sandwich Place	Neighborhood	Restaurant	Liquor Store
9	Garden District, Ryerson	Coffee Shop	Park	Café	Farmers Market	Plaza	Hotel	Restaurant	Bakery	Liquor Store	French Restaurant
15	St. James Town	Coffee Shop	Park	Café	Farmers Market	Plaza	Bakery	Hotel	Historic Site	Sandwich Place	Liquor Store
20	Berczy Park	Coffee Shop	Park	Café	Bakery	Farmers Market	Plaza	Hotel	Neighborhood	French Restaurant	Historic Site
24	Central Bay Street	Coffee Shop	Park	Café	Bakery	Farmers Market	Plaza	Sandwich Place	Historic Site	Dessert Shop	Mexican Restaurant
30	Richmond, Adelaide, King	Coffee Shop	Park	Café	Bakery	Farmers Market	Sandwich Place	Plaza	Restaurant	Gastropub	Historic Site
36	Harbourfront East, Union Station, Toronto Islands	Coffee Shop	Park	Café	Bakery	Plaza	Farmers Market	Historic Site	French Restaurant	Hotel	Mexican Restaurant
42	Toronto Dominion Centre, Design Exchange	Coffee Shop	Park	Café	Farmers Market	Bakery	Plaza	Restaurant	Hotel	Historic Site	French Restaurant
48	Commerce Court, Victoria Hotel	Coffee Shop	Park	Café	Farmers Market	Bakery	Plaza	Mexican Restaurant	French Restaurant	Historic Site	Restaurant
80	University of Toronto, Harbord	Coffee Shop	Café	Park	Sandwich Place	Bakery	Pizza Place	Spa	Farmers Market	Restaurant	Hotel
84	Kensington Market, Chinatown, Grange Park	Coffee Shop	Park	Café	Bakery	Farmers Market	Liquor Store	Sandwich Place	Historic Site	Gastropub	Neighborhood
87	CN Tower, King and Spadina, Railway Lands, Harr...	Coffee Shop	Park	Café	Bakery	Farmers Market	Beach	Restaurant	Sandwich Place	Historic Site	Hotel
91	Rosedale	Coffee Shop	Café	Park	Italian Restaurant	Spa	Farmers Market	Historic Site	Bakery	Bookstore	Restaurant
92	Stn A PO Boxes	Coffee Shop	Park	Plaza	Farmers Market	Café	Bakery	Hotel	Diner	Mexican Restaurant	Neighborhood
96	St. James Town, Cabbagetown	Coffee Shop	Park	Café	Farmers Market	Historic Site	Ice Cream Shop	BBQ Joint	Mediterranean Restaurant	Grocery Store	Pizza Place
97	First Canadian Place, Underground city	Coffee Shop	Park	Café	Farmers Market	Bakery	Plaza	Restaurant	Hotel	Historic Site	French Restaurant
98	Church and Wellesley	Chinese Chin	Mark	Dorf	Farmers Market	Historic Site	Deutsch Restaurant	Sandwich Shop	Italian Shop	Turkish Restaurant	

Turquoise cluster has several different types of restaurants; Middle Eastern, Japanese, Chinese, Caribbean, Italian, Korean, Vietnamese, Seafood, Sushi, Greek etc thus mixed ethnic neighbourhoods as also has local shops that usually have demand from locals (grocery store,

supermarket, burger joint, bakery, Sandwich place, liquor store etc).

```
#Turquoise Cluster
Toronto_merged.loc[Toronto_merged['Cluster Labels'] == 3, Toronto_merged.columns[[2] + list(range(6, Toronto_merged.shape[1]))]]
```

3]:

	Neighbourhood	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	Parkwoods	Middle Eastern Restaurant	Grocery Store	Caribbean Restaurant	Burger Joint	Supermarket	Japanese Restaurant	Italian Restaurant	Bakery	Liquor Store	Café
1	Victoria Village	Park	Supermarket	Burger Joint	Coffee Shop	Italian Restaurant	Grocery Store	Middle Eastern Restaurant	Liquor Store	Pizza Place	Restaurant
7	Don Mills	Park	Middle Eastern Restaurant	Café	Italian Restaurant	Supermarket	Bakery	Coffee Shop	Grocery Store	Liquor Store	Japanese Restaurant
11	West Deane Park, Princess Gardens, Martin Grove...	Coffee Shop	Bakery	Sandwich Place	Grocery Store	Liquor Store	Seafood Restaurant	Restaurant	Hotel	Golf Course	Japanese Restaurant
13	Don Mills	Park	Middle Eastern Restaurant	Café	Italian Restaurant	Supermarket	Bakery	Coffee Shop	Grocery Store	Liquor Store	Japanese Restaurant
17	Eringate, Bladdear Gardens, Old Burnhamthorpe...	Grocery Store	Coffee Shop	Hotel	Bakery	Liquor Store	Sandwich Place	Sporting Goods Shop	Eastern European Restaurant	Department Store	Breakfast Spot
27	Hillcrest Village	Chinese Restaurant	Bakery	Japanese Restaurant	Caribbean Restaurant	Coffee Shop	Supermarket	Korean Restaurant	Greek Restaurant	Middle Eastern Restaurant	Thai Restaurant
28	Bathurst Manor, Wilson Heights, Downsview North	Coffee Shop	Middle Eastern Restaurant	Clothing Store	Korean Restaurant	Bubble Tea Shop	Grocery Store	Restaurant	Sushi Restaurant	Bakery	Japanese Restaurant
32	Scarborough Village	Coffee Shop	Burger Joint	Park	Ice Cream Shop	Pharmacy	Supermarket	Indian Restaurant	Department Store	Gym / Fitness Center	Discount Store
33	Fairview, Henry Farm, Oriole	Chinese Restaurant	Bakery	Caribbean Restaurant	Liquor Store	Supermarket	Coffee Shop	Pharmacy	Restaurant	Japanese Restaurant	Ice Cream Shop
34	Northwood Park, York University	Coffee Shop	Middle Eastern Restaurant	Restaurant	Hotel	Grocery Store	Park	Supermarket	Liquor Store	Steakhouse	Sandwich Place
38	Kennedy Park, Ionview, East Birchmount Park	Coffee Shop	Park	Middle Eastern Restaurant	Grocery Store	Burger Joint	Ice Cream Shop	Indian Restaurant	Beach	Fish & Chips Shop	Bakery
39	Bayview Village	Coffee Shop	Supermarket	Middle Eastern Restaurant	Bakery	Korean Restaurant	Japanese Restaurant	Thai Restaurant	Restaurant	Bagel Shop	Chinese Restaurant
40	Downsvine	Coffee Shop	Clothing Store	Restaurant	Vietnamese Restaurant	Furniture / Home Store	Liquor Store	Grocery Store	Cosmetics Shop	Hotel	Middle Eastern Restaurant
45	York Mills, Silver Hills	Japanese	Café	Park	Bakery	Middle Eastern	Burger Joint	Supermarket	Bubble Tea Shop	Caribbean	Toys / Game Store

Green cluster most popular venues are café/cofee shop, park, Italian restaurant, brewery which is similar to the purple cluster which is geographically next to, but this cluster doesn't have the wide range of restaurants as popular venues (most are not the top 5). This cluster is a less ethnic diverse area or it doesn't have enough demand for such venues and inward vistors to support the venues as there is competition from nearby nieghbourhoods.

```
#Green Cluster
Toronto_merged.loc[Toronto_merged['Cluster Labels'] == 4, Toronto_merged.columns[[2] + list(range(6, Toronto_merged.shape[1]))]]
```

4]:

	Neighbourhood	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
10	Glencairn	Café	Coffee Shop	Park	Brewery	Italian Restaurant	Bakery	Liquor Store	Grocery Store	Indian Restaurant	Tea Room
16	Humewood-Cedervale	Café	Coffee Shop	Park	Italian Restaurant	Bar	Grocery Store	Bakery	Dessert Shop	Gastropub	Middle Eastern Restaurant
21	Caledonia-Fairbanks	Café	Coffee Shop	Brewery	Park	Italian Restaurant	Bar	Bakery	Middle Eastern Restaurant	Indian Restaurant	Caribbean Restaurant
23	Leaside	Park	Café	Italian Restaurant	Coffee Shop	Bakery	Grocery Store	Bookstore	BBQ Joint	Brewery	Other Great Outdoors
25	Christie	Café	Coffee Shop	Park	Bakery	Italian Restaurant	Grocery Store	Sandwich Place	Spa	Bar	Theater
29	Thorncliffe Park	Park	Café	Italian Restaurant	Coffee Shop	Bakery	Grocery Store	BBQ Joint	Pizza Place	Spa	Brewery
31	Dufferin, Dovercourt Village	Café	Coffee Shop	Bar	Park	Italian Restaurant	Brewery	Ice Cream Shop	Indian Restaurant	Restaurant	Bakery
37	Little Portugal, Trinity	Park	Café	Coffee Shop	Bakery	Sandwich Place	Farmers Market	Gastropub	Hotel	Restaurant	Grocery Store
43	Brockton, Parkdale Village, Exhibition Place	Park	Café	Coffee Shop	Bakery	Sandwich Place	Bar	Pizza Place	Plaza	Dog Run	Restaurant
62	Roselawn	Café	Park	Coffee Shop	Italian Restaurant	Grocery Store	Brewery	Indian Restaurant	Liquor Store	BBQ Joint	Supermarket
67	Davisonville North	Coffee Shop	Park	Café	Grocery Store	Italian Restaurant	BBQ Joint	Supermarket	Bakery	Shopping Mall	Indian Restaurant
68	Forest Hill North & West, Forest Hill Road Park	Café	Coffee Shop	Park	Grocery Store	Bakery	Italian Restaurant	Brewery	Tapas Restaurant	Bar	Dessert Shop
69	High Park, The Junction South	Café	Bakery	Coffee Shop	Italian Restaurant	Brewery	Park	Bar	Pizza Place	Deli / Bodega	Dog Run
73	North Toronto West, Lawrence Park	Park	Coffee Shop	Café	Italian Restaurant	Grocery Store	Supermarket	Indian Restaurant	BBQ Joint	Liquor Store	Bakery
74	The Annex, North Midtown, Yorkville	Café	Coffee Shop	Park	Grocery Store	Sandwich Place	Bar	Bakery	Pizza Place	Dessert Shop	Spa
75	Parkdale, Roncesvalles	Café	Park	Bakery	Coffee Shop	Brewery	Pizza Place	Italian Restaurant	Sandwich Place	Ice Cream Shop	Bar
79	Davisville	Park	Italian Restaurant	Café	Coffee Shop	Bakery	Indian Restaurant	Bookstore	Grocery Store	Supermarket	Liquor Store
83	Moore Park, Summerhill East	Park	Café	Coffee Shop	Italian Restaurant	Grocery Store	Indian Restaurant	Ice Cream Shop	BBQ Joint	Spa	Concert Hall
86	Summerhill West, Rathnelly, South Hill, Forest...	Café	Park	Coffee Shop	Italian Restaurant	Indian Restaurant	Grocery Store	Historic Site	Ice Cream Shop	Tapas Restaurant	Bakery

Orange cluster, also has high footfall as Coffee shops are the most popular venue. It has several different types of restaurants, even in the same neighbourhood (South Steeles, Silverstone etc) has

Italian, Caribbean, Chinese, Asian and Sushi restaurants.

```
#Orange Cluster
Toronto_merged.loc[Toronto_merged['Cluster Labels'] == 5, Toronto_merged.columns[[2] + list(range(6, Toronto_merged.shape[1]))]]
```

5:

	Neighbourhood	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
5	Islington Avenue, Humber Valley Village	Coffee Shop	Sandwich Place	Brewery	Grocery Store	Bakery	Pharmacy	Pizza Place	Liquor Store	Italian Restaurant	Restaurant
18	Guildwood, Morningside, West Hill	Coffee Shop	Bank	Sandwich Place	Park	Pharmacy	Restaurant	Indian Restaurant	Fast Food Restaurant	Fried Chicken Joint	Ice Cream Shop
22	Woburn	Coffee Shop	Pharmacy	Park	Pizza Place	Fast Food Restaurant	Hotel	Sandwich Place	Restaurant	Grocery Store	Breakfast Spot
26	Cedarbrae	Coffee Shop	Sandwich Place	Pizza Place	Fast Food Restaurant	Bank	Restaurant	Pharmacy	Fried Chicken Joint	Chinese Restaurant	Ice Cream Shop
50	Humber Summit	Coffee Shop	Hotel	Sandwich Place	Pharmacy	Indian Restaurant	Steakhouse	Italian Restaurant	Chinese Restaurant	Burger Joint	Bank
51	Cliffside, Cliffcrest, Scarborough Village West	Coffee Shop	Park	Grocery Store	Sandwich Place	Pharmacy	Gym	Pizza Place	Japanese Restaurant	Clothing Store	Bank
57	Humberlea, Emery	Coffee Shop	Pizza Place	Vietnamese Restaurant	Gas Station	Fast Food Restaurant	Bank	Pharmacy	Grocery Store	Chinese Restaurant	Asian Restaurant
70	Westmount	Coffee Shop	Sandwich Place	Bank	Pizza Place	Bakery	Restaurant	Golf Course	Gas Station	Chinese Restaurant	Hotel
77	Kingsview Village, St. Phillips, Martin Grove ...	Coffee Shop	Hotel	Restaurant	Pharmacy	Sandwich Place	Bakery	Bank	Chinese Restaurant	Golf Course	Italian Restaurant
89	South Steeles, Silverstone, Humbergate, Jamest...	Coffee Shop	Fast Food Restaurant	Sandwich Place	Indian Restaurant	Italian Restaurant	Caribbean Restaurant	Chinese Restaurant	Pharmacy	Asian Restaurant	Sushi Restaurant
94	Northwest, West Humber - Clairville	Coffee Shop	Hotel	Restaurant	Chinese Restaurant	Fast Food Restaurant	Rental Car Location	Steakhouse	Burger Joint	Indian Restaurant	Airport Lounge

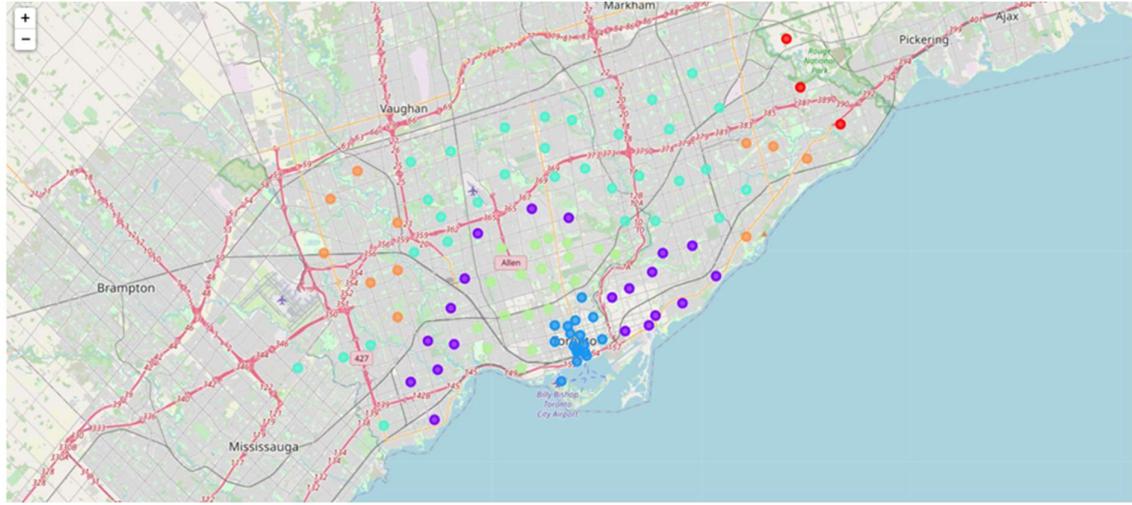


Fig 8. Toronto Cluster neighbourhoods

Conclusion

London city centre and the north of London is like central Toronto with coffee shops and restaurants, these would also have the leisure venues (e.g. Golf course, gym,) and offices that would support the demand for such venues. But as expected London does not have the wide range of restaurants like Toronto. Natural environment also shapes the demand for different venues; leisure venues across River Thames that cuts through London, Fanshawe Conservation area (London) and the beaches and the Rouge National Park in Toronto.

It depends on the dataset used if only central Toronto were used to compare it could have resulted in some neighbourhoods included in different clusters. Or if more geodata was added for London then more venues may have been returned. Also choosing the cluster numbers would change the distribution of neighbourhoods in the clusters.