Clustering Toronto boroughs and neighborhoods by restaurants' cuisines

Coursera capstone project by Eve Belyaeva

Gather dataset
Toronto boroughs and neighborhoods

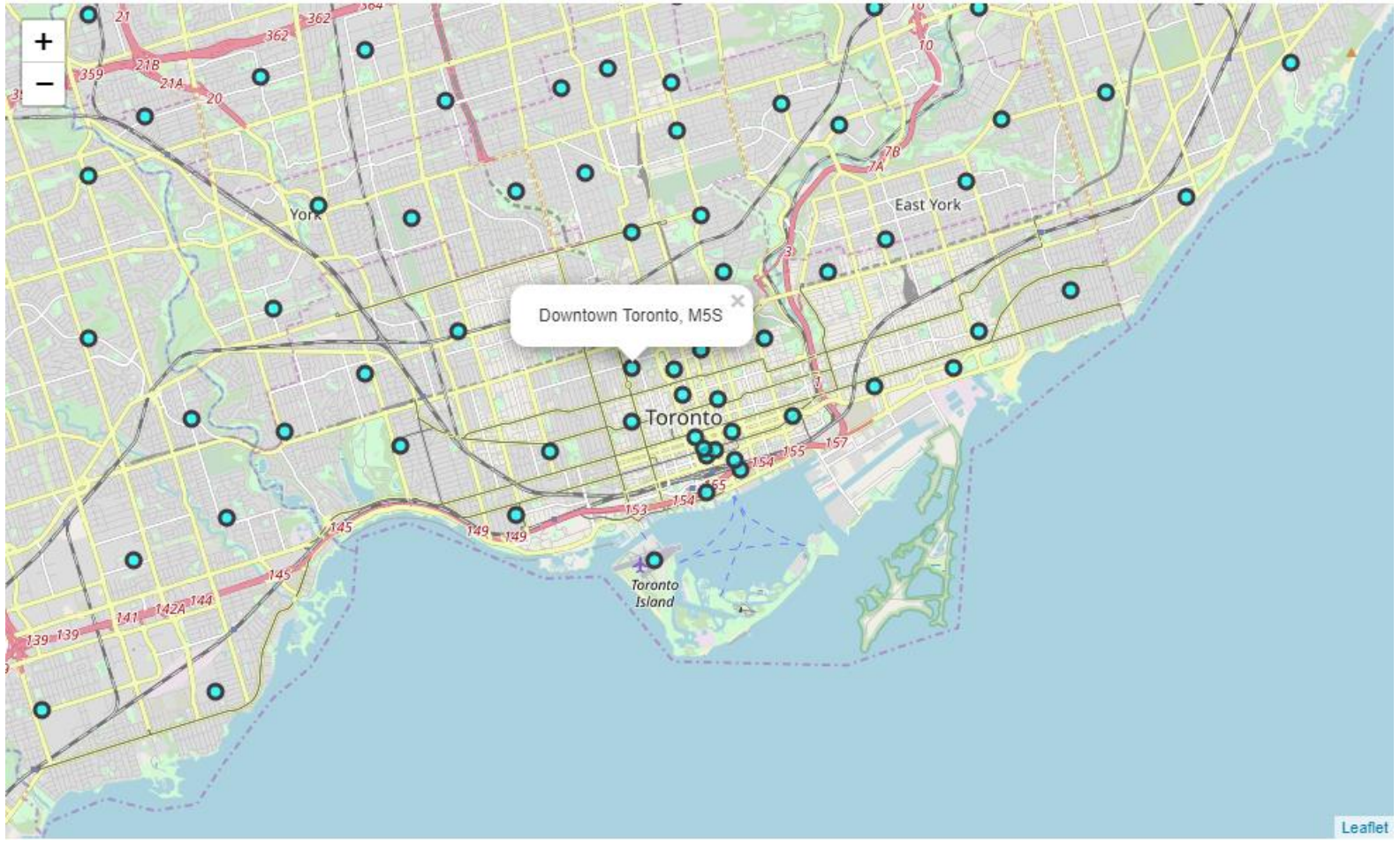
```
df = pd.read_html('https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M')[0]
df.drop(df[df['Borough']=='Not assigned'].index,inplace=True)
df=df.groupby(['Postcode','Borough'])['Neighbourhood'].apply(','.join).reset_index()
df['Neighbourhood']=df['Neighbourhood'].replace('Not assigned',df['Borough'])
url='http://cocl.us/Geospatial_data'
gd=pd.read_csv(url)
gd.rename(columns={'Postal Code':'Postcode'}, inplace=True)
df.set_index('Postcode', inplace=True)
gd.set_index('Postcode', inplace=True)
mergedDf = df.merge(gd, left_index=True, right_index=True)
mergedDf=mergedDf.reset_index()
mergedDf.head()
```

	Postcode	Borough	Neighbourhood	Latitude	Longitude
0	M1B	Scarborough	Rouge,Malvern	43.806686	-79.194353
1	M1C	Scarborough	Highland Creek,Rouge Hill,Port Union	43.784535	-79.160497
2	M1E	Scarborough	Guildwood,Morningside,West Hill	43.763573	-79.188711
3	M1G	Scarborough	Woburn	43.770992	-79.216917
4	M1H	Scarborough	Cedarbrae	43.773136	-79.239476

Code snippet for the map

```
latitude=43.653226
longitude=-79.383184


toronto_all=mergedDf.copy()
print(toronto_all.shape)
#print(toronto_all.head())

map_dots = folium.Map(location=[latitude, longitude], zoom_start=12)
# add markers to map
for lat, lng, borough, neighborhood, fsa in zip(toronto_all['Latitude'], toronto_all['Longitude'],
                                                toronto_all['Borough'], toronto_all['Neighbourhood'], toronto_all['Postcode']):
    label = '{}, {}'.format(borough, fsa)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='#3d3c42',
        fill=True,
        fill_color='#01ffff',
        fill_opacity=0.7,
        line_opacity=0.2,
        parse_html=False).add_to(map_dots)

map_dots
```

Toronto boroughs on map



Gathering restaurants data from FourSquare and preparing the data for choropleth map

	FSA	Borough	Neighbourhood	Neighbourhood Latitude	Neighbourhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
1	M1H	Scarborough	Cedarbrae	43.773136	-79.239476	Terry's Restaurant & Bar	43.774780	-79.241043	Restaurant
2	M1H	Scarborough	Cedarbrae	43.773136	-79.239476	terry's restaurant	43.774969	-79.240872	Italian
3	M1H	Scarborough	Cedarbrae	43.773136	-79.239476	Federick Restaurant	43.774697	-79.241142	Hakka
5	M1H	Scarborough	Cedarbrae	43.773136	-79.239476	Thai One On	43.774468	-79.241268	Thai
6	M1P	Scarborough	Dorset Park,Scarborough Town Centre,Wexford He...	43.757410	-79.273304	Karaikudi Chettinad South Indian Restaurant	43.756042	-79.276276	Indian

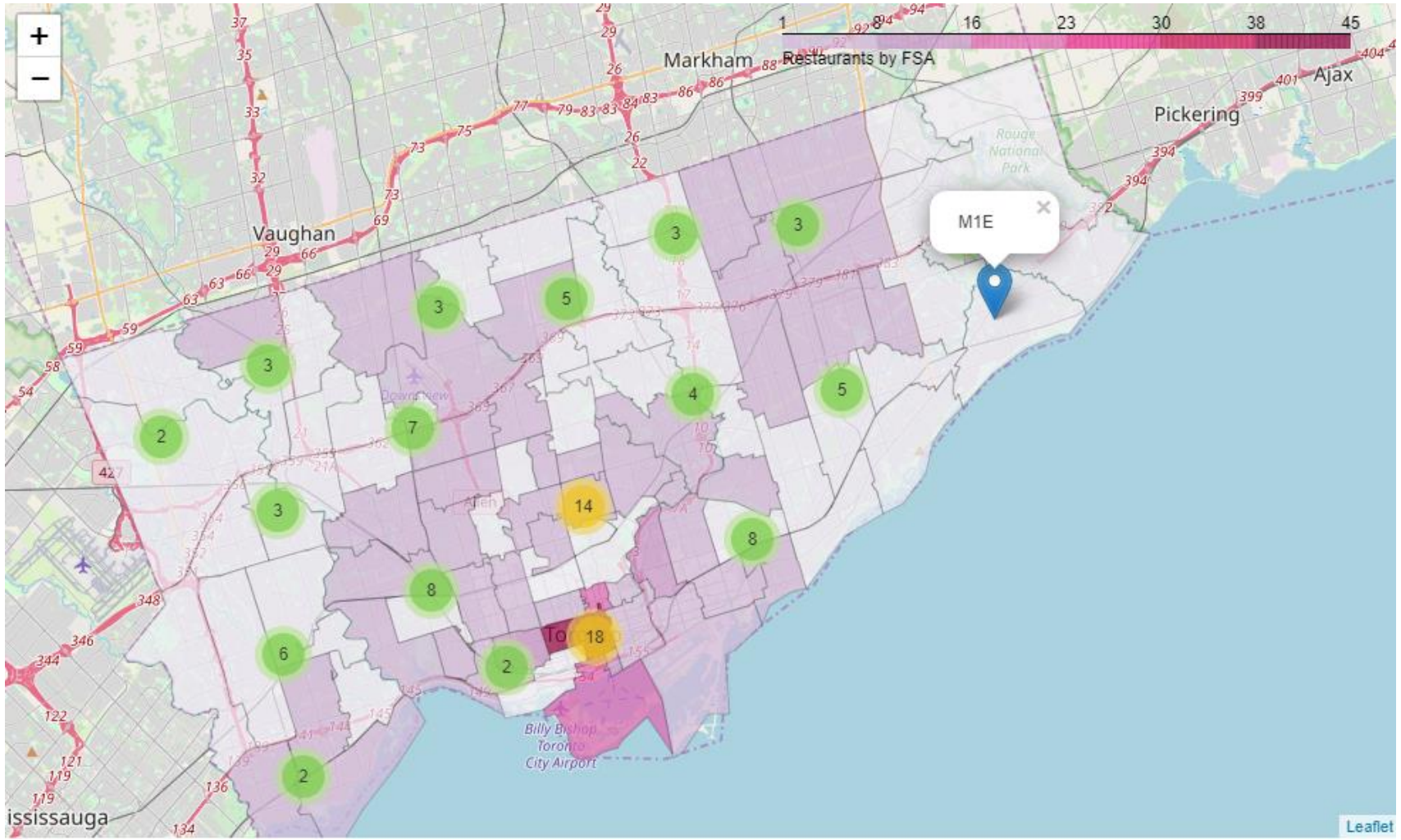
	FSA	Count
0	M1H	4
1	M1P	2
2	M1R	3
3	M1S	4
4	M1T	3

	Postcode	Borough	Latitude	Longitude
0	M1B	Scarborough	43.806686	-79.194353
1	M1C	Scarborough	43.784535	-79.160497
2	M1E	Scarborough	43.763573	-79.188711
3	M1G	Scarborough	43.770992	-79.216917
4	M1H	Scarborough	43.773136	-79.239476

Code snippet for the map

```
latitude=43.653226
longitude=-79.383184


toronto_all=mergedDf.copy()
print(toronto_all.shape)
#print(toronto_all.head())

map_dots = folium.Map(location=[latitude, longitude], zoom_start=12)
# add markers to map
for lat, lng, borough, neighborhood, fsa in zip(toronto_all['Latitude'], toronto_all['Longitude'], toronto_all['Borough'], toron
to_all['Neighbourhood'], toronto_all['Postcode']):
    label = '{}, {}'.format(borough, fsa)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='#3d3c42',
        fill=True,
        fill_color='#01ffff',
        fill_opacity=0.7,
        line_opacity=0.2,
        parse_html=False).add_to(map_dots)

map_dots
```

Choropleth map based on restaurants count in Toronto boroughs



Preparing the data to search for different cuisines distribution in boroughs

```
topvenues=bn_restaurants.copy()
topvenues=topvenues.groupby(['Venue Category']).count().reset_index()
cuisines=('Chinese', 'Japanese', 'Italian', 'Asian','American', 'Indian', 'Caribbean', 'Thai', 'New American',
       'Vietnamese', 'Greek', 'Middle Eastern','Mongolian', 'Korean', 'Spanish',
       'Latin American', 'Eastern European', 'Szechuan', 'French', 'African', 'Mexican',
       'Modern European', 'Portuguese', 'Hakka', 'Cuban', 'Ethiopian', 'Persian',
    'Deli / Bodega', 'Lebanese', 'Cantonese', 'Mediterranean')

topvenues=topvenues.loc[:,['Venue Category','FSA']]
topvenues.rename(columns={'FSA':'Count'},inplace=True)

topvenues.sort_values(by='Count', ascending=True, inplace=True)
topvenues=topvenues[topvenues['Venue Category'].isin(cuisines)]
topvenues.set_index('Venue Category', inplace=True)
cu_top10 = topvenues['Count'].tail(10)
cu_top10.head()
```

```
Venue Category
New American    10
Vietnamese      10
Thai            10
Caribbean       12
Indian          19
Name: Count, dtype: int64
```

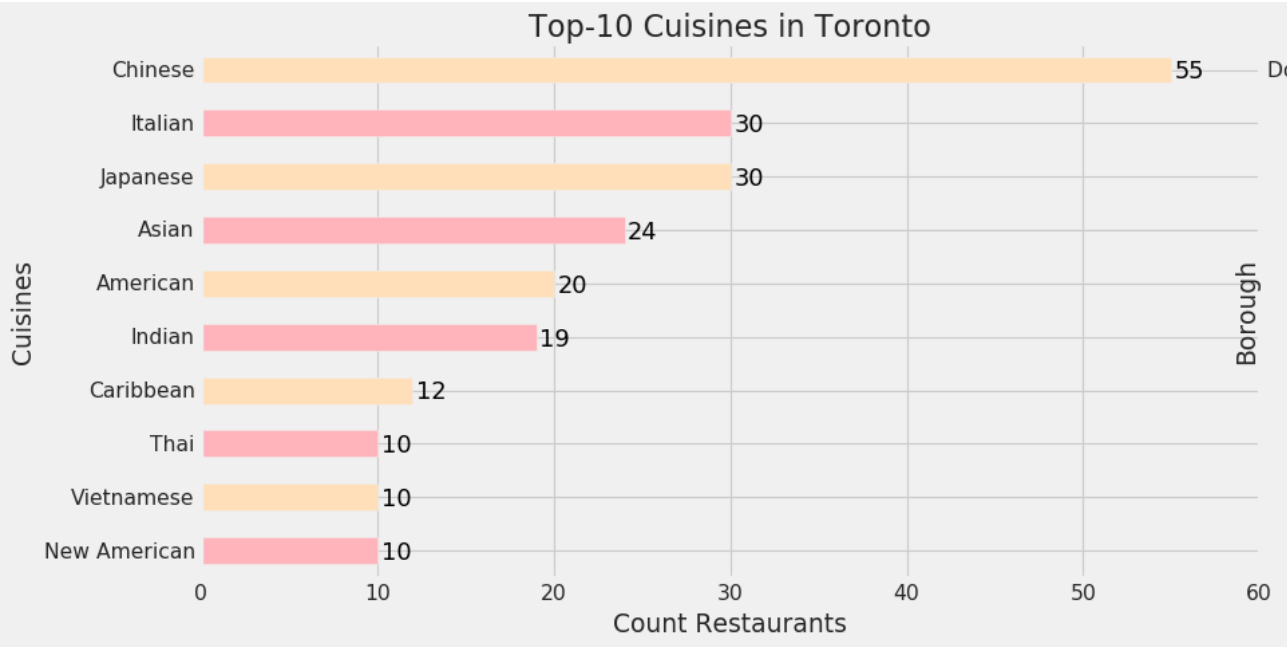
```
topboroughs=bn_restaurants.copy()
#delete Restaurants without Cuisine
topboroughs=topboroughs[topboroughs['Venue Category'].isin(cuisines)]
topboroughs=topboroughs.groupby(['Borough']).count().reset_index()
topboroughs=topboroughs.loc[:,['Borough','FSA']]
topboroughs.rename(columns={'FSA':'Count'},inplace=True)
topboroughs.sort_values(by='Count', ascending=True, inplace=True)
topboroughs.set_index('Borough', inplace=True)
topboroughs = topboroughs['Count'].tail(10)
topboroughs.head()
```

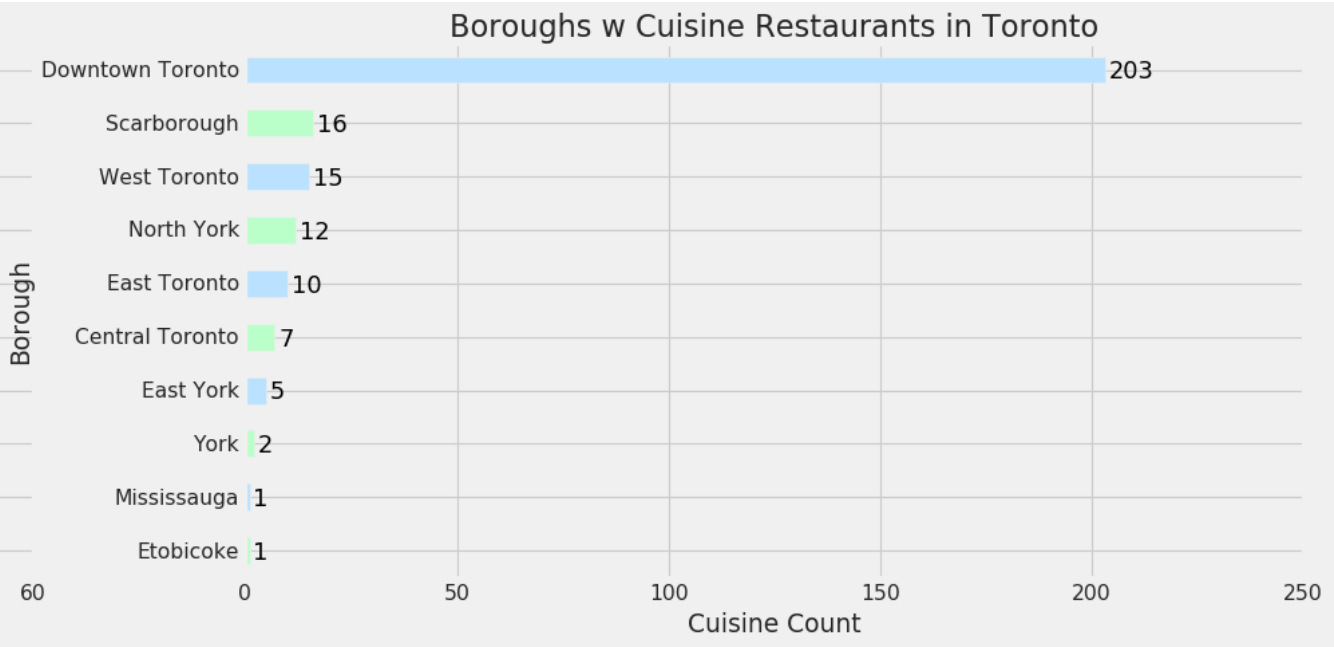
```
Borough
Etobicoke          1
Mississauga        1
York               2
East York          5
Central Toronto    7
Name: Count, dtype: int64
```

Code snippet for the barh plots

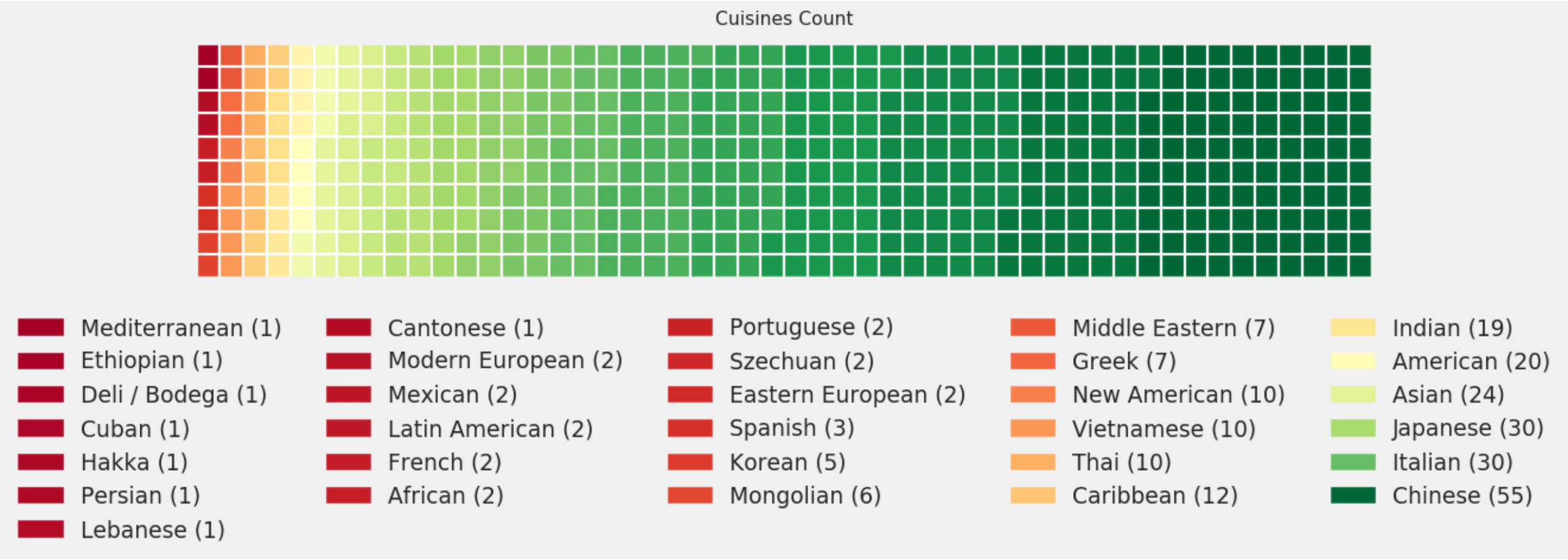
```
plt.style.use('fivethirtyeight')
colors1=['#ffb3ba','#ffdfba']
colors2=['#baffc9','#bae1ff']
colors=['#ffb3ba','#ffdfba','#ffffba','#baffc9','#bae1ff']

fig = plt.figure() # create figure

ax0 = fig.add_subplot(1, 2, 1) # add subplot 1 (1 row, 2 columns, first plot)
ax1 = fig.add_subplot(1, 2, 2) # add subplot 2 (1 row, 2 columns, second plot). See tip below**

# Subplot 1: Box plot
cu_top10.plot(kind='barh', figsize=(25,6), color=colors1, ax=ax0) # add to subplot 1
for a in ax0.patches:
    #print(a,' ',str(a.get_y()))
    ax0.annotate(str(a.get_width()),(a.get_width()+0.2,a.get_y()+0.1), color='black',fontsize=16)
ax0.set_xlabel('Count Restaurants')
ax0.set_ylabel('Cuisines')
ax0.set_title('Top-10 Cuisines in Toronto')

# Subplot 2: Line plot
topboroughs.plot(kind='barh', figsize=(25,6), color=colors2, ax=ax1) # add to subplot 2
for a in ax1.patches:
    #print(a,' ',str(a.get_y()))
    ax1.annotate(str(a.get_width()),(a.get_width()+0.9,a.get_y()+0.1), color='black',fontsize=16)
ax1.set_xlabel('Cuisine Count')
ax1.set_ylabel('Borough')
ax1.set_title('Boroughs w Cuisine Restaurants in Toronto')
#ax1.legend([])
#ax1.get_legend().remove()

plt.show()
```

Visualization of the top cuisine data





Visualization of the all cuisine data



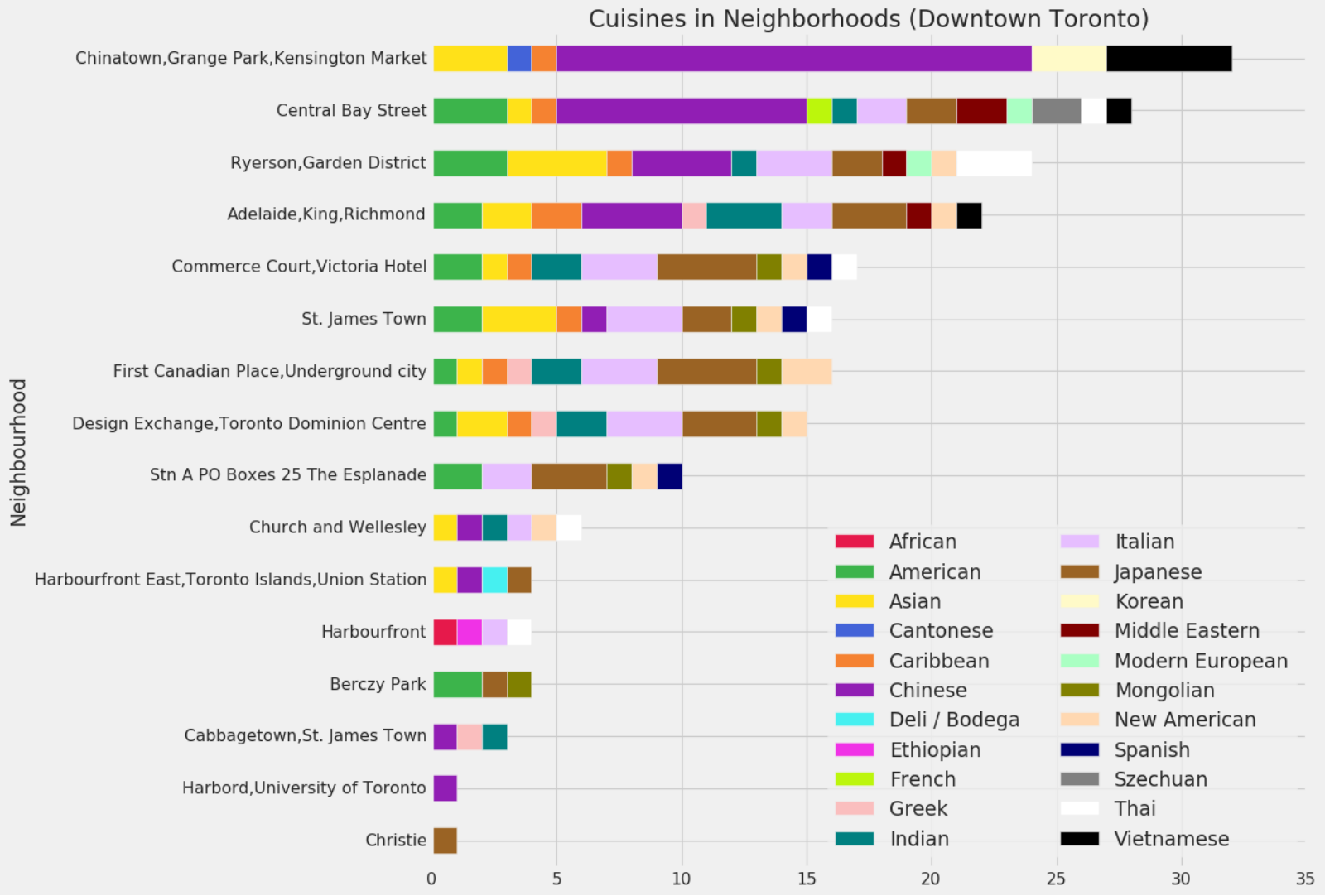
Cuisines in Downtown Toronto borough

	Neighbourhood	African	American	Asian	Cantonese	Caribbean	Chinese	Deli / Bodega	Ethiopian	French	Greek	Indian	Italian	Japanese	Korea
0	Cabbagetown,St. James Town	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1	Cabbagetown,St. James Town	0	0	0	0	0	0	0	0	0	0	1	0	0	0
									0	0	1	0	0	0	0
									0	0	0	0	0	0	0
									0	0	0	0	0	0	0

Venue Category	African	American	Asian	Cantonese	Caribbean	Chinese	Deli / Bodega	Ethiopian	French	Greek	Indian	Italian	Japanese
Neighbourhood													
Adelaide,King,Richmond	0	2	2	0	2	4	0	0	0	1	3	2	3
Berczy Park	0	2	0	0	0	0	0	0	0	0	0	0	1
Cabbagetown,St. James Town	0	0	0	0	0								
Central Bay Street	0	3	1	0	1								
Chinatown,Grange Park,Kensington Market	0	0	3	1	1								

	African	American	Asian	Cantonese	Caribbean	Chinese	Deli / Bodega	Ethiopian	French	Greek	Indian	Italian	Japanese	Korea
Neighbourhood														
Christie	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Harbord,University of Toronto	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cabbagetown,St. James Town	0	0	0	0	0	1	0	0	0	1	1	0	0	0
Berczy Park	0	2	0	0	0	0	0	0	0	0	0	0	1	0
Harbourfront	1	0	0	0	0	0	0	1	0	0	0	1	0	0

Cuisines in Downtown Toronto in barh plot



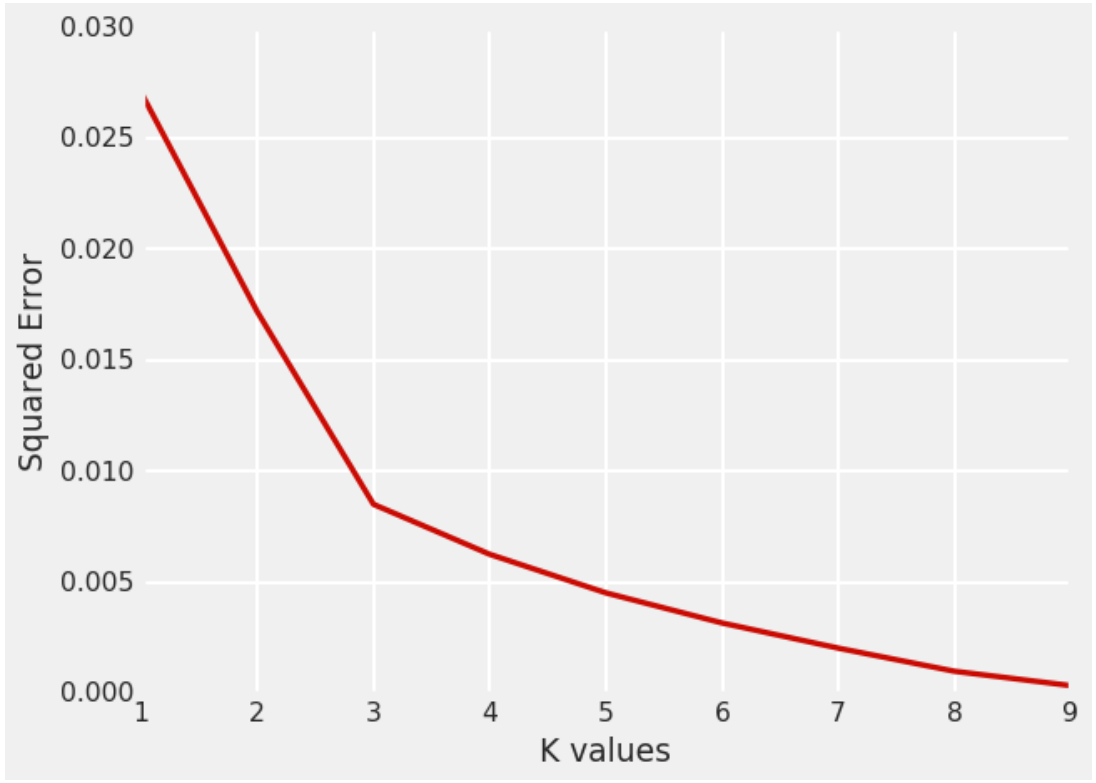
Preparing data for clusterization

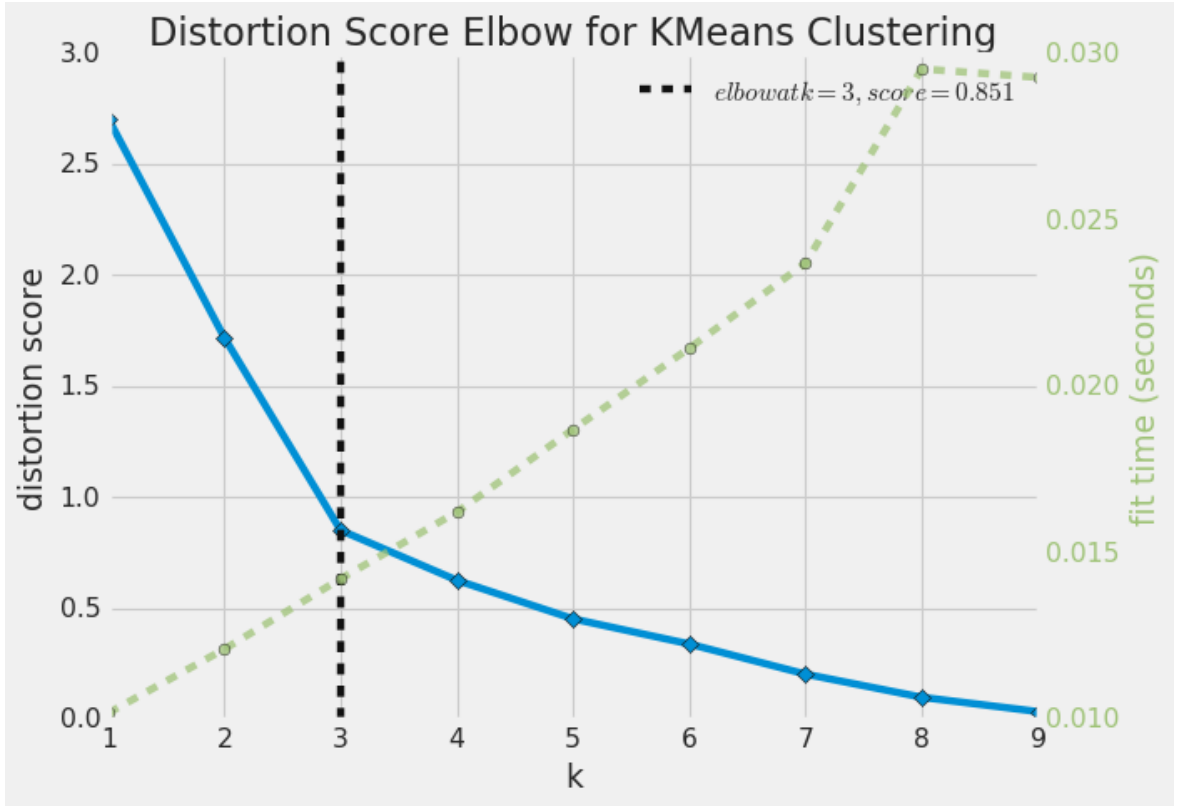
	Borough	African	American	Asian	Cantonese	Caribbean	Chinese	Cuban	Deli / Bodega	Eastern European	Ethiopian	French	Greek	Hakka	Indian	Italian	Japanese	Korean	Latin American	Lebanese	Mediterranean	Mexican	Middle Eastern	Modern European	Mongolian	New American	Persian	Por
1	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
2	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	Scarborough	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	

	Borough	African	American	Asian	Cantonese	Caribbean	Chinese	Cuban	Deli / Bodega	Eastern European	Ethiopian	French	Greek	Hakka	Indian	Italian	Japanese	Korean	Latin American	Lebanese	Mediterranean	Mexican	Middle Eastern	Modern European	Mongolian	Am
0	Central Toronto	0.000000	0.000000	0.142857	0.000000	0.000000	0.142857	0.000000	0.000000	0.142857	0.000000	0.000000	0.000000	0.0000	0.142857	0.285714	0.000000	0.000000	0.000000	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.0
1	Downtown Toronto	0.004926	0.088670	0.093596	0.004926	0.044335	0.206897	0.000000	0.004926	0.000000	0.004926	0.004926	0.019704	0.0000	0.064039	0.113300	0.128079	0.014778	0.000000	0.0	0.0	0.000000	0.019704	0.009852	0.029557	0.0
2	East Toronto	0.000000	0.000000	0.100000	0.000000	0.100000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.300000	0.0000	0.100000	0.100000	0.000000	0.000000	0.000000	0.1	0.1	0.000000	0.000000	0.000000	0.000000	0.0
3	East York	0.200000	0.200000	0.000000	0.000000	0.200000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000	0.200000	0.000000	0.000000	0.000000	0.000000	0.0	0.0	0.000000	0.200000	0.000000	0.000000	0.0
4	Etobicoke	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000	0.000000	0.000000	0.000000	1.000000	0.000000	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.0
5	Mississauga	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0	0.0	0.000000	0.000000	0.000000	0.000000	0.0
6	North York	0.000000	0.000000	0.166667	0.000000	0.000000	0.083333	0.000000	0.000000	0.083333	0.000000	0.000000	0.000000	0.0000	0.083333	0.166667	0.250000	0.000000	0.000000	0.0	0.0	0.000000	0.083333	0.000000	0.000000	0.0
7	Scarborough	0.000000	0.000000	0.000000	0.000000	0.000000	0.562500	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0625	0.125000	0.062500	0.000000	0.062500	0.000000	0.0	0.0	0.000000	0.062500	0.000000	0.000000	0.0
8	West Toronto	0.000000	0.066667																					0.000000	0.000000	0.000000	0.0
9	York	0.000000	0.000000																					0.000000	0.000000	0.000000	0.0

	Borough	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
0	Central Toronto	Italian	Asian	Chinese	Eastern European	Indian
1	Downtown Toronto	Chinese	Japanese	Italian	Asian	American
2	East Toronto	Greek	Indian	Mediterranean	Italian	Asian
3	East York	African	American	Caribbean	Middle Eastern	Indian
4	Etobicoke	Korean	Vietnamese	Italian	American	Asian

Choosing k-value based on squared error value



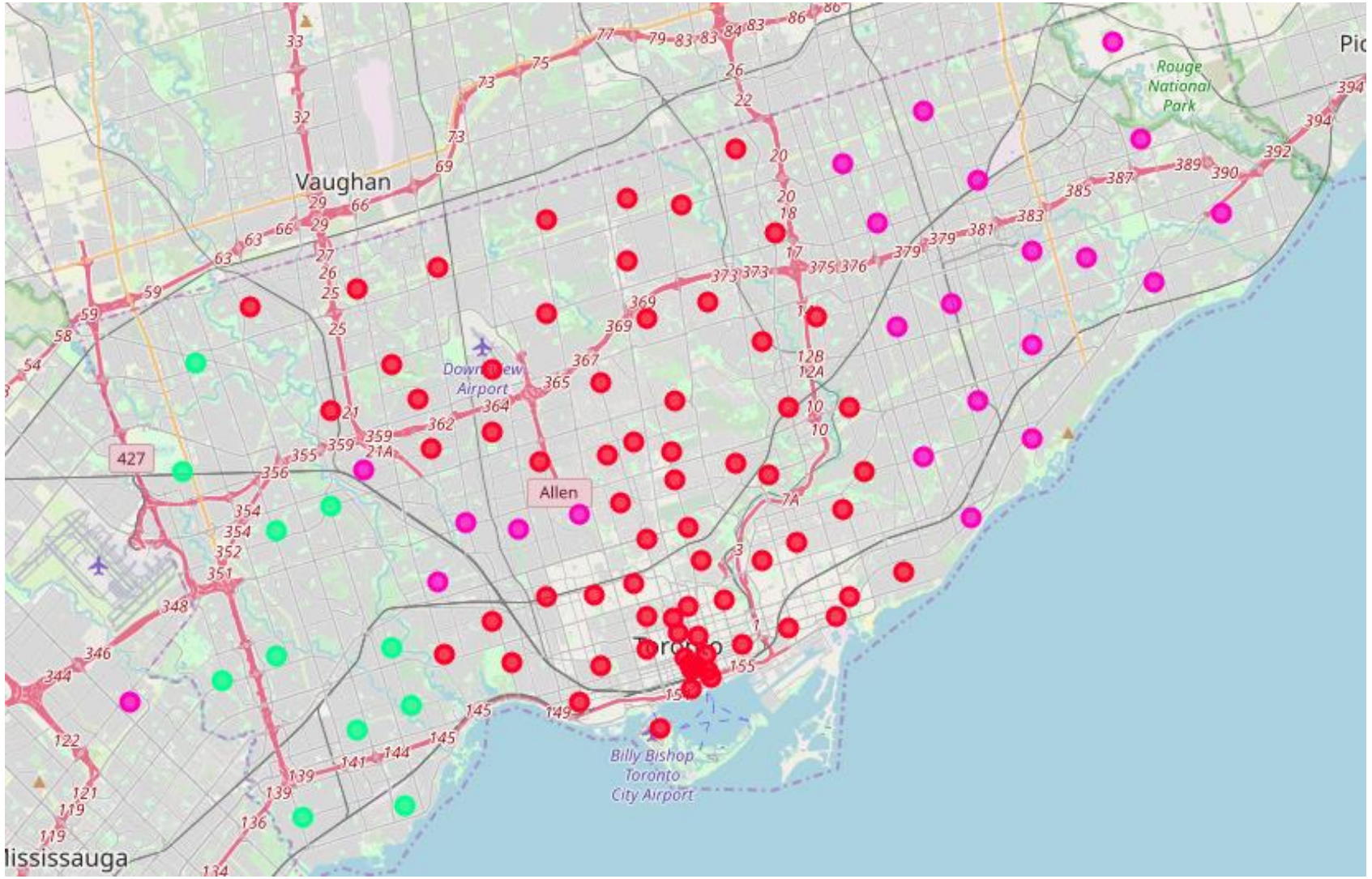


Showing the clusters on a map

	Postcode	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
0	M1B	Scarborough	Rouge,Malvern	43.806686	-79.194353	0	Chinese	Indian	Italian	Thai	Korean
1	M1C	Scarborough	Highland Creek,Rouge Hill,Port Union	43.784535	-79.160497	0	Chinese	Indian	Italian	Thai	Korean
2	M1E	Scarborough	Guildwood,Morningside,West Hill	43.763573	-79.188711	0	Chinese	Indian	Italian	Thai	Korean
3	M1G	Scarborough	Woburn	43.770992	-79.216917	0	Chinese	Indian	Italian	Thai	Korean
4	M1H	Scarborough									Korean

```
# create map
map_clusters = folium.Map(location=[latitude, longitude], zoom_start=11)
# set color scheme for the clusters
x = np.arange(kclusters)
ys = [i + x + (i*x)**2 for i in range(kclusters)]
colors_array = cm.gist_rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]
# add markers to the map
markers_colors = []
for lat, lon, poi, cluster in zip(topneighs_merged['Latitude'], topneighs_merged['Longitude'], topneighs_merged['Neighbourhoo
d'], topneighs_merged['Cluster Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=5,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters)

map_clusters
```

Three Toronto boroughs clusters



Cluster0 – mostly Chinese&Indian cuisine

	Neighbourhood	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
0	Rouge,Malvern	0	Chinese	Indian	Italian	Thai	Korean
1	Highland Creek,Rouge Hill,Port Union	0	Chinese	Indian	Italian	Thai	Korean
2	Guildwood,Morningside,West Hill	0	Chinese	Indian	Italian	Thai	Korean
3	Woburn	0	Chinese	Indian	Italian	Thai	Korean
4	Cedarbrae	0	Chinese	Indian	Italian	Thai	Korean
5	Scarborough Village	0	Chinese	Indian	Italian	Thai	Korean
6	East Birchmount Park,Ionview,Kennedy Park	0	Chinese	Indian	Italian	Thai	Korean
7	Clairlea,Golden Mile,Oakridge	0	Chinese	Indian	Italian	Thai	Korean
8	Cliffcrest,Cliffside,Scarborough Village West	0	Chinese	Indian	Italian	Thai	Korean
9	Birch Cliff,Cliffside West	0	Chinese	Indian	Italian	Thai	Korean
10	Dorset Park,Scarborough Town Centre,Wexford He...	0	Chinese	Indian	Italian	Thai	Korean
11	Maryvale,Wexford	0	Chinese	Indian	Italian	Thai	Korean
12	Agincourt	0	Chinese	Indian	Italian	Thai	Korean
13	Clarks Corners,Sullivan,Tam O'Shanter	0	Chinese	Indian	Italian	Thai	Korean
14	Agincourt North,L'Amoreaux East,Milliken,Steel...	0	Chinese	Indian	Italian	Thai	Korean
15	L'Amoreaux West	0	Chinese	Indian	Italian	Thai	Korean
16	Upper Rouge	0	Chinese	Indian	Italian	Thai	Korean
73	Humewood-Cedarvale	0	Caribbean	Chinese	Vietnamese	Italian	American
74	Caledonia-Fairbanks	0	Caribbean	Chinese	Vietnamese	Italian	American
80	Del Ray,Keelesdale,Mount Dennis,Silverthorn	0	Caribbean	Chinese	Vietnamese	Italian	American
81	The Junction North,Runnymede	0	Caribbean	Chinese	Vietnamese	Italian	American
86	Canada Post Gateway Processing Centre	0	Chinese	Vietnamese	Italian	American	Asian
98	Weston	0	Caribbean	Chinese	Vietnamese	Italian	American

Cluster1 – mostly Japanese&Asian cuisine
Cluster2 – mostly Korean&Vietnamese

	Neighbourhood	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
17	Hillcrest Village	1	Japanese	Asian	Italian	Middle Eastern	Chinese
18	Fairview,Henry Farm,Oriole	1	Japanese	Asian	Italian	Middle Eastern	Chinese
19	Bayview Village	1	Japanese	Asian	Italian	Middle Eastern	Chinese
20	Silver Hills,York Mills	1	Japanese	Asian	Italian	Middle Eastern	Chinese
21	Newtonbrook,Willowdale	1	Japanese	Asian	Italian	Middle Eastern	Chinese
22	Willowdale South	1	Japanese	Asian	Italian	Middle Eastern	Chinese

	Neighbourhood	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
88	Humber Bay Shores,Mimico South,New Toronto	2	Korean	Vietnamese	Italian	American	Asian
89	Alderwood,Long Branch	2	Korean	Vietnamese	Italian	American	Asian
90	The Kingsway,Montgomery Road,Old Mill North	2	Korean	Vietnamese	Italian	American	Asian
91	Humber Bay,King's Mill Park,Kingsway Park Sout...	2	Korean	Vietnamese	Italian	American	Asian
92	Kingsway Park South West,Mimico NW,The Queensw...	2	Korean	Vietnamese	Italian	American	Asian
94	Cloverdale,Islington,Martin Grove,Princess Gar...	2	Korean	Vietnamese	Italian	American	Asian
95	Bloordale Gardens,Eringate,Markland Wood,Old B...	2	Korean	Vietnamese	Italian	American	Asian
99	Westmount	2	Korean	Vietnamese	Italian	American	Asian
100	Kingsview Village,Martin Grove Gardens,Richvie...	2	Korean	Vietnamese	Italian	American	Asian
101	Albion Gardens,Beaumond Heights,Humbergate,Jam...	2	Korean	Vietnamese	Italian	American	Asian
102	Northwest	2	Korean	Vietnamese	Italian	American	Asian

Thank you for your attention