# Exploring Neighborhoods of Toronto to open a new Indian Restaurant

## 1. Description of the Business Problem & Discussion of the Background:

*Problem Statement: Prospects of opening an Indian Restaurant in Toronto, Canada.*

Toronto, the capital of the province of Ontario, is the most populous Canadian city. One of the most immigrant-friendly cities in North America with more than half of the entire Indian Canadian population residing in Toronto it is one of the best places to start an Indian restaurant.

In this project we go through the step by step process and analyze the neighborhoods in Toronto to identify the most profitable area. As success of the restaurant depends on the people and we already know that Toronto has greater number of Indians here, it is good idea to start restaurant here. But we need to find the best place so that it yields more profit to the owner.

Target Audience

1) Business people who wants to open an Indian restaurant in Toronto.

2) Indian crowd who wants to find neighborhoods with lots of options for Indian Restaurant.

3) Freelancer who wants to have their own restaurant as a side business.

## 2. Data acquisition and cleaning:

*2.1 Data Sources*

a) I'm using "List of Postal code of Canada: M" (https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M) wiki page to get all the information about the neighborhoods present in Toronto. This page has the postal code, borough & the name of all the neighborhoods present in Toronto.

b) Then I'm using "https://cocl.us/Geospatial_data" csv file to get all the geographical coordinates of the neighborhoods.

c) To get information about the distribution of population by their ethnicity I'm using "Demographics of Toronto" (https://en.m.wikipedia.org/wiki/Demographics_of_Toronto#Ethnic_diversity) wiki page. Using this page I'm going to identify the neighborhoods which are densely populated with Indians as it might be helpful in identifying the suitable neighborhood to open a new Indian restaurant.

d) To get location and other information about various venues in Toronto I'm using Foursquare's explore API. Using the Foursquare's explore API (which gives venues recommendations), I'm fetching details about the venues up present in Toronto and collected their names, categories and locations (latitude and longitude).

From Foursquare API (https://developer.foursquare.com/docs), I retrieved the following for each venue:

- Name: The name of the venue.
- Category: The category type as defined by the API.
- Latitude: The latitude value of the venue.
- Longitude: The longitude value of the venue.

### *2.2 Data Cleaning*

**a) Scraping Toronto Neighbourhoods Table from Wikipedia**

Scraped the following Wikipedia page, "*List of Postal code of Canada: M*" in order to obtain the data about the Toronto & the Neighbourhoods in it.

Assumptions made to attain the below DataFrame:

- Dataframe will consist of three columns: PostalCode, Borough, and Neighbourhood
- Only the cells that have an assigned borough will be processed. Borough that is not assigned are ignored.
- More than one neighbourhood can exist in one postal code area. For example, in the table on the Wikipedia page, you will notice that M5A is listed twice and has two neighbourhoods: Harbourfront and Regent Park. These two rows will be combined into one row with the neighbourhoods separated with a comma as shown in row 11 in the above table.
- If a cell has a borough but a Not assigned neighbourhood, then the neighbourhood will be the same as the borough.

Wikipedia—package is used to scrape the data from wiki.

```
In [10]: html = wp.page("List of postal codes of Canada: M").html().encode("UTF-8")
         df = pd.read_html(html, header = 0)[0]
         df.head()
```

Out[10]:

| | Postcode | Borough | Neighbourhood |
|---|---|---|---|
| 0 | M1A | Not assigned | Not assigned |
| 1 | M2A | Not assigned | Not assigned |
| 2 | M3A | North York | Parkwoods |
| 3 | M4A | North York | Victoria Village |
| 4 | M5A | Downtown Toronto | Harbourfront |

*Table 1: Dataframe formed from the scraped wiki page*

After some cleaning we got the proper dataframe with the Postal code, Borough & Neighborhood information.

Out[12]:

| | Borough | Postalcode | Neighbourhood |
|---|---|---|---|
| 0 | Central Toronto | M4N | Lawrence Park |
| 1 | Central Toronto | M4P | Davisville North |
| 2 | Central Toronto | M4R | North Toronto West |
| 3 | Central Toronto | M4S | Davisville |
| 4 | Central Toronto | M4T | Moore Park, Summerhill East |

*Table 2: Dataframe from 'List of Postal code of Canada: M' Wikipedia Table*

### b) Adding geographical coordinates to the neighborhoods

Next important step is adding the geographical coordinates to these neighborhoods. To do so I'm extracting the data present in the Geospatial Data csv file and I'm combining it with the existing neighborhood dataframe by merging them both based on the postal code.

In [13]:
```
#Reading the latitude & longitude data from CSV file

import io
import requests

url = "https://cocl.us/Geospatial_data"
lat_long = requests.get(url).text
lat_long_df=pd.read_csv(io.StringIO(lat_long))
lat_long_df.head()
```

Out[13]:

| | Postal Code | Latitude | Longitude |
|---|---|---|---|
| 0 | M1B | 43.806686 | -79.194353 |
| 1 | M1C | 43.784535 | -79.160497 |
| 2 | M1E | 43.763573 | -79.188711 |
| 3 | M1G | 43.770992 | -79.216917 |
| 4 | M1H | 43.773136 | -79.239476 |

*Table 3: DataFrame with latitude & longitude of Postal codes in Toronto*

I'm renaming the columns to match the existing dataframe formed from '*List of Postal code of Canada: M' wiki page.* After that I'm merging both the dataframe into one by merging on the postal code.

```
In [15]: toronto_DF = pd.merge(df,lat_long_df, on='Postalcode')
         toronto_DF = toronto_DF.rename(columns={'Neighbourhood':'Neighborhood'})
         toronto_DF.head()
```

Out[15]:

| | Borough | Postalcode | Neighborhood | Latitude | Longitude |
|---|---|---|---|---|---|
| 0 | Central Toronto | M4N | Lawrence Park | 43.728020 | -79.388790 |
| 1 | Central Toronto | M4P | Davisville North | 43.712751 | -79.390197 |
| 2 | Central Toronto | M4R | North Toronto West | 43.715383 | -79.405678 |
| 3 | Central Toronto | M4S | Davisville | 43.704324 | -79.388790 |
| 4 | Central Toronto | M4T | Moore Park, Summerhill East | 43.689574 | -79.383160 |

```
In [16]: print('The dataframe has {} boroughs and {} neighborhoods.'.format(
             len(toronto_DF['Borough'].unique()),
             toronto_DF.shape[0]
         )
)
```

```
The dataframe has 11 boroughs and 103 neighborhoods.
```

*Table 4: Merged new dataframe with info about Neighbourhoods, borough, postalcode, latitude & longitude in Toronto*

### d) Get location data using Foursquare

Foursquare API is very useful online application used my many developers & other applications like Uber etc. In this project I have used it to retrieve information about the places present in the neighborhoods of Toronto. The API returns a JSON file and we need to turn that into a data-frame. Here I've chosen 100 popular spots for each neighborhood within a radius of 1km.

```
In [32]: toronto_venues.head(10)
```

Out[32]:

| | Neighborhood | Neighborhood Latitude | Neighborhood Longitude | Venue | Venue Latitude | Venue Longitude | Venue Category |
|---|---|---|---|---|---|---|---|
| 0 | Lawrence Park | 43.728020 | -79.388790 | Lawrence Park Ravine | 43.726963 | -79.394382 | Park |
| 1 | Lawrence Park | 43.728020 | -79.388790 | Zodiac Swim School | 43.728532 | -79.382860 | Swim School |
| 2 | Lawrence Park | 43.728020 | -79.388790 | TTC Bus #162 - Lawrence-Donway | 43.728026 | -79.382805 | Bus Line |
| 3 | Davisville North | 43.712751 | -79.390197 | Homeway Restaurant & Brunch | 43.712641 | -79.391557 | Breakfast Spot |
| 4 | Davisville North | 43.712751 | -79.390197 | Summerhill Market North | 43.715499 | -79.392881 | Food & Drink Shop |
| 5 | Davisville North | 43.712751 | -79.390197 | Sherwood Park | 43.716551 | -79.387776 | Park |
| 6 | Davisville North | 43.712751 | -79.390197 | Winners | 43.713236 | -79.393873 | Clothing Store |
| 7 | Davisville North | 43.712751 | -79.390197 | Best Western Roehampton Hotel & Suites | 43.708878 | -79.390880 | Hotel |
| 8 | Davisville North | 43.712751 | -79.390197 | Subway | 43.708378 | -79.390473 | Sandwich Place |
| 9 | Davisville North | 43.712751 | -79.390197 | Gym | 43.713126 | -79.393537 | Gym |

*Table 8: Dataframe with venues in each neighbourhood along with the category info of the venues.*

## 3. Exploratory Data Analysis:

### *3.1 Folium Library and Leaflet Map*

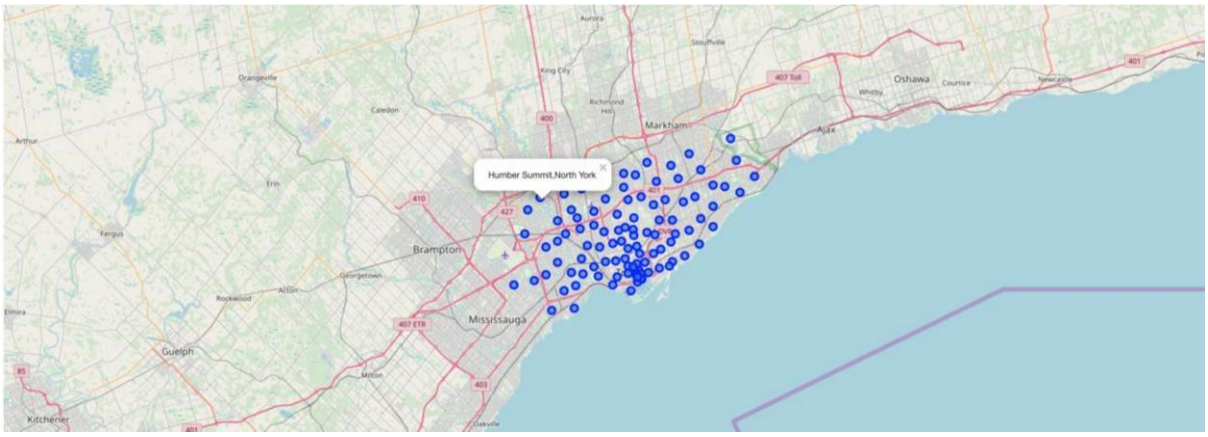
Folium is a python library, I'm using it to draw an interactive leaflet map using coordinate data.

```
# create map of New York using latitude and longitude values
map_toronto = folium.Map(location=[latitude, longitude], zoom_start=10)

# add markers to map
for lat, lng, borough, neighborhood in zip(toronto_DF['Latitude'], toronto_DF['Longitude'], toronto_DF['Borough'], toronto_DF['Neighborhood']):
    label = '{},{}'.format(neighborhood, 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_toronto)

map_toronto
```

*Code snippet: To draw the folium map*




*Map 1: Folium map of Toronto Neighbourhood with popup label*

### *3.2 Relationship between neighbourhood and Indian Restaurant*

First we will extract the Neighbourhood and Indian Restaurant column from the above Toronto dataframe for further analysis:

| | Neighborhood | Yoga Studio | Accessories Store | Afghan Restaurant | Airport | Airport Food Court | Airport Lounge | Airport Service | Airport Terminal | American Restaurant | Antique Shop | Aquarium | Art Gallery | Art Museum | Arts & Crafts Store | Asian Restaurant | Athletics & Sports | Auto Garage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Adelaide, King, Richmond | 0.000000 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.030000 | 0.000000 | 0.0 | 0.010000 | 0.010000 | 0.000000 | 0.03 | 0.000000 | 0.0 |
| 1 | Agincourt | 0.000000 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.00 | 0.000000 | 0.0 |
| 2 | Agincourt North, L'Amoreaux East, Milliken, St... | 0.000000 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.00 | 0.000000 | 0.0 |
| 3 | Albion Gardens, Beaumond Heights, Humbergate, ... | 0.000000 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.00 | 0.000000 | 0.0 |

*Table 9: Dataframe formed using Foursquare API information about venues in each neighbourhood*

Code snippet

```
toronto_onehot = pd.get_dummies(toronto_venues[['Venue Category']], prefix="", prefix_sep="")

toronto_onehot['Neighborhood'] = toronto_venues['Neighborhood']

fixed_columns = [toronto_onehot.columns[-1]] + list(toronto_onehot.columns[:-1])
toronto_onehot = toronto_onehot[fixed_columns]
toronto_grouped = toronto_onehot.groupby('Neighborhood').mean().reset_index()
toronto_grouped
```

*Code snippet: Manipulating the data to make the analysis easy*

After performing pandas one hot encoding for the venue categories, let us merge this dataframe with the Toronto DataFrame with latitude & longitude information on neighbourhood. Finally extract just the Indian restaurant values along with neighbourhood information.

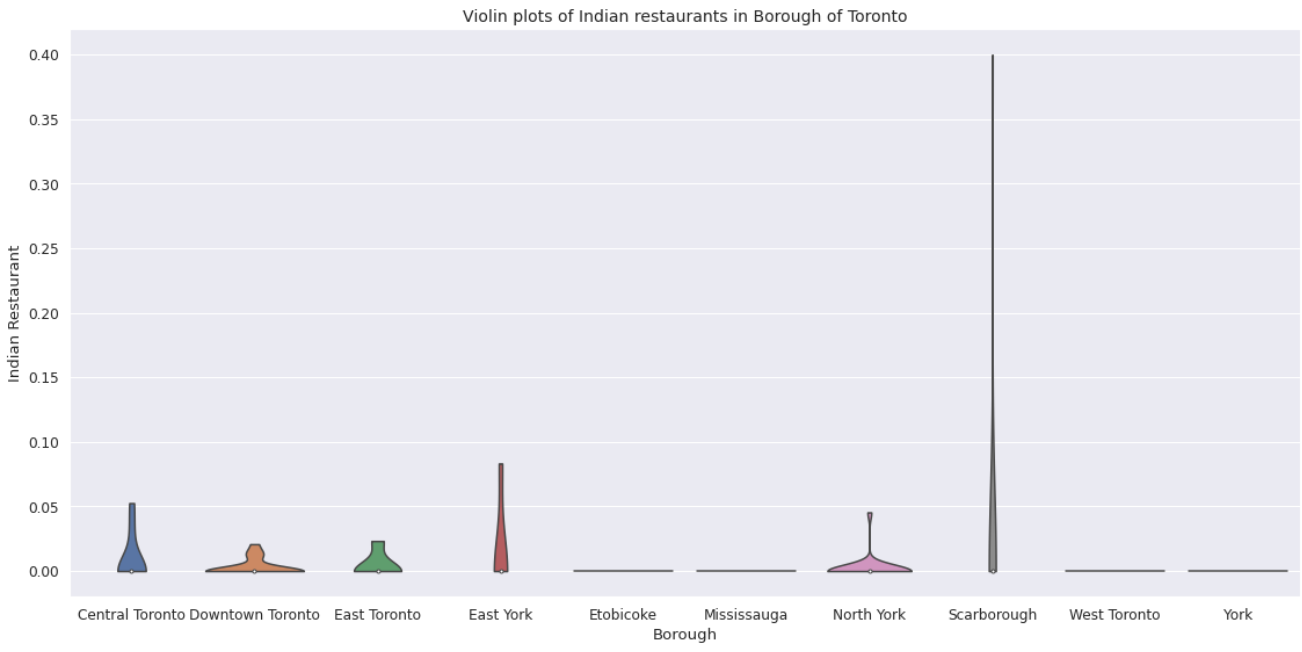
```
toronto_merged = pd.merge(toronto_DF, toronto_part, on='Neighborhood')
toronto_merged
```

]:

| | Borough | Postalcode | Neighborhood | Latitude | Longitude | Cluster Labels | Indian Restaurant |
|---|---|---|---|---|---|---|---|
| 0 | Central Toronto | M4N | Lawrence Park | 43.728020 | -79.388790 | 0 | 0.000000 |
| 1 | Central Toronto | M4P | Davisville North | 43.712751 | -79.390197 | 0 | 0.000000 |
| 2 | Central Toronto | M4R | North Toronto West | 43.715383 | -79.405678 | 0 | 0.000000 |
| 3 | Central Toronto | M4S | Davisville | 43.704324 | -79.388790 | 4 | 0.028571 |
| 4 | Central Toronto | M5N | Roselawn | 43.711695 | -79.416936 | 0 | 0.000000 |
| 5 | Downtown Toronto | M4W | Rosedale | 43.679563 | -79.377529 | 0 | 0.000000 |
| 6 | Downtown Toronto | M4Y | Church and Wellesley | 43.665860 | -79.383160 | 5 | 0.011765 |
| 7 | Downtown Toronto | M5C | St. James Town | 43.651494 | -79.375418 | 5 | 0.010000 |
| 8 | Downtown Toronto | M5E | Berczy Park | 43.644771 | -79.373306 | 4 | 0.017544 |
| 9 | Downtown Toronto | M5G | Central Bay Street | 43.657952 | -79.387383 | 5 | 0.011364 |
| 10 | Downtown Toronto | M5W | Stn A PO Boxes 25 The Esplanade | 43.646435 | -79.374846 | 5 | 0.010101 |

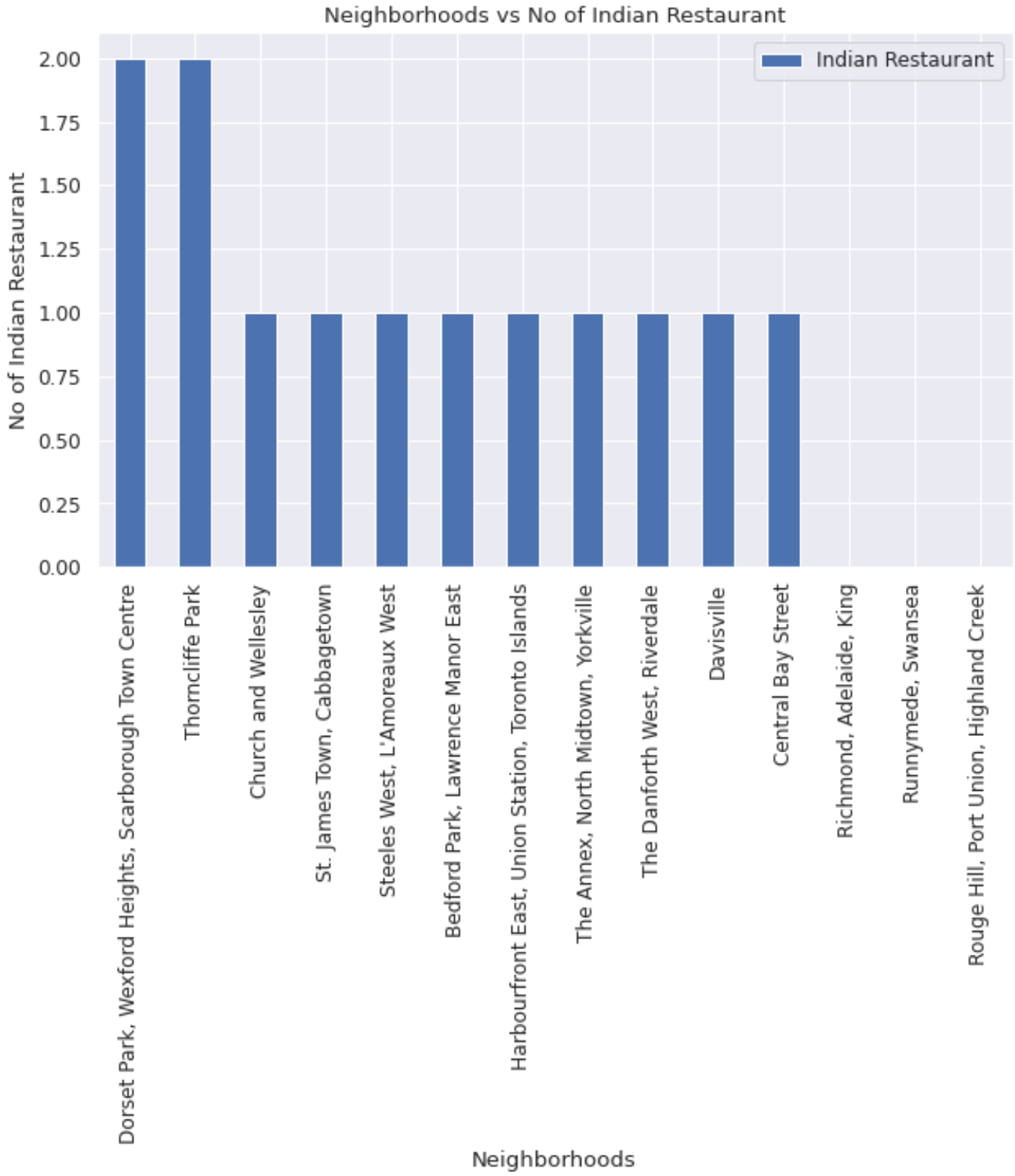
*Table 10: Toronto Dataframe for Indian restaurants count in each neighbourhood*

Let's try to draw some plot using the above dataframe:



With the help of this violin plots we can identify the boroughs with densely populated Indian restaurants. It is drawn using seaborn library to show the distribution of Indian restaurants in different boroughs.

Let’s also visualize the neighbourhood with Indian Restaurants:




**Scrap the distribution of population from Wikipedia**

Another factor that can help us in deciding which neighborhood would be best option to open a restaurant is, the distribution of population based on the ethnic diversity for each neighborhood. As this helps us in identifying the neighborhoods which are densely populated with Indian crowd since that neighborhood would be an ideal place to open an Indian restaurant.

Scraped the following Wikipedia page, “Demographics of Toronto” in order to obtain the data about the Toronto & the Neighborhoods in it. Compared to all the neighborhoods in Toronto below given neighborhoods only had considerable amount of Indian crowd. We are examining those neighborhood’s population to identify the densely populated neighborhoods with Indian population.

```
#overall population distribution
html = wp.page("Demographics of Toronto").html().encode("UTF-8")
```

*Code snippet: Scraping the wiki page*

There were only six neighborhoods in Toronto which Indian population spread across, so we are gathering the population, it’s percentage in each riding in those neighborhoods.

| | Riding | Population | Ethnic Origin #1 | Ethnic Origin 1 in % | Ethnic Origin #2 | Ethnic Origin 2 in % | Ethnic Origin #3 | Ethnic Origin 3 in % | Ethnic Origin #4 | Ethnic Origin 4 in % | Ethnic Origin #5 | Ethnic Origin 5 in % | Ethnic Origin #6 | Ethnic Origin 6 in % | Ethnic Origin #7 | Ethnic Origin 7 in % | Ethnic Origin #8 | Ethnic Origin 8 in % | Ethnic Origin #9 | Ethnic Origin 9 in % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Spadina-Fort York | 114315 | English | 16.4 | Chinese | 16.0 | Irish | 14.6 | Canadian | 14.0 | Scottish | 13.2 | French | 7.70 | German | 7.6 | NaN | NaN | NaN | NaN |
| 1 | Beaches-East York | 108435 | English | 24.2 | Irish | 19.9 | Canadian | 19.7 | Scottish | 18.9 | French | 8.7 | German | 8.40 | NaN | NaN | NaN | NaN | NaN | NaN |
| 2 | Davenport | 107395 | Portuguese | 22.7 | English | 13.6 | Canadian | 12.8 | Irish | 11.5 | Italian | 11.1 | Scottish | 11.00 | NaN | NaN | NaN | NaN | NaN | NaN |
| 3 | Parkdale-High Park | 106445 | English | 22.3 | Irish | 20.0 | Scottish | 18.7 | Canadian | 16.1 | German | 9.8 | French | 8.88 | Polish | 8.5 | NaN | NaN | NaN | NaN |
| 4 | Toronto-Danforth | 105395 | English | 22.9 | Irish | 19.5 | Scottish | 18.7 | Canadian | 18.4 | Chinese | 13.8 | French | 8.86 | German | 8.8 | Greek | 7.3 | NaN | NaN |
| 5 | Toronto-St. Paul's | 104940 | English | 18.5 | Canadian | 16.1 | Irish | 15.2 | Scottish | 14.8 | Polish | 10.3 | German | 7.90 | Russian | 7.7 | Italian | 7.3 | French | 7.2 |
| 6 | University-Rosedale | 100520 | English | 20.6 | Irish | 16.6 | Scottish | 16.3 | Canadian | 15.2 | Chinese | 14.7 | German | 8.70 | French | 7.7 | Italian | 7.4 | NaN | NaN |
| 7 | Toronto Centre | 99590 | English | 15.7 | Canadian | 13.7 | Irish | 13.4 | Scottish | 12.6 | Chinese | 12.5 | French | 7.20 | NaN | NaN | NaN | NaN | NaN | NaN |

*Table 4: TORONTO & EAST YORK population distribution by ethnicity*

| | Riding | Population | Ethnic Origin #1 | Ethnic Origin 1 in % | Ethnic Origin #2 | Ethnic Origin 2 in % | Ethnic Origin #3 | Ethnic Origin 3 in % | Ethnic Origin #4 | Ethnic Origin 4 in % | Ethnic Origin #5 | Ethnic Origin 5 in % | Ethnic Origin #6 | Ethnic Origin 6 in % | Ethnic Origin #7 | Ethnic Origin 7 in % | Ethnic Origin #8 | Ethnic Origin 8 in % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Willowdale | 117405 | Chinese | 25.9 | Iranian | 12.1 | Korean | 10.6 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 1 | Eglinton-Lawrence | 112925 | Canadian | 14.7 | English | 12.6 | Polish | 12.0 | Filipino | 11.0 | Scottish | 9.7 | Italian | 9.5 | Irish | 9.2 | Russian | 8.4 |
| 2 | Don Valley North | 109060 | Chinese | 32.4 | East Indian | 7.3 | Iranian | 7.3 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 3 | Humber River-Black Creek | 107725 | Italian | 12.8 | East Indian | 9.2 | Jamaican | 8.5 | Vietnamese | 8.0 | Canadian | 7.4 | NaN | NaN | NaN | NaN | NaN | NaN |
| 4 | York Centre | 103760 | Filipino | 17.0 | Italian | 13.4 | Russian | 9.5 | Canadian | 8.6 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 5 | Don Valley West | 101790 | English | 19.2 | Canadian | 15.1 | Scottish | 14.9 | Irish | 14.2 | Chinese | 11.2 | NaN | NaN | NaN | NaN | NaN | NaN |
| 6 | Don Valley East | 93170 | East Indian | 10.6 | Canadian | 10.4 | English | 10.1 | Chinese | 8.9 | Irish | 8.1 | Scottish | 8.0 | Filipino | 7.8 | NaN | NaN |

*Table 5: NORTH YORK population distribution by ethnicity*

| | Riding | Population | Ethnic Origin #1 | Ethnic Origin 1 in % | Ethnic Origin #2 | Ethnic Origin 2 in % | Ethnic Origin #3 | Ethnic Origin 3 in % | Ethnic Origin #4 | Ethnic Origin 4 in % | Ethnic Origin #5 | Ethnic Origin 5 in % | Ethnic Origin #6 | Ethnic Origin 6 in % | Ethnic Origin #7 | Ethnic Origin 7 in % | Ethnic Origin #8 | Ethnic Origin 8 in % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Scarborough Centre | 110450 | Filipino | 13.1 | East Indian | 12.2 | Canadian | 11.2 | Chinese | 10.7 | English | 7.8 | Sri Lankan | 7.0 | NaN | NaN | NaN | NaN |
| 1 | Scarborough Southwest | 108295 | Canadian | 16.2 | English | 14.3 | Irish | 11.5 | Scottish | 10.9 | Filipino | 9.5 | East Indian | 8.2 | Chinese | 7.2 | NaN | NaN |
| 2 | Scarborough-Agincourt | 104225 | Chinese | 47.0 | East Indian | 7.4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 3 | Scarborough-Rouge Park | 101445 | East Indian | 16.7 | Canadian | 11.8 | Sri Lankan | 11.1 | English | 9.8 | Filipino | 9.3 | Jamaican | 8.4 | Scottish | 7.2 | Irish | 7.0 |
| 4 | Scarborough-Guildwood | 101115 | East Indian | 18.0 | Canadian | 11.6 | English | 9.7 | Filipino | 8.5 | Sri Lankan | 7.8 | Chinese | 7.1 | Scottish | 7.0 | NaN | NaN |
| 5 | Scarborough North | 97610 | Chinese | 46.6 | East Indian | 11.8 | Sri Lankan | 9.4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |

*Table 6: SCARBOROUGH population distribution by ethnicity*

| | Riding | Population | Ethnic Origin #1 | Ethnic Origin 1 in % | Ethnic Origin #2 | Ethnic Origin 2 in % | Ethnic Origin #3 | Ethnic Origin 3 in % | Ethnic Origin #4 | Ethnic Origin 4 in % | Ethnic Origin #5 | Ethnic Origin 5 in % | Ethnic Origin #6 | Ethnic Origin 6 in % | Ethnic Origin #7 | Ethnic Origin 7 in % | Ethnic Origin #8 | Ethnic Origin 8 in % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Etobicoke-Lakeshore | 127520 | English | 17.1 | Canadian | 15.9 | Irish | 14.4 | Scottish | 13.5 | Polish | 9.2 | Italian | 9.1 | Ukrainian | 7.6 | German | 7.1 |
| 1 | Etobicoke North | 116960 | East Indian | 22.2 | Canadian | 7.9 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 2 | Etobicoke Centre | 116055 | Italian | 15.1 | English | 14.3 | Canadian | 12.1 | Irish | 10.8 | Scottish | 10.4 | Ukrainian | 8.1 | Polish | 7.4 | NaN | NaN |
| 3 | York South-Weston | 115130 | Portuguese | 14.5 | Italian | 12.8 | Canadian | 8.7 | Jamaican | 8.4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |

*Table 7: ETOBICOKE & YORK population distribution by ethnicity*

*3.3 Relationship between neighbourhood and Indian population*

Another key feature is the distribution of Indian crowd in each neighbourhoods. Let us analyse the neighbourhoods and identify the neighbourhoods with highest number of Indian population.

To achieve that we are joining all the neighbourhood's dataframe from using the wiki page with ethnic population and in that we are extracting just the Indian population for each neighbourhood.

| | Riding | Population | Ethnic Origin #1 | Ethnic Origin 1 in % | Ethnic Origin #2 | Ethnic Origin 2 in % | Ethnic Origin #3 | Ethnic Origin 3 in % | Ethnic Origin #4 | Ethnic Origin 4 in % | Ethnic Origin #5 | Ethnic Origin 5 in % | Ethnic Origin #6 | Ethnic Origin 6 in % | Ethnic Origin #7 | Ethnic Origin 7 in % | Ethnic Origin #8 | Ethnic Origin 8 in % | Ethnic Origin #9 | Ethnic Origin 9 in % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Willowdale | 117405 | Chinese | 25.9 | Iranian | 12.1 | Korean | 10.6 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 1 | Eglinton-Lawrence | 112925 | Canadian | 14.7 | English | 12.6 | Polish | 12.0 | Filipino | 11.0 | Scottish | 9.7 | Italian | 9.50 | Irish | 9.2 | Russian | 8.4 | NaN | NaN |
| 2 | Don Valley North | 109060 | Chinese | 32.4 | East Indian | 7.3 | Iranian | 7.3 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 3 | Humber River-Black Creek | 107725 | Italian | 12.8 | East Indian | 9.2 | Jamaican | 8.5 | Vietnamese | 8.0 | Canadian | 7.4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 4 | York Centre | 103760 | Filipino | 17.0 | Italian | 13.4 | Russian | 9.5 | Canadian | 8.6 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 5 | Don Valley West | 101790 | English | 19.2 | Canadian | 15.1 | Scottish | 14.9 | Irish | 14.2 | Chinese | 11.2 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 6 | Don Valley East | 93170 | East Indian | 10.6 | Canadian | 10.4 | English | 10.1 | Chinese | 8.9 | Irish | 8.1 | Scottish | 8.00 | Filipino | 7.8 | NaN | NaN | NaN | NaN |
| 7 | Scarborough Centre | 110450 | Filipino | 13.1 | East Indian | 12.2 | Canadian | 11.2 | Chinese | 10.7 | English | 7.8 | Sri Lankan | 7.00 | NaN | NaN | NaN | NaN | NaN | NaN |
| 8 | Scarborough Southwest | 108295 | Canadian | 16.2 | English | 14.3 | Irish | 11.5 | Scottish | 10.9 | Filipino | 9.5 | East Indian | 8.20 | Chinese | 7.2 | NaN | NaN | NaN | NaN |
| 9 | Scarborough-Agincourt | 104225 | Chinese | 47.0 | East Indian | 7.4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |
| 10 | Scarborough-Rouge Park | 101445 | East Indian | 16.7 | Canadian | 11.8 | Sri Lankan | 11.1 | English | 9.8 | Filipino | 9.3 | Jamaican | 8.40 | Scottish | 7.2 | Irish | 7.0 | NaN | NaN |
| 11 | Scarborough-Guildwood | 101115 | East Indian | 18.0 | Canadian | 11.6 | English | 9.7 | Filipino | 8.5 | Sri Lankan | 7.8 | Chinese | 7.10 | Scottish | 7.0 | NaN | NaN | NaN | NaN |
| 12 | Scarborough North | 97610 | Chinese | 46.6 | East Indian | 11.8 | Sri Lankan | 9.4 | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN | NaN |

*Table 11: Dataframe with neighbourhoods & their population distribution*

| | Ethnicity | Percentage | Population | Riding |
|---|---|---|---|---|
| 0 | East Indian | 7.3 | 109060.0 | Don Valley North |
| 1 | East Indian | 9.2 | 107725.0 | Humber River-Black Creek |
| 2 | East Indian | 10.6 | 93170.0 | Don Valley East |
| 3 | East Indian | 12.2 | 110450.0 | Scarborough Centre |
| 4 | East Indian | 8.2 | 108295.0 | Scarborough Southwest |
| 5 | East Indian | 7.4 | 104225.0 | Scarborough-Agincourt |
| 6 | East Indian | 16.7 | 101445.0 | Scarborough-Rouge Park |
| 7 | East Indian | 18.0 | 101115.0 | Scarborough-Guildwood |
| 8 | East Indian | 11.8 | 97610.0 | Scarborough North |
| 9 | East Indian | 22.2 | 116960.0 | Etobicoke North |

*Table 12: Extracted dataframe with just Indian population information*

Let's draw a graph to visualize the population spread in neighborhoods:

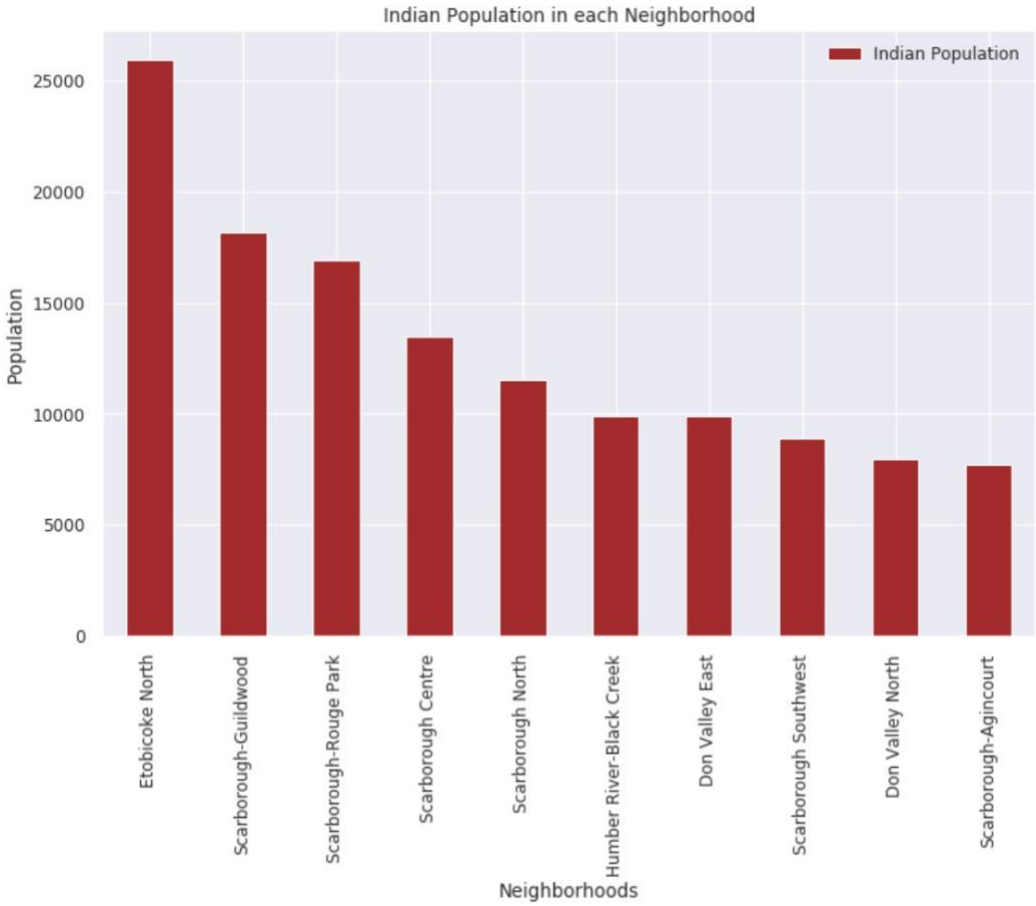



*Figure 3: Bar graph to show the population in each riding in Toronto*

This analysis & visualization of the relationship between neighbourhoods & Indian population present in those neighbourhoods helps us in identifying the highly populated Indian neighbourhoods. Once we identify those neighbourhoods it helps us in deciding where to place the new Indian restaurant. Indian restaurant placed in an densely populated Indian neighbourhood is more likely to get more Indian customers than a restaurant placed in a neighbourhood with less or no Indian population. Thus this analysis helps in the determining the success of the new Indian restaurant.

### 3.4 Relationship between Indian population and Indian restaurant

After performing the data cleaning & data analysis we couldn't identify a big relationship established between densely populated Indian neighborhoods & number of Indian restaurants. This might be because of the missing in data as this an area which can improved in future analysis to get a more insight about the business problem.

| | Indian Population | Neighborhood | Indian Restaurant |
|---|---|---|---|
| **0** | 7961.380 | Henry Farm | 0.0 |
| **1** | 8880.190 | Oakridge | 0.0 |
| **2** | 9910.700 | Humberlea | 0.0 |
| **3** | 8880.190 | Cliffside | 0.0 |
| **4** | 16941.315 | Port Union | 0.0 |

*Table 13: Dataframe of densely populated neighbourhoods with number of Indian restaurants*

## 4. Predictive Modelling:

### *4.1 Clustering Neighbourhoods of Toronto:*

First step in K-means clustering is to identify best K value meaning the number of clusters in a given dataset. To do so we are going to use the elbow method on the Toronto dataset with Indian restaurant percentage.

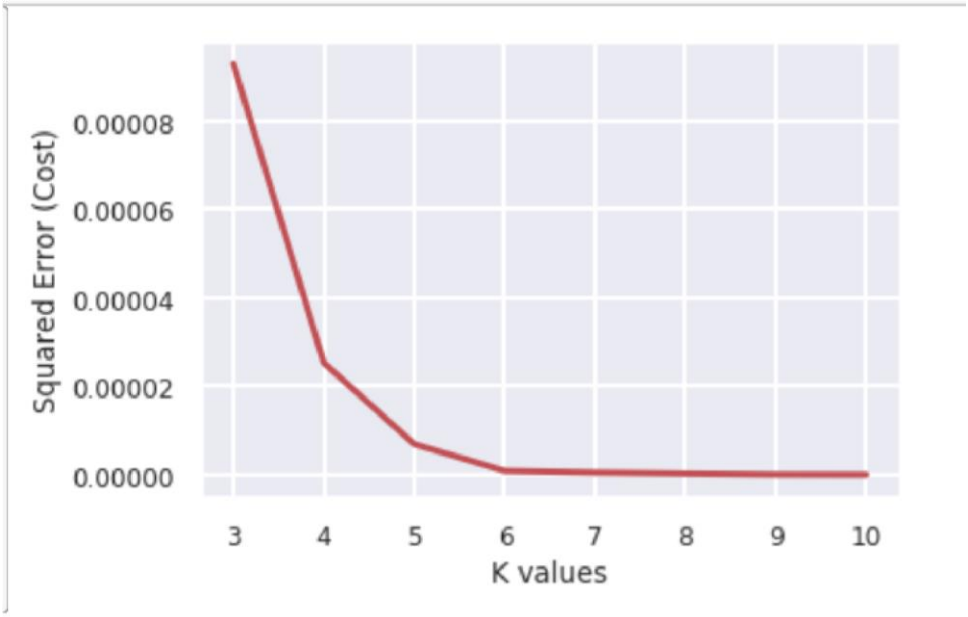



*Figure 4: Elbow method to identify best k value*

Code snippet —

```
from sklearn.cluster import KMeans

toronto_part_clustering = toronto_part.drop('Neighborhood', 1)


error_cost = []

for i in range(3,11):
    KM = KMeans(n_clusters = i, max_iter = 100)
    try:
        KM.fit(toronto_part_clustering)
    except ValueError:
        print("error on line",i)




    #calculate squared error for the clustered points
    error_cost.append(KM.inertia_/100)

#plot the K values aganist the squared error cost
plt.plot(range(3,11), error_cost, color='r', linewidth='3')
plt.xlabel('K values')
plt.ylabel('Squared Error (Cost)')
plt.grid(color='white', linestyle='-', linewidth=2)
plt.show()
```

## Clustering the Toronto Neighborhood Using K-Means with K = 6

```
kclusters = 6

toronto_part_clustering = toronto_part.drop('Neighborhood', 1)

kmeans = KMeans(n_clusters=kclusters, random_state=0).fit(toronto_part_clustering)

kmeans.labels_
```

```
: array([5, 0, 0, 0, 0, 0, 0, 2, 4, 0, 0, 0, 0, 0, 0, 4, 0, 0, 0, 5, 0, 0,
         5, 0, 0, 0, 0, 0, 4, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
         0, 0, 0, 0, 0, 0, 5, 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, 0, 0, 0, 5, 5, 0, 2, 0, 0, 4, 0,
         0, 3, 0, 0, 0, 0, 0, 0, 0, 0, 0, 5, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0,
         4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 5,
         0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 4, 0, 0, 0,
         5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 5, 0, 0,
         0, 0, 0, 2, 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], dtype=int32)
```

*Code snippet: 6 clusters & its labels*

```
#sorted_neighborhoods_venues.drop(['Cluster Labels'],axis=1,inplace=True)
toronto_part.insert(0, 'Cluster Labels', kmeans.labels_)
toronto_merged = toronto_DF
# merge toronto_grouped with toronto_data to add latitude/longitude for each neighborhood
toronto_merged = toronto_merged.join(toronto_part.set_index('Neighborhood'), on='Neighborhood')
toronto_merged.dropna(subset=["Cluster Labels"], axis=0, inplace=True)
toronto_merged.reset_index(drop=True, inplace=True)
toronto_merged['Cluster Labels'].astype(int)
toronto_merged.head()
```

*Code snippet: clustering the Toronto dataframe*

| | Borough | Postalcode | Neighborhood | Latitude | Longitude | Cluster Labels | Indian Restaurant |
|---|---|---|---|---|---|---|---|
| 0 | Central Toronto | M4N | Lawrence Park | 43.728020 | -79.388790 | 0.0 | 0.000000 |
| 1 | Central Toronto | M4P | Davisville North | 43.712751 | -79.390197 | 0.0 | 0.000000 |
| 2 | Central Toronto | M4R | North Toronto West | 43.715383 | -79.405678 | 0.0 | 0.000000 |
| 3 | Central Toronto | M4S | Davisville | 43.704324 | -79.388790 | 4.0 | 0.028571 |
| 4 | Central Toronto | M5N | Roselawn | 43.711695 | -79.416936 | 0.0 | 0.000000 |

*Table 14: Dataframe with cluster labels for neighbourhood*

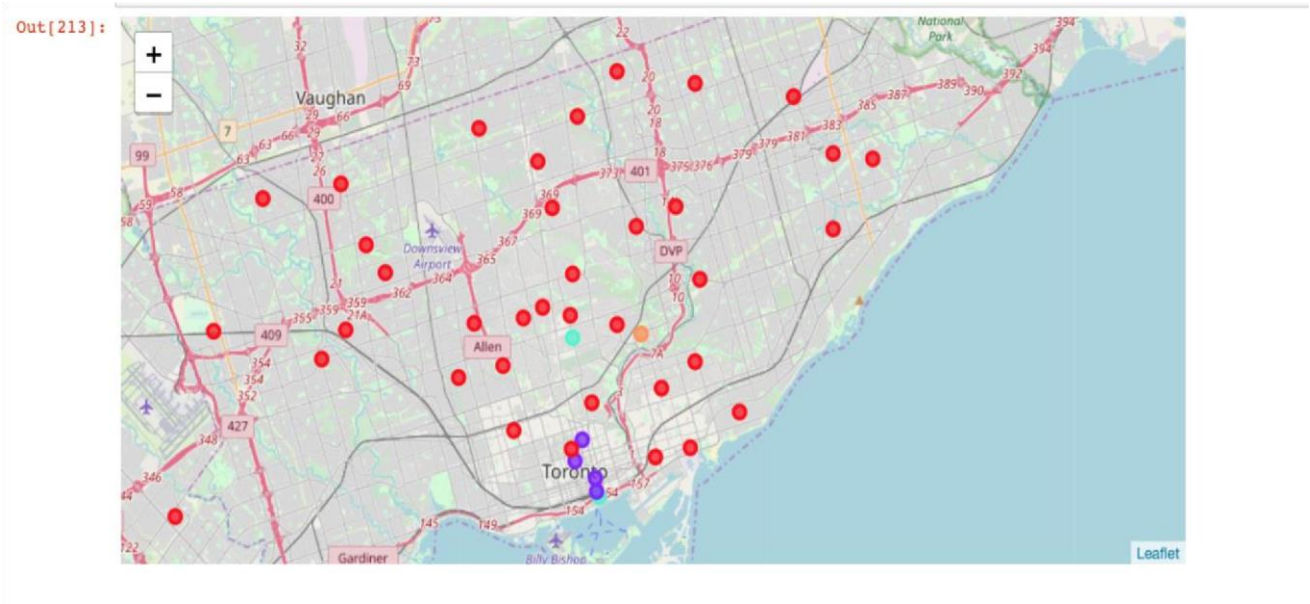



*Figure 5: Folium map for the clusters of different neighbourhoods*

### *4.2 Examine the Clusters:*

We have total of 6 clusters such as 0,1,2,3,4,5. Let us examine one after the other.

Cluster 0 contains all the neighbourhoods which has least number of Indian restaurants. It is shown in red colour in the map

```
#Cluster 0
toronto_merged.loc[toronto_merged['Cluster Labels'] == 0]
```

| | Borough | Postalcode | Neighborhood | Latitude | Longitude | Cluster Labels | Indian Restaurant |
|---|---|---|---|---|---|---|---|
| 0 | Central Toronto | M4N | Lawrence Park | 43.728020 | -79.388790 | 0.0 | 0.0 |
| 1 | Central Toronto | M4P | Davisville North | 43.712751 | -79.390197 | 0.0 | 0.0 |
| 2 | Central Toronto | M4R | North Toronto West | 43.715383 | -79.405678 | 0.0 | 0.0 |
| 4 | Central Toronto | M5N | Roselawn | 43.711695 | -79.416936 | 0.0 | 0.0 |
| 5 | Downtown Toronto | M4W | Rosedale | 43.679563 | -79.377529 | 0.0 | 0.0 |
| 11 | Downtown Toronto | M6G | Christie | 43.669542 | -79.422564 | 0.0 | 0.0 |
| 12 | East Toronto | M4E | The Beaches | 43.676357 | -79.293031 | 0.0 | 0.0 |
| 13 | East Toronto | M4M | Studio District | 43.659526 | -79.340923 | 0.0 | 0.0 |
| 14 | East Toronto | M7Y | Business Reply Mail Processing Centre 969 Eastern | 43.662744 | -79.321558 | 0.0 | 0.0 |
| 15 | East York | M4C | Woodbine Heights | 43.695344 | -79.318389 | 0.0 | 0.0 |
| 16 | East York | M4G | Leaside | 43.709060 | -79.363452 | 0.0 | 0.0 |
| 18 | East York | M4J | East Toronto | 43.685347 | -79.338106 | 0.0 | 0.0 |
| 19 | Etobicoke | M9P | Westmount | 43.696319 | -79.532242 | 0.0 | 0.0 |
| 20 | Etobicoke | M9W | Northwest | 43.706748 | -79.594054 | 0.0 | 0.0 |
| 21 | Mississauga | M7R | Canada Post Gateway Processing Centre | 43.636966 | -79.615819 | 0.0 | 0.0 |

*Table 15: Cluster 0*

Cluster 5 contains the neighborhoods which is sparsely populated with Indian restaurants. It is shown in purple color in the map.

Cluster 1&2 has no rows meaning no data points or no neighborhood was near to these centroids.

Cluster 3 contains all the neighborhoods which is medium populated with Indian restaurants. It is shown in blue color in the map.

Cluster 4 contains all the neighborhoods which is densely populated with Indian restaurants. It is shown in Orange color in the map

*Table 10: Cluster 5*

## 5. Results and Discussion:

### *5.1 Results*

- We identified that only Central Toronto, Downtown Toronto, East Toronto, East York, North York & Scarborough boroughs have high amount of Indian restaurants with the help of Violin plots between Number of Indian restaurants in Borough of Toronto.
- In all the ridings, Scarborough-Guildwood, Scarborough-Rouge Park, Scarborough Centre, Scarborough North, Humber River-Black Creek, Don Valley East, Scarborough Southwest, Don Valley North & Scarborough-Agincourt are the densely populated with Indian crowd ridings.
- With the help of clusters examining & violin plots looks like Downtown Toronto, Central Toronto, East York are already densely populated with Indian restaurants. So it

is better idea to leave those boroughs out and consider only Scarborough, East Toronto & North York for the new restaurant's location.

- After careful consideration it is a good idea to open a new Indian restaurant in Scarborough borough since it has high number of Indian population which gives a higher number of customers possibility and lower competition since very less Indian restaurants in the neighbourhoods.