Capstone Project - The Battle of Neighborhoods Report – Family relocation to North York

1. Introduction / Business Problem

Problem background

In the era of globalization there are many companies with subsidiaries all over the world. They have production facility in the countries with relatively cheap resources and not too far away from the markets where it's product to be sold. The headquarter or main offices of the business units are usually located in the financial centers of continents or influential global cities.

To be competitive those companies have developed strategies, policies and procedures based on the values essential for today's business environment. Human factor is considered as the most important for a technological breakthrough and long-term development.

One of the options to retain and develop talented employees is to offer an international assignment contract. It definitely keeps a person within the company and allows to bring new ideas/methods or even style into a different subsidiary – Diversity is a key for innovation!

Problem description

A company "Con**" with over 150 thousand employees has headquarters located in Germany, 50 plants all over the globe and presented in closed to 140 countries by sales offices.

An employee from Moscow sales office, Russia has been offered an international assignment for 3 years to work in Con**'s office in Toronto, North York Borough in particular, Canada. He has been working in Con** for 10 years, has a family with 2 kids of school age. Moreover, he is quite active, with healthy lifestyle and willingness to develop his children as much as possible. And they all are Christians.

This employee has accepted the new job opportunity. Now it's time to decide what are the main preferences to consider for relocation. After a short family meeting they came to a list:

- Developed neighborhood
- Gym nearby
- Sport facility for kids
- Restaurants of different cuisine in a walking distance
- Music hall or a theatre in proximity
- Also walking distance to a Catholic school

Target audience

An employee of Con** and his family with different interests and life habits. Also, there is an HR department of Con** to approve the relocation costs and cover rent and insurance expenses in a particular district of North York, Toronto, Canada for 3 years of assignment.

2. Data

Toronto city will be a subject of analysis only.

The following datasets is in use for this project:

Dataset 1

City of Toronto with Postal codes, Boroughs and Neighborhoods.

The dataset will be will be used as a starting point to go for exploratory analysis with a help of Foursquare API and Folium visualization, and then for clustering the neighborhoods.

This dataset is available on Wikipedia:

https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M

Out[3]:

	PostalCode	Borough	Neighborhood
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

Dataset 2

City of Toronto with Postal codes linked to their geographical coordinates.

The geo coordinates will be linked via postal codes to the Toronto info (dataset 1) and used for exploratory analysis and clustering the region.

This dataset is available to download from Coursera (from the previous assignment over this course):

http://cocl.us/Geospatial_data

Out[5]:

	PostalCode	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

Dataset 3

Toronto Catholic District School Board is a governmental web site representing online resources for catholic schools around the city. It gives the full list of schools with names linked to their addresses and postal codes.

The dataset will be used to visualize an opportunity to find a right Catholic school in the assigned cluster of North York.

This dataset is available on the following link to parse:

https://www.tcdsb.org/school/Alphabeticalschooldirectory/Pages/default.aspx

	SchoolName	Panel	Address
17	Bishop Allen Academy	Secondary	721 Royal York Road Etobicoke ON M8Y 2T3
19	Bishop Marrocco/Thomas Merton	Secondary	1515 Bloor Street West Toronto ON M6P 1A3
24	Brebeuf	Secondary	211 Steeles Avenue East Willowdale ON M2M 3Y6
28	St Basil-The-Great	Secondary	20 Starview Lane North York ON M9M 3B2
38	Cardinal Carter Academy	Secondary	36 Greenfield Avenue Willowdale ON M2N 3C8

3. Methodology

Purpose of the project

The main purpose of this project is to find 2-3 options of the optimum location for the family to settle down for 3 years in North York, Greater Toronto Area (GTA), Canada. The several options here - we need to present for an approval committee of the Employer HR with probably different rent price level behind because of the location chosen.

Approach

With the help of Toronto data (dataset 1) parsed from Wikipedia we allocate North York Borough area. Then using Foursquare API and geographical data (dataset 2) we collect info about Points of Interest in the area. We use KMEANS machine learning to cluster North York and select the part which suites our preferences. Finally, we parse Catholic School info (dataset 3) and link it to a selected cluster of North York. At the end we need to have 2-3 postal code options to fulfill the purpose of this project.

Analysis

Having installed all the required Python libraries, we begin the analysis.

In [2]:
```
#import libraries
import pandas as pd
import numpy as np
from sklearn.cluster import KMeans
pd.set_option("display.max_columns", None)
pd.set_option("display.max_rows", None)

import json # library to handle JSON files
from pandas.io.json import json_normalize

import geopy
from geopy.geocoders import Nominatim

import requests
from bs4 import BeautifulSoup

import matplotlib.cm as cm
import matplotlib.colors as colors

!conda install -c conda-forge folium=0.5.0 --yes
import folium
```

```
Solving environment: done

# All requested packages already installed.
```

We parse Wikipedia web page to get 103 postal codes of Toronto with Boroughs and Neighborhoods they belong to.

```
(103, 3)
```

Out[4]:

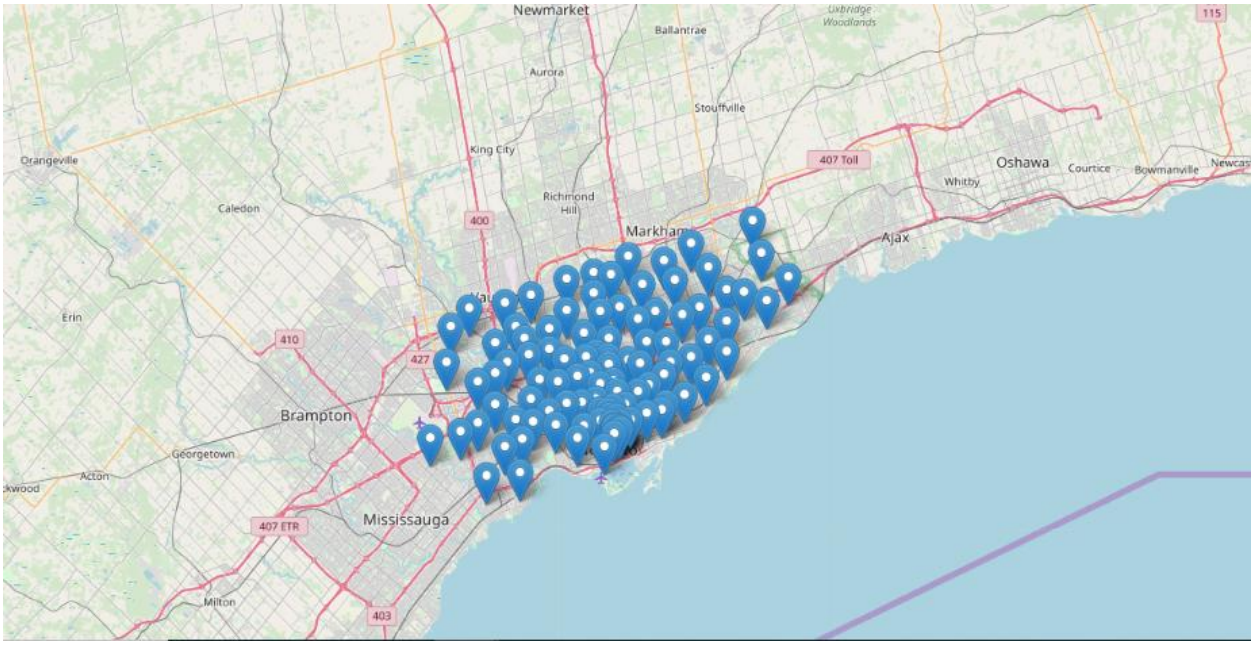
	PostalCode	Borough	Neighborhood
0	M1B	Scarborough	Rouge, Malvern
1	M1C	Scarborough	Highland Creek, Rouge Hill, Port Union
2	M1E	Scarborough	Guildwood, Morningside, West Hill

Then we merge this info with geographical coordinates of each postal code using dataset 2.

Out[6]:

	PostalCode	Borough	Neighborhood	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

Here is a Folium map to visualize the chart above



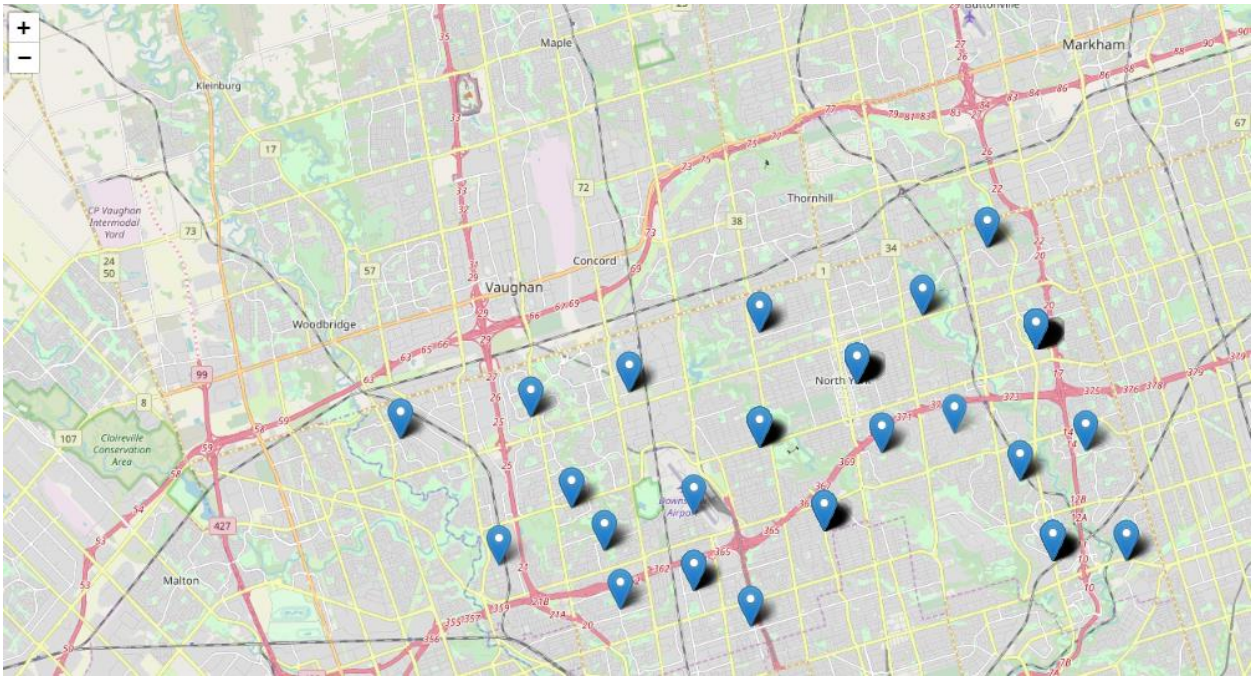
Let's select now North York since that is a designated point of the family to move to eventually. And a step before showing the map of North York let's use the Foursquare API to get Venues or Points of Interest (POI) information of the area. As you can see below – there are 243 POIs in the selected area of 23 postal codes.

```
(243, 9)
```

Out[11]:

	PostalCode	Borough	Neighborhood	Lat	Lon	VenueName	VenueLat	VenueLon	VenueCategory
84	M2H	North York	Hillcrest Village	43.803762	-79.363452	Eagle's Nest Golf Club	43.805455	-79.364186	Golf Course
85	M2H	North York	Hillcrest Village	43.803762	-79.363452	New York Fries	43.803664	-79.363905	Fast Food Restaurant
86	M2H	North York	Hillcrest Village	43.803762	-79.363452	AY Jackson Pool	43.804515	-79.366138	Pool
87	M2H	North York	Hillcrest Village	43.803762	-79.363452	Villa Madina	43.801685	-79.363938	Mediterranean Restaurant
88	M2H	North York	Hillcrest Village	43.803762	-79.363452	Duncan Creek Park	43.805539	-79.360695	Dog Run

Map of North York by postal codes (23 in total).



There are 103 unique Venue category in the North York.

```
In [14]: NY_df['VenueCategory'].unique()[:100]
```

```
Out[14]: array(['Golf Course', 'Fast Food Restaurant', 'Pool',
       'Mediterranean Restaurant', 'Dog Run', 'Toy / Game Store',
       'Burger Joint', 'Movie Theater', 'Shopping Mall', 'Bakery',
       'Candy Store', 'Tea Room', 'Electronics Store',
       'American Restaurant', 'Pharmacy', 'Clothing Store',
       'Department Store', 'Coffee Shop', 'Salon / Barbershop',
       'Smoothie Shop', 'Theater', 'Bank', 'Food Court',
       'Japanese Restaurant', 'Juice Bar', 'Liquor Store', 'Restaurant',
       'Cosmetics Shop', 'Video Game Store', 'Wings Joint',
       'Sporting Goods Shop', 'Asian Restaurant', 'Burrito Place',
       "Women's Store", 'Deli / Bodega', 'Gift Shop', 'Shoe Store',
       'Boutique', 'Luggage Store', 'Home Service', 'Chinese Restaurant',
       'Sandwich Place', 'Dessert Shop', 'Spa', 'Bus Station',
       'Bookstore', 'Baseball Field', 'Café', 'Cafeteria',
       'Grocery Store', 'Ramen Restaurant', 'Steakhouse',
       'Indonesian Restaurant', 'Plaza', 'Arts & Crafts Store',
       'Pet Store', 'Ice Cream Shop', 'Lounge', 'Vietnamese Restaurant',
       'Sushi Restaurant', 'Pizza Place', 'Middle Eastern Restaurant',
       'Discount Store', 'Bubble Tea Shop', 'Hotel', 'Convenience Store',
       'Park', 'Bar', 'Construction & Landscaping', 'Food & Drink Shop',
       'Gym / Fitness Center', 'Caribbean Restaurant',
       'Italian Restaurant', 'Gym', 'Bike Shop', 'Concert Hall',
       'Beer Store', 'Supermarket', 'Dim Sum Restaurant', 'Bridal Shop',
       'Diner', 'Fried Chicken Joint', 'Frozen Yogurt Shop',
       'Gas Station', 'Video Store', 'Massage Studio',
       'Falafel Restaurant', 'Furniture / Home Store', 'Airport',
       'Food Truck', 'Hockey Arena', 'Portuguese Restaurant',
       'Intersection', 'Financial or Legal Service',
       'Comfort Food Restaurant', 'Indian Restaurant', 'Pub',
       'Thai Restaurant', 'Greek Restaurant', 'Butcher'], dtype=object)
```

```
In [15]: #number of categories
         print('{} venue categories'.format(len(NY_df['VenueCategory'].unique())))
```

```
103 venue categories
```

We group then all Venue categories by mean value and sort by most common preference the top 10 of them.

```
(23, 13)
```

Out[18]:

	PostalCode	Borough	Neighborhoods	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	M2H	North York	Hillcrest Village	Golf Course	Pool	Mediterranean Restaurant	Fast Food Restaurant	Dog Run	Diner	Concert Hall	Construction & Landscaping	Convenience Store	Cosmetics Shop
1	M2J	North York	Fairview, Henry Farm, Oriole	Clothing Store	Fast Food Restaurant	Coffee Shop	Japanese Restaurant	Women's Store	Food Court	Toy / Game Store	Bus Station	Tea Room	Bakery
2	M2K	North York	Bayview Village	Chinese Restaurant	Café	Bank	Japanese Restaurant	Women's Store	Dog Run	Convenience Store	Cosmetics Shop	Deli / Bodega	Department Store
3	M2L	North York	Silver Hills, York Mills	Cafeteria	Women's Store	Coffee Shop	Concert Hall	Construction & Landscaping	Convenience Store	Cosmetics Shop	Deli / Bodega	Department Store	Dessert Shop
4	M2N	North York	Willowdale South	Ramen Restaurant	Coffee Shop	Sushi Restaurant	Café	Pizza Place	Sandwich Place	Juice Bar	Japanese Restaurant	Lounge	Ice Cream Shop

Machine Learning clustering with “KMeans” algorithm gives us the following map.

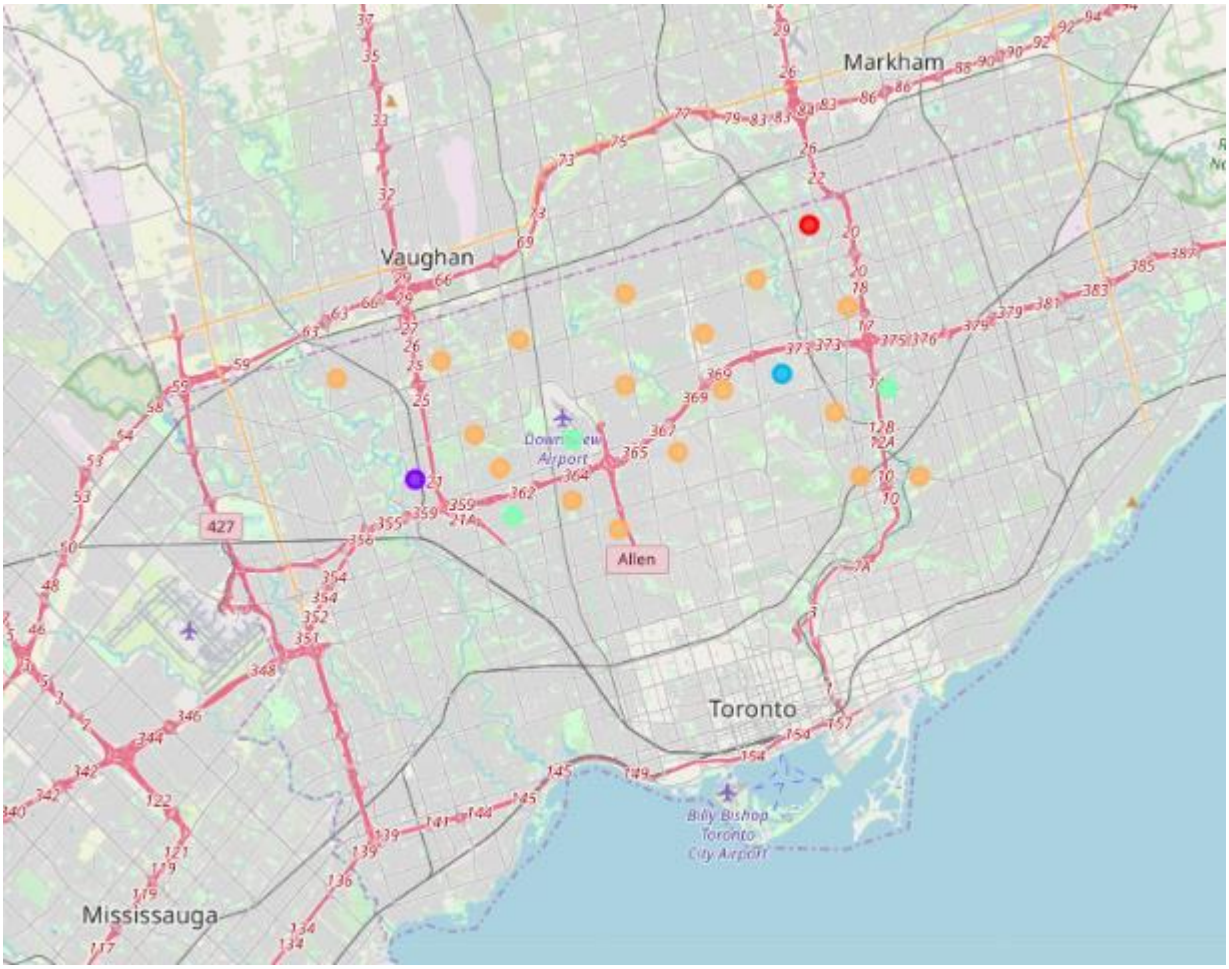
We select 5 clusters partitioning resulting into the array:

In [19]:
```
#cluster the Area
kclusters= 5

NY_clustering= NY_grouped.drop(["PostalCode", "Borough", "Neighborhoods"], 1)
kmeans= KMeans(n_clusters= kclusters, random_state= 0).fit(NY_clustering)

kmeans.labels_[0:24]
```

Out[19]:
```
array([0, 4, 4, 2, 4, 4, 4, 3, 4, 4, 4, 4, 3, 4, 4, 4, 4, 4, 4, 4, 3, 4,
       1], dtype=int32)
```



The Cluster 5 is the most developed and, the most important, - suites the purpose of this Project the most.

In [28]:
```
#Cluster 5
NY_new.loc[NY_new['Cluster Labels'] == 4, NY_new.columns[[0] + list(range(2, NY_new.shape[1]))]]
```

Out[28]:

	PostalCode	Neighborhoods	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 Mc Comm Ven
19	M6B	Glencairn	Pizza Place	Bakery	Pub	Japanese Restaurant	Women's Store	Diner	Concert Hall	Construction & Landscaping	Convenier Store
18	M6A	Lawrence Heights, Lawrence Manor	Clothing Store	Accessories Store	Sporting Goods Shop	Miscellaneous Shop	Coffee Shop	Furniture / Home Store	Boutique	Gift Shop	Vietnames Restauran
17	M5M	Bedford Park, Lawrence Manor East	Coffee Shop	Fast Food Restaurant	Italian Restaurant	Sandwich Place	Restaurant	Liquor Store	Juice Bar	Café	Pharmacy
16	M4A	Victoria Village	Intersection	Pizza Place	Portuguese Restaurant	Financial or Legal Service	Hockey Arena	Coffee Shop	Diner	Concert Hall	Constructi & Landscapi
15	M3N	Downsview Northwest	Grocery Store	Gym	Gym / Fitness Center	Discount Store	Women's Store	Dog Run	Construction & Landscaping	Convenience Store	Cosmetics Shop
14	M3M	Downsview Central	Home Service	Food Truck	Baseball Field	Women's Store	Dog Run	Construction & Landscaping	Convenience Store	Cosmetics Shop	Deli / Bodega
13	M3L	Downsview West	Grocery Store	Bank	Hotel	Park	Shopping Mall	Women's Store	Discount Store	Concert Hall	Constructi & Landscapi

At the last stage of the Analysis we have find out if any of Catholic School is located in Cluster 5. For that we first parse the Toronto Catholic District School Board web site for school location info. After some data cleaning and Secondary only Panel selection we have 31 Catholic schools in North York area:

```
(31, 3)
```

Out[31]:

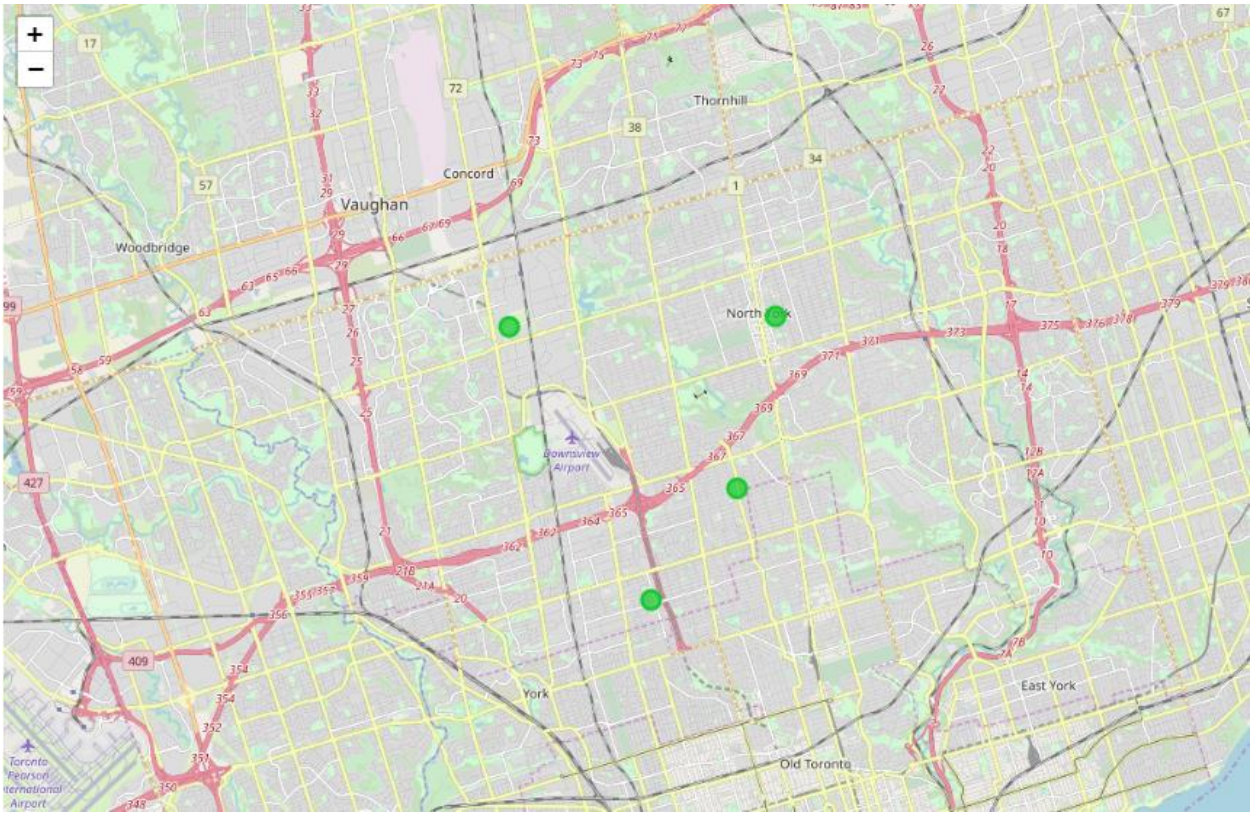
	SchoolName	Panel	PostalCode
17	Bishop Allen Academy	Secondary	M8Y
19	Bishop Marrocco/Thomas Merton	Secondary	M6P
24	Brebeuf	Secondary	M2M
28	St Basil-The-Great	Secondary	M9M
38	Cardinal Carter Academy	Secondary	M2N

Then merge this dataset by postal codes to the of Cluster 5 area data and get 4 options where both datasets match.

Out[33]:

	PostalCode	Neighborhoods	Cluster Labels	SchoolName	Panel	Latitude	Longitude
0	M6B	Glencairn	4	Dante Alighieri	Secondary	43.709577	-79.445073
1	M5M	Bedford Park, Lawrence Manor East	4	Loretto Abbey	Secondary	43.733283	-79.419750
2	M2N	Willowdale South	4	Cardinal Carter Academy	Secondary	43.770120	-79.408493
3	M3J	Northwood Park, York University	4	James Cardinal McGuigan	Secondary	43.767980	-79.487262

Map of the 4 selected Schools



4. Results

Cluster 5 of North York Are is the most developed. It has a lot of restaurants and cafés, small shops, department or grocery stores. There different sport facilities available like Gyms, a Pool, a Baseball Field and even a Hockey Arena. This Cluster also has a Concert Hall and number of parks.

However, there are only 4 Catholic Schools located in this Cluster, and there might be a compromise decision to cover only some of the Family preferences and being close to one of four Schools.

5. Observations / Recommendations

The selected Schools have the following Points of Interests nearby:

Out[36]:

	PostalCode	Neighborhoods_x	SchoolName	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	9t Co
0	M6B	Glencairn	Dante Alighieri	Pizza Place	Bakery	Pub	Japanese Restaurant	Women's Store	Diner	Concert Hall	Construction & Landscaping	Conve Store
1	M5M	Bedford Park, Lawrence Manor East	Loretto Abbey	Coffee Shop	Fast Food Restaurant	Italian Restaurant	Sandwich Place	Restaurant	Liquor Store	Juice Bar	Café	Pharm
2	M2N	Willowdale South	Cardinal Carter Academy	Ramen Restaurant	Coffee Shop	Sushi Restaurant	Café	Pizza Place	Sandwich Place	Juice Bar	Japanese Restaurant	Loung
3	M3J	Northwood Park, York University	James Cardinal McGuigan	Coffee Shop	Furniture / Home Store	Caribbean Restaurant	Bar	Massage Studio	Falafel Restaurant	Discount Store	Construction & Landscaping	Conve Store

Out of the initial list of preferences we meet the following ones:

- Developed neighborhood
- Restaurants of different cuisine in a walking distance
- Music hall or a theatre in proximity
- Also walking distance to a Catholic school

Gym and sport facility for kids are located not within 500 m around the dedicated postal codes. So, the Family has to decide if 4 out of 6 main criteria are suffice.

If the answer is YES, then the parents should foresee School's gym facility for the kids and 1-1.5 km distance to the adult gym for themselves which is not a bed option for newly settlers.

6. Conclusion

The scope of this analysis based on a limited data. There only 3 datasets are used, and the primary selection of Borough North York assumes that the relocating Employee walks to the office.

However, if we consider a short commute to the office of, say, 10-15 minutes of drive, then the searching area could be extended to the Boroughs of Vaughan, Markham and Toronto Downtown. That can bring a lot more option for the Family to decide where to live for 3 years.