Find Best Place to Open a Cafe in Toronto Canada

Aswini Chinnenahalli Siddareddy

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1. Introduction

1.1. Background

Toronto is capital city of the Ontario, Canada with a population of more than 6 Million in 2016 and with area of 243.3 sq mi. Toronto is international center for business, finance, arts, and culture, and is recognized as one of the most multicultural cities in the world. Toronto economy is diversified with technology, design, financial services, life sciences, education, arts, fashion, aerospace, environmental innovation, food services, and tourism. One of my friends who was having Subway restaurant had to close his Subway business during May 2020 due to Covid-19 Pandemic which led to reduced sales in his business. Now he is planning to open a Cafe business in Toronto, Canada region. Starting a Cafe business in such a multicultural and diversified place is not an easy task. We need to consider several factors such as accessibility, visibility, target customers before opening Cafe to be successful in business. Places near business centers, malls, areas with a lot of foot traffic, and tourist attractions will guarantee the steady flow of customers that we need to make a good profit.

1.2 Problem

Finding a location is one of the most important things in starting a cafe. The location search could take months if we start searching and analyzing the area manually. We can reduce this time to few hours/ days by using machine learning techniques and Four-square location data to find best suitable location to open a Cafe. In this project, we will find the best and most suitable location to open a Cafe in Toronto, Canada for business personal or entrepreneurs.

1.3 Interest

- This project would be interested to business personnel who wants to open a Café in Toronto, Canada.
- The analysis will help entrepreneurs to obtain necessary information in finding the best location for opening a Cafe.

2. Data sources

We will use the following datasets for this project:

i) Toronto data that contains Borough, Neighborhoods along with there latitudes and longitudes
   - Data Source: https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M
   - Description: This data set contains the required information such as postal code, borough and the name of the neighborhoods in city of Toronto

ii) Geographical location of the neighborhoods
    - Data Source: https://cocl.us/Geospatial_data
    - Description: This dataset provides the Geographical coordinates of the neighborhoods for the respective Postal Codes

iii) Venue Data using Foursquare API
    - Data Source: https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}&v={}&ll={},{}&radius={}&limit={}
    - Description: We will provide ClientID, Client Secret, and version details to get all the venue information for each neighborhood and group data by name of the neighborhood.

3. Methodology

3.1 Data cleaning and Exploratory Data Analysis

Data downloaded from above data sources are created as panda's data frame. We can see the top rows of Toronto dataset below.

	Postal Code	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	Regent Park, Harbourfront

Toronto data scraped from Wikipedia page has Boroughs that were not assigned to any neighborhood. The following assumptions were made to clean the Toronto Wikipedia dataset.

- Only process the cells that have an assigned borough. Ignore cells with a borough that is Not assigned.
- More than one neighborhood 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 neighborhoods: Harbourfront and Regent Park. These two rows will be combined into one row with the neighborhoods separated with a comma as shown in row 11 in the above table.
- If a cell has a borough but a Not assigned neighborhood, then the neighborhood will be the same as the borough.

The above assumptions are implemented, and rows are grouped by borough which is shown below.

	Borough	PostalCode	Neighborhood
0	Central Toronto	M4N	Lawrence Park
1	Central Toronto	M4P	Davisville North
2	Central Toronto	M4R	North Toronto West, Lawrence Park
3	Central Toronto	M4S	Davisville
4	Central Toronto	M4T	Moore Park, Summerhill East

The top rows of geographical location of the neighborhood's dataset which is extracted from https://cocl.us/Geospatial_data website is shown below.

	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

We merged the above two datasets into single dataset and the merged dataset is shown below.

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

We have grouped the neighborhoods by borough and the count of neighborhoods by borough can be seen below.

```
Borough
Central Toronto      9
Downtown Toronto    19
East Toronto         5
East York            5
Etobicoke           12
Mississauga          1
North York          24
Scarborough         17
West Toronto         6
York                 5
Name: Neighborhood, dtype: int64
```

We have retrieved all the venue details such as parks, islands, hotels, restaurants, café, etc. in Toronto using Four Square API to analyze number of cafés in Toronto. We must create an account in Four square API and provide client id, client secret and version details to retrieve the data from Four Square API. The top few rows of venue details of neighborhood is shown below.

```
Lawrence Park
Davisville North
North Toronto West, Lawrence Park
Davisville
Moore Park, Summerhill East
Summerhill West, Rathnelly, South Hill, Forest Hill SE, Deer Park
Roselawn
Forest Hill North & West, Forest Hill Road Park
The Annex, North Midtown, Yorkville
Rosedale
St. James Town, Cabbagetown
Church and Wellesley
Regent Park, Harbourfront
Garden District, Ryerson
St. James Town
Berczy Park
Central Bay Street
Richmond, Adelaide, King
Harbourfront East, Union Station, Toronto Islands
Toronto Dominion Centre, Design Exchange
Commerce Court, Victoria Hotel
University of Toronto, Harbord
Kensington Market, Chinatown, Grange Park
CN Tower, King and Spadina, Railway Lands, Harbourfront West, Bathurst Quay, South Niagara, Island airport
Stn A PO Boxes
First Canadian Place, Underground city
Christie
Queen's Park, Ontario Provincial Government
The Beaches
The Danforth West, Riverdale
India Bazaar, The Beaches West
Studio District
```

We merged the above venue data with the previous two datasets which shows the nearest venue for each neighborhood. We can see the merged dataset in below table.

	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	HYC Design Inc.	43.726793	-79.391681	Business Service
2	Lawrence Park	43.728020	-79.388790	Zodiac Swim School	43.728532	-79.382860	Swim School
3	Lawrence Park	43.728020	-79.388790	TTC Bus #162 - Lawrence-Donway	43.728026	-79.382805	Bus Line
4	Davisville North	43.712751	-79.390197	Homeway Restaurant & Brunch	43.712641	-79.391557	Breakfast Spot

We then grouped the venues by neighborhood to see the total number of venues in each neighborhood.

Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Agincourt	3	3	3	3	3	3
Alderwood, Long Branch	9	9	9	9	9	9
Bathurst Manor, Wilson Heights, Downsview North	23	23	23	23	23	23
Bayview Village	4	4	4	4	4	4
Bedford Park, Lawrence Manor East	23	23	23	23	23	23
...	...	...	...	...	...	...
Willowdale, Willowdale East	34	34	34	34	34	34
Willowdale, Willowdale West	5	5	5	5	5	5
Woburn	3	3	3	3	3	3
Woodbine Heights	7	7	7	7	7	7
York Mills West	3	3	3	3	3	3

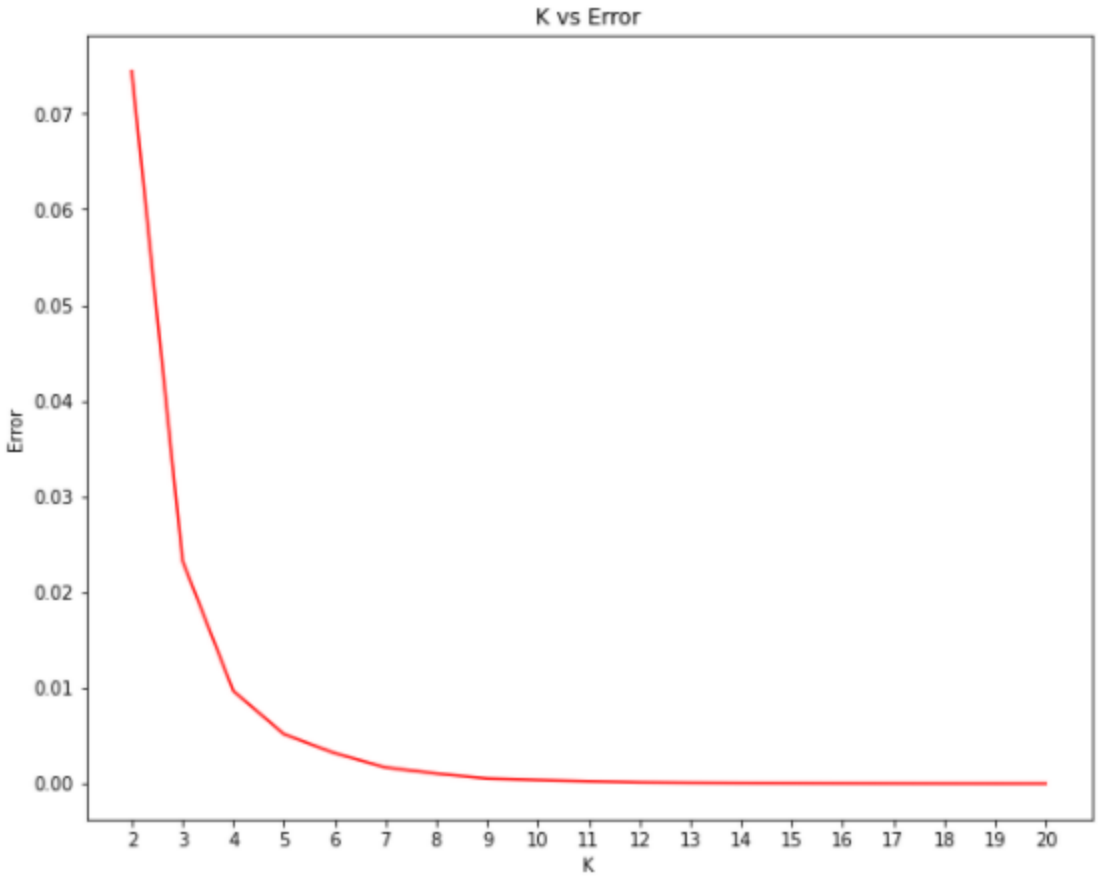
It is difficult to analyze the categorical data. So, we converted the categorical data to numerical data using a technique called one hot encoding. If the venue is present in the neighborhood, it returns the count of how many times that venue is present in neighborhood else zero. We can see the conversion in below screenshot.

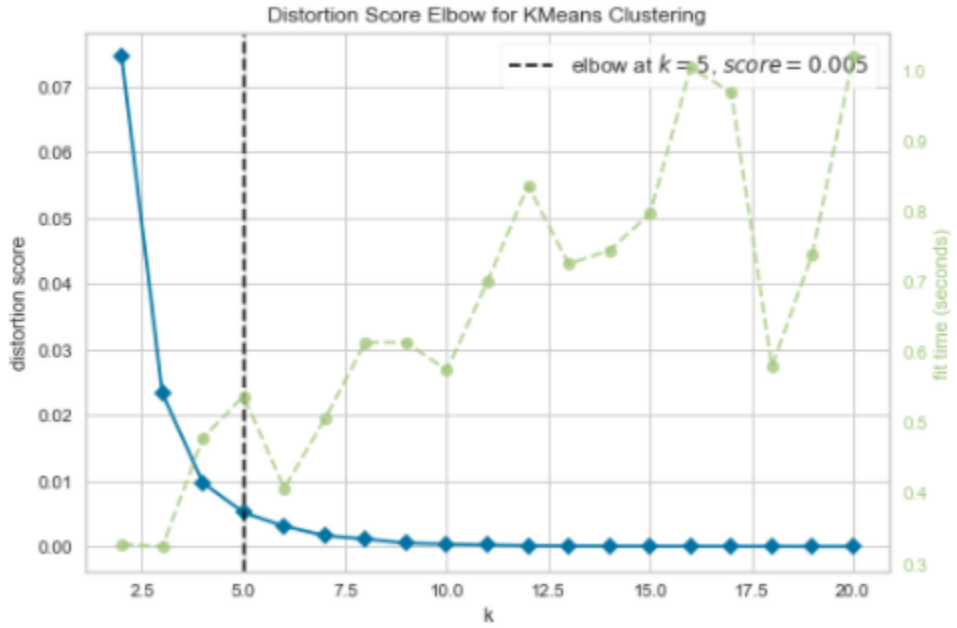
	Neighborhoods	Accessories Store	Adult Boutique	Airport	Airport Food Court	Airport Gate	Airport Lounge	Airport Service	Airport Terminal	American Restaurant	...	Turkish Restaurant	Vegetarian / Vegan Restaurant	Video Game Store	Video Store	Vietn Rest
2105	Del Ray, Mount Dennis, Keelsdale and Silverthorn	0	0	0	0	0	0	0	0	0	...	0	0	0	0	
2106	Del Ray, Mount Dennis, Keelsdale and Silverthorn	0	0	0	0	0	0	0	0	0	...	0	0	0	0	
2107	Del Ray, Mount Dennis, Keelsdale and Silverthorn	0	0	0	0	0	0	0	0	0	...	1	0	0	0	
2108	Del Ray, Mount Dennis, Keelsdale and Silverthorn	0	0	0	0	0	0	0	0	0	...	0	0	0	0	
2109	Runnymede, The Junction North	0	0	0	0	0	0	0	0	0	...	0	0	0	0	

We group the above data by neighborhood to see average number of Café's present in each neighborhood.

	Neighborhoods	Café
0	Agincourt	0.000000
1	Alderwood, Long Branch	0.000000
2	Bathurst Manor, Wilson Heights, Downsview North	0.000000
3	Bayview Village	0.250000
4	Bedford Park, Lawrence Manor East	0.043478

We have clustered the neighborhoods based on the similar number of cafés in that neighborhood. We have used K-means clustering. We have used elbow technique to find the best k value that neither overfit nor under fits our model. We chose the best value of k by providing different k values. We have chosen the best k value based on the point at which the line in the below graph has sharp turn. From the below screenshot we can see that our elbow point is at k=5 which means we have 5 clusters.



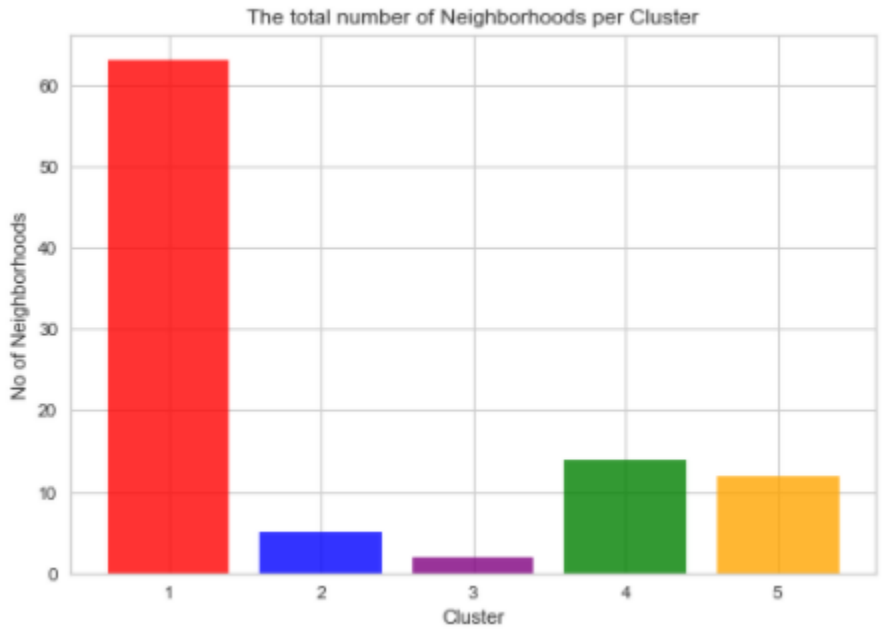


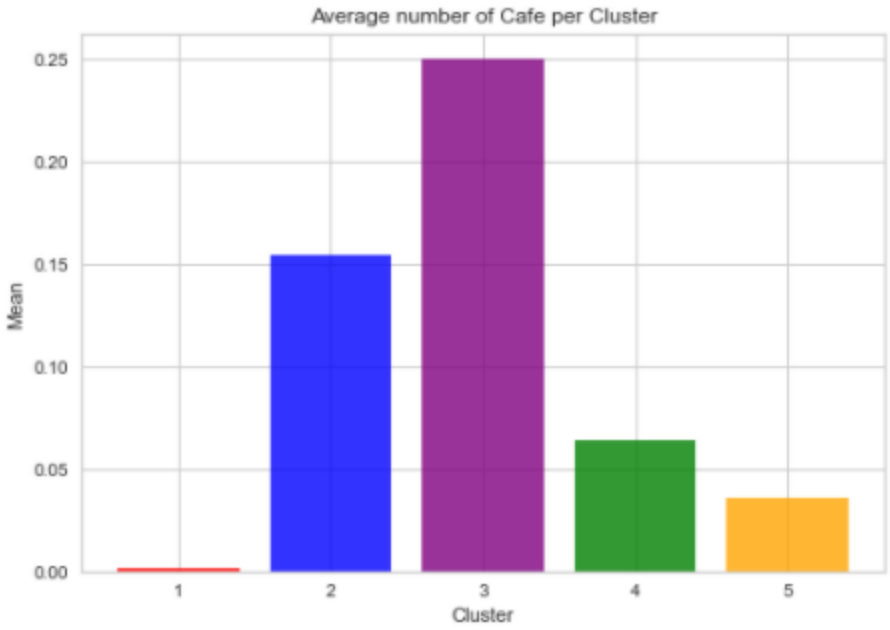
We will put the similar objects of a variable in the same cluster in k-means clustering. So, the neighborhoods that has similar frequency of café's were added to 5 clusters and are labelled from 0 to 4.

	Neighborhood	Café	Cluster Labels
0	Agincourt	0.000000	0
1	Alderwood, Long Branch	0.000000	0
2	Bathurst Manor, Wilson Heights, Downsview North	0.000000	0
3	Bayview Village	0.250000	2
4	Bedford Park, Lawrence Manor East	0.043478	4

3.2 Results

We analyze the five clusters by finding the total number of neighborhoods in each cluster and average number of cafés in that cluster. We create a bar chart to see the total number of neighborhoods per cluster and average number of cafés per cluster. From the below graph we can see that the total number of neighborhoods in cluster 1 is 63, cluster 2 has 5, cluster 3 has 2, cluster 4 has 14 and cluster 5 has 12. We can also see that the average number of café in cluster 3 is higher even though the number of neighborhoods in cluster 3 are 2 and the average number of café in cluster 1 is lower even though the number of neighborhoods in cluster 1 are 63.





Let us analyze the individual clusters by looking at their data frames.

Cluster 1:

	Borough	Neighborhood	Café	Cluster Labels	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Central Toronto	Lawrence Park	0.0	0	43.728020	-79.388790	Lawrence Park Ravine	43.726963	-79.394382	Park
1	Central Toronto	Lawrence Park	0.0	0	43.728020	-79.388790	HYC Design Inc.	43.726793	-79.391681	Business Service
2	Central Toronto	Lawrence Park	0.0	0	43.728020	-79.388790	Zodiac Swim School	43.728532	-79.382860	Swim School
3	Central Toronto	Lawrence Park	0.0	0	43.728020	-79.388790	TTC Bus #162 - Lawrence-Donway	43.728026	-79.382805	Bus Line
4	Central Toronto	Davisville North	0.0	0	43.712751	-79.390197	Summerhill Market North	43.715499	-79.392881	Food & Drink Shop
5	Central Toronto	Davisville North	0.0	0	43.712751	-79.390197	Winners	43.713236	-79.393873	Department Store
6	Central Toronto	Davisville North	0.0	0	43.712751	-79.390197	Best Western Roehampton Hotel & Suites	43.708878	-79.390880	Hotel
7	Central Toronto	Davisville North	0.0	0	43.712751	-79.390197	Subway	43.708474	-79.390674	Sandwich Place
8	Central Toronto	Davisville North	0.0	0	43.712751	-79.390197	900 Mount Pleasant - Residents Gym	43.711671	-79.391767	Gym / Fitness Center
9	Central Toronto	Davisville North	0.0	0	43.712751	-79.390197	Provocative Pizza Series	43.708293	-79.389546	Pizza Place

We can see that cluster 1 is in Central Toronto area and it has 65 neighborhoods. We have 22 unique venue locations in this cluster and there are very few cafés. Cluster 1 has highest number of neighborhoods.

Cluster 2:

	Borough	Neighborhood	Café	Cluster Labels	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
177	Etobicoke	Eringate, Bloordale Gardens, Old Burnhamthorpe...	0.10	1	43.643515	-79.577201	Carsbrooke Park	43.647051	-79.576682	Park
186	Etobicoke	Eringate, Bloordale Gardens, Old Burnhamthorpe...	0.10	1	43.643515	-79.577201	LCBO	43.642099	-79.576592	Liquor Store
185	Etobicoke	Eringate, Bloordale Gardens, Old Burnhamthorpe...	0.10	1	43.643515	-79.577201	Starbucks	43.641312	-79.576924	Coffee Shop
184	Etobicoke	Eringate, Bloordale Gardens, Old Burnhamthorpe...	0.10	1	43.643515	-79.577201	The Beer Store	43.641313	-79.576925	Beer Store
183	Etobicoke	Eringate, Bloordale Gardens, Old Burnhamthorpe...	0.10	1	43.643515	-79.577201	Shoppers Drug Mart	43.641312	-79.576924	Pharmacy
...	...	...	...	...	...	...	...	...	...	...
138	Downtown Toronto	First Canadian Place, Underground city	0.07	1	43.648429	-79.382280	Bosk at Shangri-La	43.649023	-79.385826	Asian Restaurant
139	Downtown Toronto	First Canadian Place, Underground city	0.07	1	43.648429	-79.382280	Bulldog On The Block	43.650652	-79.384141	Coffee Shop
140	Downtown Toronto	First Canadian Place, Underground city	0.07	1	43.648429	-79.382280	Petit Four Bakery	43.647744	-79.379588	Sandwich Place
141	Downtown Toronto	First Canadian Place, Underground city	0.07	1	43.648429	-79.382280	Shangri-La Toronto	43.649129	-79.386557	Hotel
123	Downtown Toronto	First Canadian Place, Underground city	0.07	1	43.648429	-79.382280	Maman	43.648309	-79.382253	Café

We can see that cluster 2 is in Etobicoke, Downtown Toronto, etc. area and Erin gate, Bloor dale Gardens, Old Bumhamthrope, First Canadian Place, Underground city etc., are few neighborhoods in that cluster. We have 19 unique venue locations in this cluster and there are a greater number of Cafés in this cluster when compared to cluster 1.

Cluster 3:

	Borough	Neighborhood	Café	Cluster Labels	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	North York	Bayview Village	0.25	2	43.786947	-79.385975	Kaga Sushi	43.787758	-79.381090	Japanese Restaurant
1	North York	Bayview Village	0.25	2	43.786947	-79.385975	Maxim's Cafe and Patisserie	43.787863	-79.380751	Café
2	North York	Bayview Village	0.25	2	43.786947	-79.385975	TD Canada Trust	43.788074	-79.380367	Bank
3	North York	Bayview Village	0.25	2	43.786947	-79.385975	Sun Star Chinese Cuisine 翠景小炒	43.787914	-79.381234	Chinese Restaurant
4	Scarborough	Birch Cliff, Cliffside West	0.25	2	43.692657	-79.264848	Birchmount Community Centre	43.695175	-79.262161	General Entertainment
5	Scarborough	Birch Cliff, Cliffside West	0.25	2	43.692657	-79.264848	Scarborough Gardens	43.694647	-79.262230	Skating Rink
6	Scarborough	Birch Cliff, Cliffside West	0.25	2	43.692657	-79.264848	Birchmount Stadium	43.695323	-79.261293	College Stadium
7	Scarborough	Birch Cliff, Cliffside West	0.25	2	43.692657	-79.264848	The Birchcliff	43.691666	-79.264532	Café

We can see that cluster 3 is in North York, Scarborough area and Bayview Village, Birch Cliff, Cliffside West are few neighborhoods in that cluster. We have 8 unique venue locations in this cluster and there are highest number of cafés in this cluster.

Cluster 4:

	Borough	Neighborhood	Café	Cluster Labels	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Central Toronto	North Toronto West, Lawrence Park	0.055556	3	43.715383	-79.405678	Blo Blow Dry Bar	43.714712	-79.400227	Health & Beauty Service
1	Central Toronto	North Toronto West, Lawrence Park	0.055556	3	43.715383	-79.405678	St. Clements - Yonge Parkette	43.712062	-79.404255	Park
2	Central Toronto	North Toronto West, Lawrence Park	0.055556	3	43.715383	-79.405678	Second Cup	43.714583	-79.400120	Café
3	Central Toronto	North Toronto West, Lawrence Park	0.055556	3	43.715383	-79.405678	GAP	43.715450	-79.400089	Clothing Store
4	Central Toronto	North Toronto West, Lawrence Park	0.055556	3	43.715383	-79.405678	Tim Hortons	43.714894	-79.399776	Coffee Shop
...	...	...	...	...	...	...	...	...	...	...
1182	West Toronto	Little Portugal, Trinity	0.047619	3	43.647927	-79.419750	Rotate This	43.648544	-79.420518	Record Shop
1183	West Toronto	Little Portugal, Trinity	0.047619	3	43.647927	-79.419750	Bazara	43.648535	-79.420521	Japanese Restaurant
1184	West Toronto	Little Portugal, Trinity	0.047619	3	43.647927	-79.419750	Get Well	43.649320	-79.421937	Bar
1185	West Toronto	Little Portugal, Trinity	0.047619	3	43.647927	-79.419750	The Communist's Daughter	43.649362	-79.420963	Bar
1186	West Toronto	Little Portugal, Trinity	0.047619	3	43.647927	-79.419750	Lost & Found	43.649378	-79.424149	Men's Store

We can see that cluster 4 is in Central Toronto, West Toronto area and North Toronto West, Lawrence Park, Little Portugal, Trinity are few neighborhoods in that cluster. We have 56 unique venue locations in this cluster and there are only few cafés. Cluster 4 has third highest average for Café's.

Cluster 5:

	Borough	Neighborhood	Café	Cluster Labels	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Central Toronto	The Annex, North Midtown, Yorkville	0.157895	4	43.672710	-79.405678	The Annex Hodgepodge	43.674975	-79.406543	Sandwich Place
1	Central Toronto	The Annex, North Midtown, Yorkville	0.157895	4	43.672710	-79.405678	Fet Zun	43.675147	-79.406346	Middle Eastern Restaurant
2	Central Toronto	The Annex, North Midtown, Yorkville	0.157895	4	43.672710	-79.405678	Toronto Archives	43.676447	-79.407509	History Museum
3	Central Toronto	The Annex, North Midtown, Yorkville	0.157895	4	43.672710	-79.405678	Dish Cooking Studio	43.674066	-79.410764	Café
4	Central Toronto	The Annex, North Midtown, Yorkville	0.157895	4	43.672710	-79.405678	Krispy Kreme Doughnut Cafe	43.674732	-79.407730	Donut Shop
...	...	...	...	...	...	...	...	...	...	...
84	West Toronto	Brockton, Parkdale Village, Exhibition Place	0.136364	4	43.636847	-79.428191	Uma Cafe	43.637016	-79.424048	Café
85	West Toronto	Brockton, Parkdale Village, Exhibition Place	0.136364	4	43.636847	-79.428191	Queen Supermarket	43.634265	-79.429112	Grocery Store
86	West Toronto	Brockton, Parkdale Village, Exhibition Place	0.136364	4	43.636847	-79.428191	Cinema Nightclub	43.637614	-79.423890	Nightclub
87	West Toronto	Brockton, Parkdale Village, Exhibition Place	0.136364	4	43.636847	-79.428191	Gardiner Expy & Dufferin St	43.633800	-79.425460	Intersection
88	West Toronto	Brockton, Parkdale Village, Exhibition Place	0.136364	4	43.636847	-79.428191	Dunn Milk Variety	43.633667	-79.431549	Convenience Store

We can see that cluster 5 is in Central Toronto and West Toronto area and The Annex, North Midtown, Yorkville are few neighborhoods in this cluster. We have 26 unique venue locations in this cluster and there are very few cafés.

The average number of cafés in each cluster is shown below:

Cluster 1 - 0.01

Cluster2 - 0.16

Cluster3 - 0.25

Cluster4 - 0.065

Cluster5 - 0.04

4. Discussion

The greater number of Café's are in cluster 3 and is represented by purple color. The neighborhoods located in North York and Scarborough area t have highest number of Cafes. There are very few Café's in cluster 1 even though there are so many neighborhoods in cluster 1. From the above graphs we can see that cluster 5 has second lowest average number of cafés. By looking at the venues, we can say that the best place to open new café is Central Toronto area as there are many neighborhoods in that area and little to no cafés. The second-best place to open a Café is in West Toronto area which is in Cluster 5. It has 12 neighborhoods in the area with very few number of cafés. We should note that, we have not included population data in this analysis and population plays a huge role in choosing a place to open a new café.

5. Conclusion

In conclusion, we have used several python libraries, Four Square API to find the best area to open a Café in Toronto, Canada. We created several visualizations to better understand our dataset and analysis using seaborn, matplotlib libraries. By using all these libraries, machine learning techniques, we were able to find the best location to open a Café in Toronto, Canada.

6. Future Directions

In this study, we mainly focused on analyzing neighborhoods, venue details. However, population, other demographic details might also contribute to evaluate Café business success criteria. By adding demographic data into analysis, we can increase the confidence and accuracy of our analysis in finding best place to open Café in Toronto.

https://github.com/umarkhan2000/IBM-DataScience-Capstone/blob/master/IBM-Capstone/Opening%20up%20a%20new%20Italian%20Restaurant%20in%20Toronto.pdf